



CHHATTISGARH STATE ACTION PLAN ON CLIMATE CHANGE



CHHATTISGARH STATE CENTRE FOR CLIMATE CHANGE

Department of Forest and Climate Change

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State Action Plan on Climate Change



Prepared by

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Executive Summary

The IPCC's sixth assessment report highlights those detrimental effects of climate change will be laying massive challenges, especially for the developing countries. The majority of the Indian economy is highly dependent on climate-sensitive sectors which increases its vulnerability to climate change and exposes more than 1.2 billion people to the threats posed by climate-induced disasters. In order to cope and counter the damages postulated by climate change, the Government of India through the Ministry of Environment, Forest and Climate Change (MoEF&CC) had directed each state to assess their climate change vulnerability and prepare an action plan including adaptation and mitigation strategies in line with the eight missions defined by National Action Plan for Climate Change (NAPCC). Accordingly, the Chhattisgarh State Action Plan on Climate Change (CSAPCC-I) was prepared in 2014 and proposed state-specific strategies for mitigating the climate change impacts, it also included adaptation strategies by integrating ongoing and proposed developmental strategies in the state. The first Chhattisgarh SAPCC (CSAPCC-I) was developed through a comprehensive stakeholder consultative process involving UNDP, various State level departments, national and state-level institutions, sectoral experts, NGOs, CSOs and local communities led by the State Level Steering Committee on climate change. The CSAPCC-I covered Agriculture and allied sectors, Forests and Biodiversity, Water Resources, Urban Development, Transport, Energy, Industry and Mining, and Human Health sectors as priority sectors for actions.

While the state has been consistently improving on its infrastructure and healthcare services provisioning, reaching in conformity with the national standards is yet far-flung. The state has more than 30% of its population living below the poverty line and can be considered as multi-dimensionally poor (based on the NITI Aayog's multidimensional poverty index released in November 2021). The majority of this poor population belongs to the deprived caste and tribes adding to the risks associated with increasing climate change-related hazards. Therefore, to achieve sustainable growth in all sectors and improve the overall quality of life standards focusing on inclusive development, Chhattisgarh Government had launched several policies and programs. In order to implement the CSAPCC-I, the Government of Chhattisgarh had established a Chhattisgarh State Centre for Climate Change (CSCCC) in August 2015.

As a brief highlight of CSAPCC-I, it is notable that the state has done tremendous work during 2014-15 to 2019-20, to mitigate as well as for adaptation to adverse climate change. For instance, **the plantation activities undertaken by the State Forest Department covered an area of 2.96 lakh ha** under RDF, RDBF and River bank Plantation. In addition to this, plantation activities in 51479.82 ha have also been carried out under CAMPA. According to the India State of Forests Reports (ISFR) 2021, **the total forest carbon stock in the state is 496.44 million tonnes as compared to 480.25 million tonnes in 2019, and is ranked 3rd in the country**, and it showed an **increase of 16.17 million tonnes from 2019**. Similarly, the Agriculture department provided **financial assistance to more than one lakh farmers** for setting up drip irrigation systems, and **around 6,900 check dams were also built during the last six years**. The energy department has **installed a total capacity of 28557.3 MW as of March 2021, out of which 627.52 MW is the share of Solar Power Plants**. Meanwhile, industries and transport departments have tightened the norms to control air pollution from 2016 onwards. The transport department is already preparing the **State Electric Vehicle Policy** and a committee have been formulated in this regard. For instance, the industries department has prepared Action Plan for the restoration of environmental qualities of industrial clusters Urla, Silatara, Korba and Bhilai. **Online**

pollution monitoring systems were installed in **163 industries** of the state for regular control and monitoring of air pollution from these industries.

As directed by Ministry of Environment and Climate Change, Government of India, the SAPCC-I needed to be revised. Considering the **Paris agreement NDC targets, SDGs, National Missions, State Priorities, a set of department wise strategies has been included in the revised (SAPCC-II) document** which will be helpful to plan department wise integrated and comprehensive approaches/activities. This will ensure a collaborative approach to tackle the climate crisis. Being the nodal agency for implementation of CSAPCC-I, the State Centre for Climate Change has been assigned by the state government to take the responsibility of revision of CSAPCC-I as per the MoEF&CC guidelines.

In the first chapter, the revised report presents the government's directive and shares a glimpse of the early kick-start meetings, which were held in accordance with the MoEF&CC's guiding principles. The chapter also explains why the document needs to be revised, how the revision process works, and what factors are considered when updating the text. In this chapter, the NDCs and their importance to NAPCC are also examined. The second chapter includes a summary of the state's locational characteristics, geographical features, and agro-climatic zones, among other things. CSAPCC-II is a dynamic document that steers the state in the right direction of preparedness among the possible climatic variation in future. Apart from the existing eight sectors of CSAPCC-I, three more departments have been included in the revised CSAPCC i.e., Rural Development, Disaster Management and Women & Child Development Department. The collective involvement of 12-line departments in the whole process has made it an effective resource document to tackle possible challenges posed by climate change.

Climatic projections based on different scenarios have been included in the revised plan. In the climate profile study, high resolution gridded precipitation data (1901-2017) are studied for trend and periodicities using Mann-Kendall, Sen's slope and Pettitt's test. The statistics suggest that the **precipitation trend is significant decreasing** for pre-monsoon and monsoon rainfall at 5% significance level and for the post-monsoon rainfall, decreasing trend is not significant at 5% significance level. Furthermore, the rainfall projections considering RCP values also shows an overall decreasing trend. Also, it is identified that there are 15 districts in Chhattisgarh with moderate to high rainfall variability that lies above the 20% mark. Summer maximum temperature projections based on RCP 4.5 scenario projects a 1.5 °C to 2.5 °C rise and based on RCP 8.5 scenario, it is showing 2 °C to 3 °C temperature rise in the state, for the next 100 years. Districts namely Korba, Bilaspur, Mungeli, Sarguja, Kabirdham and Gariyaband is expected to have more frequent drought years based on the temperature projections considering the RCP scenarios for the next 100 years.

A detailed district level vulnerability assessment has been carried out as part of the revision process of this document. The report ranks all the districts of the state on a vulnerability scale indicating the relative vulnerability of these districts, assisting policymakers to prioritise districts for implementation of adaptation strategies based on the type and extent of vulnerability. The vulnerability assessment has been carried out as per IPCC Fifth Assessment Report (IPCC 2014) framework and has considered sensitivity and adaptive capacity as the two predominant factors that determine vulnerability. Five districts namely **Mahasamund, Balrampur, Baloda Bazar, Mungeli and Gariyaband are categorised as Very Highly Vulnerable**, followed by Bijapur and Korba districts are as Highly Vulnerable Districts against adverse effect of climate change. Furthermore, **major drivers of**

vulnerability have been identified and possible strategies to address these drivers are also mentioned in the chapter. Stocktaking of the key climate change initiatives undertaken during CSAPCC-I (2014- 2020) has also been summarised in this chapter.

Proposed mitigation activities under CSAPCC-II are elaborated sector-wise in the fifth chapter. GHG implications of current policies and programs are also explained by each sector in this chapter. Various sectoral schemes, the existing implications and progress made through these schemes are rendered in this chapter. The main agenda of the chapter is to identify the tentative list of actions/ strategies which can be helpful to mitigate the adverse effect of climate change in the state. Additionally, to understand the relevance of SGDs and NDCs to each sector and to identify the demand and supply gaps accordingly.

Proposed adaptation strategies are briefed in the sixth chapter that entails proposed sectoral action plans improve adaptation against adverse effect of climate change. The agriculture sector's strategies include the development of Climate Resilient Agriculture (CRA) action strategies, installation of solar pumps, organic farming etc. The forest sector adaptation strategies include promoting assisted natural regeneration, forest fire management, enhancing tree outside forest, implementation of REDD+ strategy etc. Similarly, all other sectors also have framed strategies to adapt to climate change issues. This section will be helpful to streamline the climate change adaptation actions in the State.

The document is also providing an estimated financial matrix based on existing budgetary provisions and activities of the departments. The matrix is not only providing a brief detail on ongoing efforts of the state government which are related to climate change but also gives the insight to understand the future projected requirement of budget. The budgetary estimates given in the report will play a vital role to plan climate-resilient activities as well as accessing the available national and international climate funds. As per department wise existing **budgetary provisions, it was estimated that the total requirement of budget for the duration of 2020-2021 to 2029-2030 will be around INR 2,75,688.97 Cr to continue the existing climate-related actions of the departments.** Most of the actions proposed under the SAPCC are routed through ongoing departmental schemes, flagship national and state-level programmes. It has been observed that significant finances have been provided under – Smart Cities, Mission for Rejuvenation and Urban Transformation (AMRUT), Mahatma Gandhi Swachh Bharat Mission, MGNREGA, PMKSY, PMAY, PMKKKY, CAMPA, DMF etc. which can be earmarked for the proposed climate change counter actions. In addition to that department wise strategies are listed in the report which will also require additional funds to implement. However, there is scope to access the national/ internationally available climate finance to ensure the implementation of proposed strategies. The possible sources of international and national finance for the implementation of adaptation and mitigation measures have been listed in chapter 7. For the additional requirement of funds to support many of these initiatives proposed in the CSAPCC-II, the State will seek financial and technical support from the international organisations, bilateral agencies and private parties such as the Green Climate Fund (GCF), Adaptation Fund (established under Kyoto Protocol of the UNFCCC), Official Development Assistance (ODA) by multilateral agencies, like FAO, IFAD, EC, The World Bank Group, etc. to fulfil the climate financial requirements for the SAPCC implementation. Climate Budget Tagging/Coding (CBT), dynamic green bond markets at the domestic level and weather derivatives - hedge against the risk of weather-related losses are also explored as promising innovative climate financing instruments.

Implementation arrangement is being revisited based on the challenges and gaps in the previous CSAPCC's institutional frameworks and a revised institutional structure is being proposed. Revised implementation arrangement will ensure the integrated involvement of all 12 key departments in the implementation of the revised CSAPCC in the State. The detail on the composition of each department along with member strength, capacity, and roles and responsibilities for each of the institutions involved in the execution of CSAPCC is listed in the revised report. It explicitly mentions the proposed functions of Chhattisgarh State Centre for Climate Change under the direct implementation of climate activities. The revised CSAPCC-II lays out a roadmap for the (state) department-level Climate Change cell that will be the nodal body for informing and supporting various divisions within the department to embed adaptation and mitigation measures along with the district climate change cell. The Department-level Climate Change cell is expected to evolve itself as a Centre of Excellence and knowledge hub on climate change in the state for the specific sectors, while the district climate change cell is anticipated to facilitate the local governance.

The monitoring process is to be undertaken in the form of a state-developed mechanism to capture the reduction in emissions. It will also encompass other associated economic, social, and environmental benefits and activities resultant of the implementation of each action within the CSAPCC-II as highlighted in the last chapter of the report. Evaluations for each of the listed projects or investments involve conducting a comparative assessment. Further, 'Verification' will be conducted to establish whether the estimated benefits from these projects have occurred or not. The state will customise and internalise the monitoring and evaluation processes using tangible indicators, processes, and outcomes. The monitoring and evaluation will include a periodic assessment of sectoral and combined vulnerability along with a sectoral emission profile considering the neutralising factor based on the stocktaking of the financial allocation and resource mobilisation. The overall assessment would yield achievement of the NDC target and improve SDG index, estimate the sectoral impact in terms of improved resilience, gender mainstreaming, localisation and mainstreaming of climate actions, community participation in decentralised implementation.

The CSAPCC-II will ensure streamlined planning and implementation of climate actions of the state in line with national and international scenarios. This will also act as a guiding document to plan sector-specific activities as well as to get additional funding for the implementation purpose.

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List of Abbreviations

Acronym	Expanded Form
ADB	Asian Development Bank
AI	Artificial Insemination
AIBP	Accelerated Irrigation Benefit Programme
ANC	Antenatal Care
ANM	Auxiliary Nurse Midwife
API	Annual Parasite Incidence
ARC	Administrative Reforms Commission
ARV	Anti-Retroviral
AT&C	Aggregate Technical and Commercial
ATDC	Apparel Training and Design Centre
ATI	Administrative Training Institute
AWC	Anganwadi Centre
AWS	Automatic Weather Stations
BALCO	Bharat Aluminium Company
BCM	Billion Cubic Metres
BMC	Biodiversity Management Committee
BPL	Below Poverty Line
BRTS	Bus Rapid Transit System
CAGR	Compounded Annual Growth Rate
CBDA	Chhattisgarh Biofuel Development Authority
CBO	Community Based Organisation
CCA	Climate Change Adaptation
CCD	Conservation cum Development
CECB	Chhattisgarh Environment Conservation Board
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CDP	City development Plan
CFL	Compact Fluorescent Lamp
CGMFPP	Chhattisgarh Minor Forest Produce Federation
CHC	Community Health Centre
CIAE	Central Institute of Agricultural Engineering
CMFRI	Central Marine Fisheries Research Institute
CNG	Compressed Natural Gas
CPSU	Central Public Sector Undertakings
CREDA	Chhattisgarh Renewable Development Authority
CRIDA	Central Research Institute on Dryland Agriculture
CRMM	Chhattisgarh Rajya Matsya Mahasangh
CSAPCC	Chhattisgarh State Action Plan
CSEB	Chhattisgarh State Electricity Board
CSFDC	Chhattisgarh State Forest Development Corporation
CSIDC	Chhattisgarh State Industrial Development Corporation
CSMPB	Chhattisgarh State Medicinal Plants Board
CSPGCL	Chhattisgarh State Power Generation Company Limited

CSR	Corporate Social Responsibility
DDG	Decentralised Distributed Generation
DRR	Disaster Risk Reduction
DMRC	Delhi Metro Rail Corporation
DSM	Demand Side Management
EPC	Energy Performance Contracting
EU	European Union
FDI	Foreign Direct Investment
FSIR	Forest Survey of India Report
FYP	Five Year Plan
GDI	Gender Development Index
GDP	Gross Domestic Product
GEM	Gender Empowerment Measure
GER	Gross Enrolment Ratio
GHG	Greenhouse Gas
GHI	Global Hunger Index
GIS	Geographical Information System
GoCG	Government of Chhattisgarh
GSDP	Gross State Domestic Product
HDI	Human Development Index
IARI	Indian Agricultural Research Institute
IAY	Indira Awas Yojana
ICAR	Indian Council of Agricultural Research
ICDS	Integrated Child Development Services
IDSP	Integrated Disease Surveillance Programme
IGKV	Indira Gandhi Krishi Vishwavidyalaya
IHDI	Inequality Adjusted Human Development Index
IHSDP	Integrated Housing and Slum Development Programme
IIDC	Integrated Infrastructure Development Centre
IIHR	Indian Institute of Horticultural Research
IIIT	International Institute of Information Technology
IMR	Infant Mortality Rate
IPP	Independent Power Producer
ITDP	Integrated Tribal Development Project
ITI	Industrial Training Institute
JFMC	Joint Forest Management Committee
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KM	Knowledge Management
KVK	Krishi Vigyan Kendra
KYSK	Krishi Yantra Seva Kendra
LAPA	Local Action Plan on Adaptation
LED	Light Emitting Diode
LHW	Local Health Worker
LRTS	Light Rail Transit System
LWE	Left Wing Extremism
MBBSY	Mukhyamantri Bal Bhavishya Suraksha Yojana

MNRE	Ministry of New & Renewable Energy
MNREGA	Mahatma Gandhi National Rural Employment Generation Act
MPI	Multi-Dimensional Poverty Index
MPSRTC	Madhya Pradesh Road Transport Corporation
MPW	Multi-Purpose Worker
MSME	Micro, Small and Medium Enterprises
NAIS	National Agriculture Insurance Scheme
NAPCC	National Action Plan on Climate Change
NDP	Net Domestic Product
NDRI	National Dairy Research Institute
NFHS	National Family Health Service
NFSM	National Food Security Mission
NGO	Non-Governmental Organisation
NHM	National Horticulture Mission
NICRA	National Initiative on Climate Resilient Agriculture
NMPB	National Medicinal Plants Board
NRCFAF	National Research Centre for Agro-forestry
NRHM	National Rural Health Mission
NRLM	National Rural Livelihoods Mission
NRW	Non-Revenue Water
NSDP	Net State Domestic Product
NTFP	Non-Timber Forest Produce
NTPC	National Thermal Power Corporation
O&M	Operation and Maintenance
PDS	Public Distribution System
PESA	Panchayat Extension to Scheduled Areas
PHC	Primary Health Centre
PLF	Plant Load Factor
PMGSY	Pradhan Mantri Gram Sadak Yojana
PPP	Public Private Partnership
PRI	Panchayati Raj Institution
PSP	Private Sector Participation
PUF	Plant Utilisations Factor
PVTG	Particularly Vulnerable Tribal Group
RE	Renewable Energy
REDD	Reducing Emissions from Deforestation and Forest Degradation
RGVY	Rajiv Gandhi Gram Vidyutikaran Yojna
RKBY	Rashtriya Krishi Beema Yojna
RKVY	Rashtriya Krishi Vikas Yojana
RMSA	Rashtriya Madhyamik Shiksha Abhiyan
RSBY	Rashtriya Swasthya Beema Yojana
SAIL	Steel Authority of India Limited
SAM	Severe Acute Malnutrition
SAPCC	State Action Plans for Climate Change
SCERT	State Council for Educational Research and Training
SERC	State Electricity Regulatory Commission

SEZ	Special Economic Zone
SIHFW	State Institute for Health and Family Welfare
SIPD	State Investment Promotion Board
SJSRY	Swarna Jayanti Shahri Rozgar Yojna
SLB	Service Level Benchmarking
SPV	Solar Photo Voltaic
SRI	System of Rice Intensification
SSA	Sarva Shiksha Abhiyan
SSC	State Steering Committee
ST	Scheduled Tribe
SWAN	State Wide Area Network
T&D	Transmission and Distribution
TB	Tuberculosis
TBO	Tree Borne Oilseeds
TOF	Trees Outside Forests
TSP	Tribal Sub Plan
UGS	Underground Sewerage
UIDSSMT	Urban Infrastructure Scheme for Small and Medium Towns
ULB	Urban Local Body
UMTA	Urban Metropolitan Transport Authority
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WBCIS	Weather Based Crop Insurance Scheme
WSHG	Women's Self-Help Group
WUA	Water User Association

Chapter 1 - Introduction

1.1 Background and Context

The link between climate change and water security is evident from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report, which brings out that the patterns of rainfall are changing thus altering freshwater systems, affecting the quantity and quality of water available in many regions. In terms of climate projections, droughts and floods are likely to increase and coastal systems will be affected by submersion, coastal flooding and sea-level rise. Both population growth and economic development, especially in poor and middle-income groups in developing countries, will exacerbate the negative effects of climate change¹.

Across the Indian sub-continent, climate change is recognized as a key threat to sustainable development, exacerbating other socio-economic and environmental pressures. Potential impacts of climate change in India extend from the high Himalayan states to the coastal zones, are transboundary in nature, as well as are multi-sectoral. Recognising these challenges, state governments have been proactive in their development of State Action Plans on Climate Change (SAPCC) that identify key vulnerabilities and risks. Due to its importance for sustaining livelihoods and serving as a backbone to economic development, the rural sector, in particular, is considered highly vulnerable to the adverse effects of climate change. Climate change has been recognised as one of the key challenges for India together with increasing population, poverty and environmental degradation².

Severe floods, storms, droughts and heatwaves as well as land and forest degradation and salinization of groundwater resources that we already see today are often viewed as a foretaste of climate change interacting with other anthropogenic impacts on the environment. Mitigating climate change by reducing greenhouse gas emissions is one way of lessening the adverse effects of a more variable and changing climate. However, even if a radical reduction of global greenhouse gas emissions were possible today it would not completely prevent significant changes in the world's climate. Therefore, societies and economies at all levels and on every continent have to prepare for and adapt to the potential impact of climate change. Climate change is one of the biggest environmental and developmental challenges that natural ecosystems and socio-economic systems face.

Further, climate change in the coming decades is likely to intensify, thereby adversely impacting food production, water resources, biodiversity and health. The impact or risk of climate change is the result of interaction of climatic hazards, exposure and vulnerability of the communities and systems. According to multiple global climate risk assessments, India is one of the most vulnerable countries in the world. Assessment of the vulnerability of a system is one of the critical steps in adaptation planning.

India's economy and most of its population are highly dependent on climate-sensitive sectors such as agriculture, animal husbandry, fisheries, tourism, etc. Since climate change is expected to impact natural and human systems adversely by inducing changes in these systems, India can be considered highly vulnerable. Climate change is only likely to exacerbate India's already high physical exposure to climate-related disasters (65 per cent of India is drought-prone, 12 per cent flood-prone, and 8 per cent susceptible to cyclones)³. Consequently, climate change is highly likely to impact livelihoods by disrupting social,

¹ Poverty and Climate Change - Reducing the Vulnerability of the Poor through Adaptation, The Organisation for Economic Co-operation and Development (OECD)

² National Action Plan for Climate Change, Ministry of Environment and Climate Change, June 2008

³ Dr Chandra Shekhar Singh, Environmental Challenge due to Climate Change in Bihar, Developing State of India, Journal of Natural Sciences Research, 2014

cultural, economic, ecological systems, physical infrastructure, and human assets, accentuating health risks, and as such, posing severe risks to the development of the country.

Since climate change impacts are felt at multiple levels from the global to the local, responses to climate change too need to be at multiple levels, calling for strategic interventions at local, sub-national, national, and global levels. At the global level, India's contribution to multilateral negotiations in the United Nations Framework Convention on Climate Change (UNFCCC) has been significant and it continues to advocate for effective, cooperative, and equitable global approaches based on the principle of 'common but differentiated responsibilities and respective capabilities'.

At the national level, India has developed the National Action Plan on Climate Change (NAPCC), 2008, and comprising eight national missions at its core, and at the Sub-national level in order to address various sectoral aspects of climate change, different states also prepared their State Action Plans for Climate Change (SAPCCs) in line with the NAPCC.

National and State-level Climate Policy and Planning

India announced its Nationally Determined Contributions (NDCs) to address climate change. India's NDC targets included increasing the fossil-free installed-capacity share to 40 per cent, reducing the emissions intensity of GDP by 33–35 per cent (from 2005 levels) and adding three billion tonnes of carbon sink in the form of forest cover by the year 2030 (Goswami, 2021). Against this backdrop, the state-level climate change action plans too need to be revised and fortified, to bring them in line with India's NDCs⁵.

National-level Climate Policy and Planning Frameworks

As discussed, India's flagship climate policy document is National Action Plan on Climate Change (NAPCC) 2008. The NAPCC established 8 National missions "representing multipronged, long term and integrated strategies for achieving key goals in the context of climate change"⁶ which are listed in table 1 below.

Table 1: Eight Missions of the National Action Plan on Climate Change (NAPCC)

Mission Name	Goals and measures
National Solar Mission	Increase the share of solar energy in the total energy mix
National Mission for Enhanced Energy Efficiency	Enhance energy efficiency through market-based certification mechanisms, cost reductions through R&D, demand-side financing mechanisms, and fiscal instruments
National Mission on Sustainable Habitat	Improvements in energy efficiency in buildings, solid waste management and modal shift to public transport
National Water Mission	Ensure integrated water resources management helping to conserve water, minimise wastage and ensure more equitable distribution both across and within States
National Mission for Sustaining the Himalayan Ecosystem	Evolve management measures for sustaining and safeguarding the Himalayan glacier and mountain ecosystem
National Mission for a Green India	Enhance ecosystem services including carbon sinks
National Mission for Sustainable Agriculture	Devise strategies to make Indian agriculture more resilient to climate change
National Mission on Strategic Knowledge for Climate Change	Enhance the understanding of challenges of and response to climate change

⁴ Ministry of Environment, Forest and Climate Change, Government of India

⁵ Climate Transparency, Brown to Green Report (2018)

⁶ <http://moef.gov.in/environment/climate-change/>

The Ministry of Environment, Forest and Climate Change, Government of India, New Delhi has issued a common framework for revision of SAPCC wide its letter dated 02-04-2019. The broad guideline for the revision of SAPCCs is given below:

Figure 1: Guiding Principles, from Ministry of Environment, Forest and Climate Change

Principle 1	SAPCCs should be a policy document of the States/UTs outlining the major initiatives and strategies reflecting the commitments and proposed actions in the state to tackle the vulnerabilities and impacts of climate change across the socio-economic sectors.
Principle 2	SAPCCs should envisage an inclusive, sustainable and climate-resilient low carbon development pathways with a focus on climate change adaptation and mitigation within the key sectors in the States/UTs and should protect the poor and vulnerable sections of society from adverse effects of climate change.
Principle 3	SAPCCs should take into account recent scientific assessments and projections on global warming; vulnerability; and impacts.
Principle 4	SAPCCs should synergise with the goals of NDCs under the Paris Agreement, though the targets under NDCs are national targets. It should also contribute towards achieving other development goals including Sustainable Development Goals (SDGs).
Principle 5	SAPCC should highlight the links with National Missions related to climate change.
Principle 6	SAPCC should also be built on the evolving socio-economic development context and priorities of the state.
Principle 7	States/UTs can strengthen existing climate action measures as well as launch new initiatives in their priority sectors. Some of the initiatives can be introduced in the areas of efficient and cleaner technologies, promoting renewable energy generation, reducing emissions from transport sector, afforestation and greening activities and standardising knowledge management systems for adaptation and mitigation.
Principle 8	Time period of the implementation of SAPCCs should be clearly brought out starting with the implementation cycle of NDCs i.e. 2021-2030 and beyond.
Principle 9	Financial resources required for the implementation of the action plan should primarily be leveraged from the existing budget of the State Governments and convergence with the relevant schemes and programs.
Principle 10	SAPCCs should set out the institutional mechanism for implementation including stakeholder engagement ensuring inclusiveness along with the mechanism for capacity building and monitoring and evaluation with clear indicators for reporting.

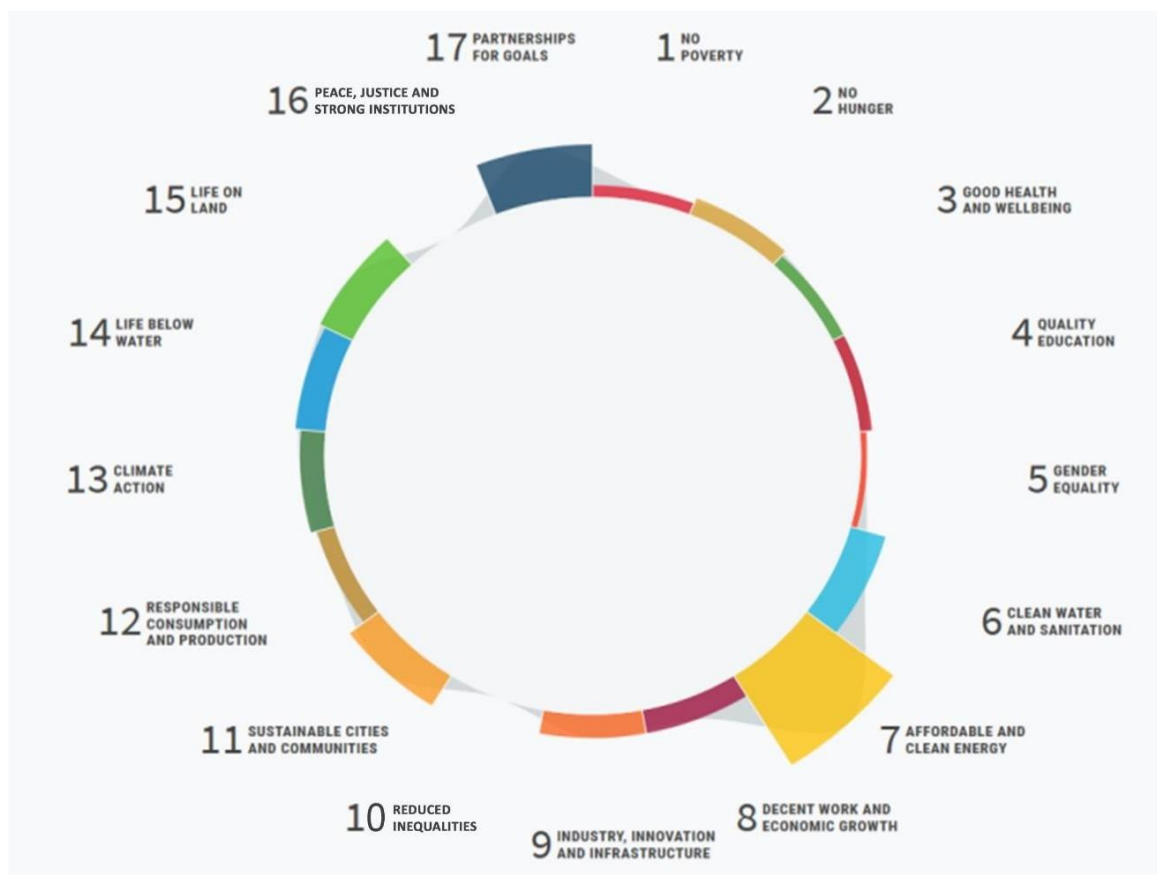
A refinement of India's National mitigation and adaptation goals is provided by the mentioned, Nationally Determined Contribution submitted to the UNFCCC by the Government of India. The NDC, initially formulated as the "Intended Nationally Determined Contribution" (INDC) in 2015, sets out eight different goals for the post-2020 period, three of which are quantitative. These goals are listed in table 2, along with an indication of missions formulated in the NAPCC that are relevant to the different goals.

Table 2: India's NDC goals

No.	NDC goal	Quantitative/ Qualitative	Relevant NAPCC missions
1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.	Qualitative	All
2	To adopt a climate-friendly and cleaner path than the one followed hitherto by others at a corresponding level of economic development.	Qualitative	All
3	To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from the 2005 level.	Quantitative	National Solar Mission National Mission for Enhanced Energy Efficiency National Mission on Sustainable Habitat National Mission for a Green India
4	To achieve about 40 per cent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of the transfer of technology and low-cost international finance including from Green Climate Fund (GCF).	Quantitative	National Solar Mission
5	To create an additional carbon sink of 2.5 to 3 billion tonnes of CO ₂ equivalent through additional forest and tree cover by 2030.	Quantitative	National Mission for a Green India (National Mission for Sustainable Agriculture)
6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.	Qualitative	National Mission for Sustainable Agriculture National Water Mission National Mission for Sustaining the Himalayan Ecosystem
7	To mobilise domestic & new and additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.	Qualitative	

Moreover, the NDC goals, are strongly linked to the other international agreements and goals, in particular, the Sustainable Development Goals (SDGs). This is illustrated in figure 2, which shows the number of actions of relevance to a particular SDG in the Indian NDC.

Figure 2: SDG- NDC Linkages for India's First NDC



Note: The size of the coloured bar indicators the number of actions of relevance to a particular SDG that are Mentioned in India's NDC, with bigger bars meaning more mentions.⁷

SAPCC Revision in the State of Chhattisgarh

To combat the negative impacts of climate change in the State, the Government of Chhattisgarh prepared the State Action Plan on Climate Change (SAPCC) as per the guidelines of the Ministry of Environment Forest and Climate Change, Government of India in 2014. The preparation of SAPCC was led by a state-level steering committee on climate change formed under the chairmanship of the Chief Secretary.

The first Chhattisgarh SAPCC (CSAPCC) was developed through a large stakeholder consultative process involving UNDP, various State level departments, National and State level institutions, sectoral experts, NGOs, CSOs and local communities. The CSAPCC covers Agriculture and allied sectors, Forests and Biodiversity, Water Resources, Urban Development, Transport, Energy, Industry and Mining, and Health sectors.

The approach of the CSAPCC was to create and define an overarching climate response framework at the State Government level to reduce vulnerability, hazards and exposure; pool, transfer, and share risks;

⁷ <https://klimalog.die-gdi.de/ndc-sdg/country/IND>

prepare and respond effectively; and increase capacity to cope with unforeseen events, while articulating flexible sector-specific response strategies and actions keeping in mind the overall state vision. The CSAPCC was in line with Government's vision on key elements such as accelerating inclusive economic growth, promoting sustainable development, securing and diversifying livelihoods, and safeguarding the ecosystem. Chhattisgarh is among the vulnerable states to climate change in India and the Chhattisgarh State Action Plan on Climate Change recognises the challenges and has detailed the importance of doing vulnerability analysis and adaptation planning in the identified sectors.

Objectivity: Why revision is required?

Considering the evolving context of climate science, policy and actions, the State Action Plan on Climate Change need to be revised and strengthened. The **objective of this document** is therefore to identify and prioritize mitigation and adaptation strategies in the light of such developments, and to refine the regionally specific action plan and strategies. More specifically, the CSAPCC-II aims to increase the level of ambition, accurateness, specificity and practicability of mitigation and adaptation actions contained, to facilitate progress from planning to action. In order to do this, this document

- a) Takes stock of the implementation of the CSAPCC-I, to derive conclusions on success factors and challenges to mitigation and adaptation planning in Chhattisgarh.
- b) Updates forward-looking plans, strategies and actions for ambitious, workable mitigation and adaptation actions and strategies.

As per the directive issued from MoEFCC, GoI about the revision of SAPCCs considering the commitments made under NDCs and other priorities of the government, an opportunity has been created for the states to revise their SAPCCs. The Government of Chhattisgarh has decided to initiate the process to revise the existing SAPCC and incorporate the NDC targets, alignment with SDG, National Missions and State Priorities. Chhattisgarh State Centre for Climate Change has taken the responsibility of revision of SAPCC as nodal agency established by the Government of Chhattisgarh for implementation of SAPCC. The present revision process has been carried out in consultation with concerned state departments. As a point of start, a brainstorming session has been organised on 31-05-2019.

Furthermore, after a marathon discussion and brainstorming session, a core group has been formed as per direction issued by the Government of India. Details of members of the "Core Group" are as follows:

Table 3: Details of Core Group Members

Particular	Member/Department/ Institution	Responsibility
Chhattisgarh State Centre for Climate Change (CGSCCC)	The Nodal Officer along with the entire team	Overall coordination of entire revision process Preparation of CSAPCC-II in association with other members of the core group. Revision of forest and biodiversity section of the Plan. Presentation of the final report for approval before the state-level steering committee.
Sectoral Nodal Officers	Agriculture Department - Prof & Head, Agrometeorology, Indira Gandhi Agriculture University, Raipur	Providing data related to the concerned department. Review of draft report shared by the nodal officer, CGSCCC Support in finalisation of CSAPCC-II.
	Water Resource Department – Chief Engineer, Mahanadi Project, Govt. of Chhattisgarh	

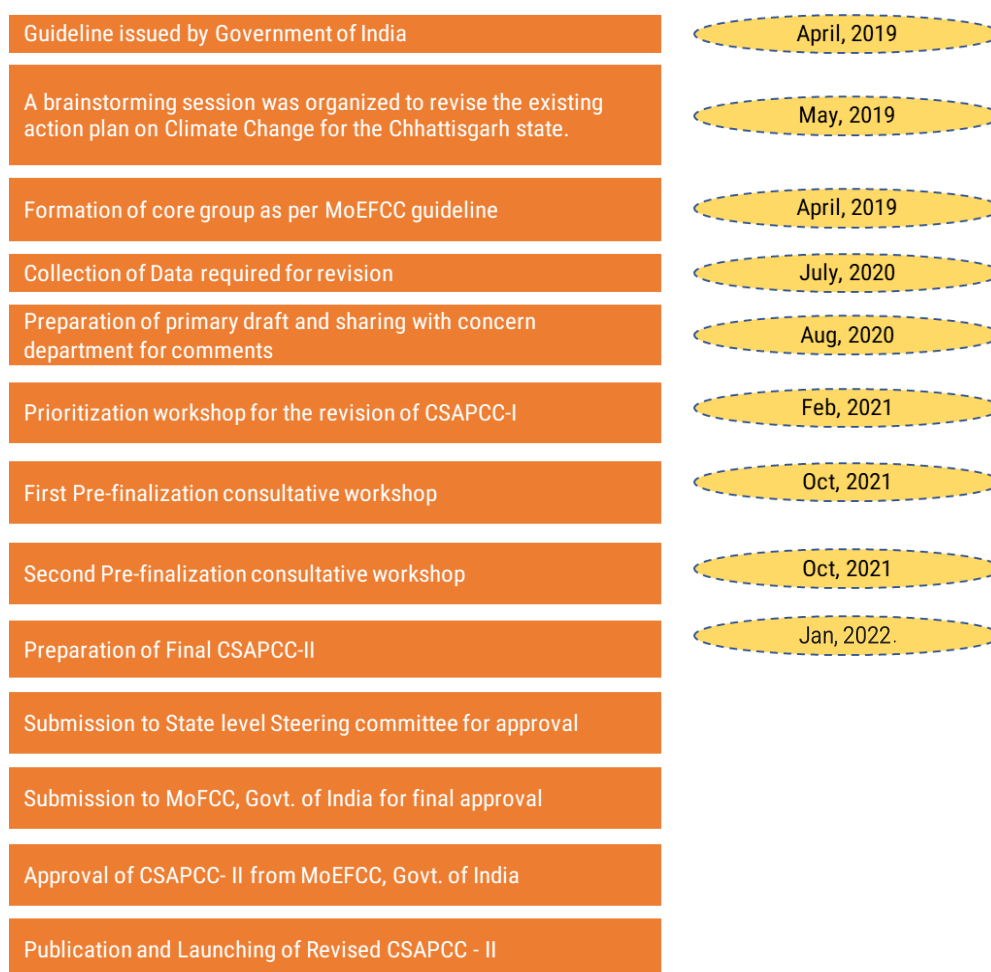
	Industry Department – Director, Industry, Govt. of Chhattisgarh	
	Health Department – Dy. Director, Medical Services, Govt. of Chhattisgarh	
	Energy Department – Chief Executive Officer, CREDA, Govt. of Chhattisgarh	
	Mining Department – Dy. Director, Mining Department, Govt. of Chhattisgarh	
	Transport Department – Additional Transport Commissioner, Govt. of Chhattisgarh	
	Urban Dev. Department – Chief Engineer, Urban Dev. Department, Govt. of Chhattisgarh	
	Panchayat & Rural dev. Department – Chief engineer, RES, Govt. of Chhattisgarh	
	Disaster Mgmt. Department – Dy. Commissioner & Under Secretary, Relief, Govt. of Chhattisgarh	
	Women & Child Dev. Department – Dy. Director, Women & Child Dev., Govt. of Chhattisgarh	
Development Partner		
UNICEF, Chhattisgarh	Chief Field Office, Chhattisgarh	Providing support in initial data collection and draft preparation
GIZ, India	Director, Climate Change, GIZ India	Providing support in technical expert engagement and final draft preparation
ICRG - Chhattisgarh	State Coordinator	Providing necessary secondary data related to draft
Knowledge Partner		
IISc, Bangaluru	Prof. Dr N H Ravindranath	Providing overall guidance and technical inputs Forest Sector Vulnerability Assessment
INRM Consultants Pvt. Ltd., New Delhi	Prof. Dr A K Gosain	Water Sector Vulnerability Assessment
CSTEP, Bengaluru	Dr Indu Murti	District level Vulnerability Assessment and Mitigation Analysis of Climate Action
Funding Partner		
Ministry of Environment, Forest and Climate Change, Government of India	Climate Change Division	Providing financial support for SAPCC revision
Research Institutions and Universities		
Indira Gandhi Agriculture University, Raipur	Concerned Department Heads	Providing data related to the draft

Pandit Ravishankar University, Raipur		
Chhattisgarh Council of Science and Technology, Raipur		
National Institute of Technology, Raipur		
State Health Resource Centre, State Health Department, Raipur		

Notes: 1. The Nodal Officers mentioned in the table is nominated by the concerned department / Government of Chhattisgarh.

2. GIZ India as development partner has been associated in later stage of CSAPCC revision and provided support to involve knowledge partners such as IISc Bengaluru, INRM Consultants Pvt. Ltd. New Delhi and CSTEP Bengaluru.

For the preparation of SAPCC report during the initial brainstorming sessions and discussions carried under various experts and department heads. The core group is formed in such a way that all the department will at least have one representative to coordinate the data compilation and updating. GIZ, UNICEF are the funding partners and IGKV, Raipur, NIT Raipur, Pt. RSU Raipur, CGCOST Raipur, SHRC Raipur etc were roped in as the knowledge partners. The process and timeline for SAPCC revision are listed below:



Chapter 2 - State Profile

2.1 Location & Geography

Chhattisgarh is a state in Central India and was formed on November 1, 2000, by partitioning 16 Chhattisgarhi-speaking south-eastern districts of Madhya Pradesh. Chhattisgarh borders the states of Madhya Pradesh in the northwest, Maharashtra in the west, Telangana and Andhra Pradesh in the south, Odisha in the east, Jharkhand in the northeast and Uttar Pradesh in the North.

Figure 3: Chhattisgarh Location Map

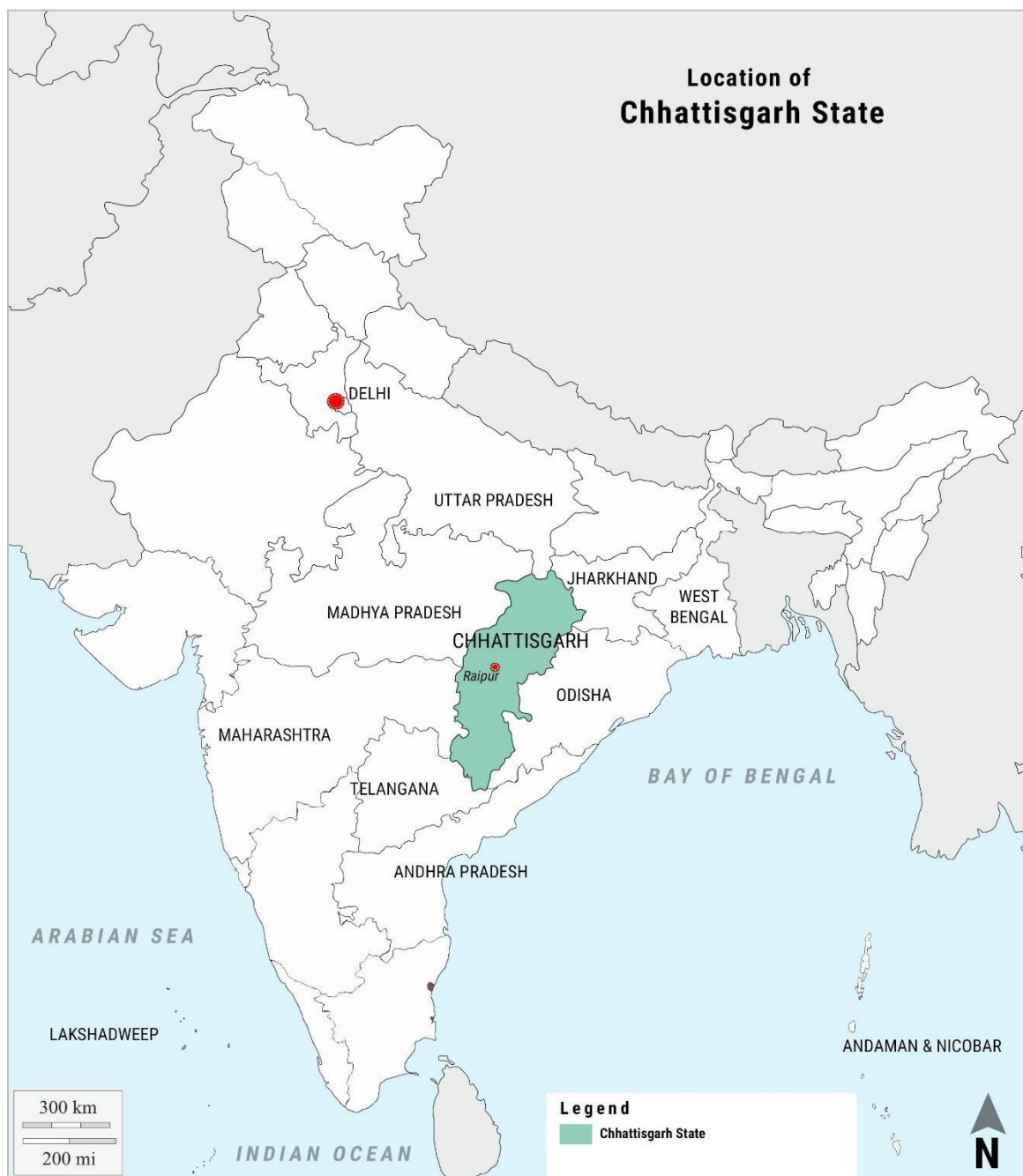


Figure 4: Map of Chhattisgarh



Raipur is the capital of Chhattisgarh, which is the 10th largest state in India, with an area of 135,190 km² (52,200 sq mi). The northern and southern parts of the state are hilly, while the central part is a fertile plain (Chhattisgarh, 2021). Deciduous forests of the Eastern Highland cover roughly 44 % of the state. In the north lies the edge of the great Indo-Gangetic plain. The Rihand River, a tributary of the Ganges, drains this area. The eastern end of the Satpura Range and the western edge of the Chota Nagpur Plateau form an east-west belt of hills that divide the Mahanadi River basin from the Indo-Gangetic plain. The central part of the state lies in the fertile upper basin of the Mahanadi River and its tributaries. This area has extensive rice cultivation. The upper Mahanadi basin is separated from the upper Narmada basin to the west by the Maikal Hills (part of the Satpuras) and from the plains of Odisha to the east by ranges of hills. The southern part of the state lies on the Deccan plateau, in the watershed of the Godavari River and its tributary, the Indravati River. The Mahanadi is the chief river of the state. The other main rivers are Hasdeo (a tributary of Mahanadi), Indravati, Jonk, Arpa, and Shivrath (ISRO, 2021). At present, the State has 28 administrative districts.

The state is broadly divisible into three agro-climatic zones – the central belt, the northern and southern belts. The central belt covers more than one-third area of the state, comprising 11 districts. The northern and the southern belts comprise of major tribal populated districts of Bastar, Dantewada, Koriya, Surguja and Jashpur. This region, with the undulating and hilly land structure, is rich in minerals and dense forests but is relatively poor in terms of irrigation and industrial development (Agriculture Department, 2021).

On the basis of regional topography, Chhattisgarh region is divided into three agro-ecological regions, the Northern Hills, the Central Plains and the Bastar Plateau.

Figure 6: Agro-climatic regions of the Chhattisgarh State

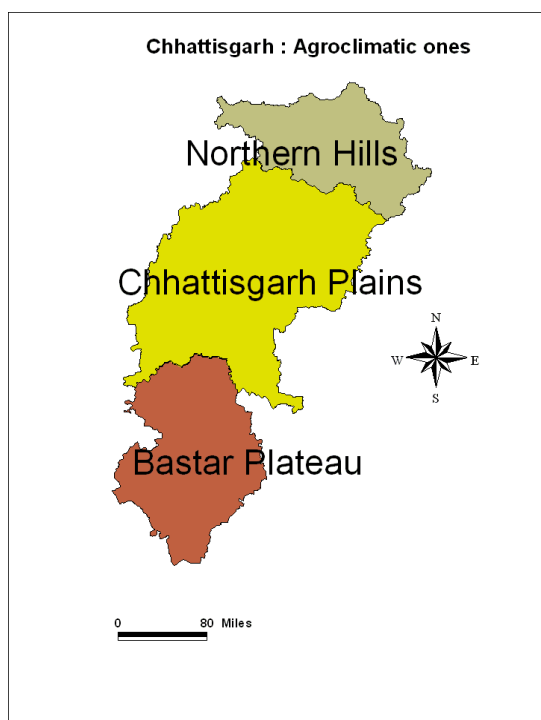
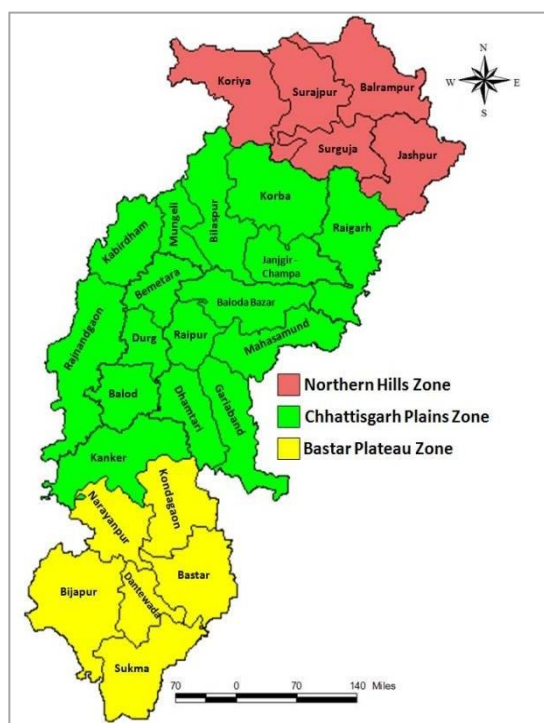


Figure 5: District boundaries and Agro Climatic Zones



Map Source: IGKV, Department of Agriculture, Government of Chhattisgarh

Northern Region: The districts that are part of this region (Korea, Surguja, Jashpur, Raigarh, and Korba) have similar geographical, climatic, and cultural contexts and harbour dense forests, hills and water reservoirs. It is home to several indigenous tribal communities such as Paharikorba and Pando, etc. Governed largely by tribal customs, culture and traditions, in the rural areas of the region, people are dependent largely on agriculture and non-timber forest produce (NTFP). The level of migration from this region is comparatively limited. The urban centres are limited to Korba and Ambikapur. Korba is the largest town, and the limited industry is concentrated here. There are coal mines in Surguja and Koriya districts.⁸

Central plains region: Raipur, Bilaspur, Janjgir-Champa, Kabirdham, Rajnandgaon, Durg, Dhamtari, Mahasamund and the newly formed district of Gaurela Pendra Marwahi are the districts that fall in the central plains. Mahanadi is the primary source of water for irrigation and domestic use. Owing to the presence of a large number of indigenous varieties of rice, the central plains of Chhattisgarh are known as the 'rice bowl' of Central India. Bhilai and Durg are well known urban areas, both with large steel plants. Rural craft is well developed in the region and well known (e.g., the silk weavers of Janjgir-Champa). The region is densely populated with Raipur and Durg account for almost half the total urban population of Chhattisgarh. (IGKV, 2021)

Southern Region: The districts in this region (Kanker, Bastar and Dantewada) are known for its varied and rich forests, diverse tribal populations, and unique culture. These districts are bordered by the States of Maharashtra, Andhra Pradesh, and Odisha. The people of the region are dependent on traditional

⁸ Chhattisgarh Inclusive Rural and Accelerated Growth Project "CHIRAAG", Indira Gandhi Krishi Vishwavidyalaya, Raipur - 2021

agriculture and forests for their livelihood. The Bailadila mines in the Dantewada district represent the limited industry in the region. (IGKV, 2021)

2.2 Demographic Profile

As per the Census 2011, Chhattisgarh has a population of 2.56 crore, 22.61 % increase from figure of 2.08 crore in the 2001 census. Total population of Chhattisgarh as per the 2011 census is 25,545,198 of which males and females are 12,832,895 and 12,712,303 respectively. In 2001, total population was 20,833,803 in which males were 10,474,218 while females were 10,359,585. The total population growth in this decade was 22.61 per cent while in the previous decade it was 18.06 per cent. (Census of India, 2011)

Table 4: National Population Profile

Population ⁹	Census 2011	Census 2001	Growth %
Male	1,28,32,895	1,04,74,218	22.52
Female	1,27,12,303	1,03,59,585	22.71
Total	2,55,45,198	2,08,33,803	22.61

The population of Chhattisgarh forms 2.11 per cent of India in 2011. In 2001, the figure was 2.03 per cent. Total population of Scheduled Tribes in the state is 78, 22,902 (30.62 per cent) and that of Scheduled Castes is 32, 74,269 (12.82 per cent).

The density of population per sq. Km. is about 189 and fairly below the national average. The literacy rate in the state is about 73 per cent a figure that has improved tremendously in the last few years due to the consistent efforts of the government. The sex ratio in Chhattisgarh is about 991 which is a healthy figure and above many of the other states. Out of the total population of Chhattisgarh, 23.24 per cent of people live in urban regions and around 76.76 per cent live in rural areas. (Census of India, 2011)

Table 5: Demographic Profile of Chhattisgarh State

Description	Rural	Urban
Population (%)	76.76	23.24
Total Population	19,607,961	5,937,237
Male Population	9,797,426	3,035,469
Female Population	9,810,535	2,901,768
Population Growth (%)	17.78	41.84
Sex Ratio	1001	956
Child Sex Ratio (0-6)	977	937
Child Population (0-6)	2,924,941	736,748
Child Percentage (0-6) (%)	14.9	12.41
Literates	11,008,956	4,370,966
Average Literacy percentage (%)	65.99	84.05
Male Literacy percentage (%)	76.98	90.58
Female Literacy percentage (%)	55.15	73.39

Source: Census of India, 2011

Education

Literacy rate in Chhattisgarh has seen an upward trend and is 70.28 per cent as per the 2011 population census. Of that, male literacy stands at 80.27 per cent while female literacy is at 59.58 per cent. In 2001,

⁹ Census of India Website: Office of the Registrar General & Census Commissioner, India (censusindia.gov.in)

the literacy rate in Chhattisgarh stood at 64.66 per cent of which males and females were 75.70 per cent and 55.73 per cent literate respectively. In actual numbers, total literates in Chhattisgarh stands at 15,379,922 of which males were 8,807,893 and females were 6,572,029.

Chhattisgarh has an Education Index of 0.526 according to 2011 NHDR (which is higher than that of States like Bihar, Jharkhand, U.P., and Rajasthan which are below the 0.5 mark) (Institute of Manpower Research, 2011). It is slightly lower than the national average of 0.563. With respect to literacy, the State has fared just below the national average.

A total of 31137 primary and 13589 upper-primary schools have been started by the government to ensure near-universal access (NER 94.00 per cent) to primary education. Apart from resources made available under DPEP & SSA, policy reforms such as the enactment of the Right to Education Act have also led to 88.89 per cent retention up to class V. Whereas, in 2009-10 the retention rate for a pupil at the primary level (61.72 per cent) in Chhattisgarh was significantly lower than the national average (74.01 per cent), the state's retention rate in 2015-16 is higher than the national average¹⁰.

Health

The state government is providing healthcare services through 26 district hospitals, 19 civil hospitals, 170 community health centres, 792 primary health centres, 5205 sub health centres, 31 civil dispensaries in Chhattisgarh (CG Economic Survey 2020-21). Under-five mortality rate has come down to 50.4 per thousand live births in 2020-21 from 64.3 in 2015-16 (NFHS-5, 2020-21) and maternal mortality ratio has reduced from 379 in 2001-03 to 159 in 2016-18 per lakh live births¹¹. For malaria, the Annual Parasitic Incidence (API) 2019 is 1.97 in Chhattisgarh (NHM, Govt of India). As per Chhattisgarh economic survey 2020-21, HIV prevalence rate is 0.65% while the notification for tuberculosis is 141 per lakh/year in 2019-20. The leprosy prevalence rate of the state is 1.54 as on October 2020 against the 8.2 per 10000 at the time of formation of the state. Despite these achievements, much remains to be done. Chhattisgarh continues to grapple with numerous public health challenges.

Chhattisgarh is continually recording considerable growth in the field of Health and development, but still has a long way to go to reach parity with National levels. The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change. These effects occur directly, due to changes in temperature and precipitation and occurrence of heatwaves, floods, droughts, and fires. Indirectly, health may be impacted by ecological disruptions brought on by climate change (crop failures, shifting patterns of disease vectors, clean air and safe drinking water), or social responses to climate change (such as displacement of populations following prolonged drought). Variability in temperatures is a risk factor, over and above the influence of average temperatures on heat-related deaths. Biological and social adaptation is more difficult in a highly variable climate than one that is more stable. The health and nutritional status of the people of Chhattisgarh have improved over the years.

Communicable diseases (including vector-borne and water-borne diseases) are infectious diseases caused by microorganisms, such as bacteria, viruses, parasites, and fungi that spread directly or indirectly. Some are caused by insect bites or from food and water (WHO). Water-borne diseases (cholera, and various diarrheal diseases) are sensitive to climate change impact including seasonal variation. Compromised hygiene during water scarce/drought situations and freshwater contamination during floods increase the risk of water-borne diseases. Low awareness about breeding sites for mosquitoes,

¹⁰ Chhattisgarh SDG 2030 Vision Document

¹¹ Sample Registration System (SRS) Statistical Report (16-18), Office of the Registrar General & Census Commissioner, India

scanty use of mosquito nets and inadequate knowledge about the symptoms of the disease are some of the key challenges resulting in the high incidence of malaria.

The Total Fertility Rate of the State is 2.5 a little high above the national level of 2.3. The IMR for the state has come down currently to 38 from the previous figure of 43 at the time of formation of the state. This is a major achievement for the state because any reduction in IMR requires synergistic efforts from several departments and improvement in social status (census of India 2011). The Maternal Mortality Ratio of 159 is slightly higher than the National average of 113 (SRS 2016-18). Sex Ratio in Chhattisgarh is 991 i.e., for each 1000 male, which is below the national average of 940 as per census 2011¹².

Over the last 10 years, the State has taken several strides to improve the delivery of health services and has been able to achieve some progress in bringing down its adverse health indicators.

Banking on the enormous stride of the health care department an incremental performance has been observed against the key performance indicators. Amongst the eight Empowered Action Groups, out of the states including Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, Uttarakhand, Uttar Pradesh, and Odisha, only three of the states i.e., Rajasthan, Jharkhand and Chhattisgarh have shown an improvement in the overall performance between 2015-16 and 2017-18. Out of the 21 large states in India, Chhattisgarh now ranks at 13 with a composite index score of 53.36 as against the highest index score of 74.01 for Kerala.¹³

Access to Drinking Water

Drinking water remains the most essential and at the highest priority in all government policies. There are 74,929 habitations of 19698 villages in the state have been provided drinking water by establishing 280096 hand pumps. Facility of fresh drinking water is being provided in 50622 schools & 30201 anganwadis centres. In addition to this, 7277 solar based dual operated pumps have been established to ensure fresh drinking water supply in interior and plain areas of the state. Water supply schemes have completed in 111 Urban Local Bodies (ULBs) under urban water supply programme, where as in process in 57 ULBs (CG Economic Survey 2020-21).

Sanitation

The state has made great progress in terms of sanitation with 100 per cent achievement of the Swachh Bharat MIS target. More than 33 lakh toilets (33,40,776)¹⁴ have been constructed in rural parts as on 28.02.2022, while 3 Lakh (3,25,050) toilets have been built in urban parts of the state. All 28 districts, 10775 Gram Panchayats and 18,769 villages have been declared open defecation free as on date.

Roads

Chhattisgarh has an excellent road network. All district headquarters, tehsils and development blocks are connected with good all-weather roads. Existing road network is being strengthened. Chhattisgarh has a border with six states. The overall Road network of the State is 33023 KM which includes 3526 KM National Highways, 4137 KM State Highways, 11580 KM Districts roads & 13780 KM rural and other roads¹⁵. Total no of national highways in the State is 19¹⁶.

Railways

Railways have an important role in the industrial development of Chhattisgarh as they help to transport large quantities of coal, iron ore and other minerals within and outside the state. Recognizing the potential for mining and metal industry-related traffic in the state, the Indian Railways established a new Railway

¹² Census of India, 2011

¹³ http://social.niti.gov.in/uploads/sample/health_index_report.pdf

¹⁴ Swachh Bharat Abhiyan, Report Card- Chhattisgarh

¹⁵ CG Socio-Economic Survey 2020-21

¹⁶ MoRTH, Govt of India.

Zone named “Southeast Central Railway” with its Headquarters at Bilaspur in Chhattisgarh. The state has the highest freight loading in the country and one-sixth of Indian Railways revenue comes from Chhattisgarh. The length of the rail network in the state is 1,108 kms. Raipur lies on the main route between Mumbai and Kolkata and daily direct trains connecting Delhi, Kolkata, Chennai, and Mumbai are available.

Air Transport

Swami Vivekanand Airport in Raipur is its sole airport with scheduled commercial air services. Raipur is linked by regular flights with New Delhi, Mumbai, Kolkata, Nagpur, Indore, Ahmedabad. An on-demand Air-taxi service is available from Raipur to Korba, Jagdalpur, Raigarh, Ambikapur and Jashpur.

Communications

Bharat Sanchar Nigam Ltd., and various private companies are providing telecommunication services in the State. There are 20.01 million telephone subscriptions (Wireline + Wireless) are available in the State as on June 2020.¹⁷

2.3 Economic Profile

As per advance estimate, the Gross State Domestic Product (market price) at current price is likely to increase Rs. 3,50,270 cr. in the year 2020-21 from Rs.3,44,955 cr. of previous year which shows growth of 1.54%. Sectoral change is estimated in 2020-21 over previous year in Agriculture sector (Agriculture, Livestock, Forestry and Fishing) Rs. 67025 cr. to Rs. 73,994 cr., Industry sector (Mining and Quarrying, Construction, Manufacturing and Electricity, Gas & Water supply) from Rs. 1,33,680 cr. to Rs. 1,29,211 cr. and Service sector from Rs. 1,18,917 cr. to Rs. 1,22,893 cr. Sectoral percentage growth over previous year are 10.40%, -3.34% and 3.34% respectively¹⁸.

Table 6: Gross State Domestic Product of Chhattisgarh at current price

(In Lakh Rs)

Sector	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	2019-20 (Q)	2020-21 (A)
Agriculture	40,38,920	42,77,314	54,29,526	51,97,657	59,13,001	67,02,549	73,99,351
Industry	95,97,369	92,59,138	99,85,131	1,13,99,677	1,27,63,725	1,33,68,027	1,29,21,107
Services	72,70,475	78,34,753	87,39,937	93,29,385	1,08,09,867	1,18,91,660	1,22,89,294
Gross State Value Added (Basic prices)	2,09,06,764	2,13,71,205	2,41,54,594	2,59,26,719	2,94,86,593	3,19,62,236	3,26,09,752
Product taxes-Products subsidies	12,05,047	11,45,094	21,25,581	23,01,625	23,23,520	25,33,299	24,17,231
Gross State domestic product (market prices)	2,21,11,811	2,25,16,299	2,62,80,175	2,82,28,344	3,18,10,113	3,44,95,535	3,50,26,983

(P)= Provisional, (Q)= Quick, (A)= Advance

Source: Planning, Economics & Statistics Department, Government of Chhattisgarh

¹⁷ The Indian Telecom Services Performance Indicators April – June, 2020, Telecom Regulatory Authority of India.

¹⁸ Planning, Economics & Statistics Department, Government of Chhattisgarh, Press note

Anticipated growth in Gross State Domestic Product 2020-21 at Constant Price

As per advance estimate, the Gross State Domestic Product (market price) at constant price is likely to decrease at -1.77% over the previous year 2019-20. In which Agriculture sector (Agriculture, Livestock, Forestry and Fishing), Industry sector (Mining and Quarrying, Construction, Manufacturing and Electricity, Gas & Water supply) and Service sector are expected to grow /decrease at 4.61%, -5.28% and 0.75% respectively, over the previous year.

Table 7: Gross State Domestic Product of Chhattisgarh at Constant Prices (base year 2011-12)

(In Lakh Rs)

Sector	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	2019-2020 (Q)	2020-2021 (A)
Agriculture	31,21,630	30,92,063	37,50,127	33,41,450	36,68,406	38,03,052	39,78,337
Industry	83,37,415	84,99,275	89,40,226	97,72,387	1,06,91,067	1,10,57,952	1,04,73,691
Services	60,64,312	64,23,198	67,75,483	68,96,577	74,70,518	80,46,614	81,06,591
Gross State Value Added(Basic prices)	1,75,23,357	1,80,14,536	1,94,65,836	2,00,10,414	2,18,29,991	2,29,07,618	2,25,58,619
Product taxes-Product subsidies	10,57,987	10,43,841	19,04,642	20,03,155	19,39,499	20,79,885	19,86,547
Gross State domestic product (market prices)	1,85,81,344	1,90,58,377	2,13,70,478	2,20,13,569	2,37,69,490	2,49,87,503	2,45,45,166

(P)= Provisional, (Q)= Quick, (A)= Advance

Source: Planning, Economics & Statistics Department, Government of Chhattisgarh

Unemployment Rate

According to the report of Center for Monitoring Indian Economy (CMI) released on 16 September 2021, the unemployment rate in Chhattisgarh is 3.8 percent, while the national unemployment rate is 7.6 percent. Circumstances in Chhattisgarh are far better than many major and developed states of the country¹⁹. In order to achieve full employment over the next five years, the challenge for public policy is to create conditions for the generation of 15 lakh jobs²⁰.

The state is continuously taking enormous efforts to create employment especially in rural areas. For example, total 38.08 lakh families were provided employment in 2019-20 through MNREGA only. Total 1356.17 lakh man day were created, in which women participation was 51%. Whereas 413885 families were provided employment for 100day in the year²¹. It is noteworthy that Chhattisgarh is an agricultural state. 74 percent of the state's population resides in villages and their source of livelihood is agriculture and forest produce. The state government has made continuous efforts to improve agriculture and rural economy in the state. Rural areas of Chhattisgarh now have better employment opportunities. During the COVID transition period, State Government ensured better implementation of MNREGA, systematic procurement and processing of paddy, along with the continuous collection, procurement and processing of minor forest produce, which provided continuous employment to the people of rural areas²².

¹⁹ CG Jansampark (www.dprcg.gov.in)

²⁰As per the Report, Jobful Growth for Chhattisgarh 2019-2024, Rajiv Gandhi Institute for Contemporary Studies.

²¹ Economic Survey of Chhattisgarh 2020-21

²² CG Jansampark (www.dprcg.gov.in)

Status of Poverty in the State

According to the Tendulkar Committee report of the National Sample Survey, 39.93 percent of the population were below the poverty line in 2011-12 in Chhattisgarh, the highest among all the states in the country. Most recent data show that the state has more than 30 per cent²³ of its population living below the poverty line and can be considered as multi-dimensionally poor (based on the NITI Aayog's multidimensional poverty index released in November 2021). As per the Poverty Head Count Ratio methodology of the Tendulkar committee, SC, STs and OBCs constitute the major poor population across social groups in rural-urban areas in the state.

Table 8: HCR across Social Groups during 2011-12 in Chhattisgarh

Sector	SC	ST	OBC	Others	Total
Rural	17.5	45.6	36.3	0.6	100.0
Urban	19.4	19.8	50.7	10.1	100.0

Source: Directorate of Economics and Statistics, Chhattisgarh

ST/SCs are covered under deprivation criterion in Socio-Economic Caste Census (SECC), 2011 for priority in different poverty reduction schemes in rural areas. Food insecurity is less prevalent in Chhattisgarh due to a robust Public Distribution System (PDS) under Chhattisgarh Food Security Act, 2012 and Mid-Day Meal (MDM) scheme for school children. Poverty estimation is based on monetary transactions towards consumption expenditure by households. For households purchasing food grains and other necessary items at a subsidized price, expenditure reduction implicit in the subsidy is not reported, instead, reduced subsidized price is reported in the consumer expenditure even though the items are consumed in these households adequately.

2.4 State Government: Main Developmental Priorities and Policies

Development challenges faced by Chhattisgarh are diverse and numerous- ranging from low social and human development, high incidence of poverty- especially among women and tribal, inequity in access to resources and services, high proportion of vulnerable population, sub-optimal economic productivity, poor social and physical infrastructure, rich natural resources but locked by national policies and the constraints imposed by widespread Left-Wing Extremism (LWE). Each of these is equally critical for inclusive and accelerated growth in the next plan. On human development indicators, the State has been working hard to come at par with national averages. The State's economy grew at an impressive pace in the last decade, but not all sections of the society were able to reap its benefit. Despite targeted efforts at reducing deprivation, limited success was achieved in ensuring equity in the redistribution of benefits. The Inequality-adjusted Human Development Index (HDI) – using 2004-05 data – that looks at disparities among social groups in the attainment of key human development indicators suggests high variation within the State in terms of incomes, education, and health. Some of the development issues in the State category wise is mentioned below.

Disparity in Health and Education

This disparity is highest on education and health parameters, which, when adjusted for inequality, erodes the State's absolute HDI value by nearly 35 percent. Differences have narrowed over the past few years but are still significant and their reduction will be a priority for the next plan.

²³ NITI Aayog's multidimensional poverty index released on November 2021

In general, the state's development indicators, related to health, education, gender, amenities and infrastructure, lags the achievements made at all India level. Between 2005-06 and 2015-16 (NFHS-3 and NFHS-4), the State has made commendable progress in some of these development indicators. In these ten years, indicators like institutional births, percentage of children who are breastfed within one hour of their birth and percentage of women who have a bank account which they themselves use, have recorded growth (NFHS-3 and NFHS-4). In other indicators also, the State has recorded remarkable/appreciable progress. As a result, the gap between Chhattisgarh and all of India, in most of the development indicators, has narrowed down, but the State must strive hard to bridge this gap completely.

Farm Sector Underperformance

According to the state's estimates, for nearly 80 per cent of its population, the main source of livelihood is agriculture. Yet, agriculture contributes merely 18 per cent to the state's gross domestic product and has been the slowest growing sector for at least the past five years. The problem: majority of farmers still use traditional farming methods and rely on monsoons, resulting in low growth and crop productivity. That's also because only 35 per cent of the cultivated area is irrigated while the rest depends on rainfall, subject to the vagaries of the rain. The Indian Council of Agricultural Research said that the red and yellow soils, mostly found across Chhattisgarh, are already deficient in nitrogen, phosphorus, zinc and boron. On top of that, the productivity of crops is also hurt by low usage of high yield.

Left-Wing Extremism Issue

According to the data published by the Ministry of Home Affairs, Government of India, Chhattisgarh is the worst LWE-affected state. LWE is rooted in the larger historical and spatial challenges affecting the rural areas of Chhattisgarh. All possible help and significant resources are required to address this national concern and bring development to LWE affected areas. Scheme based response to the needs of these areas has not been effective as seen in the low penetration of MGNREGA in LWE affected districts; a different development paradigm is required. The spatial growth of LWE has thereafter been dramatic and alarming. These are also areas that suffer from the greatest illiteracy, poverty, and overpopulation in India, and span parts of many Indian states. Infrastructure improvement has to go hand in hand with softer interventions that address awareness, low skills, underemployment and human development and the State has been galvanizing resources from all quarters to accelerate development and mainstream the people living in affected districts- a strategy that will be continued in the coming years. , Government of India, Ministry of Home Affairs has declared following districts are the LWE affected in Chhattisgarh –Bastar, Bijapur, Dantewada, Jashpur, Kanker, Korea (Baikunthpur), Narayanpur, Rajnandgaon, Sarguja, Dhamtari, Mahasamund, Gariyaband, Balod, Sukma, Kondagaon and Balrampur.

Tribal Development Issues

The most vulnerable and deprived among STs - the Particularly Vulnerable Tribal Groups (PVTGs) - rank the lowest on human development indices among social groups and live in the most inaccessible areas. Chhattisgarh has five PVTGs i.e, Abujh Maria, Baiga, Hill Korba, Kamar and Birhor (Ministry of Tribal Affairs, GoI, 2022). Recent assessments have noted an increase in PVTG population from 1.24 lakh to more than 1.5 lakh and a general improvement in their health, education and income standards, including a shift towards stable livelihoods. This has been mainly possible due to the doorstep delivery of basic services like mobile clinics, health check-ups and monitoring camps, educational bridge courses, residential schools and distribution of agriculture kits. The increasing prevalence of sickle-cell anaemia among many PVTGs is a cause of great concern and the state will facilitate more state-specific research to address it. The Conservation cum Development (CCD) Plans for each PVTG will continue to address specific health issues around mortality reduction, fertility increase, creation of livelihood support infrastructure and innovative interventions that meet the twin concerns of development and conservation.

Development Priorities

Sustained focus on extremely poor households meeting the automatic inclusion criteria and households with at least four deprivations as per SECC, 2011 data:

- Strengthening agriculture by enhancing irrigation area coverage, agriculture intensity, promoting crop diversification (Linkage with SDG 2-Focus on Sustainable Agriculture), increasing input availability, agriculture extension and farm-mechanisation.
- Ensure availability of work for all who are capable of working under rural wage employment programme.
- Rainwater conservation by increasing coverage of area under watershed development.
- Land treatment with livelihood package and convergence for enhancement of productivity especially on lands rights recognised under FRA, 2006
- Strengthening of hospital and community-based diagnostic and treatment services.
- Scale-up of care, support & treatment services across the state through public & private health institutions.
- Focus on women's health and improving women participation in governance.
- To progressively move towards universal rural electrification by reaching out to remaining electrified households – the state government shall accord the highest priority to providing electricity to all the villages and majra/tolas (hamlets).
- To reduce AT&C loss to 8 per cent by the year 2030.
- Mainstreaming of climate concerns into all aspects of development policy and implementation
- Prepare mitigation/action plan for heat, flood, drought and lighting.
- Sustainable utilisation & conservation of the vast NTFP's potential, through participatory mechanisms.

The government of Chhattisgarh are doing enormous works which are directly or indirectly related to climate change. The following are a few major policies/ programs undertaken by the state government:

Important Policies of State Government

Suraji Gaon Scheme – Chhattisgarh Government has come up with an innovative vision to revive the ruraleconomy by striking a balance between modernity and tradition at the grassroots. The Government has introduced a Scheme in the name of Suraji Gaon Scheme (or Well Governed Villages) with the tag line *"Chhattisgarh Ke Char Chinhari - Narwa, Garuwa, Ghurwa, Bari – Gaon la Bachana Hai Sangwari"* (NGGB Scheme). This means the collective action to ensure water conservation (Narwa), livestock development (Garuwa), use of compost (Ghurwa) and cultivation of vegetables and fruits in the backyard (Baadi). The scheme is supposed to achieve the four objectives through an integrated approach to the primary sector with the best use of native resources along with the benefits of the government's modern schemes in agriculture, water resources, energy, forest, and rural development. The logic is simple and clear, the Narwa (rivulets and streams) focuses on low-cost water conservation structures such as check dams, gully controls, underground dykes at strategic locations on water streams to ensure harvesting surface water and recharge of the subsoil as well as groundwater. The National Watershed Mission and MGNREGA are going to jointly execute the programme. The direct result will be an increase in arable area with the possibility of growing two crops in a year. Garuwa (livestock) programme is for the protection and improvement of livestock, especially milking cattle through the provision of cattle sheds (Goathan) in each village is managed by the Gram Sabha. They would function as 'Day Care Centres' for cattle equipped with fodder, water, and Artificial Insemination (AI) facilities. Apart from protection to crops from animal grazing – a perpetual menace across the country – bio-fertiliser through manure and energy from Biogas will be accrued benefits to villagers. Cultivation of fodder in earmarked wastelands is also part of Garuwa. Village Panchayats will accomplish the task with the help of Veterinary and Forest Departments, and MGNREGA. The Ghurwa (compost) is designed to encourage villagers to produce biofertilisers with the help of various schemes under agriculture and horticulture. In today's expensive chemical driven farming,

Ghurwa is seen as an inexpensive traditional alternative that can pave way for increased organic farming. The Baadi is to encourage the cultivation of fruits and vegetables in the backyard of village homes not only as a source of additional income for villagers but also as handy nutritional supplements. Departments of Horticulture will help in developing the backyard kitchen gardens by providing seedlings, fertilizers, and energized community dug wells.

Table 9: Status of Suraji Gaon Scheme

N o.	Program name	Selected Village/Nala Number	Details of Major Works (Number of Works Completed)
1	Narva	881 (Nala)	Loose Boulder Check (3111), Other (2328), Gully Plug (1802), Staggered Contour Trenching (1544), Brush Wood Check (1411)
2	Garwa	4336 (Gaon)	Plantation (30110), Construction of Kotana (2082), Drinking Water Tank (1879), Vermi Compost Tanka (1716), Formation of Gothan Management Committee (1588)
3	Ghuruva	3343 (Gaon)	Upgradation of Traditional Ghuruwa (Swaprena) (226455), Bhoo-Nadep (Swaprena) (48897), Crop Residue Management (Trichoderma/Decomposer) (Swaprena) (16815), Vermi Bed (8939), Vermi Tanka (Government Scheme) (6621)
4	fence	2930 (Gaon)	Seed Distribution (71427), Vegetable Seed Distribution (24350), Plant Distribution (17999), Fruit Plant Distribution (6497), Plants Supply for Life Fencing (4482)
5	pasture	1091 (Gaon)	CPT (275), Seed Kharif Season M.P. Chari (127), Seed Kharif Season Maize (126), Fencing (120), Land Leveling (108),
Grand total		Channel: 881; Village: 11700	-

Reference: Official website of Suraji Gaon Scheme, Government of Chhattisgarh, 2021
(<https://nggb.cg.nic.in/#/home>)

CG Mukhyamantri Bal Sandarbh Yojana – Free Health Check-up & Medical Facility to Children Mukhyamantri Bal Sandarbh Yojana is a healthcare scheme being run by the Women and Child Development Department of Chhattisgarh Government. The scheme was started in the state in 2009. The main objective of Mukhyamantri Bal Sandarbh Yojana is to provide health check-ups and medical counselling facilities to children suffering from severe malnutrition and other crisis. 709784 children were benefitted from FY 2018-19 under this scheme²⁴.

CG Indira Van Mitn Yojana

Chhattisgarh Government has launched a new scheme named CG Indira Van Mitn Yojana 2021. The new scheme is going to make forest dwellers of the state self-reliant (atmanirbhar). In this scheme, the state govt. will form groups of youth in around 10,000 villages of tribal areas who would be responsible to conduct all forest-based economic activities. These economic activities would create self-employment opportunities for forest dwellers²⁵.

²⁴ <http://www.cgwcd.gov.in/>

²⁵ Department of Forest, Government of Chhattisgarh

CG Saur Sujala Yojana

The main objective of Saur Sujala Yojana is to empower the farmers by providing them with Solar Irrigation Pumps at subsidised rates. This scheme will not only make farmers more able to cultivate their land but will also help in strengthening agriculture and rural development in rural Chhattisgarh. Under this scheme government will distribute Solar Irrigation Pumps of 3 HP and 5 HP capacity to the farmers²⁶.

Chief Minister Suposhan Abhiyan

Chief Minister Suposhan Abhiyan has been started from 02 October 2019 on the occasion of his birth anniversary. The main objective of the campaign is to free children from malnutrition and anaemia up to the age of 06 years and women in the age group of 15 to 49 years from anaemia. Under the campaign, hot food is being provided to about 1-85 lakh beneficiaries of the state and 3-53 lakh beneficiaries are being provided egg, chick, laddu, groundnut, porridge etc. According to the situation and need of the district, an action plan and strategy is being prepared and implemented at the district level to conduct the campaign²⁷.

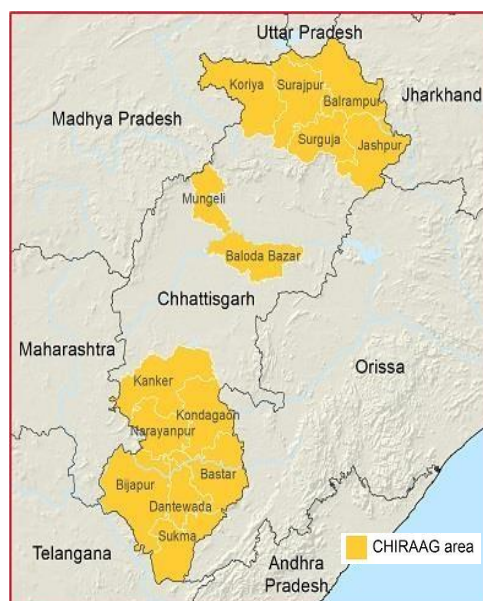
Godhan Nyay Yojana

Government is procuring the cattle dung at the rate of 2 Rs. Per KG from the Dairy Farmers, and it is processed to prepare vermicompost, super compost, super compost plus. This biofertilisers are then sold to the farmers (vermicompost 10 Rs per kg, super compost 6 Rs per kg, and super compost plus 6.5 Rs per kg). The self-help group which is preparing the compost and the gothan samiti are sharing the profit in the ratio 85 and 15 percentage respectively.²⁸

Rajiv Gandhi Kisan Nyay Yojana

Government is promoting diversification of crops by providing incentives if the farmer took other crops (like scented rice, fortified rice, pulses, oil seed, horticulture etc.) instead of paddy. If the farmer is practising plantation agriculture, the incentive is given continuously for three years (10,000 per acre)²⁹.

Figure 7: The districts covered in CHIRAAG project



Chhattisgarh Inclusive Rural and Accelerated Agriculture Growth Project (CHIRAAG)

The project development objective is to improve income opportunities and the availability of nutritious foods in the targeted households of the tribal-dominated areas of Chhattisgarh. The project will be implemented across 25 blocks in 14 districts: Bastar, Narayanpur, Kanker, Bijapur, Sukma, Kondagaon and Dantewada in the southern region; Mungeli and Baloda Bazar in the central region; and Surguja, Koriya, Surajpur, Balrampur and Jashpur in the northern region³⁰.

²⁶ <http://www.creda.in/>

²⁷ <http://www.cgwcd.gov.in/>

²⁸ <http://www.cgwcd.gov.in/>

²⁹ Department of Finance, Government of Chhattisgarh

³⁰ www.ifad.org/en/web/operations/-/project/2000003444

State Millet Mission

The Millet Mission has been launched to increase the yield of millets like Kodo, Kutki and Ragi in view of increasing demand in both India and abroad. The crops are rich in nutrition and are sold at good prices in urban areas. Presently, the cereal crops are mostly grown in Vananchal and the support price of these crops are not fixed and there is no arrangement for its purchase. So, despite growing such an important and valuable crop, the farmers who grow it remain poor. The Millet Mission aims to not only increase the income of the farmers of Vananchal and tribal areas but also give a new identity to the state of Chhattisgarh. The processing of millets will also provide employment to farmers and various youth and women's groups in the state. Overall, the Kodo, Kutki, Ragi crops are produced in around 20 districts of the state, 14 of which have signed the MoU in the first phase of the mission's implementation. The state will sign the MoU with more districts in the next phase. Under Millet Mission, the state will ensure good procurement arrangements and take the crops to the city markets after processing. The state will also fix a support price for the crops and include them under the purview of Rajiv Gandhi Kisan Nyay Yojana. With this, the farmers growing these cereal crops will be able to get input assistance like other farmers.

Mukhyamantri Vriksharopan Protsahan Yojana (Chief Minister's Tree Plantation Incentive Scheme) The Mission was launched to encourage commercial/industrial plantation of non-impertinence species in the private sector of farmers (where paddy has been cultivated in 2020 and paddy has been sold to the government), land of forest rights holder, government departments, joint forest management committee and revenue land of gram panchayats. One of the prominent objectives of the scheme is to reduce the adverse effects of climate change by improving the environment and increase the income of farmers through plantation.

The scheme also aims to protect forests by promoting plantation on private and community land, increased production of wood and progressive reduction in import of wood and reducing biological pressure on wood available in forests. It controls floods, droughts, etc. and at the same time the scheme is meeting the needs of wood of industries, large scale employment generation, contributing to GDP increase³¹.

Apart from these, there are many more schemes aligned with livelihood development, climate resilience etc. and are being discussed in the upcoming chapters.

³¹ <https://www.cgforest.com/CMPlantation/Login.aspx>

Chapter 3 - Climate Profile

3.1 Introduction

Climate in a narrow sense is defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to decades, to centuries to thousands of years (IPCC, 2017). Climate variability refers to variations in the mean state of temperature, monthly or seasonal rainfall, etc., and other statistics such as standard deviations, statistics of extremes, etc., beyond that of individual weather events. A good understanding of the historical climate trends, current climate variability and climate change projections are very critical for identifying the most vulnerable regions, cropping systems, communities, etc., and to prioritise, develop and implement adaptation/resilience measures.

In this Chapter the trends in observed climate, current climate variability and climate change projections are presented for the state of Chhattisgarh. Study of the Chhattisgarh region for various attributes of hydrology, climatology, and topography with the perspective to understand, plan, and mitigate those events that are uncertain because of disturbances in natural environments due to climate change, one of the most serious threats, both globally and locally, is important. The survival and growth of society are closely linked with the prevailing environmental conditions. However, soon, that may be frequently disrupted due to climate change. Climate is a statistical portrayal of meteorological variables such as precipitation, temperature, humidity, etc. in any region over a prolonged period. Climate can be contrasted to weather, which is the present status of meteorological variables over a shorter period, up to some weeks. Climate change is the variation in the mean and variability of global or regional climates over time scales ranging from decades to millions of years. The climatic alterations can be triggered by the internal Earth activities, external factors such as variations in solar radiation and human activities. The globally averaged combined land and ocean temperature data as calculated by a linear trend shows warming of 0.85 [0.65 to 1.06] °C, over the period 1880–2012 [Intergovernmental Panel on Climate Change (IPCC), 2013]. India has experienced an increase of 0.42°C, 0.92°C and 0.09°C in annual mean temperature, mean maximum temperature and mean minimum temperature respectively over the last 100 years.

3.2 Climatic Profile and Characteristics

The term climatic water balance refers to the balance obtained by comparing the precipitation as input with potential evapotranspiration as an expenditure. Water balance has been calculated for four stations in Chhattisgarh. This type of analysis is quite necessary for the calculation of climate type in the state of Chhattisgarh. Parameters derived out of this type of exercise is Water surplus, Water Deficit, Actual Evapotranspiration, and derived indices can be the Index of Humidity Index, Aridity Index, Moisture Adequacy, Moisture Index. The criterion for classification of climate is given in the table below:

Table 10: Classification of climate on the basis of moisture Index

Moisture Index	Climate Type (symbol)
Above 100	Per-Humid (A)
80-100	Humid (B4)
60-80	Humid (B3)
40-60	Humid (B2)
20-40	Humid (B1)
0-20	Moist sub-Humid (c2)
0 to -33.3	Dry sub-Humid (c1)
-33.3 to -66.7	Semi-arid
Less than -66.7	Arid

Source: IGKV Raipur, 2021

Figure 9: Agroecological zonations of Chhattisgarh

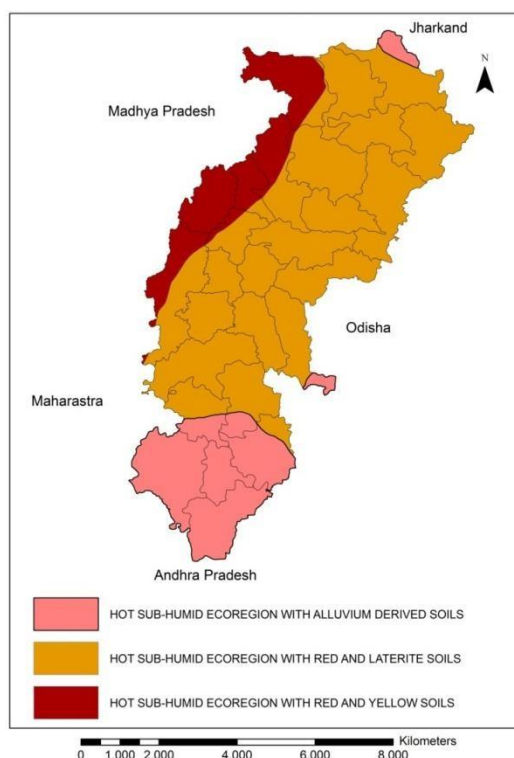
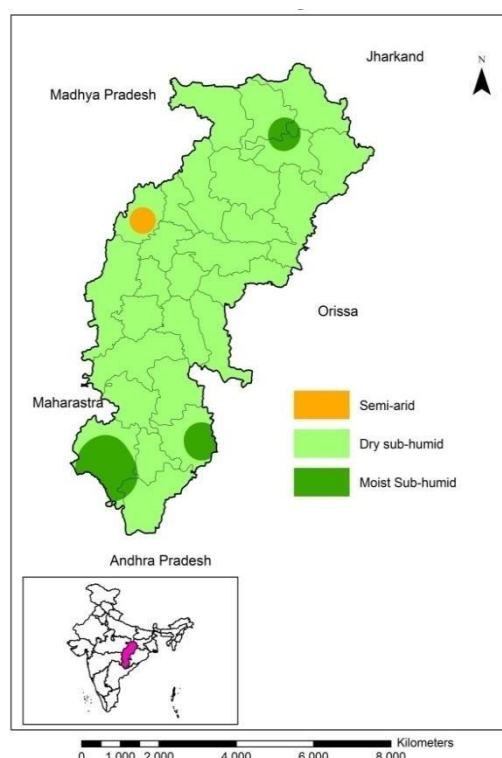


Figure 9: Climatic type of Chhattisgarh state



Map Source: IGKV, Raipur

Agroecological Zonations of Chhattisgarh

The National Bureau of Soil Survey and Land-use Planning (NBSS and LUP) has delineated the country at the National level into different agroecological regions based on soils, physiography, length of the growing season (LGP) and bioclimate. At the state level, agroecological zonation is done considering soil family association (1:250000 scale), landform, annual rainfall at the sub-divisional level and LGP. The agroecological zonation maps prepared for the entire country have been as a basis to extract zones for the Chhattisgarh state by superimposing GIS Maps of district boundaries. The base map of 20 AER of NBSS & LUP (Gajbhiye and Mandal, 2006) has been utilised for this demarcation. Major geographical area of the state lies in zone 11. Chhattisgarh/Mahanadi Basin Agro-eco-region (J3 C3), Moderately to gently sloping Chhattisgarh/Mahanadi Basin, hot moist/dry subhumid transitional ESR with deep loamy to clayey red and yellow soils, medium AWC and LGP 150-180 days (J3Cd/Cm5) as shown in Fig. 9. Further classification of this zonation into sub-regions is the same as there is no further sub-division in any of the zone. Agro-climatic features of various zones in Chhattisgarh state are given in the table below:

Table 11: Agro-climatic features of various zones in Chhattisgarh state

Features	Chhattisgarh Plains Zone	Northern Hill Region	Bastar Plateau
Geographical extent	Raipur, Mahasamund, Dhamtari, Gariabund, Balodabazar, Durg, Balod, Rajnandgaon, Kawardha, Bemetara, Bilaspur, Korba, Janjgir-champa, Raigarh and Kanker districts.	Surguja, Koriya, Jashpur, Surajpur and Balrampur district.	Bastar, Kondagaon, Sukma, Bijapur, Naraynapur and Dantewada districts.

Annual rainfall(mms)	950-1200	1160-1380	1250--1410
Soil type	Bhata (Lateritic), Matasi (Sandy loam), Dorsa (clay loam), Kanhra (clay)	Hilly soils, Tikra, Goda Chawar, Bahara	Marhan (coarse sandy) Tikra (sandy), Mal (sandy loam), Gabhar (clay and clayey loam)
Crops	Rice, Small millets, sesamum, pulses (moong, arhar, urid) and oilseeds (soybean, sunflower, groundnut) Sugarcane, Cabbage, Cauliflower, Tomato, Colocasia, Banana, Papaya, Mango Rabi: Summer rice, wheat, mustard, sunflower and groundnut chickpea.	Rice, gram, Wheat, Black Gram, Groundnut, Toria, Niger, Sugarcane, Potato, Mango, Guava and Litchi.	Rice, Minor Millets, Toria, Linseed, Horse Gram, Lentil, Jackfruitall rabi crops can be grown on residual moisture

Source: IGKV, 2021

Features of Southwest Monsoon rainfall:

The highest southwestern rainfall has been observed for Jashpurnagar (1361.7 mm) while the lowest has been observed for Kawardha 807.0 mm. The impact factor can be observed that the intensity of cyclonic depression decreases significantly particularly when cyclone depressions reach the western part of the state. Chhattisgarh state receives 1056 mms of rainfall during the SWM season. At the district level, Chhattisgarh state as a whole is subjected to 28 per cent variable monsoon rainfall which is relatively high compared to All-India monsoon rainfall variability (11 per cent). Region-wise lowest variability is seen in the Chhattisgarh plains zone and NHR (tied at 28 per cent) and the highest in the Bastar Plateau. At the district level, the highest variability in the monsoon rainfall is observed in Balrampur district followed by Bijapur (40 per cent) and the lowest variability is found in Kondagaon district. On average, SWM rainfall in the state is spread over 49 days. At the regional level, the highest number of rainy days are observed in the Bastar Plateau region (65 days) and the lowest over the Chhattisgarh Plains region (53 days) and these are intermediate over the Northern Hill Region (61 days). At the district level, Bastar district recorded a maximum number of rainy days (76 days) followed by Jashpurnagar district (71 days) and these were least in Balod district (IGKV, Raipur, 2021)

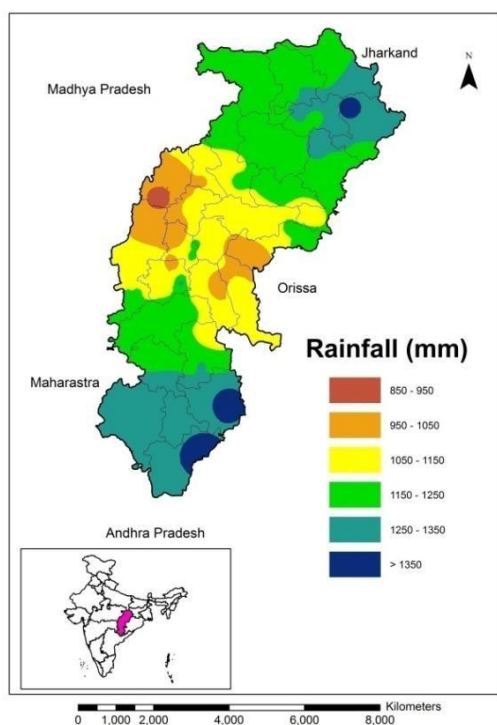
Features of Northeastern Rainfall:

Northeastern rainfall is also a crucial factor and production of rainfed rice grown largely depends on the quantity and coinciding with the flowering phase of long duration photo-sensitive varieties of this region. Lowest rainfall has been observed in Baghbahra (32.3 mms) and Chhuria (22.3 mms) and the highest rainfall has been observed for Jashpurnagar. Rainfall during NEM season for the entire state is 69 mms with a variability of 86 per cent which is almost three times and significantly higher than the variability observed for the monsoon season rainfall. Bastar Plateau Zone receives significant amount of rainfall (94 mm) mainly in the Bijapur district followed by Bastar district. Northern Hill Zone receives a fairly good amount of 70 mm rainfall mainly in the Surguja and Jashpur district. Thus, it can be said that the chances of receiving rainfall over the Chhattisgarh Plains zone are relatively less. Among the districts in this zone, Bilaspur district receives abundant rainfall (76 mm) during this season followed by Kanker district (74 mm) and is lowest in Gariaband district (IGKV Raipur, 2021).

Variability in NEM rainfall is low over Bastar Plateau region (92 per cent) compared to Chhattisgarh plains zone (109 per cent) and Northern Hill Region (105 per cent). In Gariabandh and Korba districts, the NEM

rain is highly variable (132 per cent) followed by the Mahasamund district (124 per cent). Average number of rainy days during NEM season for the state is four. However, it ranges from three days in many districts to seven days in the Bastar district. Only the southern side of the state experiences a relatively strong NEM season.

Figure 10: Annual Rainfall in Chhattisgarh



Features of summer and winter rainfall:

Summer season rainfall is also a critical factor in this region as summer ploughing largely depends on this parameter. Highest quantity of summer season rainfall is found highest for Pendra (121.1 mm) followed by Pendra road (94.9 mm), Dharmajaigarh (74.0 mm) and Bilaspur (54.4 mm) and the lowest quantity has been observed for Dondi. The mean summer rainfall for the state is 41 mm. At the regional level, the Bastar Plateau region gets more rainfall (64 mm) than the Chhattisgarh Plain region (30 mm) and Northern Hill region (49 mm). Districts Bastar (143 mm) and Balrampur (87 mm) receive high rainfall whereas the lowest is in Durg district (8 mm) in the Chhattisgarh Plains region. This summer season rainfall can be attributed largely due to the local activities but the significance of this type of rainfall can't be ignored. This rainfall largely contributes towards initial field preparations, summer ploughing which largely leads to a great advantage for the farmers following this practice in insect-pests and

disease spores' destruction and perennial weeds control etc., Rain during the winter season is very meagre and there are insignificant values observed. Therefore, the winter season can be termed as driest. Highest winter rainfall is being observed in the Bijapur district. (Source: IGKV Raipur, 2021)

3.3 Past and On-going Climate Change Trends

Historical climate assessment (based on IMD) and Climate change projection (based on CORDEX)

IMD (Indian Meteorological Division) gridded rainfall data of resolution $0.25^\circ \times 0.25^\circ$ from 1901 to 2017 and a temperature data of resolution $1.0^\circ \times 1.0^\circ$ for a period of 1951-2017 are used to analyze trend and variability of climate data considering the criticalness of Kharif season (JJAS) and Rabi season (OND). CORDEX (Coordinated Regional Climate Downscaling Experiments) data of grid-scale $0.44^\circ \times 0.44^\circ$ resolution to assess short (2021-2050) and long term (2021-2100) analysis considering RCP (Representative Concentration Pathway) 4.5 and 8.5 scenario condition. The 28 districts of Chhattisgarh were analyzed using gridded spatial information of the districts. The information depicted in tables and figures is the data for 28 districts. Furthermore, a detailed discussion on trend and variability information is provided for all 28 districts considering spatial information.

In this study, high resolution ($0.25^\circ \times 0.25^\circ$) gridded precipitation data (1901-2017) are studied for trend and periodicities, the statistics of Mann-Kendall, Sen's slope and Pettitt's test is tabulated below in Table -12. The statistics suggest that the precipitation trend is significantly decreasing for pre-monsoon, monsoon and annual rainfall series at a 5% significance level and for post-monsoon rainfall, the decreasing trend is not significant at 5% significance level (NIT Raipur, 2022).

Table 12: Mann-Kendall, Sen's slopes and Pettitt's change point of rainfall for Chhattisgarh

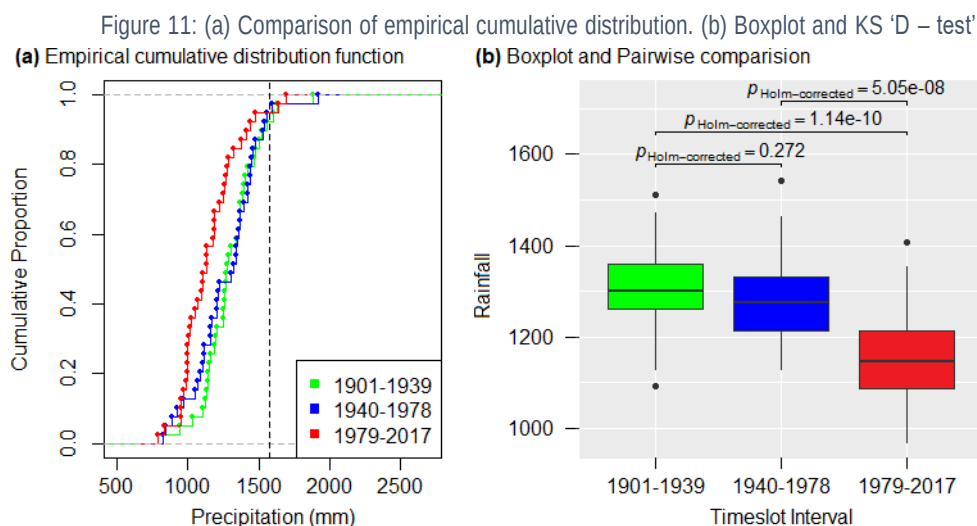
S No.	Description	Mann-Kendall(Z)	p_value	Sen's slope (mm/year)	Pettitt's (year)	p_value
1	Pre-Monsoon	-2.735	0.006	-0.218	1971	0.002
2	Monsoon	-2.820	0.005	-1.241	1961	0.000
3	Post-Monsoon	-1.152 (not significant at 5 % significance)	0.249	-0.142	1964	0.324
4	Winter	-3.428	0.001	-0.208	1948	0.001
5	Annual	-3.682	0.000	-1.850	1961	0.000

Source: NIT Raipur, 2022

Analysis of temporal variations using the sequential Mann-Kendall trend test suggests that for pre-monsoon rainfall, a long term of about seven decades (1953-2017) has been observed to be following a decreasing trend, and from 1986 onwards observed to be significant. The monsoon rainfall, on the other hand, had a long-term increasing trend for a period of seven decades (1903-1973). Later, during 1974-2017, a decreasing trend was observed and it became significant from 1998 onwards. The annual rainfall of the Chhattisgarh region had a long-term increasing trend of approximate seven decades (1903-1971), in which 1937-1953 were observed to be significant. In the later period, from 1972-2017, a decreasing trend was observed, and it became significant from 1987 onwards. This shows uncertainties involved in predicting the impact of climate change over long periods and cautions us to take a conservative approach to safeguard human life and welfare.

Spatial pattern variability on summer precipitation (Jun, July & Aug) was not observed and significantly influenced mid-autumn (Oct) in the upper (Seonath basin) subdivision for the period 1979-2017. The eCDF and boxplot interpretation also suggest that the upper (Seonath basin) subdivision has a consistent range of precipitation magnitude in all time slots but has a sudden fall in cumulative precipitation refer to Fig.

11. The middle subdivision including Mahanadi stream, Hasdeo, Ib, and Mand river does not experience summer spatial pattern variability (Jun, July & Aug). The retreating monsoon (Oct, Nov & Dec) was more dominant and observed effects in the middle subdivision.



3.2.1. Rainfall trend during 1901-2017

The overall trend in Chhattisgarh is decreasing with the most significant decreasing trend observed in Sarguja, Balarampur, Jangir-Champa, Surajpur, Raigarh, Korla, Raipur, & Mahasamund having Z-value - 5.10, - 5.04, -4.72, -4.71, -4.67, -4.54, -4.29, -4.00, respectively. This decreasing trend has a fall of the maximum of 3.95 mm/year to 3.05 mm/year. Similarly, Narayanpur, Kabirdham, Mungeli, Dantewada, & Kanker observed a decreasing trend but not significant at 5 % significance level. Whereas, Sukma and Bijapur observed the increasing trend, refer to Fig. 12.

A similar trend is observed even in Kharif season (JJAS) with respect to annual rainfall. Surajpur, Raigarh, Jangir-Champa, Baloda-Bazar, Surajpur, & Balarampur observed a significant decreasing trend having Z- value -4.36, -4.15, -4.11, -4.08, -4.07, -4.02. This decreasing trend has an annual fall ranging from 2.6mm/year to 2.96 mm/year. Other districts including Bemetara, Bilaspur, Bastar, Durg, Balod, Rajnandgaon, Mungeli, Kabirdham, Narayanpur, Kanker, & Dantewada observed a decreasing trend but not significant. Sukma and Bijapur in Kharif season depict a significant increasing trend with +2 mm/year for Sukma and +3mm/year for Bijapur.

3.2.2. Rainfall variability of Kharif season (JJAS) during 1901-2017

This section describes the analysis of rainfall variability of Kharif season (JJAS) for the period 1901-2017. Indicators of rainfall variability including coefficient of variation (CV), standard deviation and mean rainfall for Kharif and Rabi season are presented and illustrated in Table 13. The coefficient of variation of Kharif season or JJAS rainfall was typically moderate to high in the district of Chhattisgarh and was in the range in-between 17% in Bilaspur district to 24% in Raipur, Bijapur and Baloda-Bazar district.

Moderate rainfall variability (<20%)

11 districts of Chhattisgarh with moderate rainfall variability that lies below the mark of 20% and these include Sarjuga (19%), Bemetara (18%), Mungeli (18%), Bilaspur (17%), Koriya (19%), Raigarh (19%), Korba (19%), Narayanpur (19%), Jashpur (19%), Kondagaon (18%) and Bastar (19%).

Moderate to High rainfall variability (>20%)

16 districts of Chhattisgarh that showed moderate to high rainfall variability above the mark of 20% are – Balarampur (20%), Kabirdham (20%), Baloda-Bazar (24%), Mahasamund (21%), Dhamtari (22%), Surajpur (21%), Balod (21%), Gariband (23%), Durg (20%), Rajnandgaon (20%), Raipur (24%), Janjgir-Champa (20%), Kanker (20%), Dantewada (22%), Bijapur (24%), and Sukma (21%).

Historical temperature climate data assessment for trend and variability:

IMD (Indian Meteorological Division) gridded temperature data of resolution 1° x 1° for a period of 1951- 2017 are used to analyze trends and variability. The details are illustrated below:

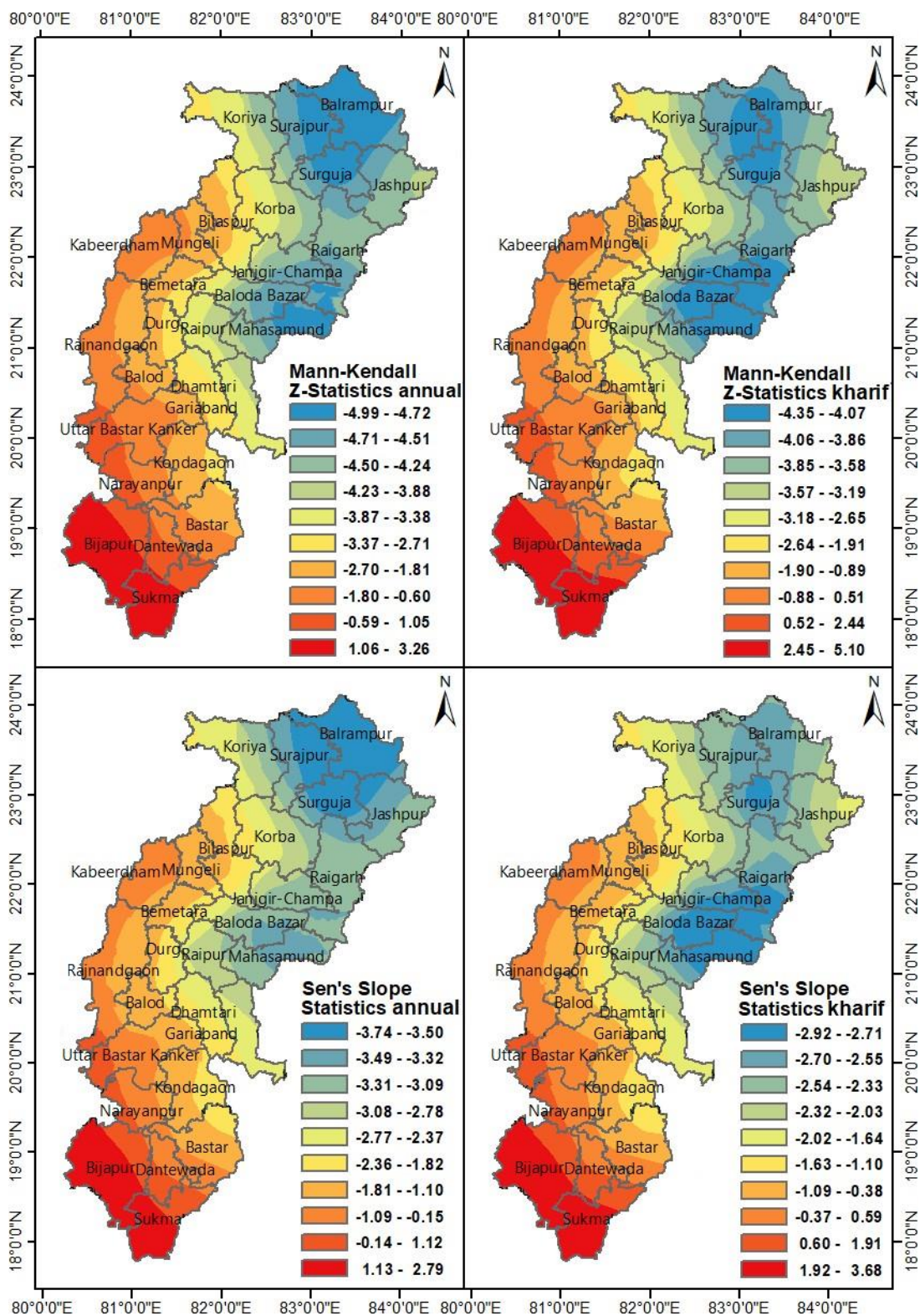
Temperature trend during 1951-2017:

Temperature time series during 1951-2017 depicts moderate increasing warming trend in Chhattisgarh for summer maximum, whereas moderate versatile trend for winter minimum. The average maximum temperature in the districts of Chhattisgarh during March-April-May (MAM) was clinched high and ranged from 36.11°C in Sukma to 38.88°C in Rajnandgaon district. The summer maximum temperature during the historical period (1951-2017) has increased in the range of 0.15°C in Balrampur to 1.10°C in Gariyaband refer to Fig. 13 and Table 14.

The average minimum temperature in the districts of Chhattisgarh during December-January-February (DJF) was observed and ranged from 9.90°C in Koriya to 17.47°C in Sukma district. The winter minimum temperature during the historical period (1951-2017) has varied in the range of -0.28°C in Raigarh to

0.43°C in Koriya. It is also noticed that Koriya being the coldest district during winter is more influenced by temperature variability. In the past 67-year Koriya has increased by 0.43°C, refer to Fig. 14 and Table 14.

Figure 12: Mann-Kendall and Sen's Slope statistics for assessing the trend and its magnitude for precipitation during 1901-2017.



Source: NIT Raipur, 2022

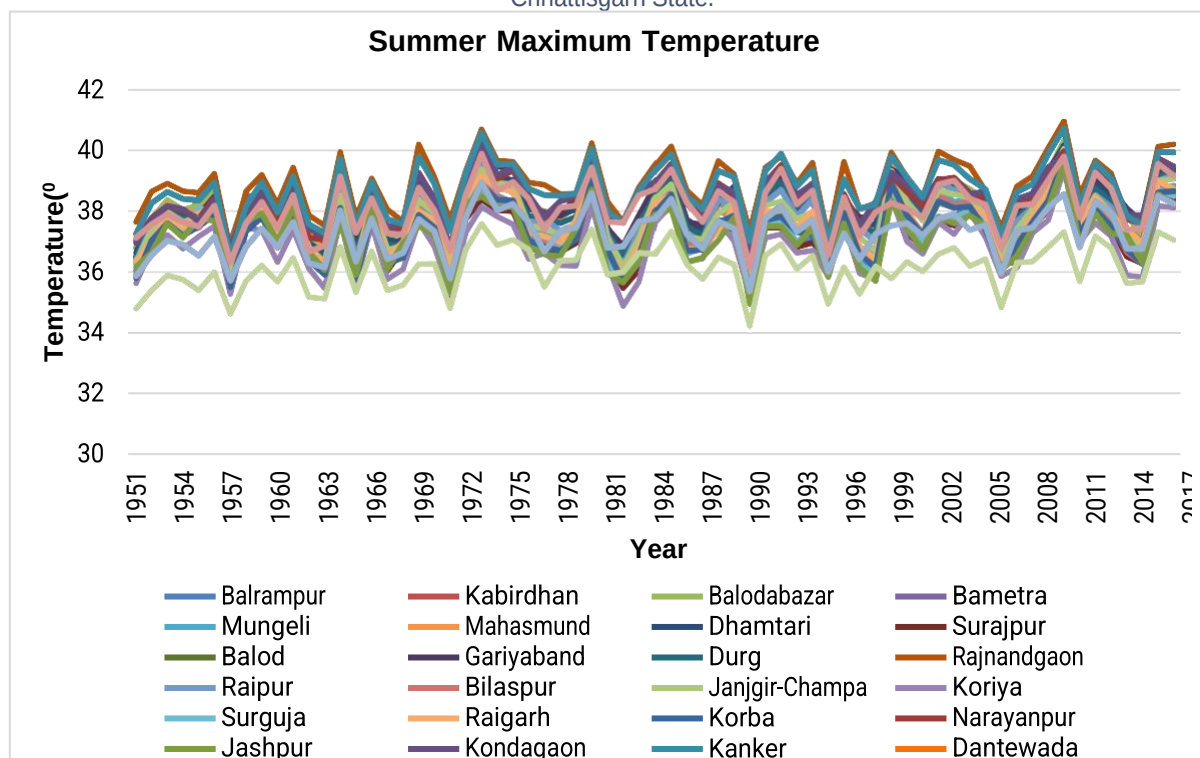
Table 13: Historical (1901-2017) mean annual, Kharif (JJAS) and Rabi (DJF) season rainfall, containing Standard Deviation and Coefficient of Variance of Kharif and Rabi season rainfall.

Districts	Mean annual rainfall (mm)	Kharif (JJAS)			Rabi (DJF)		
		Mean rainfall (mm)	Standard Deviation (mm)	CV (%)	Mean rainfall (mm)	Standard Deviation (mm)	CV (%)
Surguja	1495	1305	253	19	87	64	73
Balrampur	1344	1156	234	20	84	63	75
Kabirdham	1135	979	194	20	75	58	77
Baloda Bazar	1197	1081	254	24	56	49	89
Bemetra	1160	1032	188	18	62	46	75
Mungeli	1255	1091	195	18	72	56	78
Mahasmund	1294	1156	247	21	63	51	82
Dhamtari	1324	1176	260	22	74	70	93
Surajpur	1350	1190	246	21	71	58	82
Balod	1306	1155	245	21	79	68	87
Gariaband	1117	966	223	23	73	64	88
Durg	1223	1088	222	20	65	53	81
Rajnandgaon	1247	1098	214	20	76	62	82
Raipur	1237	1116	268	24	61	56	93
Bilaspur	1317	1165	197	17	67	52	77
Janjgir-Champa	1374	1235	245	20	62	50	80
Koriya	1308	1159	224	19	65	54	83
Raigarh	1462	1295	252	19	74	54	73
Korba	1454	1301	253	19	70	55	78
Narayanpur	1463	1266	236	19	101	75	74
Jashpur	1533	1304	247	19	100	76	76
Kondagaon	1427	1213	218	18	105	74	70
Kanker	1404	1255	256	20	84	71	84
Dantewada	1559	1312	286	22	128	79	61
Bastar	1552	1281	241	19	128	80	62
Bijapur	1479	1281	302	24	112	69	61
Sukma	1430	1169	241	21	147	84	57

Source: NIT Raipur, 2022

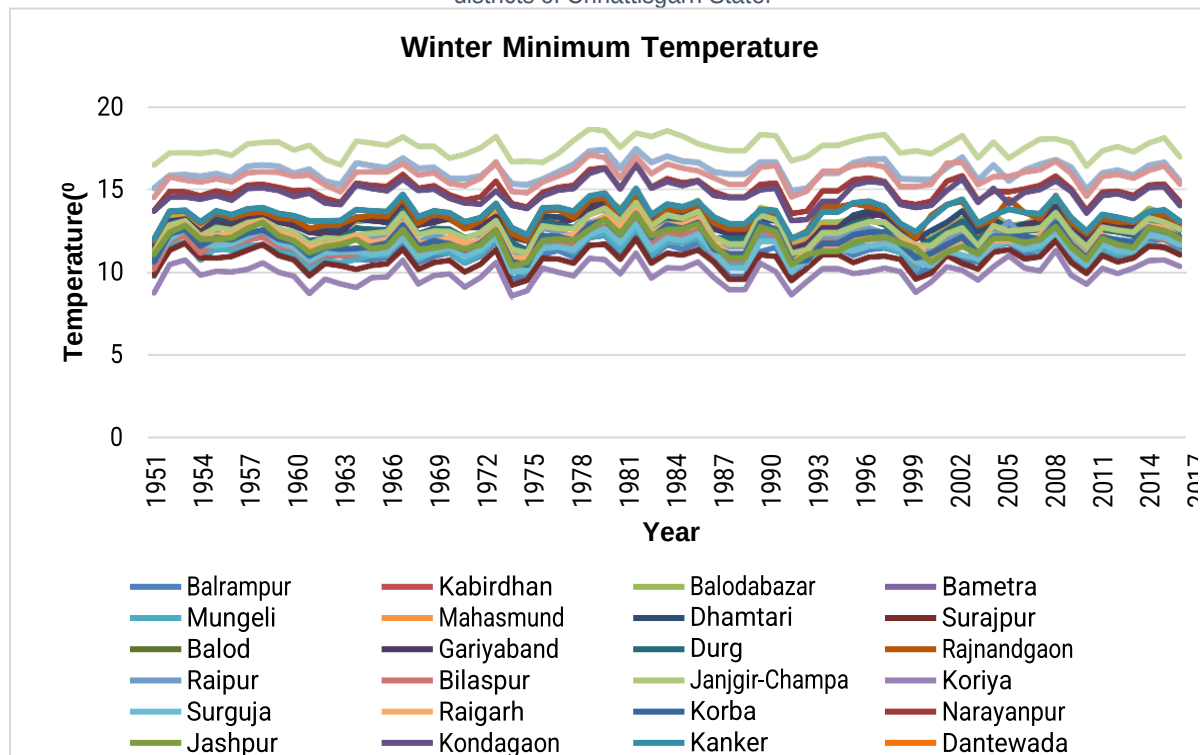
Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Figure 13: Graphical representation of Summer maximum temperature (March-April-May) during 1951-2017 for the districts of Chhattisgarh State.



Source: NIT Raipur, 2022

Figure 14: Graphical representation of Winter minimum temperature (December-January-February) during 1951-2017 for the districts of Chhattisgarh State.



Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Table 14: Historical (1951-2017) winter minimum temperature and summer maximum temperature, containing Mann-Kendall (Z) statistics, Sen's Slope and 67-year variation.

District	Winter minimum temperature				Summer maximum temperature			
	Mean temperature (°C)	Man-Kendall (Z)	Sen slope	67 Year Variation (°C)	Mean temperature (°C)	Mann-Kendall (Z)	Sen slope	67 Year Variation (°C)
Balrampur	11.13	-0.06	0.00	-0.01	37.44	0.27	0.00	0.15
Kabirdham	11.24	1.11	0.00	0.31	37.48	1.80	0.01	0.80
Baloda bazar	13.09	-0.06	0.00	-0.01	38.17	1.85	0.01	0.77
Bemetra	12.01	0.06	0.00	0.01	37.77	2.06	0.01	0.91
Mungeli	11.24	1.11	0.00	0.31	37.48	1.80	0.01	0.80
Mahasmund	12.97	-0.15	0.00	-0.05	38.18	2.40	0.01	0.93
Dhamtari	12.91	-0.37	0.00	-0.08	38.06	2.23	0.01	0.87
Surajpur	10.70	0.71	0.00	0.15	37.18	0.68	0.00	0.31
Balod	13.48	-0.23	0.00	-0.05	38.67	2.24	0.01	0.92
Gariaband	12.85	-0.11	0.00	-0.03	38.20	2.75	0.02	1.10
Durg	12.46	-0.15	0.00	-0.03	37.92	2.10	0.01	0.90
Rajnandgaon	13.29	0.24	0.00	0.07	38.88	1.96	0.01	0.84
Raipur	12.01	0.06	0.00	0.01	37.77	2.06	0.01	0.91
Bilaspur	11.56	0.95	0.00	0.25	37.38	1.86	0.01	0.79
Janjgir-champa	12.48	0.24	0.00	0.08	37.73	1.90	0.01	0.79
Koriya	9.90	1.81	0.01	0.43	36.84	1.46	0.01	0.59
Surguja	11.39	-0.39	0.00	-0.13	37.30	0.75	0.01	0.35
Raigarh	12.01	-1.07	0.00	-0.29	37.55	1.54	0.01	0.64
Korba	11.88	0.58	0.00	0.16	37.29	1.89	0.01	0.81
Narayanpur	14.90	0.22	0.00	0.06	38.34	2.51	0.01	0.98
Jashpur	11.81	-0.73	0.00	-0.23	37.15	0.77	0.00	0.32
Kondagaon	14.67	0.35	0.00	0.07	38.38	2.80	0.02	1.01
Kanker	13.48	-0.23	0.00	-0.05	38.67	2.24	0.01	0.92
Dantewada	16.07	0.70	0.00	0.19	37.24	2.62	0.01	0.96
Bastar	16.07	0.70	0.00	0.19	37.24	2.62	0.01	0.96
Bijapur	15.76	1.26	0.00	0.28	38.09	2.55	0.01	0.99
Sukma	17.47	1.04	0.00	0.26	36.11	2.59	0.01	0.87

Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Drought Years during 1901 – 2017

The historical climate data has been analysed for meteorological droughts during the period of 1901 – 2017. The Standard Precipitation Index (SPI) is a relatively new drought index based only on precipitation. It's an index based on the probability of precipitation for any time scale. In this study, years with SPI value less than (-1.5) is considered as severe drought and less than (-2.0) as extreme drought condition with respect to long term average and these years are considered as rainfall deficient years or Drought years.

For severe condition with SPI < - 1.50

16 districts for more than 10 times experienced severe drought condition and the maximum frequency of drought were at Surguja (19), Raigarh (18), and Janjgir-Champa (18). Whereas, other 11 districts with less than 10 drought years with minimum drought years observed at Sukma (2) refer to Fig. 15 and Table 15.

For extreme condition with SPI < - 2.00

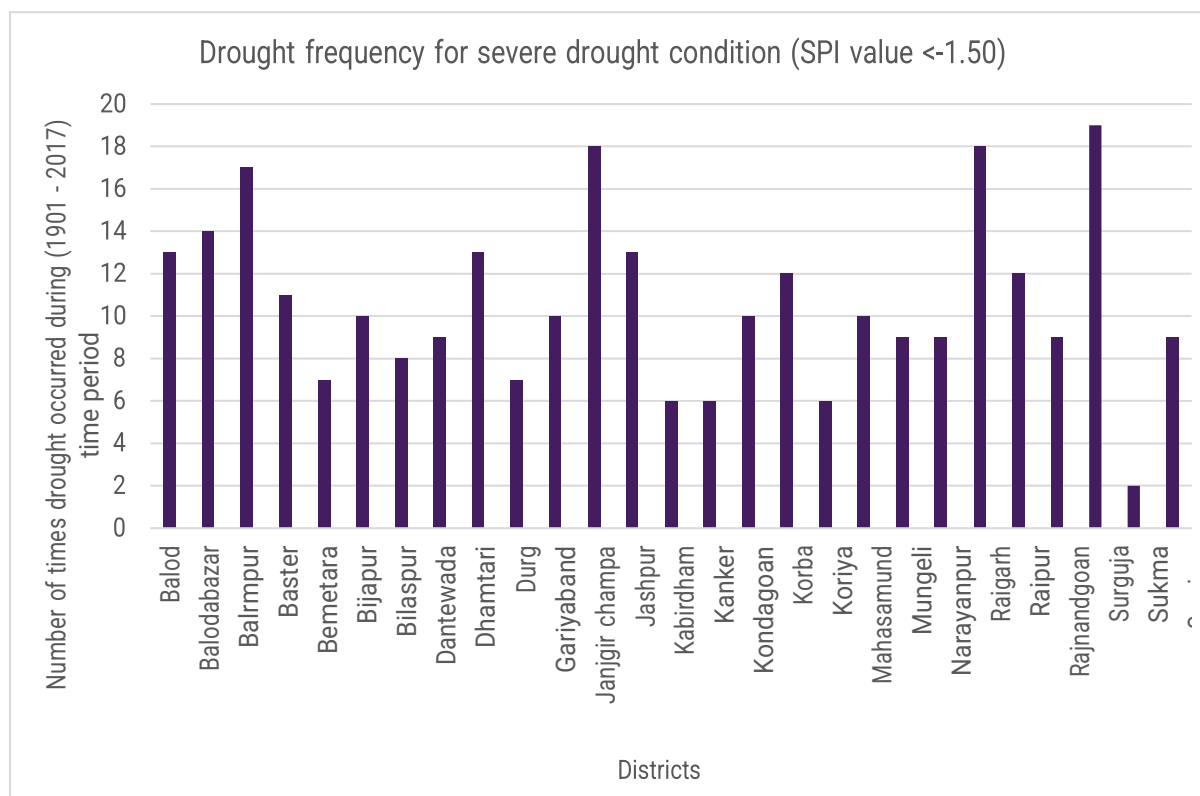
Only 3 districts experienced extreme drought condition, namely Sarguja (14), Raigarh (11), and Jashpur (10). Whereas other 24 districts were well below the 10 extreme drought years with minimum drought years observed for Sukma (0), Bemetara (1), and Durg (1) refer to Fig. 16 and Table 15.

Table 15: Statistics for the number of drought years based on Kharif (JJAS) season rainfall during 1901 - 2017.

Districts	Drought Years		Districts	Drought Years		Districts	Drought Years	
	Severe	Extreme		Severe	Extreme		Severe	Extreme
BALOD	13	5	DURG	7	1	MAHASAMUND	10	6
BALODABAZAR	14	6	GARIYABAND	10	5	MUNGELI	9	4
BALRMPUR	17	9	JANJGIR CHAMPA	18	8	NARAYANPUR	9	5
BASTER	11	4	JASHPUR	13	10	RAIGARH	18	11
BEMETARA	7	1	KABIRDHAM	6	3	RAIPUR	12	7
BIJAPUR	10	3	KANKER	6	3	RAJNANDGOAN	9	2
BILASPUR	8	4	KONDAGOAN	10	4	SURGUJA	19	14
DANTEWADA	9	2	KORBA	12	9	SUKMA	2	0
DHAMTARI	13	6	KORIYA	6	4	SURAJPUR	9	8

Source: NIT Raipur, 2022

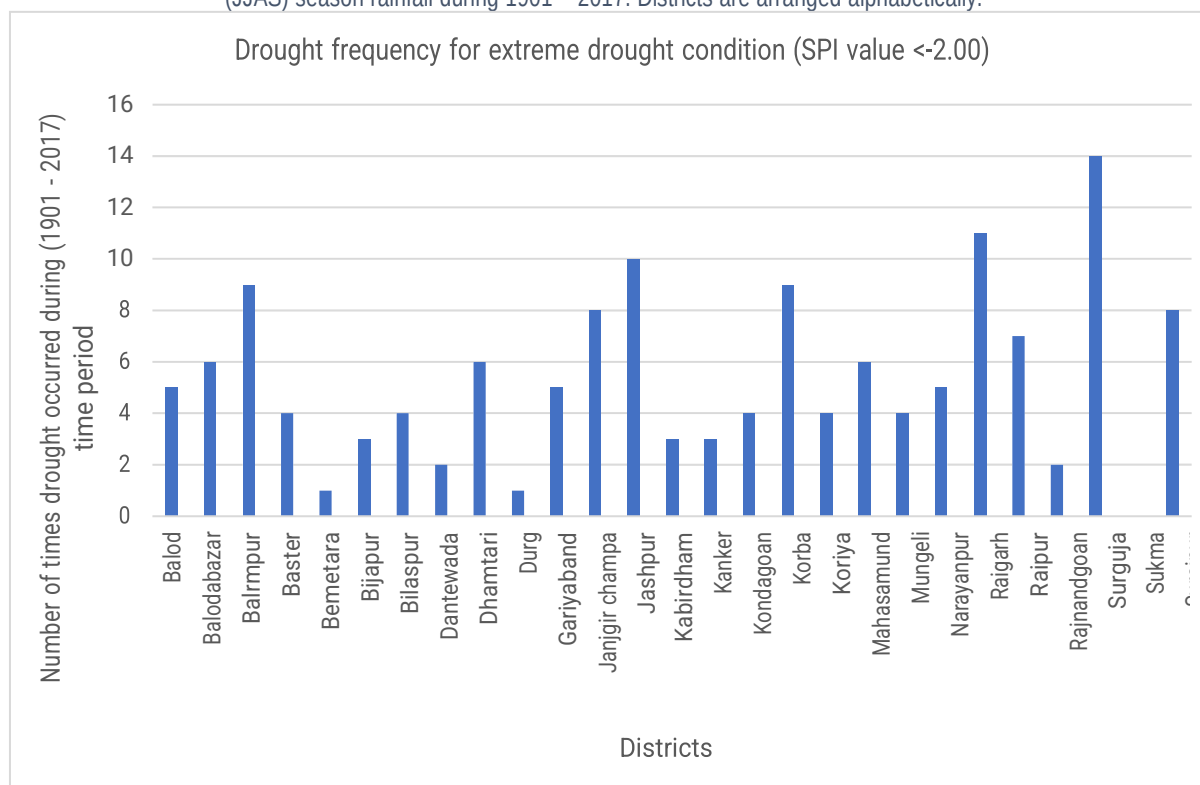
Figure 15: Occurrence of Drought years (No of years out of 117) based on severe drought condition (SPI < -1.5) for Kharif (JJAS) season rainfall during 1901 – 2017. Districts are arranged alphabetically.



Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Figure 16: Occurrence of Drought years (No of years out of 117) based on extreme drought condition (SPI < -2.0) for Kharif (JJAS) season rainfall during 1901 – 2017. Districts are arranged alphabetically.



Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

3.4 Development of Climate Change Scenarios

Projection of precipitation by using RCMs (Regional Climate Models of CORDEX)

In this section of the analysis, RCM data is presented. Seventeen RCM dataset is used in the study. The South Asian region is highly susceptible to climate change; any variations in the behaviour of monsoon will play a pivotal role in socio-economic growth. It is also reported that many of the coupled models project an increase in precipitation over South Asia (IPCC 2007). In such a situation, it is necessary to study how climate change will affect the cities because the population of India is gradually increasing in the urban areas.

As per IPCC (Intergovernmental Panel of Climate Change) AR5 (Assessment Report 5)

RCP – The RCP is the latest generation of scenarios that provide input to climate models. RCPs are time and space-dependent trajectories of concentrations of greenhouse gases and pollutants resulting from human activities, including changes in Land Use.

The four RCPs, RCP2.6, RCP4.5, RCP6, and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 W/m², respectively).

RCP 4.5 – Intermediate emissions, here radiative forcing is stabilised shortly after the year 2100, consistent with a future with relatively ambitious emissions reductions.

RCP 8.5 – High emissions, and is characterized by increasing greenhouse gas emissions that lead to high greenhouse gas concentrations over time.

AR5 global warming increase (°C) projections		
	2046-2065	2081-2100
Scenario	Mean and likely range	Mean and likely range
RCP 2.6	1.0 (0.4 to 1.6)	1.0 (0.3 to 1.7)
RCP 4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)
RCP 6.0	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)
RCP 8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)

Across all RCPs, global mean temperature is projected to rise by 0.3 to 4.8 °C by the late-21st century.

The findings for the Chhattisgarh study area are summarised below:

Rainfall trend analysis for future projection considering RCP 4.5

scenario condition Short-Term (2021-2050):

Future projections based on the RCP 4.5 scenario condition show an increasing trend in 19 districts, with Raipur showing an increasing trend with a Z-value of 2.03. Furthermore, the remaining 8 districts show a decreasing trend, with Balarampur, Surajpur, and Jashpur showing a decreasing trend with a Z-value of 0.005, 0.019, and 0.007, respectively refer Fig. 17 and Table 16. From Table 15, it is also observed that the mean rainfall for the projected duration 2021-2050 with respect to the historical period 1901-2017 is decreased in most of the districts of Chhattisgarh, refer to Table 16.

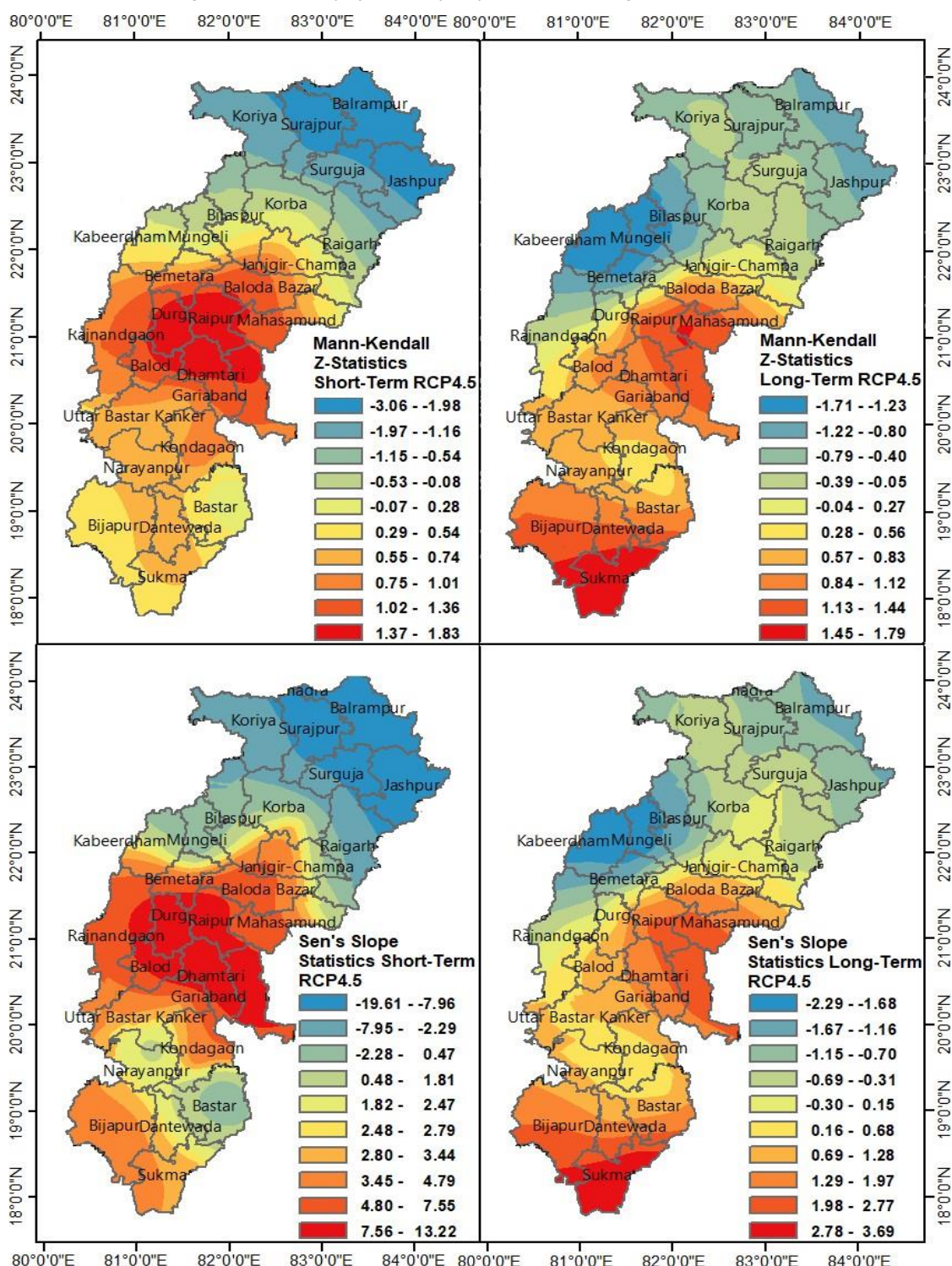
Long-Term (2021-2100):

Future projections based on the 4.5 RCP scenario condition show an increasing (decreasing) trend in 15 (12) districts, with no significant increasing (decreasing) trend is expected. Furthermore, the expected shifting of increasing trend ranges from 0.03 mm/year at Durg to 3.33 mm/year at Sukma district, whereas the decreasing trend ranges from -0.10 mm/year at Janjgir-Champa to -2.0 mm/year at Mungeli district refer Fig. 17 and Table 16. From Table 5, it is also observed that the mean rainfall for the projected duration 2021-2100 with respect to the historical period 1901-2017 is decreased in most of the districts of Chhattisgarh, refer to table 15.

Short-Term and long-term rainfall variability considering RCP 4.5 scenario condition

This section describes the analysis of short-term and long-term rainfall variability considering RCP 4.5 scenario condition. Indicators of rainfall variability including coefficient of variation (CV), standard deviation and mean rainfall for RCP 4.5 scenario is presented and illustrated in Table 16. The coefficient of variation of RCP4.5 scenario condition was typically moderate to high in the districts of Chhattisgarh and was in the range in-between 11.6% in Dantewada district to 28.1% in Raipur district for short-term. Whereas for long-term rainfall variability this range lies in-between 15.2% in Narayanpur to 30% in the Durg district.

Figure 17: Mann-Kendall and Sen's Slope statistics for assessing the trend and its magnitude for future projection of precipitation considering RCP 4.5 scenario condition.



Moderate rainfall variability (<20%)

There are 12 districts in Chhattisgarh with moderate rainfall variability below the 20% mark, and these include Bemetara (18%), Mungeli (20%), Surajpur (20%), Bilaspur (15%), Koriya (20%), Raigarh (20%), Korba (17%), Narayanpur (13%), Kondagaon (18%), Kanker (20%), Dantewada (12%), Bastar (19%) for short-term rainfall variability. Similarly, there are only four districts below the 20% mark for long-term rainfall

variability and these include Bilaspur (18%), Korba (19%), Narayanpur (15%), and Dantewada (15%) refer to Table 16.

Moderate to High rainfall variability (>20%)

There are 15 districts in Chhattisgarh with moderate to high rainfall variability above the 20% mark, and these include Balarampur (20%), Kabirdham (20%), Baloda-Bazar (24%), Mahasamund (25%), Dhamtari (26%), Balod (25%), Gariband (27%), Durg (28%), Rajnandgaon (26%), Raipur (28%), Janjgir-Champa (23%), Surguja (20%), Bijapur (20%), and Sukma (22%) for short-term rainfall variability. Similarly, there are 23 districts above the 20% mark for long-term rainfall variability in which Durg is expected to experience maximum rainfall variability of about 30% refer to Table 16.

Table 16: Historical observed (1901-2017), RCP 4.5 Short-term (2021-2050), and RCP 4.5 (2021-2100) Long-term rainfall variability containing Standard Deviation and Coefficient of Variance.

Districts	Mean annual rainfall Observed (mm)	RCP 4.5					
		Short-Term (2021-2050)			Long-Term (2021-2100)		
		Mean rainfall (mm)	Standard Deviation (mm)	CV (%)	Mean rainfall (mm)	Standard Deviation (mm)	CV (%)
Surguja	1495	1397	281	20	1385	308	22
Balrampur	1344	1197	242	20	1173	254	22
Kabirdham	1135	1248	255	20	1203	251	21
Baloda Bazar	1197	1009	238	24	1044	280	27
Bemetra	1160	1109	201	18	1096	276	25
Mungeli	1255	1357	270	20	1313	297	23
Mahasmund	1294	980	246	25	1033	284	28
Dhamtari	1324	1296	335	26	1319	336	25
Surajpur	1350	1265	250	20	1253	287	23
Balod	1306	1198	296	25	1232	312	25
Gariaband	1117	1167	319	27	1209	341	28
Durg	1223	1183	332	28	1192	357	30
Rajnandgaon	1247	1205	310	26	1222	326	27
Raipur	1237	1081	304	28	1113	323	29
Bilaspur	1317	1215	179	15	1189	217	18
Janjgir-Champa	1374	1199	277	23	1181	285	24
Koriya	1308	1130	222	20	1142	247	22
Raigarh	1462	1284	246	19	1267	294	23
Korba	1454	1307	221	17	1302	251	19
Narayanpur	1463	1487	185	12	1491	226	15
Jashpur	1533	1458	341	23	1419	305	21
Kondagaon	1427	1419	258	18	1421	286	20
Kanker	1404	1281	253	20	1291	264	20
Dantewada	1559	1468	170	12	1497	228	15
Bastar	1552	1411	272	19	1434	313	22
Bijapur	1479	1445	295	20	1486	348	23
Sukma	1430	1486	331	22	1569	402	26

Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Rainfall trend analysis for future projection considering RCP 8.5

scenario condition Short-Term (2021-2050):

Future projections based on the RCP 8.5 scenario condition show an increasing trend in 19 districts with a maximum Z-value of 1.6 in Balarampur and a minimum Z-value of 0.0 in the Kondagaon district. Furthermore, the remaining 8 districts show a decreasing trend, with a maximum Z-value of -0.8 in Mungeli and a minimum Z-value of 0.0 in the Dantewada district refer Fig. 19 and Table 17. From Table 17, it is also observed that the mean rainfall for the projected duration 2021-2050 with respect to the historical period 1901-2017 is decreased in most of the districts of Chhattisgarh, refer to Table 17.

Long-Term (2021-2100):

Future projections based on the RCP 8.5 scenario condition show an increasing trend in 4 districts, with no significant increasing trend. Similarly, the remaining 23 districts show a decreasing trend with 6 districts with an expectation of a significant decreasing trend, including Raipur, Raigarh, Mungeli, Mahasamund, Bemetara, Baloda-Bazar. Furthermore, the expected shifting of increasing trend ranges from 0.26 mm/year at Narayanpur to 1.31 mm/year at Sukma district, whereas the decreasing trend ranges from -0.40 mm/year at Bastar to -3.25 mm/year at Raipur district refer Fig. 19 and Table 17. From Table 17, it is also observed that the mean rainfall for the projected duration 2021-2100 with respect to the historical period 1901-2017 is decreased in most of the districts of Chhattisgarh, refer to Table 17.

Short-Term and long-term rainfall variability considering RCP 8.5 scenario condition

This section describes the analysis of short-term and long-term rainfall variability considering RCP 8.5 scenario condition. Indicators of rainfall variability including coefficient of variation (CV), standard deviation and mean rainfall for RCP 8.5 scenario is presented and illustrated in Table 17. The coefficient of variation of RCP 8.5 scenario condition was typically moderate to high in the districts of Chhattisgarh and was in the range in-between 10.1% in Dantewada district to 29.2% in Raipur district for short-term. Whereas for long-term rainfall variability this range lies in-between 15.1% in Dantewada to 32.8% in the Durg district.

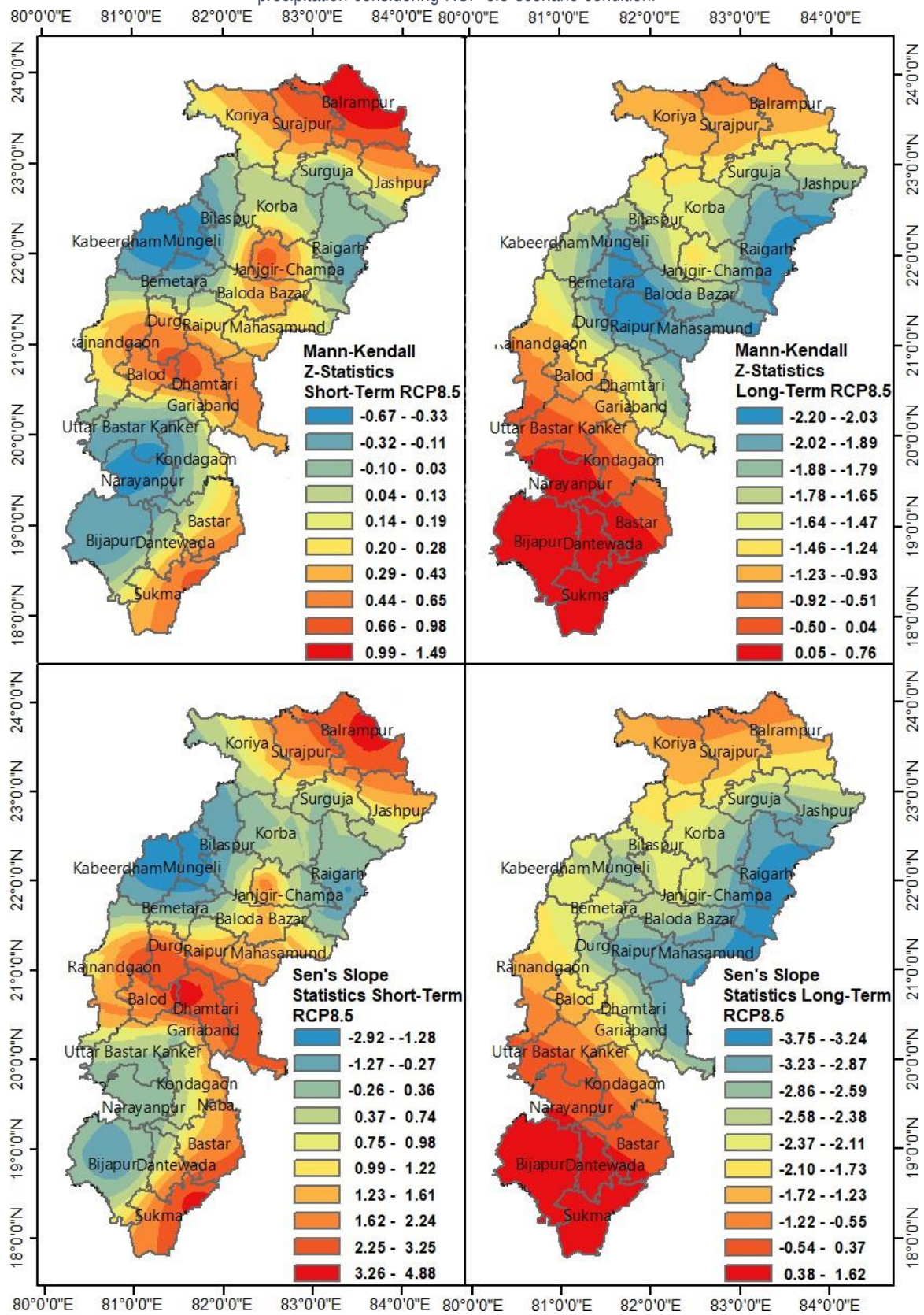
Moderate rainfall variability (<20%)

There are only 2 districts in Chhattisgarh with moderate rainfall variability below the 20% mark, and these include Dantewada (15%), and Narayanpur (16%) for long-term rainfall variability. Similarly, there are 12 districts below the 20% mark for short-term rainfall variability and these include Bilaspur (19%), Sarjuga (19%), Narayanpur (11%), Bijapur (19%), Dantewada (10%), Kanker (19%), Kondagaon (19%), Mahasamund (19%), Bastar (18%), Koriya (17%), Jashpur (16%), Surajpur (17%) refer Table 17.

Moderate to High rainfall variability (>20%)

There are 15 districts in Chhattisgarh with moderate to high rainfall variability above the 20% mark, and these include Mungeli (22%), Kabirdham (22%), Baloda-Bazar (29%), Mahasamund (28%), Raigarh (23%), Bemetara (29%), Korba (21%), Gariyaband (28%), Rajnandgaon (24%), Raipur (28%), Janjgir-Champa (25%), Durg (29%), Balod (24%), Dhamtari (24%) and Sukma (23%) for short-term rainfall variability. Similarly, there are 25 districts above the 20% mark for long-term rainfall variability in which Durg is expected to experience maximum rainfall variability of about 32.8% refer to Table 17.

Figure 18: Mann-Kendall and Sen's Slope statistics for assessing the trend and its magnitude for future projection of precipitation considering RCP 8.5 scenario condition.



Source: NIT Raipur, 2022

Table 17: Historical observed (1901-2017), RCP 8.5 Short-term (2021-2050), and RCP 8.5 (2021-2100) Long-term rainfall variability containing Standard Deviation and Coefficient of Variance.

Districts	Mean annual rainfall observed (mm)	RCP 8.5					
		Short-Term (2021-2050)			Long-Term (2021-2100)		
		Mean rainfall (mm)	Standard Deviation (mm)	CV (%)	Mean rainfall (mm)	Standard Deviation (mm)	CV (%)
Surguja	1495	1432	271	19	1401	347	25
Balrampur	1344	1183	179	15	1170	275	24
Kabirdham	1135	1212	265	22	1195	275	23
Baloda Bazar	1197	1078	310	29	1045	301	29
Bemetra	1160	1130	327	29	1104	290	26
Mungeli	1255	1359	303	22	1337	330	25
Mahasmund	1294	1098	308	28	1049	314	30
Dhamtari	1324	1307	314	24	1287	348	27
Surajpur	1350	1263	214	17	1247	304	24
Balod	1306	1213	291	24	1200	320	27
Gariaband	1117	1223	339	28	1180	338	29
Durg	1223	1182	341	29	1165	382	33
Rajnandgaon	1247	1216	289	24	1209	332	27
Raipur	1237	1115	326	29	1080	331	31
Bilaspur	1317	1240	232	19	1211	259	21
Janjgir-Champa	1374	1255	318	25	1247	379	30
Koriya	1308	1127	186	17	1141	264	23
Raigarh	1462	1369	314	23	1324	381	29
Korba	1454	1375	286	21	1350	348	26
Narayanpur	1463	1431	154	11	1464	239	16
Jashpur	1533	1460	231	16	1423	342	24
Kondagaon	1427	1414	272	19	1398	301	21
Kanker	1404	1276	246	19	1260	296	23
Dantewada	1559	1428	144	10	1456	220	15
Bastar	1552	1420	251	18	1398	309	22
Bijapur	1479	1421	268	19	1465	378	26
Sukma	1430	1497	339	23	1520	379	25

Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Draught Years during 2021 – 2100

The projected climate modelled data has been analysed for expected meteorological drought occurrence during the period of 2021 – 2100. The Standard Precipitation Index (SPI) is a relatively new drought index based only on precipitation. It's an index based on the probability of precipitation for any time scale. In this study, years with SPI value less than (-1.5) is considered as severe draught and less than (-2.0) as extreme drought condition with respect to long term average and these years are considered as rainfall deficient years or Drought years.

RCP 4.5

For severe condition with SPI < - 1.50: 14 districts with more than 5 times expected to experienced severe drought condition and maximum drought years were observed in Korba (9), Bilaspur (8), and Mungeli (8), and Kabirdham (8). Whereas, other 13 districts lie below the 5 drought years with minimum drought years observed Baloda Bazar (0) refer Fig. 19 and Table 18.

For extreme condition with SPI < - 2.0: 14 districts with less than 5 times expected to experienced extreme drought condition and maximum drought years were observed in Rajnandgaon (5). Whereas, other 13 districts do not experience extreme drought condition refer Fig. 19 and Table 18.

RCP 8.5

For severe condition with SPI < - 1.50: 5 districts with more than 10 times expected to experience severe drought condition and maximum drought years were observed in Gariyaband (11) and Surguja (11). Whereas, other 22 districts lie below the 10 drought years with minimum drought years observed Balarampur (1) refer Fig. 20 and Table 19.

For extreme condition with SPI < - 2.0: 20 districts with less than or equals 5 times expected to experience extreme drought condition and one district with maximum drought years was expected to observed in Raigarh (8). Whereas, other 6 districts do not experience extreme drought condition refer Fig. 20 and Table 19.

Table 18: Statistics for the number of drought years based on RCP 4.5 scenario condition.

Districts	Drought Years		Districts	Drought Years		Districts	Drought Years	
	Severe	Extreme		Severe	Extreme		Severe	Extreme
Balrampur	5	0	Gariaband	4	0	Korba	9	0
Kabirdham	8	2	Durg	7	0	Narayanpur	6	0
Baloda Bazar	0	0	Rajnandgaon	7	5	Jashpur	4	0
Bemetra	4	1	Raipur	3	0	Kondagaon	5	0
Mungeli	8	3	Bilaspur	8	3	Kanker	7	2
Mahasmund	1	0	Janjgir-Champa	7	2	Dantewada	4	1
Dhamtari	4	0	Koriya	5	1	Bastar	2	1
Surajpur	5	1	Surguja	4	0	Bijapur	2	1
Balod	4	3	Raigarh	6	0	Sukma	2	1

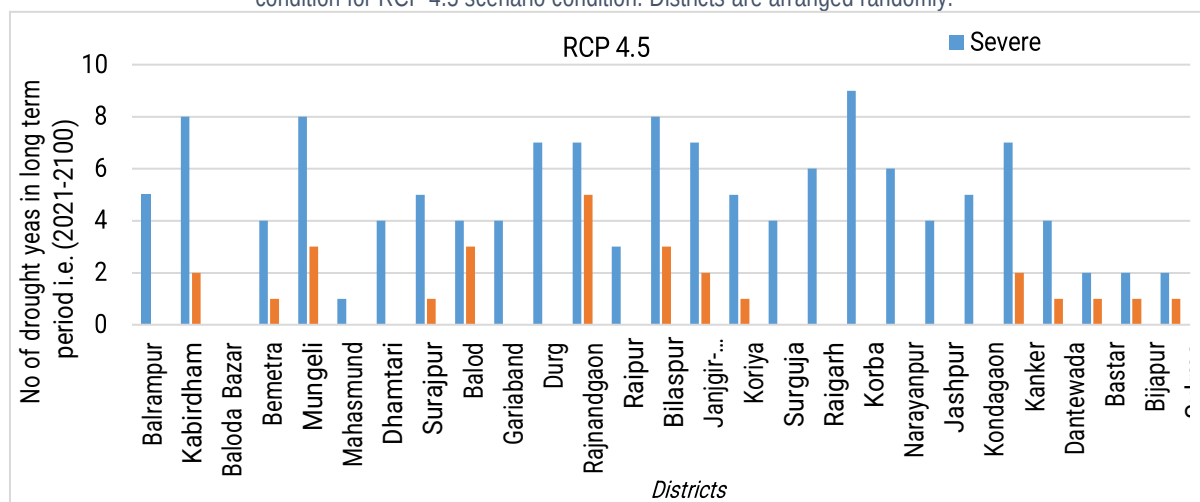
Table 19: Statistics for the number of drought years based on RCP 8.5 scenario condition.

Districts	Drought Years		Districts	Drought Years		Districts	Drought Years	
	Severe	Extreme		Severe	Extreme		Severe	Extreme
Balrampur	1	1	Gariaband	11	2	Korba	8	4
Kabirdham	7	2	Durg	5	0	Narayanpur	5	0
Baloda Bazar	10	5	Rajnandgaon	9	1	Jashpur	4	0
Bemetra	7	2	Raipur	9	4	Kondagaon	6	0
Mungeli	10	4	Bilaspur	7	2	Kanker	5	1
Mahasmund	6	1	Janjgir-Champa	9	3	Dantewada	2	0
Dhamtari	9	2	Koriya	8	3	Bastar	2	0
Surajpur	8	2	Surguja	11	5	Bijapur	5	2
Balod	4	1	Raigarh	10	8	Sukma	2	1

Source: NIT Raipur, 2022

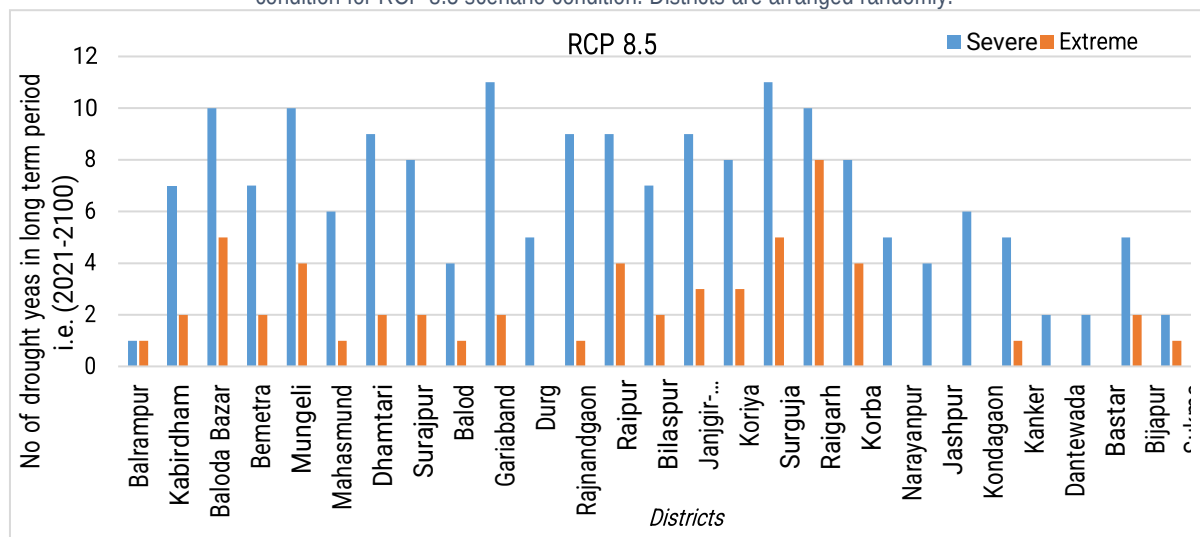
Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Figure 19: Expected Drought years (No of years out of 80) based on severe (SPI < -1.5) and extreme (SPI < -2.0) drought condition for RCP 4.5 scenario condition. Districts are arranged randomly.



Source: NIT Raipur, 2022

Figure 20: Expected Drought years (No of years out of 80) based on severe (SPI < -1.5) and extreme (SPI < -2.0) drought condition for RCP 8.5 scenario condition. Districts are arranged randomly.



Source: NIT Raipur, 2022

Note: At present the data availability is for 27 districts, data related to newly formed district will be incorporated later.

Summer Maximum Temperature Projections for the Short Term (2021- 2050) and Long Term (2021- 2100) periods

- RCP 4.5:** In the Short Term (2021-2050), warming of summer maximum temperature is projected to be in the range of 1⁰ C to 1.5⁰ C across all the districts of Chhattisgarh. Whereas, in the long-term period (2021-2100), warming of summer maximum temperature is projected to be in the range of 1.5⁰ C to 2.5⁰ C across all the districts of Chhattisgarh.
- RCP 8.5:** In the Short Term (2021-2050), warming of summer maximum temperature is projected to be in the range of 1⁰ C to 2⁰ C across all the districts of Chhattisgarh. Whereas in the long-term period (2021-2100), warming of summer maximum temperature is projected to be in the range of 20 C to 30C across all the districts of Chhattisgarh.

Chapter 4 - Vulnerability

The Fifth Assessment Report (AR5) of IPCC (2014) focuses on the concept of 'risk', which arises "from the interaction of vulnerability, exposure and hazard". In the risk management framework adopted by the IPCC, vulnerability is considered as a *system property* comprising of sensitivity and adaptive capacity and represents the propensity of a system to be adversely affected, independent of exposure.

IPCC³² defines:

Vulnerability is, "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt".

Adaptive Capacity is, "the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences".

Sensitivity is, "the degree to which a system or species is affected, either adversely or beneficially by climate variability or change". The effect may be direct (e.g., change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).

With a high proportion of the State's population dependent on natural resource-based livelihoods, immense and continuous pressure is being applied to these natural systems. For example, the unsustainable and destructive collection practices of non-timber forest produce (NTFPs) have led to forest degradation and soil erosion in the State. This coupled with low natural regeneration rates, manmade fires and poor watershed management techniques has led to the spread of invasive species³³. Such a cause-and-effect phenomenon may be observed across all sectors of the State.

Furthermore, the State has historically been exposed to droughts and floods. The Southwestern and North-eastern districts are more exposed to these hazards when compared to other districts. They also have low levels of technology and socio-economic and infrastructure development, increasing their vulnerability to the impacts of climate risks³⁴. The frequency and magnitude of these hazards may be expected to increase due to climate change, exacerbating their vulnerability to future climate risks.

Assessing the inherent vulnerability of a system, in this case, the districts of Chhattisgarh, is essential, as it helps to understand the sensitivities and lack of capacities to adapt. This information may be used to develop measures to address gaps and deficiencies of the system, making vulnerability assessments the entry point for adaptation planning.

Ranking of districts on a vulnerability scale indicates the relative vulnerability of these districts, assisting policymakers to prioritise districts for implementation of adaptation strategies. Drivers of the vulnerability identified as an output of vulnerability assessments may assist policymakers to formulate, sustainable, regenerative, climate-resilient policies. This knowledge may help to identify vulnerable communities, regions, or sectors, enabling policy makers to plan for adaptation strategies as well as prioritise the allocation of adaptation funds where it is most needed.

³² IPCC (2014) AR5 WGII Glossary

³³ CGSAPCC, 2014

³⁴ INRM, 2014

4.1 Analysis of Impacts of Climate Change on Various Sectors

4.1.1 Agriculture and Allied Sectors

Overview, Characteristics and Status

The total geographical area of the state is about 138 lakh ha, out of which the area of crop production is 46.35 lakh ha, it is 33 per cent of the total geographical area which is about 57 per cent of the state has medium to light land. Chhattisgarh is one of the richest bio-diverse areas in the country, with about 63.40 lakh ha. the area is forest cover, which is 46 per cent of the total geographical area of the state.

The total population of the state is about 2.55 crore, out of which about 80 per cent of the population is involved in agriculture. There are about 40.11 lakh farmer households in the state, out of which about 82.6 per cent are small and marginal category (Source: Agriculture Census, 2015-16). *Paddy, Soyabean, Urad and Arhar* are the main crops of the kharif season and Gram and Tiwada are mainly produced in the rabi season. Some districts of the state are suitable for sugarcane production and at present 04 cooperative sugar factories are being operated successfully in the state. Other crops in the state include maize, small grains, moong, wheat, groundnut etc. the plains in the middle of Chhattisgarh are called the paddy bowl of central India.

The state is working on growth in the bi-cropping sector, crop pattern diversification and income growth through agro-based small scale industries under a joint scheme. the focus is on better utilisation of water resources by the government for proper utilisation of agricultural sector strength. With a view to reduce the dependence of farmers on rainfall, the government is working to increase the irrigation facility of the state. Currently around 15.43 lakh ha. the state has a unique irrigated area, which is about 33 per cent of the total production area.

State Organic Farming Mission is currently under practice in the State and through which 24,950 farmers have been completed 3 years on farming 9,980 Ha within this time period. Furthermore, 6,000 Ha area is under the process of conversion to organic farming.

Central Paramparagat Krishi Vikas Yojana (PKVY) is going on in 27,250 Ha, having 25447 farmers as beneficiaries. Furthermore, a plan to implement Bharatiya Prakritik Krishi Padhathi (BPKP) in 85,000 Ha area. Individual farmers will be benefitted from Large Area Certification (LAC) for about 33,000 Ha. Additionally, 110 Villages of Dhamtewada District will be benefitted for Large Area Certification (LAC).

As a result of the efforts made by the state government for the development of agriculture and economic upliftment of farmers, the state has received the "Krishi Karman" award five times (2010-11, 2012-13 and 2013-14 for paddy production, for pulses production in 2014-15 and, 2016-17 for highest food grain production under category II which is dedicated to the farmers of the state whose hard work resulted in the state receiving the said award it is.

As indicated in the table below the main crops are paddy, wheat, maize, groundnut, pulses, and oilseeds. Chhattisgarh is also called the "rice bowl of India". Chhattisgarh is home to more than 23,000 native varieties of rice. The increase in the growth rate in the area of Rabi crops is also due to the intensive efforts of the state government for increasing the double-cropped area. Increase in irrigation sources through different schemes of state Govt., played a major role to increase the double-cropped area.

The state of Chhattisgarh is divided into three agro-climatic zones. information on agro-climatic area, soil, irrigation, cropping pattern is shown in the following table:

Table 20: Agro Climatic Zones and Cropping System

Agro-climatic zone	Combined districts	Total geographic area	Non-production area	Types of soil	Irrigation percentage	Cropping system	
						Rain-based	Irrigated
Chhattisgarh Plains	Raipur, Gariaband, Baloda Bazar, Mahasamund, Dhamtari, Durg, Balod, Bemetra, Rajnandagaon, Kabirdham, Bilaspur, Mungeli, Korba, Janjgir, Raigarh and part of Kanker Districts (Narharpur and Kanker vikaskhand)	68.49 lakh ha. (50%)	32.95 lakh ha.	Bhantha-36% MTC-21% Dorsa-22% Kanhra-18% Cachar-3%	43 %	Paddy-falling, Paddy-Tiwada, Paddy-Gram/ Wheat, Soyabean-Gram/ Wheat, Soya bean Aarhar/ Kodo/ Urad/ Moong/ Moong/ Soya bean Sesame + Arhar, Maize-Mustard	Paddy-Gram/ Wheat/ Sunflower, Paddy/ Maize, Maize - Urad, Soyabean + Arhar, Sugarcane
Bastar Plateau	Remaining portions of Jagdalpur, Narayanpur, Bijapur, Kondagaon, Dantewada, Sukma and Kanker	39.06 lakh ha. (29%)	6.40 lakh ha.	Bhantha-2% MTC-25% Dorsa-34% Kanhra-10% Cachar-5%	5 %	Paddy, Maize, Small Grains/ Ramtil - Padat, Arhar + Moong/ Urad - Padat	Paddy - Wheat/ Gram, Maize-Gram/ Mustard, Paddy-Maize, Sugarcane
Northern Region of Sarguja	Dharamjaygarh Tehsil of Sarguja, Surajpur, Balrampur, Korea, Jashpur and Raigarh Districts	28.47 lakh ha. (21%)	8.35 lakh ha.	Bhantha -13% MTC-29% Dorsa-28% Kanhra-28% Cachar-2%	11 %	Paddy, Maize-Falling, Padat-Kulthi/ Ramtil, Arhar-Padat, Paddy-Wheat, Maize-Mustard, Sugarcane	Paddy - Wheat, Maize-Wheat/ Mustard, Sugarcane

Source: Official website of the department of Agriculture, Government of Chhattisgarh

Horticulture

Although the productivity is not very high, special emphasis is being given to the field of horticulture, because the climate here is suitable for growing horticultural crops like mango, banana, guava and other fruits and a variety of vegetables.

The popularity of horticulture crops is increasing due to the high value of horticulture crops as compared to agricultural crops. However, special impetus is needed to boost the state's irrigation resources and especially horticulture crops in the state. A brief analysis of the state of horticulture in the state as per the old and current data is given below. However, new efforts are being made to prepare and compile statistical data through systematic data collection on horticultural crops in the state.

Fruit crops - The major fruit crops grown in the state of Chhattisgarh are Mango, Guava, Lemon, Litchi, Cashew Nuts, Walnuts, Chiku etc. Apart from these major Fruits Crops, Sitafal, Bell, Plum, Amla etc. the total area of fruit crops in the state in 2020-21 is 2,54,754 Ha and production is 34,58,745 MT. Mangoes can generally be produced across the state while the northern hilly areas of Surguja and Jashpur districts are suitable for the production of Litchi. Cashew nuts can be grown well in the plateau area of Bastar and Raigarh districts.

Vegetables - Most vegetable crops like Solanesi crops, Kukurbits, beans, cabbage, cauliflower etc. are grown very well in the state. The total area of vegetable crops in the state in 2020-21 is 4,89,271 hectares and production are 68,68,126 MT.

Spices - Chillies, ginger, garlic, turmeric, coriander, and fenugreek are the major spices grown in the state. The total area of spices in 2020-21 is 67,756 Ha and production is 4,49,353 MT.

Flowers - Chhattisgarh the area in the field of floriculture is negligible. To meet the growing demand for flowers with the formation of a new state, it is necessary to promote commercial flower cultivation among farmers. Major flowers like marigold, tuberose, gladiolus, roses, gallardia, christmas, orchid, etc. can be grown very well without much caution. the area under floriculture in the state is 13,089 hectares and production are 2,29,868 MT in 2020-21.

Aroma and medicinal plants - medicinal crops in the state include ashwagandha, sarpagandha, satwar, buch, aola, tikhur and aromatic crops like lemongrass, pamarosa, jamaroza, pachauli, e-cetridora. the area under aromatic and medicinal crops in 2020-21 is 35.20 hectares and production are 22,195 metric tonnes.

Table 21: Horticulture Production and Productivity

Sl No	Crops	2019-20		
		Area in Ha.	Production in MT	Productivity in MT per. Ha.
1	Fruits	258630	2548936	9.86
2	Vegetables	525147	7158909	13.63
3	Spices	55376	354525	6.40
4	Flowers	13493	76219	5.65
5	Medicinal & Aromatics	8957	59172	6.61
	Total	861603	10197755	11.84

Source: Official website of Horticulture Department, Government of Chhattisgarh

Fisheries

The state is playing an important role in providing nutritious food to the local people by generating employment at the local level through fisheries. about 2.20 lakh beneficiaries from weaker sections of the society are getting employment from fisheries. 88,671 rural pond sewage in the state is available in 2021-22 for fisheries with 1.094 lakh hectares and 1,770 irrigation reservoirs 0.826 lakh hectares, a total of 1.920 lakh hectares. out of the available water bodies by 2021-22, 1.812 lakh hectares of water, 1.011 lakh rural ponds and 0.801 lakh hectares of irrigation reservoirs have been brought under fisheries.

Table 22: Fish Production and Productivity

Key type of water field	Total available water fields(in hectare lakhs)		Water sector under fisheries(in hectare lakhs)		Developed percentage
	Tank	Water field	Tank	Water field	
Rural pond	91,928	1.094	79,983	1.011	92.66
Irrigation Reservoir	1,770	0.826	1,635	0.801	96.97
Total	93,698	1.920	81,618	1.812	94.38

Source: Official website of Fisheries Department, Government of Chhattisgarh

The main rivers Mahanadi, Indravati and their tributaries (3573 km) are available for fisheries in the state. 59 fish seed fields in government and private sector 78 circular hatchery and 1126 promotion ponds with total augmentation water area of 639.29 hectares are available for fish seed production work till 2021-22. at present, the requirement of fish seeds is 1.34 crore standard fry, against which the production is 2.85 crore per annum the target for 2021-22 is 300 crores.

The fisheries industry in the state is based in which major carp fish plays an important role. 91,928 ponds (1.094 lakh hectares) of culture are the mainstay of fisheries in the state. 92 per cent of the total increase in fish production under fisheries from 2007-08 to 2020-21 was recorded at 31.5 per cent.

Table 23: Fish Production in the State

Fish production (lakh tonnes)	Base year 2007-08	Year 2020-21
(lakh tonnes)	1.39	5.77

Source: Official website of Fisheries Department, Government of Chhattisgarh

Table 24: Rural urban distribution of fish production

Source	Fish production (MT)	Competitive in production
Rural pond	5,54,253	95.99
Irrigation reservoir	18,629	3.22
Rivers	4,482	0.79
Total	5,77,364	100

Source: Official website of Fisheries Department, Government of Chhattisgarh

The average productivity of rural ponds is 36.82 kg per hectare and irrigation reservoirs are 233 kg/ha/year. the main reasons for continuous increase in fish production and productivity are as follows:

- Use of balanced nutritious supplements in ponds, fertilisers, and intensive fish seed harvesting (based on modern technology).
- Accumulation of large size fingerling fish seeds (75 mm and more) in selected reservoirs and ponds.
- Imparting skill upgradation training to fishermen working in reservoirs and ponds.
- To increase the capacity of fish farmers by equip rating them with boat nets.
- Promotion of fish seeds in seasonal ponds.
- Setting up of display units.

Some progressive farmers of the state are producing 8000 to 12000 kg/hectare of major carp fish, production of 48 Angasius fish upto 70 tonnes per hectare is also being achieved.

In addition to the field implementation of district and development block, training, study tours, demonstration units were set up outside the state to raise awareness among the department fisheries. At present 2.20 lakh persons of the state are engaged in fisheries and 3.18 lakh human days employment is being created. *Source: Official Website, Fisheries Department, Government of Chhattisgarh*

Climate Change Concerns / Perceived Impacts on Agriculture Sector

Chhattisgarh is potentially highly vulnerable to climate change and its impacts. The State has a high level of reliance on rain-fed, subsistence agriculture, in a situation where increasingly erratic rains are likely to become the norm. Less than one-third of the total cultivable land in Chhattisgarh is covered by irrigation facilities, that too in protective in nature and main source of irrigation are canals and reservoirs; the rest is fed by seasonal rivers. Limited proper irrigation facilities and residual soil moisture leaves nearly half of the arable land as fallow for the second crop, increasing the risk exposure of the state. Increasingly, this has led the State to spend a significant share of its budget on risk mitigation measures such as loan waivers for drought-hit farmers and crop insurance schemes, depriving the sector of real investments to improve efficiency. Productivity in the State is low as compared to other states of India. Available data from the Department of Statistics indicates that the state falls short of the national average in the productivity of cereal crops, oilseeds and pulses. The irrigated area is only 33 per cent, over the last decade, there has been a shift in trend from public to private irrigation sources and from surface to groundwater dependency. In a nationwide assessment of agricultural vulnerability, the Central Research Institute for Dryland Agriculture (CRIDA) in 2014 underscored the importance of enhancing agricultural- water use efficiencies in Chhattisgarh. The study highlighted the projected increase in the number of drought years as the major exposure factor, while a higher share of net-sown area and a correspondingly lower proportion of net-irrigated area, contributed to the higher vulnerability of the agricultural sector with reference to change in climate scenario, by increasing sensitivity and reducing adaptive capacities.

In Chhattisgarh, paddy is grown in about 4.42 million hectares and out of which about 67 per cent is rain-fed (Commissioner, Land Records, Government of CG, 2020). Farmers depend upon their socio-economic conditions. During kharif, growing rice is a tradition while, in rabi, there are fewer options for the stakeholders to take profitable and/or suitable crops. Under these circumstances, farmers generally follow a cropping pattern of rice – wheat, rice–mustard and rice–winter vegetables under partially or assured irrigation and rice- fallow, rice – utera (Lathyrus, chickpea and linseed) under rain-fed situation. There is evidence to suggest that there is considerable regional climate change including rainfall departures on the negative side impacting the rural livelihood system and agricultural production – the source of food, income and employment security for majority of its people. There is scope to increase productivity and increase income from agriculture and allied sectors in the state. There is a direct link between climate change and food and economic security of the agrarian people of the state. The most vulnerable groups of the state live in drought-prone areas, forests and rain-fed farming situations. Even small unforeseen changes in the climate could cause irreversible losses and may force these people into destitution.

- Agriculture productivity in the State is comparatively lowest in India. Data from the Department of Statistics indicate that the state falls short of the national average in the productivity of cereal crops, oilseeds and pulses.
- There is a limited area under irrigation. Due to difficult terrain and fragile ecosystems, there has been inadequate infrastructure development in the area. Lower extension 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.

- Chemical used in the agriculture sector is steadily on the rise. This is not only resulting in the increase of the input cost but also contaminates the local water bodies and the soil.
- Limited proper market linkages lead to an increased number of intermediaries, which results in low-value realisation to the producer. Limited supply of inputs at the right time and in right quantity coupled with inadequate extension work leave the farmers to practice less efficient agriculture.
- There is only limited facility available for proper collection and storage of surplus products at the farm level and above as well as presence of any organised market network from rural market to terminal market level.
- Small and Marginal Land holdings: They have difficulty in accessing critical inputs for agriculture, especially credit, water, power, quality seeds, fertilisers, pesticides and timely technical assistance. They also suffer from weak bargaining power. The majority of tie-ups are between processors/retailers and medium and large farmers because the corporate/bulk buyers find the transaction costs of dealing with a large number of small producers prohibitively high.

Table 25: Impact of Fluctuation in Local Weather on Agriculture and Livelihoods

Month	Regular season	Impact of fluctuation on local weather
June, July	Sowing and nursery preparation; transplanting rice planting pulses and oilseed crops	Delay in sowing and transplanting often get exposed to intermittent dry spells and terminal season drought that resulted in fewer panicles, poor grain filling, increased sucking pest menace and reduced production, besides hampering the timing and intensity of the second crop
October, November	Harvesting of paddy, oilseeds and pulses (ii) Sowing of oilseeds and pulses	Rain during this period affects the harvesting of the crops and affects the grain quality It also leads to delay in sowing the second crop. It results in reduced acreage as farmers refrain from sowing
December, January	Flowering and grain development of Rabi crops Harvesting of pulses and oilseeds Preparatory stage for the economically important forest produce 'Mahua'	Crops are vulnerable to prolonged rain, excess cold, fog and frost Economic loss due to rains during harvesting Too much cold affects the formation of its 'kunchi' - the early stage of bud root Increase in minimum temperature impacts flowering, panicle formation and ripening of wheat crop.
March April	Important period for the collection of forest produce including mahua	Rain during this period makes the flowers drop prematurely or destroys flowers, and some flowers turn upward and do not even fall

Animal Husbandry

Animal husbandry is an important activity in rural areas of the state which not only provides supplementary income to the family dependent on agriculture but also provides a major source of animal produce protein. Livestock is available as the only source of income at the time of drought and other natural calamities such as cyclones or floods. Thus, livestock occupies a prominent place in the economy of the villagers.

Table 26: Livestock number of different species in the region

Major livestock	17 th Animal Census 2003	18 th Animal Census 2007	19 th Animal Census 2012	20 th Animal Census 2019
Cow dynasty (in lakh)	88.81	94.91	98.13	99.84
Buffalo dynasty (in lakh)	15.98	16.05	13.90	11.75
Goat (in lakh)	23.36	27.68	32.25	40.06
Sheep (in lakh)	1.21	1.40	1.68	1.80
Pig (in lakh)	5.53	4.13	4.39	5.27
Poultry (in lakh)	81.81	142.45	179.55	187.12

Source: Official Website of Livestock Development Department, Government of Chhattisgarh

Four pillars of animal husbandry keeping in view the efficient management, balanced nutrition, improved breeding and disease control, the department of livestock development aims to increase the livestock product of the state through animal health service, training and extension service in a time-bound manner. The state's small cattle herders are to be financially empowered by increasing the means of livelihood based on livestock by providing improved animal and bird supply. Thus, livestock not only provides assured sources of income to the rural household but also provides employment opportunities. Livestock provides milk, eggs, meat, wool, energy for leather transportation, organic manure and kitchen products etc. A clear livestock development and breeding policy has been created to ensure revolutionary changes in animal husbandry, freedom from poverty and malnutrition to small cattle herders and economic growth by connecting the market with the mainstream of the economy. The policy determines the priorities, capabilities and possibilities of all aspects/circumstances of livestock development in the state.

Duties of the department -

- Livestock health protection - disease preventive immunisation, disease investigation and treatment
- Animal breeding - artificial insemination /artificial insemination planned reproduction from natural conception
- Training & expansion - efficient livestock management, malnutrition alleviation, fodder development, human resource development
- Implementation of individual schemes for livestock development.
- Implementation of employment-oriented bank credit-linked schemes.
- Implementation of development schemes for rural socio-economic upgradation.

Institutions run for animal health protection and development works-

- Veterinary clinic - 340
- Veterinary dispensary - 829
- Animal disease research laboratory - 16
- Mobile veterinary unit - 27
- Artificial insemination centre - 22
- Artificial insemination substation - 248
- Main village block - 10
- Main village block sub-centre - 99

Source: Administrative report 2020-21, Livestock Development Department, Government of Chhattisgarh

Table 27: Status of animal production in the state

Animal products	Chhattisgarh (2001-02)	Chhattisgarh (2019-20)	National (2019-20)
Milk (Thousand tonnes)	795	1677	198405
Egg (Crore)	77.04	202.89	11438.31
Meat (Thousand tonnes)	9.54	66.06	8599.40

Source: Official Website of Livestock Development Department, Government of Chhattisgarh

Table 28: Availability of animal products per capita

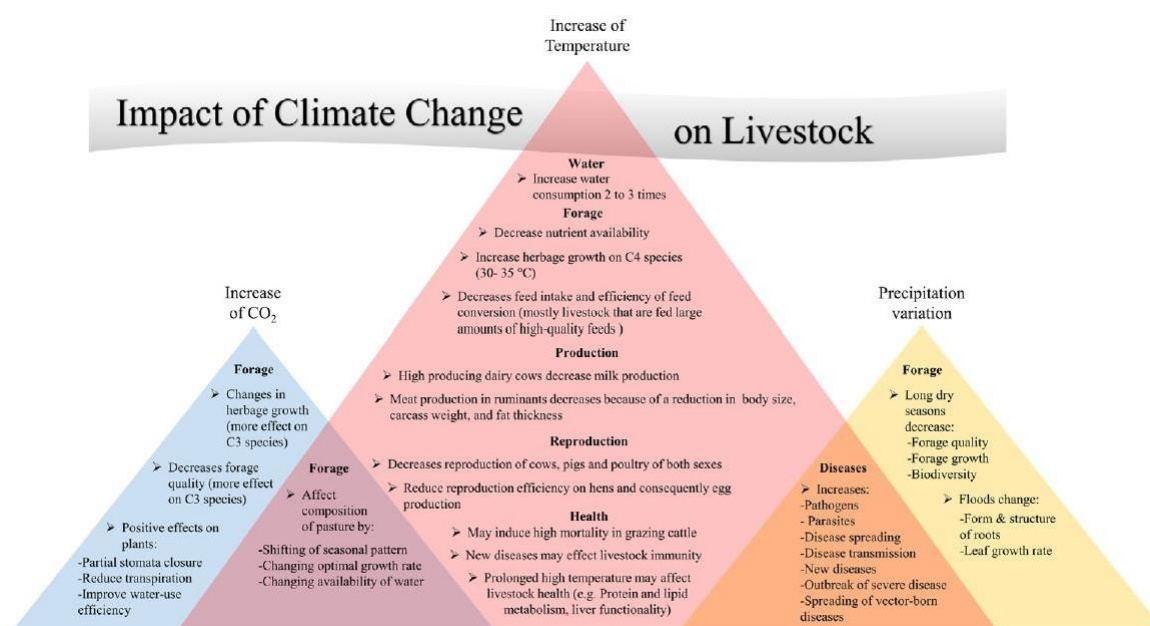
Animal products	Chhattisgarh (2001-02)	Chhattisgarh (2015-16)	National (2015-16)
Milk (gram daily)	104	132	329
Egg (number per annum)	37	57	64
Meat (kg per annum)	0.46	1.56	5.44

Source: Official Website of Livestock Development Department, Government of Chhattisgarh

Impacts of Climate Change on Livestock

The impacts of climate change on livestock are primarily due to an increase in temperature and atmospheric CO₂ concentration, precipitation variation, and a combination of these factors. The impacts of climate change on livestock production factors are shown in Figure 21.

Figure 21: Impact of climate change on livestock



(Source: Rojas-Downing et al., 2017)

Temperature affects most of the critical factors for livestock production, such as water availability, reproduction and health. Forage quantity and quality are affected by a combination of increase in temperature, CO₂ concentration and precipitation variation. Livestock diseases are influenced by an increase in temperature and precipitation variation.

In the following sections, the various impacts on livestock health, feed and fodder, production, and disease incidence is discussed.

Effect of Heat Stress on Livestock

Heat stress on livestock is dependent on temperature, humidity, species, genetic potential, life stage, and nutritional status. Heat stress decreases forage intake, milk production, the efficiency of feed conversion, and performance of livestock. Warm and humid conditions cause heat stress, which affects behaviour, metabolism, and at times lead to mortality. All animals have a thermal comfort zone, which is a range of ambient environmental temperatures that are beneficial to physiological functions (FAO, 2014). During the day, livestock keep a body temperature within a range of $\pm 0.50^{\circ}\text{C}$. When temperature increases more than the upper critical temperature of the range (varies by species type), the animals begin to suffer heat

stress. It results in reduced feed intake, increased water intake, and altered physiological functions such as reproductive and productive efficiency, and a change in respiration rate.

Impact of Climate Change on Feed and Fodder

Higher temperatures increase lignin formation in plant tissues, and thereby reduce the digestibility and rates of degradation of fodder and crop residues in the ruminants. This will lead to reduced nutrient availability for animals, and ultimately to a reduction in livestock production.

Impact of Climate Change on Livestock Production

Environmental stressors reduce body weight, average daily gain, and body condition of livestock. It could also lead to decline in milk yield quality: reduced fat content, lower-chain fatty acids, solid-non-fat, and lactose contents; and increased palmitic and stearic acid contents are observed. Animals exposed to heat stress reduce feed intake and increase water intake, and there are changes in the endocrine status, which in turn increase the maintenance requirements leading to reduced performance (Gaughan and Cawsell-Smith, 2015). Generally, the higher production animals are the most affected. Adaptation to climate change stressors may be accompanied by production losses.

Impact on milk yield of cows

Multiple regression analyses of the different micro climatological parameters and milk yield of cows maintained at the divisional farm has shown that air temperature, effective temperature, and temperature-humidity index significantly affect average daily milk yield, weekly milk yield, monthly milk yield, and daily total milk yield of cows. The temperature-humidity index is used commonly to indicate the degree of stress on dairy cattle. When the THI exceeds 74, high producing dairy cows are affected adversely. However, relative humidity had a highly significant effect on average weekly milk yield and average monthly milk yield of a cow (Samir Das. 2017).

Impact on egg and meat production in poultry

The thermoregulation characteristics of poultry vary due to their high rate of metabolism associated with more intensive heat production and low heat dissipation capacity caused by their feathers and limited sweat glands. Above 30°C, the feed and energy intake decline and the birds may not be able to compensate for it. This results in declined production and the rate of mortality increases with heat stress. The high ambient temperature decreases the digestibility of nutrients in poultry, which might be due to reduced activity of trypsin, chymotrypsin, and amylase. Consequently, the lower and insufficient nutrient supply limits egg production, egg mass and shell quality of egg in layers, and the growth rate in broilers (Samir Das. 2017).

Impact of Climate Change on Livestock Reproduction

Reproductive processes are affected by thermal stress. Heat stress inhibits oocyte growth in cows by altering progesterone secretion, the secretion of luteinizing hormone, follicle-stimulating hormone, and ovarian dynamics during the oestrus cycle. Heat stress has also been associated with impairment of embryo development and increase in embryonic mortality in cattle. Heat stress during pregnancy slows growth of the foetus and can increase foetal loss. Secretion of the hormones and enzymes regulating reproductive tract function may also be altered by heat stress. In males, heat stress adversely affects spermatogenesis, perhaps by inhibiting the proliferation of spermatocytes. Conception rates of dairy cows may drop 20–27 per cent in summer, and heat stressed cows often have poor expression of oestrus due to reduced oestradiol secretion from the dominant follicle developed in a low luteinizing hormone environment. Reproductive inefficiency due to heat stress involves changes in ovarian function and

embryonic development by reducing the competence of oocytes to be fertilised and the resulting embryo (Naqvi et al., 2012).

Impact of Climate Change on Livestock Diseases

Warmer and wetter weather (particularly warmer winters) will increase the risk and occurrence of animal diseases, because certain species that serve as disease vectors, such as flies and ticks, are more likely to survive year-round. Variations in temperature and rainfall are the most significant climatic variables affecting livestock disease outbreaks. If rainfall increases, some of the parasitic diseases may become more prevalent and start to spread in livestock. This may contribute to an increase in diseases such as ovine chlamydiosis, caprine arthritis, equine infectious anaemia, equine influenza, Marek's disease, and bovine viral diarrhoea. There are many rapidly emerging diseases that continue to spread over large areas. Outbreaks of diseases such as foot and mouth disease or avian influenza affect very large numbers of animals.

Impact of Climate Change on Livestock Adaptation

In order to maintain normal body temperature within physiological limits, heat stressed animals initiate compensatory and adaptive mechanisms to re-establish homeothermy and homeostasis, which are important for survival, but may result in reduction of productive potential. The animals thriving in the hot climate have acquired some genes that protect cells from the increased environmental temperatures (Collier et al., 2012). But as the surface temperature increases, the adaptive capacity of the livestock is also reducing.

It is clear from the discussion in the previous sections that climate change has an adverse impact on livestock. Currently, no comprehensive analyses of possible impacts of climate change on agriculture and animal husbandry in Chhattisgarh are available. At the same time, it is evident that a changing climate can pose serious threats to the existing livestock in Chhattisgarh. Any short-term or long-term fluctuations of climate can have dramatic effects on livestock productivity and impact food security. Recent years have seen increased climatic variability like frequent floods and drought - affecting both agricultural productivity and livestock. Also, the increased population pressure and subsequently decreasing per capita availability of land is leading to unsustainable agricultural practices, and livestock rearing. If global patterns of increase in temperatures and decrease in water availability, and changes being recorded and projected for India apply to the State, productivity of most crops and livestock would decrease.

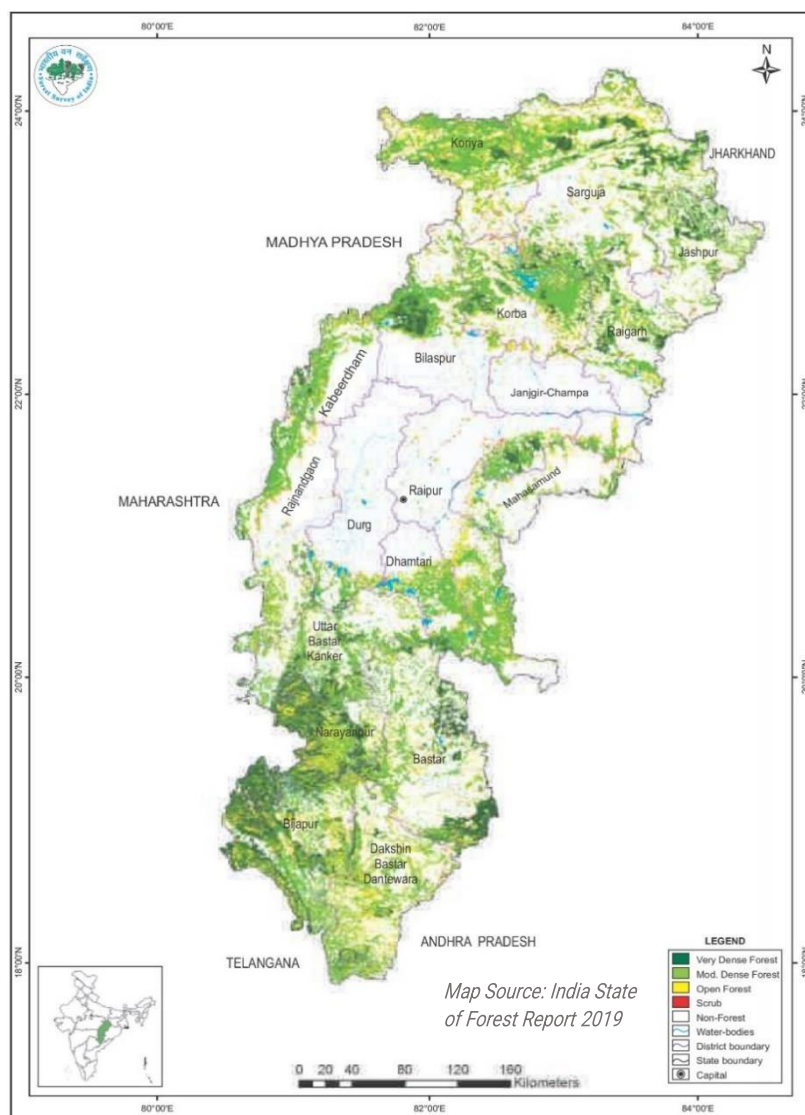
The rural economy in the State is dominated by small farmers (<2ha) comprising over 75 per cent of the total farm households. The average size of land holdings in the State is 1.4 ha and is likely to decline with increasing population pressure. Under such a scenario, crop production alone cannot provide an adequate livelihood to the majority rural population, and livestock could emerge as an important source of income and employment for the rural poor. They act as a buffer against income shocks of crop failure, which is a frequent phenomenon in Chhattisgarh. Livestock provide a continuous stream of outputs and thus income from livestock helps consumption smoothening. Species like poultry, goat, sheep, and pigs are of short- generation interval, have a high prolificacy rate and require less land, investment, and operational expenses and are better suited to the resource endowment of the poor. Cattle and buffalo are an important source of manure and draught power, which are vital to improving crop production and environment. Chhattisgarh is rich in livestock wealth. The state has about 144.18 lakhs animal population out of which 94.91 lakhs are cattle, 16.04 lakhs are buffaloes, and the remaining 33.23 lakhs are other animals, which include sheep, goat, horse, and other species. The State has about 142.45 lakhs total poultry population.

4.1.2 Forest and Biodiversity Sector

Overview, Characteristics and Status

Chhattisgarh is gifted with the most pristine and abundant set of natural resources in the country. Mountain, Plateau, and Plains eco-systems constitute roughly a third of each of its physiography. Dense, green, and untouched, its forests are also the source of major rivers like Mahanadi, Narmada, Indravati, and an exotic flora-fauna.

Figure 22: Forest Cover map of Chhattisgarh



Recorded Forest Area, Protected Areas and Forest Cover

The Recorded Forest Area (RFA) in the State is 59,816 sq km of which 25,897 sq km is Reserved Forest, 24,036 sq km is Protected Forest and 9,883 sq km is Unclassed Forest (India State of Forest Report, 2021). The state has two National Parks, eight Wildlife Sanctuaries, three Tiger Reserves and one Biosphere Reserve which is covering 18.92 per cent of total forest area of the state under the protected area network (*Source: Annual Report 2019-20, Department of Forest*).

Forest Cover

The Forest Cover in the State is 55,716.6 sq km which is 41.21 per cent of the State's geographical area. In terms of forest canopy density classes, the State has 7,068.21 sq km under Very Dense Forest (VDF),

32,278.59 sq km under Moderately Dense Forest (MDF) and 16,369.80 sq km under Open Forest (OF) (ISFR, 2021). The Forest Cover in the State has increased by 63.57 sq km in 2019 as compared to its previous assessment reported in ISFR 2017. Whereas, Forest Cover increased by 106.03 sq km in 2021 with respect to the ISFR 2019. The year-wise change in forest cover at the state level including the district is outlined below.

Table 29: District-wise Forest Cover (Area in Km²)

District	Geographical Area (GA)	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of GA	%Change as Compared to 2017 Assessment	Scrub
Bastar	10,470	937.7	2,104.4	1,190.2	4,232.3	40.4	-0.51	41.52
Bijapur	8,530	2,047.1	2,991.6	1,499.6	6,538.3	76.6	26.1	4.5
Bilaspur	8,272	399.2	1,570	491.6	2,460.8	29.7	3.9	46.1
Dantewada	8,298	250.6	2,325.8	1,896.5	4,472.8	53.9	9.6	39.3
Dhamtari	4,084	49	1,384.7	426.3	1,860	45.5	0.83	10.7
Durg	8,535	44	511.7	221.4	777.1	9.1	0.76	20.86
Janjgir-Champa	3,853	2	22.2	127.1	151.4	3.9	1.5	13.9
Jashpur	5,838	225.3	1,316.8	576.6	2,118.7	36.3	2.9	21.5
Kabirdham	4,235	80.6	1,077.9	389.4	1,547.9	36.5	-0.84	12.6
Korba	6,598	203	2,313.1	884.9	3,400.9	51.5	3.7	92.0
Koriya	6,604	78.5	2,579.9	1,438.1	4,096.6	62.0	7.2	91.1
Mahasamund	4,790	4	515.3	428.9	948.2	19.8	3.3	29.7
Narayanpur	4,653	1,126.7	1,688.7	982.1	3,797.4	81.6	1.1	19.6
Raigarh	7,086	237.9	1,590.9	794.5	2,623.4	37.1	3.1	27.7
Raipur	12,383	146	2,402.9	1,086.9	3,635.8	29.4	5.9	53.8
Rajnandgaon	8,070	31	1,755.6	752.8	2,539.4	31.5	4.3	46.8
Surguja	15,732	714.3	3,923.5	2,471.9	7,109.8	45.2	27.1	67.3
Uttar Bastar Kanker	7,161	488.9	2,202.8	705.3	3,396.8	47.4	0.87	8.1
Grand Total	1,35,192	7,068.2	32,278.6	16,369.8	55,716.6	41.2	106.03	615.3

Source: Indian State Forest Report, 2021

Carbon Stock in Forest of Chhattisgarh

Forest being the major terrestrial sequester of carbon has been in the epicentre of policy decisions towards addressing the growing climate change concern. The total carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 496.44 million tonnes (1,820.28 million tonnes of CO₂ equivalent) which is 6.89 per cent of total forest carbon of the country (*Indian State Forest Report, 2021*). Pool wise forest carbon in Chhattisgarh is given in the following table.

Table 30: Forest Carbon in Chhattisgarh in different pools (in '000 tonnes)

ISFR Year	AGB	BGB	Dead wood	Litter	SOC	Total
2019	1,45,912	46,908	1,858	9,969	2,75,603	4,80,250
2021	1,52,714	48,947	2,520	8,487	2,83,769	4,96,437

Source: Indian State Forest Reports, 2019 & 2021

Forest Fire

Occurrence of forest fire besides resulting in soil degradation, changes in climate conditions, incalculable loss of forest products and biodiversity contained there within imparts adverse impact on ecology. As per the ISFR 2021 report, 3.47 per cent of the total forest cover in Chhattisgarh is extremely fire-prone and 6.56 per cent of the total forest cover is very highly fire-prone.

Table 31: Forest Fire-Prone Classes

S. N.	Forest Fire-Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire-prone	1,935.04	3.47
2	Very highly fire-prone	3,655.58	6.56
3	Highly fire-prone	8,159.70	14.64
4	Moderately fire-prone	11,275.57	20.24
5	Less fire-prone	30,691.11	55.09
	Total	55,717.00	100

Source: Indian State Forest Report, 2021

Socio-Economic Contribution of State Forest

Joint Forest Management

Joint Forest Management (JFM) has become the cornerstone of Forest Management in India since 1990 when enabling guidelines were issued by the Government of India (GoI) in this regard. These guidelines were widely seen as an attempt to implement the changing perspective on the role of communities in protecting, using and managing forests, as articulated in the National Forest Policy, 1988. A new component entitled strengthening of JFM committees was added to the National Afforestation Programme (NAP) in November 2001 to accelerate the pace of formation of JFM committees and to activate the existing JFM committees. This was further strengthened by the regional link with the proposed State Forest Policy, 2001 of Chhattisgarh in which it is envisaged: -

- Preference to environmental protection and increase in employment/rise in income opportunities of local community over generation revenue from forests.
- Preference to development of participatory approach over contractual system of working in the forests.
- Development of Forest committees in the fringe forest areas especially women in protecting and managing forests.

Chhattisgarh is a pioneering State in implementing the JFM programme. The Government of Chhattisgarh issued the first resolution in this regard in 2001 & learning from experience, the State revised it in, 2002, 2003, 2007 and 2013. The C.G Government Resolution (GR) makes provision for three kinds of committees within a radius of 5 km from the periphery of forest.

The state has total of 7887 JFMCs, the Joint Forest Management (JFM) which covers 55.52 percentage of the forest area in the state. The JFMC has been made the basis of Forest Management by the Chhattisgarh State Forest Department. Out of the total of 19720 villages in the State; 11185 villages situated within the 5-kilometre range of the forest areas forms the JFM area.

Table 32: Circle wise number of total JFMCs formed in the state, the forest area allotted to them and total number of JFMC members

No. of JFMCs	7887
Area covered under JFM	33190 sq. km.
Percentage of Forest Area under JFM	55.52%
Total No. of Committee members	27.63 lakh
Female JFMC members	14.36 lakh
Male JFMC members	13.27 lakh
Scheduled Caste members	4.71 lakh
Scheduled Tribes members	15.21 lakh
Other	7.71 lakh

Source: Chhattisgarh State Forest Department

Table 33: Following works have been carried out through JFM in the state

Sl No	Particulars	Work Done
01	Village Covered	603
02	Stop Dam	191
03	Tube Wells	109
04	Bridge / Culverts	75
05	Solar Panel for Street Lights	1851
06	Drinking water facilities	1936
07	Irrigation Facilities	9000
08	Fire Protection and other	2645
09	Road (Earthen and Murrum)	67
10	Income Generation Activities (IGA)	326
11	IGA Beneficiaries	15000
12	Benefit Sharing with JFMCs	372.70 Cr

Source: Chhattisgarh State Forest Department

Wildlife Management and Biodiversity conservation

Chhattisgarh state is very rich in faunal diversity. Considering the importance, a State Wildlife Board have been constituted under the chairmanship of honourable Chief Minister of the State. Keeping in the view of protection and management of Wildlife, 2 national parks, 8 Sanctuaries, and three tiger reserves have been notified in the state. Additionally, a biosphere reserve as the Achanakmar-Amarkantak biosphere has also been notified in the state. The detail of national parks, sanctuaries and tiger reserves are as under:

Table 34: National Parks and Sanctuaries of Chhattisgarh

Sl No	Particulars	Forest Circle	Forest Division	Area (sq km)
National Parks				
01	Kanger Vally	Jagdalpur	Baster	200
02	Guru Ghasidas	Sarguja	Baikunthpur	1440.7
Sub – Total (A)				1640.7
Forest Sanctuary				
01	Badalkhol	Sarguja	Jashpur	104.4
02	Gomarda	Bilaspur	Raigarh	277.8
03	Barnavapara	Raipur	Raipur	244.6
04	Tamorpingla	Sarguja	Surajpur	608.5
05	Semersot	Sarguja	Balrampur	430.3
06	Bhiramgarh	Jagdalpur	Bijapur	138.9
07	Pamed	Jagdalpur	Bijapur	262.1

08	Bhoramdev	Durg	Karwardha	351.2
Sub – Total (B)				2418.1
Tiger Reserve				
01	Indiravati	Jagdalpur	Bijapur	2799
02	Achanakmar	Bilaspur	Bilaspur	914
03	Udanti-Sitanadi	Raipur	Gariyabandh/ Dhamtari	1842.5
Sub – Total (C)				5555.5
Biosphere Reserve				
01	Achanakmar-Amarkantak	Bilaspur	Mungeli, Marwahi and Bilaspur	1695.5
Sub – Total (D)				1695.5
Grand Total (A) + (B) + (C) + (D)				11310.9

Source: Annual Report 2019-20, Department of Forest, Government of Chhattisgarh

Management of Wild Elephant

Movement of wild elephants is being observed in Jashpur, Balrampur, Surajpur, Sarguja, Koira, Raigarh, Kobra, Mahasamud and Baloda Bazar Districts of the state. Total number of wild elephants has been increased to 247 in May 2017 from 32 in the year 2002. It is a notable point that the cases of Human - Wild Animal (Elephant) conflict have increased along with an increase in the population of elephants. Considering this fact, the state forest department is regularly working to stop such events. Different preservative measures like monitoring, early warning, mobile radio collar system, Gajraj Rescue vehicles, monetary compensation for loss etc. were done by department. A radio-based program, 'Hamar Hathi, Hamar Goath' is being broadcasted every evening.

The elephant project is also being implemented with financial support of Government of India to decrease the human-elephant conflict in the state. Establishment of Lamaru Elephant Reserve is also in process to ensure science-based elephant management in the state.

Conservation of Hill Myna

The Hill Myna (*Gracula religiosa*) has been recognised as the State Bird of Chhattisgarh. The southernmost part of the state is the main identified habitat area for the Hill myna. Considering the importance of Hill Myna, effort for detailed documentation, restrictive measures on its illegal poaching etc. are being taken by the department to promote the natural habitat condition. Plantation of most likely plant species of Hill myna like Banyan Tree, Pipal, Samel, Tejana are being promoted in these areas.

Conservation of Wild Buffalo

Wild Buffalo is declared as the state animal of Chhattisgarh. Increased biotic pressure in forest areas is resulting as a threat to its existence. Continuous efforts to protect and increase the number of Wild Buffalo are being taken by the state forest department.

Crocodile Management

Conservation measures are being undertaken vide crocodile management initiatives of the department. A conservation reserve for crocodiles has been declared in Kotmi Sonar Village of Jangeer Champa Forest Division of the State.

Chhattisgarh State Minor Forest Produce Cooperative Federation Limited

Chhattisgarh State Minor Forest Produce (Trading and Development) Cooperative Federation Limited is an apex organisation with three-tier cooperative structure comprising a state-level Apex body, 31 District Unions and 901 Primary Forest Produce Cooperative Societies. At present there are about 10300 collection centres (called Phads) of Tendu leaves spread over the length and breadth of the state and approximately

13.76 lakhs Minor Forest Produce gatherer families. Federation is responsible for all aspects relating to management, development and trade of minor forest produce sector in the state.

Some of the major achievements during 2014-15 to 2019-20 are as under: -

- Collection of total 87,83,982.2 Bora of tendu leafs worth Rs 3,25,901.556 Lakh has been carried out by 901 collection committees of the state.
- Collection of 4,26,296.874 quintal Saal Seed, 96,789.58 quintal Harra, 36,636.516 quintal Tamarind with seed, 16,757.873 quintal Chironji Kernels, 9089.244 quintal Mahua Seed, 8,245.791 quintal Kusmi Lakh, 3,183.757 quintal Rangini Lakh, 27.6 quintal Nagarmotha, 1491.32 quintal Bahera, 125.11 quintal Kalmegh, has been done.

(Source: Annual Report, 2019-20 Department of Forest)

The federation is doing tremendous work in the field of minor forest produce procurement and processing. The federation has been procured 52 types of minor forest produce of Rs. 180.51 Crores at minimum support price in the year of 2020-21. The Tribal Cooperative Marketing Federation of India Ltd., Government of India New Delhi (TRIFED), has awarded Chhattisgarh, 1st prize for purchase of maximum Non-Timber Forest Products (NTFP) in 2020-21, and also, for production of 121 value added products from different kind of NTFPs. *(Source: Official Website, CG Jansampark)*

Key Concerns of Forest Sector

1. Lack of understanding at the field level staff of the forest department on the impacts of climate change in forestry.
2. Lack of scientific and technical capacity of the current human resource in the department to carry on climate-relevant actions at the ground level.
3. Anthropogenic disturbance of forest for collection of fuel-wood, timber, food, fodder, MFPs for sustenance, as well as income generation, uncontrolled grazing of animals, has led to an increased rate of consumption of bio-resources, impacted regeneration of natural forest and led to forest degradation and deforestation.
4. Traditional and unsustainable collection of NTFPs and medicinal plants and removal of roots /base of products such as collection of; tubers, roots of Palash, bark of Arjun, fruits and seeds of Sal & Char have also contributed to forest degradation.
5. Most of the biodiversity rich forests area in the State also have enormous mineral wealth potential. Exploiting this potential through unsustainable mining practice and development of new mines & mineral based industries in the recent past has led to destruction of rich habitats.
6. Encroachment and Diversion of forest lands for non-forestry purpose of agriculture, human settlement, minor and major irrigation projects; roads; urbanisation & other development projects. Such incidents are also resulting loss of plant diversity in the state.
7. Spread of invasive weeds like Lantana, and Ageratum conyzoides has posed serious hindrance in germination and growth of indigenous species.
8. Incidence of forest fires resulting in destruction of forest diversity and ecology.
9. Increased incidence of Human-animal conflict due to wildlife habitat destruction and disturbance from development activities.
10. Degradation in water and nutrient cycle impacting natural regeneration and forest health.
11. Present budgetary allocation for forestry sector is not commensurate for meeting up NDC goal.
12. In addition to the aforesaid anthropogenic drivers, deforestation or diversity of state forest is also impacted by changing of natural parameters like temperature, precipitation patterns and moisture level and pest outbreaks.

Perceived Climate Impacts

It is evident that a changing climate can pose serious threats to the existing forests in Chhattisgarh which are already stressed from climatic and non-climatic factors. The specific impacts of climate change over the state forests are outlined below:

- Temperature fluctuation and change in moisture content are likely to impact the phenological cycle, including advancing/late unfolding, blossoming, and ripening in the leaves and fruit of wild plants. Such variability might also change the patterns of hibernation, migration, and breeding of wildlife and changes in synchronous relationships between predators and prey, as well as those between insects and plants,
- Projected short term weather variability or long-term seasonal variation coupled with increasing carbon-dioxide concentration could possibly impact the growth, productive capacity, natural regeneration and certain species including change in function and composition of forest.
- Proliferation of existing weeds and evolution of new phenotypes, even the formation of novel species' associations and other ecological surprises.
- Climate change mediated ecological imbalance including food destruction could lead to wildlife wandering into areas of human habitation and clashing with humans unsuccessfully for resources and thereby escalating the man-animal conflict scenario in the state.
- Climate change impacts humans directly, and both humans and biodiversity indirectly through its influence on forest landscapes. Since local communities are also dependent on biodiversity, they are affected when species are affected. They are also impacted by associated disturbances such as flooding, droughts, wildfires and insects but also by other drivers of change such as land use, pollution and overexploitation.
- Climate change would have extensive impacts on forest configuration especially changes in species composition, productivity & biodiversity.
- Increased temperature and prolonged droughts can result in increased fire incidence and lead to forest degradation.
- There is growing evidence to indicate that climate change, coupled with socio-economic and land use pressures, is likely to adversely impact forest biodiversity, carbon sinks, biomass productivity or carbon uptake rates, livelihoods of forest-dependent communities and economies.
- Higher predicted incidences of extreme events will also have a devastating effect on the forest flora and fauna as will the increase in forest fires due to droughts.

4.1.3 Water Resource Sector

Overview, Characteristics and Status

The State covers parts of five river basins. The Mahanadi Basin has 77,302 Sq km, Godavari Basin has 38,361 Sq km, Ganga Basin has 18,865 Sq km, Brahmani Basin has 1,316 Sq km and Narmada Basin has 2113 Sq km of catchment area respectively in the state. A map depicting the catchment area of respective river basins in the State is given in the table below and shown in Figure 23. River Mahanadi, draining the vast central region of Chhattisgarh state, forms the most important and biggest drainage system of the state. The Mahanadi Basin extends over an area of 1,43,441 Sq Km and major part of the Mahanadi Basin falls in Chhattisgarh. This river system collects the rainwater of the basin in Chhattisgarh as well as part of the basin in Odisha and carries it to the Bay of Bengal. However, in case of Godavari basin, out of the total basin area of 3,12,813 Sq km, major part of the basin falls in Maharashtra and only about 38,361 Sq Km (12.26% of the basin area) falls in the State of Chhattisgarh. The major rivers that drain the state are Mahanadi, Indravati, Son and Narmada. Mahanadi and Godavari cover 85 per cent of the total basin area. Mahanadi is the main river of the state. The other main rivers are Hasdo (a tributary of Mahanadi), Rihand, Indravati, Jonk, Arpa, and Shivnath. Chhattisgarh has fairly good rainfall, yet frequent droughts in recent times plague the State. One reason for this is the neglect of traditional water harvesting practices. The

details of river basins are given in Table 35. The river basins are shown in Figure 23. Each river basin has its own unique characteristic.

Table 35: Major River Basins in Chhattisgarh State

No.	Major Rivers	Catchment Area (sq. km)	Proportion of state covered (%)	Tributaries/ Sub-basins	Districts
1	Ganga	18789	13.6	Son	Surguja, Koriya, Jashpur and Bilaspur
2	Mahanadi	77432	56.2	Seonath. Ib, Mand, Hasdeo, Pairi, Jonk, Tel, Kelo	Raipur, Mahasamund, Dhamtari and parts of Durg, Rajnandgaon, Kawardha, Korba, Kanker, Bastar, Surguja, Raigarhand Bilaspur.
3	Godavari	39497	28.6	Indravati, Sabari, Wain ganga	Parts of Durg, Bastar, Rajnandgaon, Kanker and Dantewada
4	Narmada	759	0.6	Narmada	Parts of Rajnandgaon, Bilaspur, and Kawardha
5	Bramhani	1423	1	Sankh	Part of Jashpur

Source: Chhattisgarh at a Glance, 2018, Water Resources Department-Chhattisgarh & INRM

Surface water

The State is divided in to five river basins. The area contributing to the Mahanadi Basin is the largest; Godavari Basin comes next, followed by Ganga Basin, Brahmani Basin and then the Narmada Basin. Most of the rivers in the state have a torrential regime characterised by high flow of water for three to four months during monsoon (June to September) during which around 80 per cent of the annual runoff flows. Floods and droughts are the main characteristics of the annual flow of the rivers in Chhattisgarh requiring storage reservoirs for efficient use of the available surface water resources.

Table 36: Water Availability

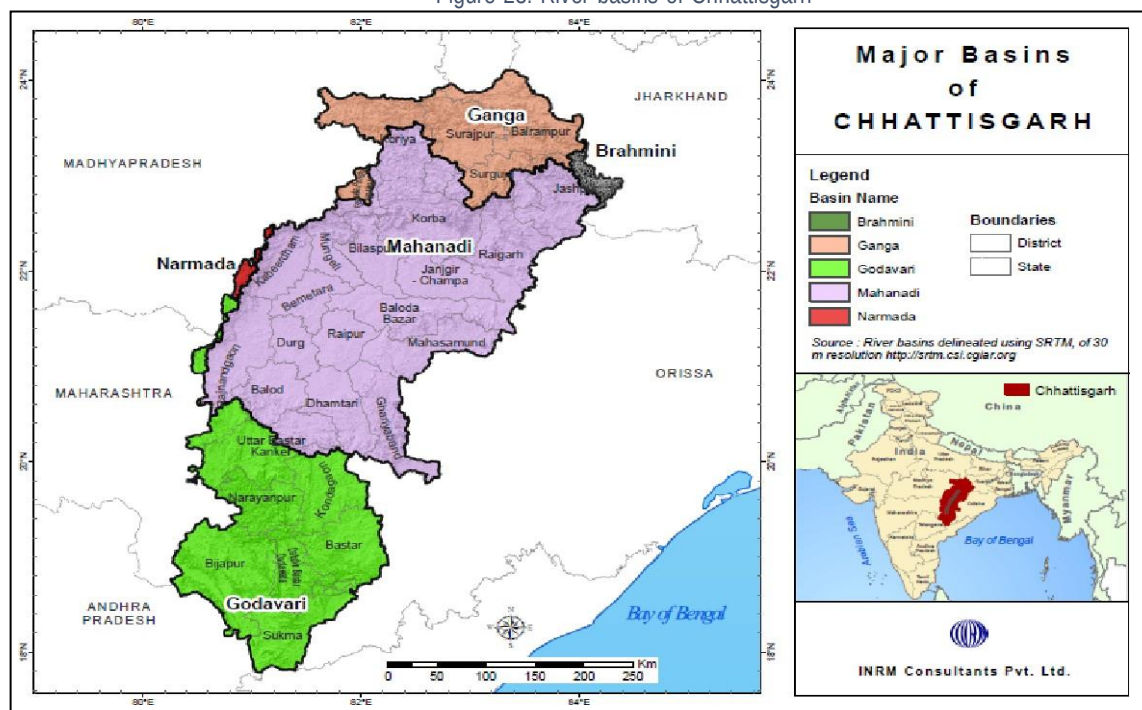
	India	Chhattisgarh	%
Surface Water	18,69,000 MCM	48,296 MCM	3.2
Ground Water	4,35,420 MCM	14,548 MCM	3.17

Estimated surface water flowing through rivers is 48,296 million cum. and due to various geographical and interstate constraints the usable surface water in the state is 41,720 million cum. Surface water being used at present is only about 18,249 million cum³⁵.

86.3 per cent of the households have access to safe drinking water in the state. About 26 per cent of the households have access to drinking water availability away from the premises in the state (Census 2011).

³⁵ Government of Chhattisgarh: Water Resources Department

Figure 23: River basins of Chhattisgarh



Groundwater:

Groundwater is an essential and vital component of our life support system. The groundwater resources are being utilised for drinking, irrigation and industrial purposes. The important attribute of groundwater regime monitoring is through monitoring of groundwater level. The natural conditions affecting the regime involve various hydro meteorological parameters like rainfall, evapotranspiration, runoff, etc., whereas anthropogenic influences include pumpage from the aquifer, recharge due to irrigation systems and other practices like water conservation structures etc. The Total Annual Ground Water Recharge of the State has been assessed as 12.65 bcm and Annual Extractable Ground Water Resource is 11.55 bcm. The Total Current Annual Ground Water Extraction is 5.35 bcm and Stage of Ground Water Extraction is 46.34 %. Out of 146 assessment units (blocks), 9 units (6.16 %) as 'Critical', 27 units (18.49 %) have been categorized as 'Semi-critical' and 110 units (75.34 %) as 'Safe' categories of assessment units. There are no 'Over-exploited' and 'Saline' categories of assessment units³⁶. There are 1499 number of groundwater monitoring stations (observation wells - both dug wells and piezometers) as on 2018³⁷. In Chhattisgarh the depth to water level generally varies from 2-5 meter below ground level. The contribution in Annual Replenishable Groundwater Resource from rainfall during monsoon season is more than 70 per cent in the state.

There is growing concern on deterioration of groundwater quality due to geogenic and anthropogenic activities. The quality of groundwater has undergone a change to an extent that the use of such water could be hazardous. Increase in overall salinity of the groundwater and presence of high concentrations of fluoride, nitrate, iron, arsenic, total hardness and few toxic metal ions have been noticed in large areas in several states of India.

Fluoride: 85 per cent of rural population of the country uses groundwater for drinking and domestic purposes. High concentration of fluoride in groundwater beyond the permissible limit of 1.5 mg/l poses

³⁶ Dynamic Ground Water Resources of India, 2020

³⁷ Groundwater Year Book, 2017-18

the health problem. The occurrences of fluoride beyond permissible limit (> 1.5 mg /litre) in groundwater have been observed in many districts of Chhattisgarh state³⁸.

Nitrate: Nitrate is a very common constituent in the groundwater, especially in shallow aquifers. The source is mainly from anthropogenic activities. High concentration of nitrate in water beyond the permissible limit of 45 mg/l causes health problems.

Iron: High concentration of Iron (>1.0 mg/l) in groundwater has been observed in Bastar, Dantewada, Kanker and Koriya districts of Chhattisgarh.

Arsenic: Arsenic as a contaminant is significant in terms of its toxic nature with exceedingly diverse manifestations of poisoning. Drinking water is the major pathway for ingestion of arsenic in human system. It is observed in Rajnandgaon district of Chhattisgarh.

Table 37: Groundwater Quality in Chhattisgarh

Groundwater Contaminants	Districts affected (in part)
Fluoride (>1.5 mg/l)	Bastar, Bilaspur, Dantewada, Janjgir-Champa, Jashpur, Kanker, Korba, Koriya, Mahasamund, Raipur, Rajnandgaon, Surguja, Raigarh, Durg, Baloda Bazaar
Iron (>1.0 mg/l)	Bastar, Dantewada, Kanker, Koriya
Nitrate (>45 mg/l)	Bastar, Bilaspur, Dantewada, Dhamtari, Jashpur, Kanker, Kawardha, Korba, Mahasamund, Raigarh, Raipur, Rajnandgaon
Arsenic (>0.05 mg/l)	Rajnandgaon

Source: Water Resource Department, Government of Chhattisgarh, 2021

A comprehensive master plan for the state, for optimum use of water resources is under preparation. The state is moving ahead towards a more integrated and sustainable approach to water resources management.

Groundwater Status

Annual Replenishable Groundwater Resource in the state are 12.42 Billion Cubic Meters³⁹ (BCM), however due to natural discharge during non-monsoon season; the net annual groundwater availability is 11.63 BCM. The stage of groundwater development is 35 per cent as the total annual groundwater draft is just 4.05 BCM compared to 62 per cent nation average. The per capita water availability of water is estimated to decline over the period as the population increases in the state. Rainfall is the major source of groundwater recharge in the area and receives maximum (85 per cent) rainfall during the southwest monsoon season. The state is blessed with good rainfall with an average 1150 mm per year.

Name of Semi critical Blocks are Gurur, Balod, Saja Dhamdha, Patan, Durg, Dhamtari and Bilha. As reported by CGWB, Chhattisgarh out of 146 blocks, 18 have been categorized as semi-critical from groundwater development point of view. Out of 146 blocks of the state, one block is categorised as overexploited block (Gurur in Balod district), 2 blocks are under critical, 18 under semi-critical category about availability of groundwater and remaining 125 blocks are safe. Groundwater is used for irrigation purposes which impacts the sustainability of the water.

³⁸ <http://cgwb.gov.in/wqoverview.html>

³⁹ As per the data from Water Resource department, Government of Chhattisgarh

Irrigation

Irrigation is the prime need of the state for its overall development and therefore the state government has given top priority to development of irrigation potential. Net sown area of the Chhattisgarh state is 4.683 million hectares and the gross sown area is 5.561 million hectares. It is estimated that about 75 per cent of the gross sown area of the state can be irrigated with proper use and management of available water resources. Irrigation potential was 1.328 million hectares at the time of formation of the state (i.e. on 1st November 2000) which was 23 per cent of the gross sown area. The irrigation potential has now been raised to 1.844 million hectares at the end of March 2012 which is 33.15 per cent of the gross sown area. Apart from the state budget, irrigation projects are also being financially assisted by Central Government (AIBP), ADB, and NABARD etc.

Key Concerns of the Sector

Poor Water Quality: Besides the sustainability of sources, widespread pollution of surface and groundwater is affecting the quality. The state is facing challenges to tackle chemical contaminations such as iron in the Southern and Northern parts of the state, fluoride in a few districts and salinity and arsenic in the Bemetara and Rajnandgaon districts.

Low Water Use Efficiency: Poor management of water resources leading to wastage and under-utilisation of available resources. Siltation of reservoirs has reduced their capacity and ability to supply the required volumes of water; many of the medium and low storage volume reservoirs have a large surface area relative to their depth, resulting in high seepage and evaporation losses. This has resulted in a widening gap between the irrigation potential created and utilised. Implementation of participatory irrigation management is often limited or non-existent due to uncertainty of water availability. Further, the farmers who have their holdings at the head of the canal tend to appropriate more water than required, whereas the farmers at the tail end often fail to get their apportioned share of water.

Lack of Capacity on Operation and Maintenance of Water Supply Infrastructure: The water supply sector has suffered from lack of capacity building programme of local bodies and other institutions for operation and maintenance. The major water supply technology in rural areas is the hand pump, which is not only a low level of service but secure one with a limited operational life. Due to lack of ownership, technical skills and the financial management of schemes, becomes a challenge. In many cases there are problems with cross drainage – either due to the inadequate provision of cross-drainage infrastructure, or damaged or broken infrastructure.

Lack of Capacity on Sanitation Programs: Sanitation programme requires renewed emphasis on capacity building, both of the programme managers as well as the implementers in the field. The state and district officials, especially the District Collectors/CEOs of Zila Panchayats (district level local government body) need to be trained in the various approaches, especially community approaches and triggers for collective behaviour change.

Small and Scattered Habitations: There are regions in the state that are covered with forest area and with small habitations covering 15 to 50 households in forest region. Providing water with pipe water supply schemes is neither feasible nor optimal for such region. For such small habitation coverage by drilling of tube well is essential. Out of these, high yield tube wells are used for mini-Piped Water Supply Scheme. In addition, solar or electric power Mini Piped Water Supply are planned for these areas by PHED and CREDA.

Inter-State Dispute: Recently disputes over sharing of the Mahanadi waters have arisen. The issues are related to agriculture and industrial water allocation and use, environmental flows, water pollution and groundwater use in the Mahanadi River basin.

Perceived Climate Impacts

- Climate change can affect the hydrological regime-changing water flows, precipitation levels including a shift in rainfall pattern and evapotranspiration. These changes would in turn impact the communities and natural ecosystem adversely; through variability in water availability in the rivers and surface water bodies; changes in the groundwater recharge; impacting crop yields and jeopardising food security.
- Increased incidences of drought are certain to exacerbate existing land degradation and widespread water stress.
- Health concerns due to occurrence of extreme events such as floods and droughts.
- Extreme precipitation events could have geomorphological significance to the State. The response of hydrological systems, erosion processes and sedimentation in this region could alter significantly due to climate change.
- Increase in rainfall is likely to cause flash floods, landslides and damages to the landmass. This has a very severe implication for the existing infrastructures such as dams, bridges, roads, etc.

4.1.4 Urban Development Sector

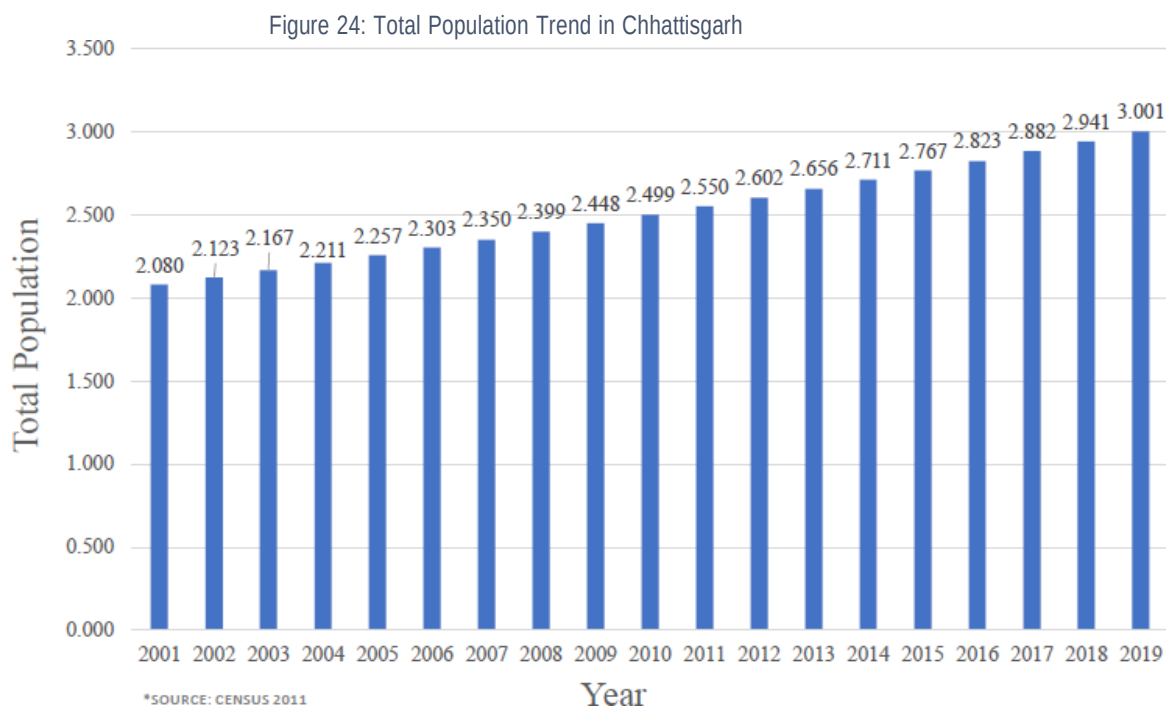
Overview, Characteristics and Status

Chhattisgarh is the ninth-lowest urbanised state with an urban population percentage of 23.24. It is also the ninth-lowest in terms of percentage decadal growth of urban population. Census 2011 data also shows that the percentage growth of urban male population stood at 40.09 as opposed to 30.06 for India, and for urban female population, at 43.69 against a figure of 33.73 for India. The data also shows that as against a total percentage decadal growth of 22.59 during 2001-2011 for the State as a whole, the corresponding figure for urban population in the State was significantly higher at 41.83, showing a dramatic growth in urbanisation.

Table 38: Decadal growth of population in Chhattisgarh (compared to India) ⁴⁰

India/State/	Percentage Decadal Growth (Persons) 2001-2011			Percentage Decadal Growth (Males) 2001-2011			Percentage Decadal Growth (Females) 2001-2011			Percentage Share of Urban Population	
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	2001	2011
India	17.6	12.2	31.8	17.2	12.1	30.0	18.1	12.2	33.7	27.8	31.2
Chhattisgarh	22.6	17.7	41.8	22.5	17.9	40.1	22.7	17.6	43.6	20.1	23.2

⁴⁰ Census of India, 2011



Urban Agglomerations and Population Growth

Urban Agglomerations in Chhattisgarh with a population above 1,00,000 as per 2011 census are shown in the table below. In 2011, the State has 182 towns (as opposed to 97 in 2001), 168 statutory towns (as opposed to 75 in 2001), and 14 Census towns (as opposed to 22 in 2001). The State has 14 Municipal Corporations, 43 Municipal Councils, and 112 Nagar Panchayats (official website of Urban Development Department), with a total urban population of 59,36,538 (Census, 2011). Top seven urban centres in the State are Raipur, Durg, Bhilai, Bilaspur, Korba, Rajnandgaon, and Raigarh.

Table 39: Urban agglomerations with population above 1,00,000 in Chhattisgarh ⁴¹

Rank	Name	District	Population 2011	Male	Female	Population below 5 yrs	Literacy Rate
1	Raipur	Raipur district	11,22,555	5,78,339	54,4,216	1,42,826	86.45
2	Durg-Bhilainagar	Durg district	10,64,077	5,45,683	5,18,394	1,16,977	87.02
3	Bilaspur	Bilaspur district	4,25,821	2,32,995	2,19,856	52,550	87.29
4	Korba	Korba district	3,65,073	1,89,466	1,75,607	45,529	84.36
5	Rajnandgaon	Rajnandgaon district	1,63,122	81,873	81,249	18,677	87.95
6	Raigarh	Raigarh district	1,49,991	76,898	73,093	18,344	87.27
7	Jagdalpur	Bastar district	1,25,345	63,910	61,435	13,804	85.44
8	Ambikapur	Surguja district	1,23,173	64,130	59,043	14,172	87.74
9	Dhamtari	Dhamtari district	1,01,645	50,769	50,876	11,283	85.94

Source: Census of India, 2011

⁴¹ Census of India, 2011

Urban Infrastructure and Services

Provision of urban services and maintenance of public assets is mainly the responsibility of Urban Local Bodies (ULBs) consisting of Municipal Corporations, Municipalities, and Nagar Panchayats. Service level benchmarking (SLB) carried out by the Ministry of Urban Development, Government of India) data for 43 cities and towns in the State shows significant deficits in terms of service levels for water supply, sewerage, solid waste management, and storm water drainage. For example, the typical hours of water supply delivery range from 2 to 4 hours. The SLB data is indicative of the fact urban agglomerations in Chhattisgarh too face the typical problems that plague ULBs elsewhere in India as well – inadequate operation and maintenance (O&M) budgets to run water treatment plants, lack of staff both at managerial and technical level to manage the water supply system and staff need training in modern water utility management and operational techniques. Insufficient revenue is generated from water sales to assist with O&M costs. There is a lack of water meters, so it is difficult to charge commercial and high users of water, and also no incentive to stop people.

Key Concerns of the Sector

- LWE and security issues lead to escalated development and maintenance costs that go well beyond the funds allotted by national programmes; also, maintenance of highways and roads in LWE affected areas are an issue; many of these are in poor repair.
- Waste Management - The state has plans to implement waste management under AMRUT and Smart City schemes. However, these have yet to be implemented on ground.
- Poor city level KPI of energy usage - The state has a very small percentage of renewable sources of power as compared to national average.
- Non-climate-resilient urban planning – With most of its population living in urban areas, Chhattisgarh has immense scope for urbanisation in the decades to come. However, the rapid urbanisation is unplanned and has much scope for compliance with climate resilient infrastructure development.
- Many vehicles in Chhattisgarh support the industries and mining sector – Most of the times these mines and industries operate in hinterland, poor road conditions not only increase the wear and tear of the vehicles but also reduces the fuel efficiency of the vehicles (increasing GHG emissions). Chhattisgarh has one of the poorest road connectivity among all the Indian states. In terms of road density, the state rank is poor, it is well below the national average, at 55.1 km per 100 km² against the Indian average of 125 km per 100 km².

Perceived Climate Impacts

Urbanisation tends to be associated with elevated surface and air temperature a condition referred to as the urban heat island. Increase heat waves and temperature coupled with urban heat island effect can increase the risks of morbidity and mortality, exacerbate air pollution, increase the use of air conditioning load leading to energy shortage and associated GHG emission.

- Increased temperature and heat waves – Chhattisgarh experienced the highest number of heatwaves mainly affecting the urban poor.
- Extreme rainfall events – Heavy and intense rainfall/ flash floods can cause urban flooding, infiltration of logged water into groundwater and increase disruptions of infrastructure services. 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, roadblocks due to landslides and mudslides and affect emergency evacuation operations.
- Roads, railways, and other transport infrastructure can also have a severe impact on the natural environment, from the removal of vegetation during construction or the subsequent fragmentation of

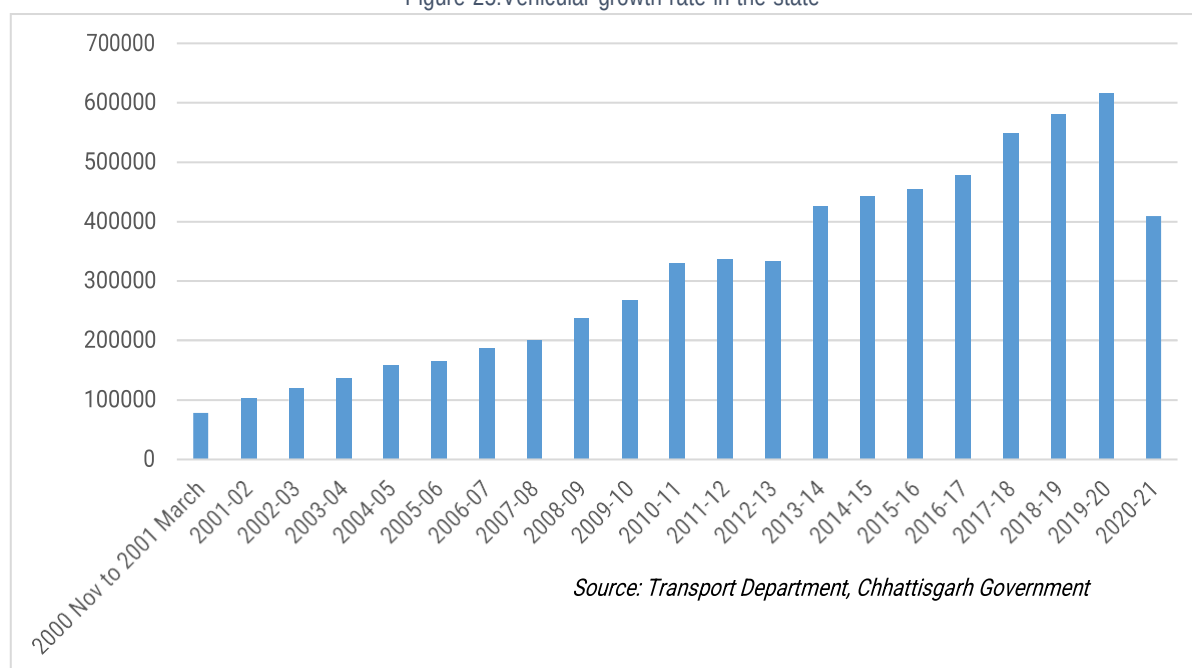
habitats and disturbance of animals; such fragmentation, without proper ecological infrastructure planning, can severely disturb wildlife and reduce biodiversity.

4.1.5 Transport Sector

Overview, Characteristics and Status

Till the end of March 2021, a total of 66,20,427 vehicles were registered, the total number of registered vehicles in the state of Chhattisgarh, which was 2.4 million in the FY 2007-2008, subsequently has increased substantially registering a total growth of 13.59 per cent. Category wise growth includes 20.82 per cent for cars and light vehicles, the highest for any vehicular segment. In 2010-11, revenue collections from duty and taxes on motor vehicles, etc., was 426.74 crore and 351.85 crore in 2009-10, an approximate growth of 21.28 per cent.

Figure 25: Vehicular growth rate in the state



In undivided Madhya Pradesh, till 31.12.2002 only means of public transportation available was the Madhya Pradesh State Road Transport Corporation (MPSRTC) under the Department of Transportation. After the formation of Chhattisgarh, the corporation was dissolved, and the transport sector has been privatized. This resulted in an increase in the state and inter- state transport, and new reciprocal agreements were entered into with neighbouring states.

Key Concerns of the Sector

- Increasing congestion, especially in urban agglomerations; increasing air pollution from vehicular emissions.
- Updation or expansion of vehicular fleets for public transportation facilities is required be carried out based on the increasing population growth and demand.
- Need to draft EV policy at the earliest to increase the usage of energy-efficient vehicles.
- Need to improve ridership in public transport by improving the facilities and improving age-friendliness and passenger friendliness.

Perceived Climate Impacts

Urbanisation tends to be associated with elevated surface and air temperature a condition referred to as the urban heat island. Increase heatwaves and temperature coupled with urban heat island effect can increase the risks of morbidity and mortality, exacerbate air pollution, increase the use of air conditioning load leading to energy shortage and associated GHG emission.

- Extreme rainfall events – Heavy and intense rainfall/ flash floods can cause urban flooding, infiltration of logged water into groundwater and increase disruptions of infrastructure services. 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, roadblocks due to landslides and mudslides and affect emergency evacuation operations.
- The transport sector's consumption of fossil fuels translates into energy-related carbon dioxide (CO₂) emissions, which is projected to increase as transportation needs grow, with a direct impact on climate. Additionally, transport-related pollution, noise, and vibration can pose serious threats to human health and wellbeing. Local air pollution is caused by exhaust emissions produced by traffic, mostly in the form of Sulphur Oxides (SO_x), Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Hydrocarbon (HC), Volatile Organic Compounds (VOC), toxic metals, Lead Particles and Particulate Matter (PM) – including Black Carbon. These emissions represent a large proportion of pollutants, especially in developing cities. Such air pollutants are a cause of cardiovascular/pulmonary and respiratory disease. For example, exposure to lead can cause increased blood pressure, liver and kidney damage, impaired fertility, comas, convulsions, and even death. Children are particularly vulnerable; they can suffer from reductions in IQ and attention span, learning disabilities, hyperactivity, impaired growth and hearing loss.
- Road accidents remain a serious public health issue, and many victims tend to be pedestrians, cyclists and motorcyclists, for whom infrastructure provision is often neglected. Climate change is only likely to exacerbate this by impacting available infrastructure assets. Likewise, congestion is caused when the volume of traffic reaches the capacity of infrastructure. It is particularly common in urban areas, where it can severely limit the positive effects of agglomeration. Travel times for public- transport users, as well as pedestrians and cyclists, frequently increase if dedicated infrastructure is not provided. Congestion also increases fuel consumption and the level of pollution, as fuel is still consumed whilst cars are stationary. Again, climate change can exacerbate these impacts, leading to traffic-filled roads that can become physical and psychological barriers that can sever communities and divide entire cities.
- Roads, railways, and other transport infrastructure can also have a severe impact on the natural environment, from the removal of vegetation during construction or the subsequent fragmentation of habitats and disturbance of animals; such fragmentation, without proper ecological infrastructure planning can severely disturb wildlife and reduce biodiversity.

4.1.6 Energy Sector

Overview, Characteristics and Status

Power Situation in Chhattisgarh

Chhattisgarh has excellent power infrastructure and is a power surplus state with five times more power generation than the actual demand (in terms of installed capacity). With the potential to produce 50,000 MW of power, Chhattisgarh has the prospect to become the power hub of India. As of March 2021, the total installed power generation capacity for Chhattisgarh was 28,557.3 MW.

Table 40: Installed Capacity, Thermal Coal-Based, Hydel, Cogen, & IPP in Megawatt ⁴²

S. N.	Sector		Megawatt
1	Chhattisgarh State Power Generation Company Limited (CSPGCL)	Thermal (Coal Based)	2840
		Hydel (with Small Hydel)	138.7
		Co-generation	6
2	Captive Power Plant		5085.54
3	Independent Power Producer (IPP)		19534
4	Solar Photovoltaic Power Plants (off grid & On grid)		627.52
5	Bio Mass		239.59
6	Co-generation		29.00
7	Small Hydro Power Plants		56.95
	Total		28557.3

Source: CEI, Govt of CG, CSPGCL.

Table 41: State-wise primary energy consumption in sectors in FY 2016-17 (in GWh) ⁴³

State/UTs	Domestic	Commercial	Industrial	Municipal	Transport	Agriculture	Miscellaneous	Total Elec. (Mtoe)
NORTHERN REGION								
Chandigarh	713	525	401	26	0	2	98	1765
Delhi	13927	8038	4682	1076	540	33	1248	29545
Haryana	7545	4179	15007	897	336	10732	4286	42983
Himachal Pradesh	2109	716	6877	589	0	58	199	10548
Jammu & Kashmir	3179	1043	2077	660	0	344	1120	8423
Punjab	12877	3903	18758	673	171	12999	792	50173
Rajasthan	11475	4646	19216	2335	158	22543	599	60972
Uttar Pradesh	30701	5851	25043	2648	1713	14305	4530	84792
Uttarakhand	2596	1279	8148	413	15	159	896	13507
Sub-Total (NR)	85122	30180	100210	9318	2933	61176	13768	302708
WESTERN REGION								
Chhattisgarh	5415	1353	10712	373	924	4544	315	23635
Gujarat	14526	4984	65809	2236	808	12649	1287	102299
Madhya Pradesh	11908	3099	14336	1695	1998	21301	805	55143
Maharashtra	30323	15861	51122	4496	2589	32058	4756	141206
Daman & Diu	96	57	2291	11	0	3	8	2466
D & N Haveli	107	33	6904	12	0	10	889	7954
Goa	1097	401	2931	5	0	20	51	4506
Sub-Total (WR)	63472	25787	154105	8828	6319	70586	8112	337209

Source: https://beeindia.gov.in/sites/default/files/press_releases/UNNATEE%20Report.pdf⁴² CREDA as on December 2019⁴³ https://beeindia.gov.in/sites/default/files/press_releases/UNNATEE%20Report.pdf

The industrial sector continues to be the largest consumer of electricity in Chhattisgarh, with a consumption of 10,712 GWh. The domestic sector has been riding the wave of increasing demand on the account of a prospering economy that has increased the spending power of the middle class and increased the sale of white goods like refrigerators and air conditioners. The electricity consumption in the agriculture sector is mainly due to the usage of electric pumps, which account for close to 90 per cent of the agriculture pumps used in the country. The share is expected to decrease in the future, with the government launching the ambitious Kisan Urja Suraksha Evam Utthaan Mahabhiyan (KUSUM) scheme, where the government aims to install 27.5 lakh solar pumps (17.5 lakh stand-alone and 10 lakh grids connected) in the country.

Few noteworthy ongoing Thermal power projects in the State include the Korba West Extension thermal power plant (TPP) (1 x 500 = 500 MW) at Korba, and the Marwa TPP (2 x 500 = 1000 MW) at Janjgir-Champa. In addition, non-conventional energy sources have been accorded very high priority. A special agency – CREDA has been set up. Micro-Hydel power potential is also being tapped in a big way, and several projects have been identified for viable private investment. The Hasdeo Bango reservoir offers a relatively cheaper source of power generation.

The state has 16 per cent of the total coal deposits of India. 44,483 million tonnes of coal have been estimated in 12 coalfields of the State located in Raigarh, Surguja, Koriya and Korba districts. The state ranks 2nd in coal production by contributing over 18% to the total national production.⁴⁴ Coal washing is an integral part of coal production. Raw coal coming from mines is washed to remove the ash contents to make them fit for feeding into boilers, particularly those of steel plants. Barring a few instances, a coal washery does not form part of a coal mine in India.

Table 42: Installed Capacity of Coal Washeries in India as on 31.03.2018

S. N.	Washery & Operator (NON-COKING COAL)	State of Location	Capacity (MTY) 31.03.2018*
1	Dipka, Aryan coal beneficiation pvt. Ltd.	Chhattisgarh	14.00
2	Gevra, Aryan coal beneficiation pvt. Ltd.	Chhattisgarh	6.25
3	Chakabuwa, Aryan Energy private Ltd.	Chhattisgarh	7.50
4	Korba, ST-CLI Coal washeries Ltd.	Chhattisgarh	NA
5	Bilaspur, Gupta coalfield & washeries Ltd.	Chhattisgarh	NA
6	Tamnar, Jindal Steel & Power Ltd.	Chhattisgarh	6.00
	TOTAL NON-COKING COAL		33.75

State Electricity Board and Reforms

Power Sector reforms were initiated in the early years of its formation. The Chhattisgarh State Electricity Board (CSEB - formed in November 2000) was re-organised into the following five companies in accordance with the provisions of Electricity Act 2003 in December 2008:

1. The Chhattisgarh State Power Holding Company Limited
2. The Chhattisgarh State Power Generation Company Limited
3. The Chhattisgarh State Power Transmission Company Limited
4. The Chhattisgarh State Power Distribution Company Limited
5. The Chhattisgarh State Power Trading Company Limited
6. The Chhattisgarh State Power Generation Company Limited became functional w.e.f. 01.01.2009.

⁴⁴<http://chhattisgarhmines.gov.in/en/coal>

The reforms also encouraged private players to use Chhattisgarh's locational advantage for setting up Captive power plants. It allowed and facilitated third party sales to buyers outside the State. In addition to the Chhattisgarh State Power Generation Company Limited (CSPGCL), the power in the State is generated by Independent Power Producers (IPP), which includes LANCO and Jindal Power. Over 87 per cent of private-sector power capacity and over 93 per cent of state - owned power capacity is from coal-based power plants.

Chhattisgarh Renewable Energy Development Agency

The State has placed significant emphasis on renewable energy development. CREDA is the State Nodal Agency of Ministry of New & Renewable Energy (MNRE), Government of India responsible for Development, Deployment, and Promotion of Renewable Energy (RE) in the state. RE based power plants currently generate about 808 MW and contribute over 5% to the total power generation in the State.

The State Electricity Regulatory Commission (SERC) has mandated renewable purchase obligations to promote RE. Obligated entities are required to procure RE Power up to 20% (by 2020) of their power consumption. RE Power generation has been declared as a priority sector under state industrial policy. In order to further promote RE power, the State has announced state policies for promotion of solar, wind, hydro, and biomass power projects.

Achievements of CREDA in the rural sector include electrification of remote un-electrified villages and hamlets through solar photovoltaic (SPV) of total capacity 3500KW. Other rural initiatives include electrification of 1137 tribal hostels, 306 health centres, 209 remote police stations/camps, installation of 265 SPV Pumps for drinking water supply in remote villages, and installation of 232 SPV Pumps for irrigation in far flung locations from grid. Likewise, urban RE power achievements include rooftop SPV Power Plant of total 13.6 MW capacity in 1089 locations, solar water heating systems of total 12 lakh LPD capacities in 2500 locations. Raipur and Bilaspur have been selected as Solar City Projects of MNRE, with a target to reduce energy consumption up to 10 per cent (from base year 2011) in the next 10 years through energy efficiency and renewable energy installations. CREDA will also be the nodal agency for promotion of the Wind Energy Policy of the State.

Electricity Generation

The State Electricity Generation is dominated by fossil fuels, especially by coal or thermal power. Thus, the share of hydroelectric power in the state is comparatively less.

Table 43: Year Wise Thermal Coal Based, Hydel, Cogen Power, Captive & IPP Generation (Gigawatt Hour)

Sector		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Total
Chhattisgarh State Power Generation Company Limited (CSPGCL)	Thermal (Coal Based)	12636.7	12101.3	12559.7	15592.5	15278.5	17906.3	20834.4	21277.5	18212.34	1,46,399.2
	Hydel (with Small Hydel)	343.78	358.46	299.36	326.36	315.68	184.53	242.52	268.81	269.18	2,608.68
	Co-generation	2.35	6.22	3.39	12.41	9.74	7.91	7.25	6.09	7.63	62.99
Captive Power Plant		22042.2	22992.2	21555	22039.2	24104.7	36104.8	27690.9	27587.1	26828.1	2,30,944.2
Independent Power Producer (IPP)		39586.4	45376.7	50861.8	50831.1	65589.6	74588.6	80000.6	84837.5	91714.9	5,83,387.1
Solar Photovoltaic Power Plant		2.55	6.85	10.56	12.33	52.94	122.77	192.57	344.74	359.95	1,105.26
Biomass		1019.84	1121.46	1207.44	1144.04	1229.16	1391.93	1390.52	1105.92	886.01	10,496.32
Co-generation							21.44	42.03	41.28	48.98	153.73
Small Hydro Project			1.96	10.55	13.43	4.84	6.89	62.7	69.75	106.89	277.01
Total		75633.8	81965.2	86507.7	89971.3	106585	130335	130463	1,35,539	1,38,434	9,75,434.6

Source: CEI, Govt of CG, CSPGCL.

Table 44: Year Wise RE Generation (Gigawatt Hour)

Sources	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Total
Solar Photovoltaic Power Plant	2.55	6.85	10.56	12.33	52.94	122.77	192.57	344.74	359.95	1105.26
Biomass	1019.84	1121.46	1207.44	1144.04	1229.16	1391.93	1390.52	1105.92	886.01	10496.3
Cogeneration						21.44	42.03	41.28	48.98	153.73
Small Hydro Project		1.96	10.55	13.42	4.84	6.89	62.7	69.75	106.88	276.99
TOTAL	1022.39	1130.27	1228.55	1169.79	1286.94	1543.03	1687.82	1561.69	1401.82	12,032.3

Table 45: Anticipated Month Wise Power Supply Position for 2018-19, Chhattisgarh ⁴⁵

	Peak				Energy			
Month	Demand	Availability	Surplus (+) Deficit (-)		Require ment	Availa bility	Surplus (+) Deficit (-)	
	(MW)	(MW)	(MW)	(%)	(MU)	(MU)	(MU)	(%)
Apr-19	4,250	4,405	155	3.6	2,692	2,780	88	3.3
May-19	4,168	4,231	63	1.5	2,680	2,736	56	2.1
Jun-19	4,205	4,405	200	4.8	2,617	2,728	111	4.2
Jul-19	4,214	4,010	-204	-4.8	2,601	2,646	45	1.7
Aug-19	4,310	4,259	-51	-1.2	2,687	2,635	-52	-1.9
Sep-19	4,505	4,087	-418	-9.3	2,654	2,584	-70	-2.6
Oct-19	4,714	4,405	-309	-6.6	2,891	2,790	-101	-3.5
Nov-19	4,121	4,211	90	2.2	2,634	2,719	85	3.2
Dec-19	4,080	4,054	-26	-0.6	2,681	2,791	110	4.1
Jan-20	3,952	3,788	-164	-4.1	2,685	2,817	132	4.9
Feb-20	4,170	3,919	-251	-6.0	2,466	2,394	-72	-2.9
Mar-20	4,463	4,331	-132	-3.0	2,730	2,873	143	5.2
Annual	4,714	4,405	-309	-6.6	32,018	32,494	476	1.5

⁴⁵ <http://www.cea.nic.in/reports/annual/lgbr/lgbr-2019.pdf>

Figure 26: Peak electricity demand and availability



Figure 27: Energy requirement and availability



From the above table 45, Chhattisgarh had a negligible shortage of 0.2 per cent against forecast surplus of 4.7 per cent. Since Chhattisgarh are anticipated to have surplus on annual basis, only in terms of energy. All other States in the country are likely to have a demand-supply gap of varying degrees both in term of energy and peaking, which can be met by arranging power from surplus states through various market mechanisms.

However, a major challenge in the transmission and distribution of electrical power system in the state is transmission and distribution (T&D) losses. The Aggregate Technical and Commercial (AT&C) loss trajectory calculated under UDAY scheme for the state is at 26.86 per cent.

Chhattisgarh Biofuel Development Authority (CBDA)

Based on the state's excellent potential for production of tree-borne oilseeds (TBOs) such as Pongamia, Pinnata (Karanj) and Jatropha (Ratanjot) it was felt that there is a need for effective and coordinated management and monitoring of the activities connected with promotion of plantation, collection of seeds, extraction of biofuel and marketing of biofuel from tree borne oilseeds. As such, the State set up the CBDA for promotion of biofuel in January 2005. The major aims and objectives of the CBDA are:

- Promote research and development facility for undertaking need-based research, developing appropriate technology and extension packages
- Increasing rural income and women empowerment
- Generating rural employment
- Promoting renewable energy through harnessing the biofuel energy
- Growing TBOs and extracting biofuel through identification of areas conducive for TBOs
- Reducing the import bill of oil for the country/State
- Reduction of toxic emission during combustion of Biofuel, which is practically free of sulphurous compound
- Reduction of greenhouse gas emissions through substitution of fossil fuels with plant oils-based fuels
- Self-reliance and fuel security; and
- Earning carbon credits.

CBDA's activities will be executed through coordinated efforts of the concerned departments of the State Government. Since the ultimate use of Biofuel is an application of alternate energy hence CREDA is the

Nodal Agency and Energy Department the Nodal Department for this Authority. Besides finalising various plans under Biofuel Development Programme, sensitisation of farmers, investors and other stakeholders are the basic aims of the CBDA. For this, various types of pamphlets/booklets have been published. Also, rural-based programmes, farmers trainings etc. have been organised. Private investors desirous of setting up biodiesel plants along with undertaking captive plantations are being provided with information under the programme. CBDA also coordinates with various State departments/agencies for efficient execution of the biofuel development programme.

Chhattisgarh Environment Conservation Board (CECB)

The CECB has also been playing a key recommendatory and regulatory role in the power sector. It has taken steps to ensure that the State adopts super-critical technology for all-new large power plants to improve fuel burning efficiency by 1-3 per cent and making the use of high concentration slurry-based disposal systems for fly ash disposal to minimise pollution and dispersal/fugitive emissions of fly ash for all new thermal power plants from 2010 onwards. The CECB also recommends the use of 'beneficiated' or washed coal in thermal power plants in the state for energy output maximisation and efficiency, as well as recommending plantation and advocating the use of alternative fuels.

Table 46: Future/Upcoming Power Projects under CSPGCL

Sl No	Projects	District
1	IFFCO-CSPGCL TPP, [JV] Prem Nagar (2X660= 1320 MW)	Sarguja
2	Bodhghat HPP (4X125= 500 MW)	Dantewada
3	Kanhar HPP (2X25= 50 MW)	Sarguja
4	Rehar HPP (3X32= 96 MW)	Sarguja

Additionally, in a move announced on 6 December 2012, the GoCG has also decided to set up a geothermal power plant at Tatapani, in the Balrampur-Ramanujan district.

Key Concerns of the Sector

- While state-sector power generation capacity has increased mainly through renovation and modernisation of existing plants and installation of additional capacity and improved energy infrastructure like very high-tension transformers and 100 per cent increase in line extensions. However, in terms of efficiency the progress has been mixed. On the production side the Plant Utilization Factor (PUF) of thermal power plants is up from 65.75 to 88.99 per cent - one of the best in the country. However, on the distribution side, losses are still high.
- Ash utilisation cannot be achieved as there are no cement plants located in the nearby vicinity of CSPGCL power stations.
- Lower renewable energy penetration – Implementation of RET (with specific to solar energy technology) is heavily dependent on grants/aids like CFA and state funding assistance without proper development of market-based ecosystem and therefore the likely reduction/obsolescence of subsidy/grant might impact the market. Lower retail tariff as against high initial investment. In renewable energy projects in most cases disinterested private sector investors/consumers further there is poor supply chain and disinterested financial institution. Land acquisition is a major challenge for ground mounted solar and hydro power units.
- Limited awareness amongst consumers over the benefits of adoption of renewable energy and energy efficiency measures is the major barrier preventing the adoption and mainstreaming of technologies.
- Limited availability of RESCOs and ESCOs in the state.
- No policy regulation/ incentive to mandate or motivate energy audit and implementation of energy conservation measures across building, commercial and MSME sector.

- Several studies clearly show gender differences in energy production, energy use, and access to energy and the participation of women in energy-related planning and decision-making. Especially in rural areas of developing countries, a lack of energy services is evident. Lack of access to energy mainly affects women in their role as household managers because they are usually responsible for providing energy for the household. Without access to convenient, affordable fuels for cooking and heating as well as efficient cooking devices, women have to spend large amounts of time and physical energy obtaining traditional fuels (such as wood, charcoal, dung and agricultural waste) to heat water and cook meals. Furthermore, energy is often a precondition for income-generating activities. Energy poverty is also a growing problem affecting poor households. The share of female-headed (single mothers or elderly) poor households is notably high. Indoor air pollution, a result of extensive use of fuel wood and other biomass burning for household energy, is a major problem affecting the health of women. The participation of women in energy planning and decision-making is extremely low. Therefore, the State will develop a separate equity focused strategy to address rural energy security including substitution efforts for reducing fuel wood consumption in association/coordination with the Forest Department. Such a strategy should involve incorporating gender analysis at each step of policy, programme, and project planning and implementation will help to identify gender-related impacts, develop the right questions for further research and data collection, and make gender a standard consideration for planners and decision-makers. The power sector in its turn can support the strategy by livelihood enhancement by up-gradation of traditional watermills, poverty reduction, and livelihood enhancement by providing electricity facilities through micro-hydro Projects and other such initiatives.

Perceived Climate Impacts

While there have been no Chhattisgarh specific detailed studies on climate change available evidence shows several pointers on the impact the energy sector has on climate, as also the impact climate change is likely to have on the energy sector.

Energy services are a necessary input for development and growth. At the same time, fossil energy conversion, and end-use, is recognised as major contributor to global warming. Today 70 per cent of greenhouse gas emissions come from fossil fuel combustion for electricity generation, in industry, buildings, and transport – and these emissions are projected to rise. By 2050, the global population will grow to 9 billion, with growth mostly concentrated in developing countries with improved living standards. If we continue as we are today, delivering energy services and sustaining economic growth will result in a tripling of annual greenhouse gas (GHG) emissions.

Efforts are underway, in developed and developing countries, to arrest and reverse the growth in GHG emissions and lower the carbon footprint of development. The energy sector is a primary target of these efforts. Consequently, capacity is being built to integrate lower carbon development objectives into long-term (20 to 30 year) energy planning processes. Experience and knowledge of new technologies and measures to lessen carbon footprints are being exchanged. There is significant focus on the major scale-up of renewable energy sources, efficiency measures (supply and demand side), loss reduction, and cleaner fossil fuel combustion technologies.

Energy services and resources will be increasingly affected by climate change—changing trends, increasing variability, greater extremes, and large inter-annual variations in climate parameters in some regions. Though potential climate impacts have been recognised strongly within the energy sector, the focus has mainly been on the responsibility for greenhouse gas mitigation rather than on the management of energy services. Climate impacts across the entire energy supply chain. Impacts on energy supply and demand are the most intuitive but there are also direct effects on energy resource endowment,

infrastructure, and transportation, and indirect effects through other economic sectors (e.g., water, agriculture). This exposure is driven in part by the current state of the sector (e.g., inefficiencies in energy and water use mean energy services are vulnerable and have less capacity to deal with change).

Increasing temperatures are almost certain to reduce heating demands but increase cooling demands overall, but inter-annual variability will remain, and cold periods will not disappear. Seasonal demand profiles will alter responding to user needs for energy for heating and cooling in buildings, for industrial processes, and for agriculture (e.g., irrigation). Flooding and droughts will continue, with likely impacts on infrastructure (including silting of reservoirs), and on demand. Climate change may impact the generation cycle efficiency and cooling water operations of fossil fuel fired, nuclear, and biomass fired power plants.

The generation potential of renewables may change but is impossible to assess without additional locally specific studies:

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

Energy transportation infrastructure (for power, oil, and gas) are also variously exposed to wind gusts, storms, storm-related landslides and rockfalls, land movements, siltation and erosion processes, as well as changes in water basins. The table below summarises potential impacts on the energy sector.

4.1.7 Industry Sector

Overview, Characteristics and Status

Chhattisgarh is making significant investments in industrial infrastructure. The Chhattisgarh Industrial Development Corporation has set up five Industrial Growth Centres, five Industrial Parks and 12 Integrated Infrastructure Development Centres (IIDC). The state has one notified SEZs. With excellent natural resource base, good rail and road connectivity to major ports and cities, direct air connectivity to all major metros, comprehensive natural gas pipeline network with a capacity of 30 MMSCDM across the State, excellent power supply and energy infrastructure, favourable policy initiatives such as the Industrial Policy 2019-24, SEZ Policy, and other such policies, investor-friendly governance and support provided by the Chhattisgarh State Industrial Development Corporation (CSIDC) and the State Investment Promotion Board (SIPB), as well as a rich labour pool, the State is fast becoming an industrial powerhouse and an attractive investment destination for industries. Key industries in the State include mining, iron and steel, cement, power, IT and ITeS, biotechnology and pharmaceuticals, food processing, gems and jewellery, etc. Other industrial growth sectors include apparel, aluminium and metals, MFP and processing-value addition of MFP, handicrafts, automotive and engineering, etc. The state is the iron and steel hub of the country. The Bhilai Steel Plant of Steel Authority of India Ltd (SAIL) produces more than 3 million tons of iron and steel per annum. In addition, substantial capacities have been set up by the private sector. For the establishment of food parks in the state, total government land of 110 blocks were identified out of 146 blocks. The infrastructure development for the establishment of food park is in progress.

Chhattisgarh is in the central part of India. The state shares its border with Madhya Pradesh and Maharashtra in the west, Uttar Pradesh in the north, Odisha and Jharkhand in the east, and Andhra Pradesh and Telangana in the south.

At current prices, the Gross State Domestic Product (GSDP) of Chhattisgarh stood at Rs. 3.62 trillion (US\$ 51.39 billion) in 2020-21. GSDP (in Rs.) of the state at current prices grew at a CAGR of 9.97 per cent between 2015-16 and 2020-21.

Chhattisgarh is presently one of the few states that have surplus power. Korba district in Chhattisgarh is known as the power capital of India. It is also among the few profitable states in terms of utility-based electricity. As of April 2021, Chhattisgarh had a total installed power-generation capacity of 13,076.27 MW, comprising 8,229.83 MW under private utilities, 1,971.05 MW (state utilities) and 2,875.39 MW (central utilities). Energy requirement in the state was 27,303 million units in 2019-20.

Mineral resources are Chhattisgarh's biggest strength. It is a leading producer of minerals such as coal, iron ore and dolomite. Moreover, considerable reserves of bauxite, limestone and quartzite are available in the state. The state accounts for 35.4 per cent of tin ore reserves of India. Chhattisgarh is the only state in India that produced tin concentrates.

Chhattisgarh has emerged as one of the most preferred investment destinations in India. The state (including Madhya Pradesh) attracted cumulative Foreign Direct Investment (FDI) worth US\$ 1.43 billion between April 2000 and March 2020. Between October 2019 and March 2021, FDI inflow in Chhattisgarh stood at US\$ 0.03 million. During 2019, 61 Industrial Entrepreneurs' Memorandum (IEMs) were filed in Chhattisgarh with a proposed investment of Rs. 5,132 crore (US\$ 743.30 million). Total merchandise exports from Chhattisgarh are estimated at US\$ 1,278.69 million in FY20 and US\$ 2,320.29 million in FY21.

A wide range of fiscal and policy incentives for businesses were announced under its Industrial Policy, 2014-19. Additionally, the state has well-drafted policies for the IT/ITeS, solar energy, agro and food processing, minerals and biotechnology sectors. Chhattisgarh stands fourth among Indian states in rankings based on ease of doing business and reforms implementation, according to a study by the World Bank and KPMG.

Following completion of the 30-kms Korichhapar-Dharamjaigarh section by IRCON International in January 2021, the complete section of 74 kms between Kharsia and Dharamjaigarh is functional

- Commencement of this section has made way in evacuating coal from the North Chhattisgarh area
- Goods train can reach up to Durgapur, and the Baroud and Chhaal mines of South-eastern Coalfields

Key Sectors:

- **Metals and Mining:** Chhattisgarh is the only state in India to produce tin concentrates and accounts for 36 per cent of the country's tin ore reserves. Dante Wada is the sole district producing tin from 6 mines. During 2019-20, tin concentrate production in the state stood at 15,546 kg. Chhattisgarh's combined export of aluminium and products, iron ore, and iron and steel products reached US\$ 1,037.19 million in FY21. Total mineral production in the state during 2019-20 was Rs. 11,125 crore (US\$ 1.53 billion). In August 2020, Chhattisgarh accounted for about 13.7 per cent of the total mineral production in India.
- **Cement:** Chhattisgarh has abundant limestone reserves that support a strong cement sector. Chhattisgarh accounts for around 5.4 per cent of the total limestone reserves in India. Limestone production in the state reached 42.41 million tonnes in 2018-19.

- **Agriculture:** Around 80 per cent employment in the state is dependent on agriculture. The state's position as the 'Rice Bowl of Central India' and its reliance on agriculture has led to brisk growth in the food processing industry as a special-thrust industry. Non-Basmati rice is the most exported commodity from the state. Its exports reached US\$ 257.67 million in FY20 and US\$ 474.82 million in FY21. Total horticulture production in the state reached 9,876.16 thousand metric tonnes in 2018-19 with 775.02 thousand hectares of area under cultivation. Between 2011-2012 and 2019-20, the Gross Value Added (GVA) from the primary sector in the state increased at a CAGR (in Rs.) of 9.28 per cent.
- **Apparel:** Chhattisgarh is one of the leading producers of tussar and kosa silks in the country and has the potential to be a strong player in the Indian apparel industry. Raw silk production in the state reached 349 metric tonnes in 2018-19 and 480 metric tonnes in 2019-20P.

Chhattisgarh which has been ranked consistently 4th in the DIPP-World Bank Ease of doing business(EoDB) rankings for 2016 & 2015, has gone a step further in 2017 and with an impressive implementation score of 99.46 per cent & feedback score of 78.44 per cent is amongst the **Top achiever** states of the country (As per the DIPP-World Bank BRAP-17 rankings).

The State also has a well-established MSME sector, with a large and diversified base. As of FY 2020-21, 602 Micro, small, medium, Large and Mega such units were established in the state with a total investment of 263719.11 INR Lakh and providing employment to over 10701 individuals.

Key Concerns of the Sector

1. In the state large area of land is covered by forest, so that land availability for industrial purpose is very limited.
2. Lack of industrial infrastructure and infrastructural support facilities like rail, air connectivity, dry port, cargo terminal etc.
3. Due to large area of forest covered, land development for industrial parks/estate is affected.
4. Lack of skilled workforce in the state.
5. Challenges towards clean energy transition:
 - a. Poor market ecosystem including lack of supply chain institutions in the domain of rooftop solar and energy-efficient technology options.
 - b. Monopolistic and subsidy driven market particularly for decentralised solar application.
 - c. Lack of long-term business visibility and poor awareness amongst SME units towards the energy cost, energy cost reduction possibilities and financial and fiscal benefits entitled with adoptions of renewable energy technology and energy conservation measures (e.g., schemes such as TEQUP, CLCSS supporting technology up gradation).
 - d. Lack of finance for renewable energy and energy-efficient measures, MSME units faces challenge to meet collateral requirement.
 - e. Disinterested financial institutions for financing renewable energy and energy-efficient measures, MSME units faces challenge to meet collateral requirements as neither the RE nor EE products are considered as collateral, stringent and cumbersome documentation, and time-consuming loan processing procedures.
 - f. Lower energy expenditure as share of total operating expenses.
 - g. Poor capacity utilisation of the industrial units and perceived risk towards sustainability of business operation particularly amongst SME owners restrict them for investment.

Perceived Climate Impacts

- Industry is likely to be vulnerable to a variety of climate risks, including extreme weather events that can adversely impact industrial infrastructure.

- Agro-based and food processing industries that rely on agricultural resources can be particularly vulnerable due to variability in the production.
- Industries that are either water or energy-intensive could also be similarly vulnerable to climate change and its impacts due to decline in the surface as well as groundwater levels.
- Because of their financial and technical resources, large industrial organisations typically have a significant adaptive capacity for addressing vulnerability to weather extremes but MSMEs typically with lower financial and technical resources have therefore less adaptive capacity. As such, climate change is likely to disproportionately impacts smaller industrial establishments, those in high risk or highly dependent on climate vulnerable resources such as agriculture.
- 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, 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.
- On the contrary, industries could also contribute to climate change. The industrial sector emissions of GHGs include CO₂ from energy use, from non-energy uses of fossil fuels and from non-fossil fuel sources (e.g., cement manufacture), as well as non-CO₂ gases. Many industrial segments also emit a range of non-CO₂ GHGs including N₂O from the chemical and food industries. Industries can also contribute to climate change by a variety of other means, including higher consumption of energy and use of energy-inefficient technologies.

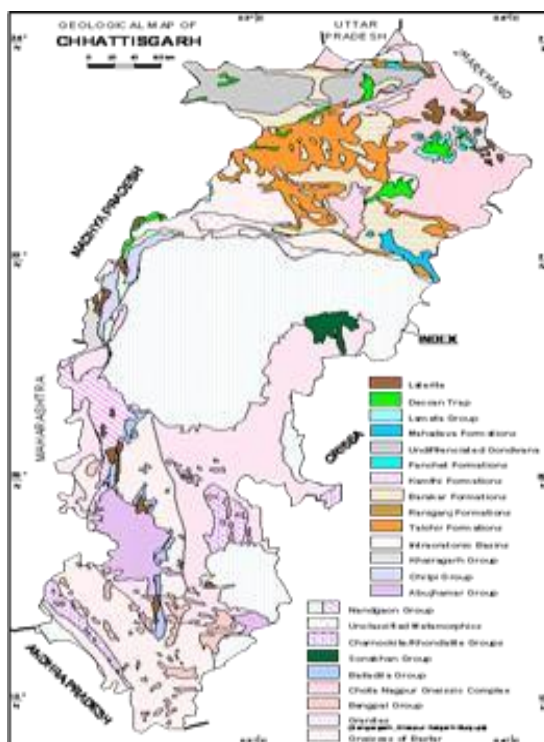
4.1.8 Mining Sector

Figure 28: Mineral Map of Chhattisgarh

Overview, Characteristics and Status

Chhattisgarh is among the richest Indian states in terms of mineral wealth, with 28 varieties of major minerals, including diamonds and ranks second in the country in mineral production. The state holds a major share of coal deposits in India, which has led to the State also being a major power producer and being a power surplus. It is the only state in India to have tin ore reserves. About one-fifth of the iron-ore in the country is mined in the state and one of the best-quality, iron-ore deposits in the world is found at the Bailadila mines in the South of Chhattisgarh from where it is exported to Japan and other countries.

Rich deposits of bauxite, limestone, dolomite, and corundum are also found in the state, making it the ideal location for low cost of production of end products such as cement and aluminium. During 2018-19, the state had contributed 15.11 per cent⁴⁶ in the national revenue from minerals.



⁴⁶ Economic survey of Chhattisgarh 2020-21

Table 47: Details of Production of key Minerals in the State

Mineral	Production – 2019-20 (Thousand Tonnes)
Coal	1,57,064
Iron-ore	34,724
Limestone	42,699
Dolomite*	-
Bauxite	1,566
Tin (Concentrate)	15,546

*In kilogram

Source: Department of Geology and mining, Government of Chhattisgarh

Department of Geology and Mining is one of the important Department of Government of Chhattisgarh and the main functions and activities of the Department are systematic survey and assessment of the mineral deposits of the State, their exploitation, administration of mines and mineral concession, enforcement measures for prevention of illegal mining and smuggling of minerals and assessment and collection of mining revenue. The Department strives for sustainable development of mineral resources in a scientific and eco- friendly manner; so as to create a conducive environment for industrial growth in the state.

Table 48: Details of the Major Mineral Mines in the State

Mineral Name	Number of mines	Area(in hectare)
Coal	60	65,974.445
Iron ore	24	8,348.640
Limestone	108	10,649.917
Bauxite	26	5,665.059
Tin	12	300.183
Graphite	01	67.110
Runner moulding sand	02	7.682
Moulding Sand	02	8.080
Total	235	91021.113

Source: Department of Geology and mining, Government of Chhattisgarh

As per the above table, the highest mines in the State are of limestone followed by coal iron ore and bauxite respectively, although area wise coal mines cover the largest mined area in the state followed by limestone and iron ore.

Key Concerns of the Sector

1. Under-developed evacuation infrastructure in the mineral-bearing regions like connecting roads and railway stations results in cost augmentation and lowers profitability over and above the environmental concerns.
2. Mining has a lot of negative effects on the environment of the region where mining takes place. Impacts can result in erosion, sinkholes, loss of biodiversity, or the contamination of soil, groundwater, and surface water by the chemicals emitted from mining processes. These processes also have an impact on the atmosphere from the emissions of carbon which affect the quality of human health and biodiversity.
3. Restoration and rehabilitation of mines after completion of mining activity is not being taken up effectively. Thus, many mining sites are in poor environmental conditions, although the State follows strict environmental and rehabilitation laws to ensure that the mined areas return to its original state, but not all the mining companies have complied with the mine closure plans.

4. Mining operation in most cases leads to environmental violations like encroachment of forest land, disappearance of flora, fauna and reduced area of green belts.
5. Mines not only use the precious land but also directly use the water in large quantities. Often, this water has high concentration of contaminants after the use, which is then discharged into freshwater bodies after the post and primary treatment. After the recovery of ores, previously drained underground mines and open pits are refilled with water, further diverting the surface and the groundwater flows leading to a higher amount of losses. 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. The water use footprint of the mining activity is huge.

Perceived Climate Impacts

According to IPCC's Fifth Assessment Report and subsequent observations of the climate change network in the country as well as in the state, the following events may affect mining activities in Chhattisgarh:

1. The high level of precipitation, mainly high intensity and short duration rains will increase the rainwater infiltration on spoil piles, resulting in aquifer-level contamination in coal-bearing areas. The water quality of nearby streams may be affected.
2. Concentrated rainfall might increase the risk of mining operations and damage the outbound transport infrastructure. Changes in the frequency and intensity of storm events could affect mining operations (e.g., tailing dams, sediment and erosion control). 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 due to flooding in the mines. Disruption of land transportation routes and supply of raw materials (construction material, fuel) might delay extraction and dispatch of minerals.
3. Similarly, the excessive heat that is likely to prevail during the summer months may cause heat strokes to the workers. This may also cause more mining accidents and shorter working hours and lower productivity.
4. Generally, climate change effects will be associated with reduced efficiency, increased operation cost and slowing of mining expansion into new areas.
5. Mining process requires power to cool underground mines and surface facilities. A rise in temperature increases power demand and associated costs.
6. Heavy rainfall also causes other environmental impacts which include heavy silting downstream. Heavy rainfall combined with faulty waste management practices on site can lead to an enhanced increment of pollutants in the river.

4.1.9 Health Sector

Key Health Indicators and Performance

Chhattisgarh is continually recording considerable growth in the field of Health and development, but still has a long way to go to reach parity with National levels. The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change. These effects occur directly, due to changes in temperature and precipitation and occurrence of heatwaves, floods, droughts, and fires. Indirectly, health may be impacted by ecological disruptions brought on by climate change (crop failures, shifting patterns of disease vectors, clean air and safe drinking water), or social responses to climate change (such as displacement of populations following prolonged drought). Variability in temperatures is a risk factor, over and above the influence of average temperatures on heat-related deaths. Biological and social adaptation is more difficult in a highly variable climate than one that is more stable. The health and nutritional status of the people of Chhattisgarh have improved over the years.

Communicable diseases (including vector-borne and water-borne diseases) are infectious diseases caused by microorganisms, such as bacteria, viruses, parasites, and fungi that spread directly or indirectly. Some are caused by insect bites or from food and water (WHO). Water-borne diseases (cholera, and various diarrheal diseases) are sensitive to climate change impact including seasonal variation. Compromised hygiene during water scarce/drought situation and freshwater contamination during flood increase the risk of water-borne diseases. A low awareness about breeding sites for mosquitoes, scanty use of mosquito nets and inadequate knowledge about the symptoms of the disease are some of the key challenges resulting in the high incidence of malaria. The table below provides information (cases and deaths) on vector-borne diseases in Chhattisgarh.

Table 49: Vector Borne Disease ⁴⁷

Disease	2017	2018	2019	2020
Malaria	1,40,575	1,99,098	1,99,098	1,76,935
Dengue	2681	12,439	7641	2309
Chikungunya	11	39	44	7

Source: IDSP Chhattisgarh

Table 50: Zoonotic Diseases ⁴⁸

Diseases	2017	2018	2019	2020
Dog Bite	33105	39515	50529	45735
Snake Bite	4074	4482	5388	4308

Source: IDSP Chhattisgarh

Table 51: Water Borne Diseases ⁴⁹

Diseases	2017	2018	2019	2020
Acute Diarrheal Diseases	362630	270669	347025	247573
Typhoid	75227			

Date Source: IDSP Chhattisgarh

Table 52: Acute Respiratory Infection

Acute Respiratory Infections (ARI Cases)	
2017	962643
2018	944555
2019	1189194
2020	655386

Data Source: IDSP Chhattisgarh

Table 53: IMR, % full Immunisation & MMR ⁵⁰

Data to be Collected	Data	Remarks
State Infant Mortality Rate (IMR)	43	SRS 2014
	41	SRS 2015
	39	SRS 2016
	38	SRS 2017
	38	SRS 2018
	38	SRS 2019 till December
% Full Immunisation	84 (2014-15)	HMIS Data

⁴⁷ National Health Policy, 2018 (13th Issue), CBHI, Ministry of Health and Family Welfare, GOI; Directorate of National Vector Borne Disease Control Programme Dte, GHS, Ministry of Health & Family Welfare.

⁴⁸ National Health Policy, 2018 (13th Issue), CBHI, Ministry of Health and Family Welfare, GOI; Directorate of National Vector Borne Disease Control Programme Dte, GHS, Ministry of Health & Family Welfare.

⁴⁹ Sample Registration System (SRS 2014 – 2019)

⁵⁰ Sample Registration System (SRS 2014 – 2019)

	87 (2015-16)	
	85 (2016-17)	
	87 (2017-18)	
	92 (2018-19)	
	68 (2019-20 till December)	
Maternal Mortality rate (MMR) (per 100000 live births)		141 SRS (15-17)

The Total Fertility Rate of the State is 3.4 a little high above the national level of 2.9. The IMR for the state has come down currently to 38 from the previous figure of 43 at the time of formation of the state. This is a major achievement for the state because any reduction in IMR requires synergistic efforts from several departments and improvement in social status. The Maternal Mortality Ratio of 141 is slightly higher than the national average of 122. Sex Ratio in Chhattisgarh is 991. That is for each 1000 male, which is below the national average of 940 as per census 2011.

Over the last ten years, the State has taken several strides to improve the delivery of health services and has been able to achieve some progress in bringing down its adverse health indicators.

Banking on the enormous stride of the health care department an incremental performance has been observed against the key performance indicators. Amongst the eight Empowered Action Groups, out of the states including Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, Uttarakhand, Uttar Pradesh, and Odisha, only three of the states i.e., Rajasthan, Jharkhand and Chhattisgarh have shown an improvement in the overall performance between 2015-16 and 2017-18. Out of the 21 large states in India, Chhattisgarh now ranks at 13 with a composite index score of 53.36 as against the highest index score of 74.01 for Kerala.⁵¹

Health Infrastructure

The overall health infrastructure of the state has been quite poor when the state received its own independent status. Until recently, there was only one medical college for modern medicine in the state at Raipur. Similarly, the number of sub-centres, primary health centres or community health centres were way below the requirement, keeping in mind that the state was sparsely populated with very remote and difficult to reach terrain with almost half of its land covered with dense forests. In the past attention was focused on the improvement of health infrastructure to increase coverage and to subsequently make adent on these indicators. As a result, facilities have seen a quantum increase in numbers, the table below shows the current numbers. The state is also having presence of a large number of indigenous practitioners in the form of Ayurveda, Unani, Siddha, and other systems along with Homoeopathy.

Table 54: Health Infrastructure of Chhattisgarh⁵²

S. N.	Item	Ref. Year	Unit	Statistics
Health Resources				
1	District Hospitals	2020-21	No.	26
2	Leprosy Sanatoriums & Hospitals	2020-21	No.	3
3	Polyclinics	2020-21	No.	1
4	Civil Dispensaries	2020-21	No.	31
5	Community Health Centres	2020-21	No.	170
6	Primary Health Centres	2020-21	No.	792

⁵¹ http://social.niti.gov.in/uploads/sample/health_index_report.pdf

⁵² CG Economic Survey 2020-21 & Chhattisgarh at a glance, 2020, Directorate of Economics & Statistics, Government of Chhattisgarh

7	Sub - Health Centres	2020-21	No.	5205
8	State Health Family Welfare Centres	2020-21	No.	1
Rural Health and Family Welfare Training Centre				
1	General Nursing Training Centre (Govt.)	2019-20	No.	14
2	Multipurpose Worker School Female (Govt.)	2019-20	No.	5
3	Multipurpose Worker School Male (Govt.)	2019-20	No.	5
4	Govt. Ayurvedic Dispensaries	2019-20	No.	637
5	Homeopathy Dispensaries	2019-20	No.	52
6	Unani Dispensaries	2019-20	No.	6

Status of Health in Chhattisgarh

Chhattisgarh is currently facing several challenges in improving the health and nutritional status of its people. The newer public health challenges include the escalating burden of chronic non-communicable diseases leading to an epidemiological transition. The rising elderly population is leading to a demographic transition. Environmental factors and climate change also have an impact on the disease patterns. Currently, the ongoing problems of maternal and child mortality, communicable diseases, and HIV/AIDS pandemic need greater interventions and support from the already overstretched and overburdened health systems. (Galhotra et al. 2014).

A report published by the Indian Council of Medical Research and the Public Health Foundation of India notes that in Chhattisgarh, HIV/AIDS, tuberculosis and other lower respiratory infections, diarrhoea and malaria together have led to 39% of deaths in 2016 among children between 0-14 years of age. Recent figures from the National Vector Borne Disease Control Programme show that in 2017, Chhattisgarh alone accounted for 42% of all malaria-related deaths in India. (Raza, 2018).

The National Anti-Malaria Program (NAMP) is being implemented all over the country and 100% central funding is provided to tribal districts in Chhattisgarh, where a five-year enhanced malaria control project with assistance of the World Bank is in operation. Centrally Sponsored disease control programmes for the control of Malaria, Tuberculosis, Leprosy, Blindness, Aids, etc. are also being implemented. Danish support has been extended to the State of Chhattisgarh for Basic Health Services Programme (CGBHSP).

Impacts of Climate Change on Health

Climate change has various impacts on human health. The rise in illness and deaths is due to the increase in frequency and intensity of heatwaves, increased precipitation, floods and droughts. High temperature is known to increase the level of 'ground level ozone' and other 'climate-altering pollutants' other than carbon dioxide, which further exacerbate cardio-respiratory and allergic diseases, and certain cancers (NAPCC&HH, 2018). There is an increase in transmission and spread of infectious diseases, changes in the distribution of water-borne, food-borne and vector-borne diseases and occurrence of disasters and increased probability of malnutrition. Economically weaker populations are more prone to be adversely affected due to variability and change in climatic conditions. Diseases such as malaria, yellow fever, dengue and cholera are all sensitive to climate change. The health effects may occur either due to direct or indirect causes of climate change or extreme weather events. The National Action Plan for Climate Change and Human Health from the Ministry of Health and Family Welfare, by the Government of India has reported regarding the impacts of climate change on human health. It is discussed in the following sections.

Direct Impacts of Climate Change on Health

The changes in climate variables such as temperature, precipitation, occurrence of heatwaves, floods, droughts and fires have direct impacts on health, which are as follows:

Heat-stress related impacts on health

The IPCC Special Report on Extreme Events (IPCC, 2012) has reported that there is a decrease in the number of cold days and nights, and increase in the number of warm days and nights, at the global scale. As the daily maximum temperature increases, there is an increase in the number of heat-related illnesses. If the body temperature increases above 40.6°C, the physical and cognitive functions get impaired, there is increase in the risk of organ damage, which could result in loss of consciousness and may even cause death due to heatstroke. Various factors interact leading to mortality, majorly affecting the vulnerable population.

Many studies have reported that there would be an increase in temperature-related morbidity events due to cardiovascular, respiratory, and kidney diseases. These impacts have been related to the duration and intensity of heat. Health risks during heat extremes are greater in people who are physically active. It has been reported that many heat waves have hit Indian states during 2017 and 2018 causing many deaths (MoES, 2019). The significant correlation between mortality and high temperature and high heat index has been well documented across the country.

Drought, storm and flood-related impacts on health

Climate change results in more hot days, more drought periods, dust storms heavy rains with flooding. It may directly affect health with injuries, hypothermia, hyperthermia, drowning, and indirectly through population dislocation, crowding, poor living conditions, faeco-oral transmission of gastro-intestinal pathogens - causing water and food-borne illnesses, respiratory illness and other infectious diseases (e.g., leptospirosis, vector-borne disease, cholera and also mental illnesses). The reason primarily is the contamination of water and issues in sewage disposal.

Ozone

Ozone is a secondary pollutant and its pollution is increased due to warming temperature, which enhances the photochemical reactions involving precursor hydrocarbons and oxides of nitrogen in it. It persistently causes damage to structure of airway or lung tissue. It increases the risk of severe symptoms of asthma, respiratory illness and may even cause deaths. It may also result in severity of cardio-pulmonary attacks and allergic rhinitis.

Air pollution

Air pollution is a major environmental risk to health. The formation, transport and dispersion of many air pollutants are determined partly by climate and weather factors such as temperature, humidity, wind, storms, droughts, precipitation and partly by human activities. Thus, climate change will influence the dynamics of air pollution. By reducing air pollution levels, the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma can be reduced. Climate change can also have a significant combined effect on regional air quality as it affects the conditions that effect pollutant transport like changes in chemical reaction rates and boundary layer mixing. Carbon dioxide (CO₂), one of the major drivers of climate change can slow down the dispersal of air pollutants and increase the frequency of stagnation episodes, which results in the degradation of air quality. It also enhances the production rate of pollutants such as Ozone and PM_{2.5}, especially in the urban areas.

Ultraviolet radiation

The IPCC AR5 report states that ultraviolet radiation (UVR) is linked to a higher incidence of skin carcinoma for every 1°C increment in average temperatures. However, exposure to the sun also has beneficial effects on synthesis of Vitamin D, with important consequences for health. Accordingly, the balance of gains and losses due to increased UVR exposures vary with location, intensity of exposure, and other factors (such as diet) that influence Vitamin D levels. Excess exposure to UVR even within the ambient environmental range may result in sunburn, photo-ageing, cataracts, immune suppression and skin melanomas. UVR induced immune suppression may influence occurrence of various infectious diseases as well as effect vaccine efficacy.

Indirect Impacts of Climate Change on Health

Indirect impacts of climate change on health are due to ecological disruptions, rising sea-level, changing temperatures and precipitation patterns which leads to crop failures, shifting patterns of disease vectors, water-borne and vector-borne diseases. Climate dependant diseases particularly affecting the vulnerable populations include the following:

Air-borne cardio-vascular illness

Climate change influences various illnesses including respiratory tract infections like asthma, rhinosinusitis, chronic obstructive pulmonary diseases, respiratory viral diseases (Avian Influenza) and circulatory collapse, posing danger to cardiac patients. The reasons for such risks are poor air quality, high ozone, dust storms, extreme heat, desertification, alteration of allergens, change in timing and duration of survival and transmission cycle of respiratory virus, alteration in bird migration. Further, the other contributory factors are demographic factors (age, sex, immunity status, pregnant women, prevailing endemic illnesses etc) low socio-economic status, overcrowding, poor hygienic conditions, accessibilities to health care facilities, population with tuberculosis, immune-compromised level, or mentally or physically challenged people.

Vector-borne diseases

Climate change and other weather parameters have significant impact on vector-borne diseases such as Malaria, Dengue, Chikungunya, Japanese Encephalitis, Kala-Azar, and Filariasis. The known parameters are temperature, humidity, wind, rainfall, flood and drought, affecting 'distribution of vector' and 'effectiveness of transmission of pathogen' through vectors. The temperature affects vectors survival, population growth, feeding behaviour, susceptibility to pathogen, incubation period, seasonality of vector activity as well as pathogen transmission. The roles of rainfall on vectors are increase in breeding sites due to increase in surface water, increase vegetation and expansion of vertebrate hosts, flooding bring vertebrate host close to the human population.

Other factors affecting vector-borne diseases are population growth, population displacement, socio-economic status, changes in residential patterns, changes in land use, water projects, agricultural practices, housing projects, international travel, the resistance of diseases vectors and pathogens, accessibility to health care and diagnostic facilities.

Water-borne and food-borne diseases

The water and food-borne diseases such as typhoid, hepatitis, dysentery, and others caused by microorganisms such as *Vibrio vulnificus*, *Vibrio cholera*, *E. Coli*, *Campylobacter*, *Salmonella*, *Cryptosporidium*, *Giardia*, *Yersinia*, *Legionella* are some climate-dependant infectious diseases. The increase in temperature is seen to be associated with increased survival and abundance of microorganisms. Decreased precipitation and drought result in decreased availability of safe water, reuse of wastewater, contamination of water sources, transmission from vertebrate to human, or human to human. Flooding causes contamination of water sources, as well as disruption of sewage disposal

systems, which is exacerbated by population displacement, overcrowding, poor sanitation and hygiene, subsequent faeco-oral contamination and spread of pathogens etc.

Malnutrition

Climate change results in food insecurity, namely, food availability, food accessibility, food utilisation, and food system stability. Drought occurrence results in decreased crop yield, disruption of dietary diversity and supply chain, increase in market prices, also a reduction in animal and aquatic products. These factors reduce overall food consumption and may therefore lead to macro as well as micronutrient deficiencies. Malnutrition and consequent disorders like retarded child growth and development have been identified as one of the health threats by the Working Group-II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014).

A major challenge posed to the state is the need to arrest severe and acute malnutrition grappling more than half its children. Limited ante and post-natal care, poor feeding practices among pregnant/ nursing mothers and among children, lack of adequate sanitation are among the reasons for this high level of malnourishment. About 45 per cent children under 3 years of age are stunted and nearly 18 per cent are wasted. As per NFHS-3, only 55 per cent women in the state received the mandatory three ANC check-ups and only 25 per cent received post-natal care within 2 days of delivery. While exclusive breastfeeding is practised by more than 82 per cent of the nursing mothers, colostrum is being fed by only one-fourth of the nursing mothers. The rural sanitation coverage in the state is only 57.26 per cent, one of the worst amongst major states-after Bihar and Jharkhand.

Key Climate Concerns

- The biggest bottleneck is the placement and retention of medical practitioners. Additional incentives are required for retention of senior health personnel, especially those serving in LWE areas. Current ownership of health services by PRIs is weak, as a result of which local accountability of health services is poor. Functionaries report to their line department and PRIs have a little role in monitoring services. Though Panchayat Health Committees are supposed to perform this oversight, at present it is more in terms of tracking financial progress and quantitative indicators and less with quality.
- The health insurance cards under the PM Swashtya Vima and the Ayushman Bharat don't have effective coverage. Only a few have access to these cards. And those who have the cards are also not able to avail the full facilities because, for OPD, the private medical practitioners don't entertain these cards. The provision of free primary and secondary facilities, including the cost of medicines and diagnostics would cost around Rs. 300 crores, which will be more effective in the outreach than the Rs. 185-crore matching contribution made to the insurance plan under the Ayushman Bharat.⁵³
- There is an increase in the incidence of respiratory infections.

Perceived Climate Impacts

- Ischaemic heart disease, chronic obstructive pulmonary disease and lung cancer - GHG emission that are driving climate change are the major contributor to health-damaging air pollution. Air pollution inside and outside the home is the second leading cause of deaths from NCDs worldwide; it is responsible for 26 per cent of deaths from ischaemic heart disease 24 per cent of those from strokes, 43 per cent from chronic obstructive pulmonary disease and 29 per cent from lung cancer.⁵⁴

⁵³ Meeting with the UN Agencies for Development of SDG Action Points and Future Work Plan 2019, State Planning Commission, Government of Chhattisgarh

⁵⁴ COP-24 Special Report – Health and Climate Change -WHO

- Cardiovascular and respiratory diseases - Heat waves cause short-term increase in mortality. Deaths from heatstroke increase during heatwaves. Weather affects concentration of harmful air pollutants.
- Climatic conditions strongly affect water-borne diseases (WHO, 2012). Survival of disease-causing organisms is directly linked with surrounding temperature and the climate conditions affect water availability and quality. Flooding can result in contamination of water.
- Lightning is a symptom and a cause of climate change. A recently established task team is working to make lightning data available and useful for climate science and service applications. The footfall of the burnt patients due to lightning needs to be recorded.

Direct impacts of climate change on human health could include exposure to thermal extremes – leading to morbidity and mortality due to thermal extreme such as cardiovascular and respiratory diseases; and altered frequency and/or intensity of other weather events – leading to injuries, psychological stress; damage to public health infrastructure, by floods and other natural calamities.

Indirect impacts of climate change on human health could include effects on range and activity of infective vectors and parasites – leading to changes in geographic areas and incidence of vector-borne diseases e.g., malaria, dengue fever and several types of encephalitis; altered local ecology of water-borne and food-borne ineffective agents because of higher temperatures – leading to changed incidence of diarrheal and other infectious diseases. Cholera and higher ambient temperatures foster the growth of pathogens that thrive in or on food e.g., Salmonella infection. Other impacts could include altered food (especially crop) productivity due to changes in climate and extreme weather events, and associated pests and diseases – leading to malnutrition and hunger, and consequent impairment of child growth and development. Climate change can also potentially impact the levels and biological impacts of air pollution, including pollen and spores – leading to asthma and allergic disorders, other chronic respiratory disorders and deaths. Likewise, climate change could impact freshwater availability freshwater, in turn leading to lack of hygiene and thus increase water-borne diseases. They can also compound the ever- increasing traffic and exhaust, as well as industrial emissions, are raising concentrations of SO₂, NO_x, and O₃ – leading to health hazards. Thermal stress – heat and cold waves are another potential impact of climate change on human health, as are indirect impacts arising out of other climate-related disasters such as floods and droughts.

4.1.10 Rural Development Sector

Overview, Characteristics and Status

The 73rd Amendment Act of the constitution of India and the Chhattisgarh Panchayati Raj Act of 1993 (CPRA), lay emphasis on decentralised planning for the local economic development and also for providing social justice by the Panchayat.

The state has three-tier PRI system-Zila Panchayat, Janpad Panchayat and Gram Panchayat. All the tiers have been assigned and enshrined with powers, roles and responsibilities mentioned in the CPRA, 1993. The state also falls in the jurisdiction of the fifth schedule area under which 13 districts are fully and six districts are partially under PESA. Under the 11th schedule of the constitution, the state has also devolved

all 29 subjects. The women's participation at all the tiers is above⁵⁵ 50 per cent which is higher than the women representation in both the houses of Parliament (around 11 per cent).

Table 55: Basic Profile of PRIs

Particulars	Numbers
No of Villages (Revenue + Forest)	20619
No. of Gram Panchayats	11664
No. of Districts	28
No. of District Panchayats	27
No. of Janpad Panchayats	146

Source: Department of Panchayat and Rural Development (dpcg.cgstate.gov.in)

There are three wings of the rural development department as it stands now, Panchayat Raj wing deals with matters and programs/connected with the Panchayat Raj institution including a proposal for the construction of Panchayat Bhavan, grants to PRIs for various purposes, training of ERs and other connected purposes. The Rural Work wing deals with schemes and programs connected with rural roads and bridges. The main anti-poverty programs and other scheme connected with model villages, up gradation of block infrastructure etc. are executed by the Rural Development wing.

Key Concerns of the Sector

In Chhattisgarh above 40 per cent of the population live below the poverty line. A large proportion of the rural poor are still sheltered less or have houses not fit for living. Many habitations /villages do not have proper connectivity. The main characteristic of rural areas in Chhattisgarh are –

- High Incidence of poverty
- High Incidence of unemployment
- Low percentage of irrigated land
- Low agriculture productivity
- Poor rural infrastructure and connectivity
- Homelessness
- Low skills and absence of markets

Perceived Climate Impacts

In rural areas, specifically, environmental change has immediate and direct effects on the health and well-being of millions of households that depend on natural resources for their basic livelihoods.²

Rural households tend to rely heavily on climate-sensitive resources such as local water supplies and agricultural land; climate-sensitive activities such as arable farming and livestock husbandry; and natural resources such as fuelwood and wild herbs.⁵ Climate change can reduce the availability of these local natural resources, limiting the options for rural households that depend on natural resources for consumption or trade. Land may become less fertile; fewer NTFPs may be available for forest-based livelihood; there may be less local fuelwood for cooking. They also face particular geographic and demographic obstacles in responding to and preparing for climate change risks. In particular, physical isolation, limited economic diversity, and higher poverty rates increase the vulnerability of rural communities.

⁵⁵ Chhattisgarh SDG Vision 2030

Chhattisgarh has one of the highest levels of poverty in India. As per Tendulkar Methodology, around 40 per cent of its population were below poverty line (BPL) in 2011-12 as compared to 21.92 per cent for India as a whole. There is, however, a sharp contrast between rural and urban poverty. One of the reasons behind poverty and low human development index is the inaccessibility of many villages. A large number of villages are still deprived of the facility of all-weather roads. Rural poverty in Chhattisgarh makes the rural communities even more vulnerable to climate impacts. Systems of fundamental importance to rural populations are already stressed by remoteness and limited access. The distinctive characteristics of rural areas which make them uniquely vulnerable to the impacts of climate change are:

- Greater dependence on agriculture and natural resources which makes them highly sensitive to climate variability, extreme climate events, and climate change.
- Existing vulnerabilities caused by poverty, lower levels of education, health issues etc. can all aggravate climate change impacts in many ways.

4.1.11 Disaster Management Sector

Overview, Characteristics and Status

The state is prone to many natural and man-made hazards including drought, civil strife, cyclonic storms, epidemics, fire, man-animal conflict, lightning, heatwave, and floods. The prevalence, frequency and severity of these hazards vary across all districts of the state. The juxtaposition of development indicators with proneness to multiple hazards in Chhattisgarh shows that poorly performing districts lie in areas which are highly prone to civil strife and drought.

Situation of Lightning Disaster in Chhattisgarh

Chhattisgarh accounts for an average of 200 deaths⁵⁶ per year due to lightning against national average of 400 deaths per year. Due to the prevalent geographical conditions that are undulating hilly topography, deciduous monsoon jungles, low altitude clouds, rich mineral content etc., during the monsoon from June to September especially in summer and initial and terminal phase of monsoon, lightning causes huge loss to life and property. Seasonally, 57 per cent of the lightning fatalities occurred in the monsoon season (June–September), followed by 31 per cent in summer or pre-monsoon (March–May).

Table 56: Death Toll during the last eight years 2011-2019

Year	Deaths
2011	215
2012	166
2013	260
2014	188
2015	229
2016	226
2017	243
2018	201
2019	167
Total	1895

Source- Revenue and Disaster Management Department, Government of Chhattisgarh

⁵⁶ Revenue and Disaster Management Department, Government of Chhattisgarh

Situation of Agricultural Drought in Chhattisgarh

The last decade has shown the increasing severity of Drought situation in Chhattisgarh. Statistics of Drought Years for Chhattisgarh state during 2000 – 2018 (Based on monsoon rainfall) has shown increased frequency of Drought years in Chhattisgarh in the last decade. In the year 2015, the Chhattisgarh Government declared 25 districts in the State as drought-hit and in the year 2017 around 96 Tehsils in 21 districts were declared as drought-hit.

Table 57: Drought Affected Districts in Chhattisgarh from 2000-01 till 2017-18 ⁵⁷

Sr. No	Year	Districts Affected	Tehsils/Villages/Farmers Affected
1	2000-01	12	-
2	2001-02	16	1082 Villages
3	2002-03	-	-
4	2003-04	16	1141 Villages
5	2005-06	-	-
6	2006-07	8	2292 Villages
7	2007-08	3	777 Villages
8	2008-09	5	-
9	-	-	-
10	2015-16	25	117 Tehsils & 24,18,011 farmers
11			
12	2017-18	21	96 Tehsils & 9,58,411 farmers

Source: Revenue and Disaster Management Department, Government of Chhattisgarh

Situation of Flood in Chhattisgarh-

As per the data available with the Revenue and Disaster Management Department, Government of Chhattisgarh many parts of the state faced floods in the last 17 years (2001-2017).

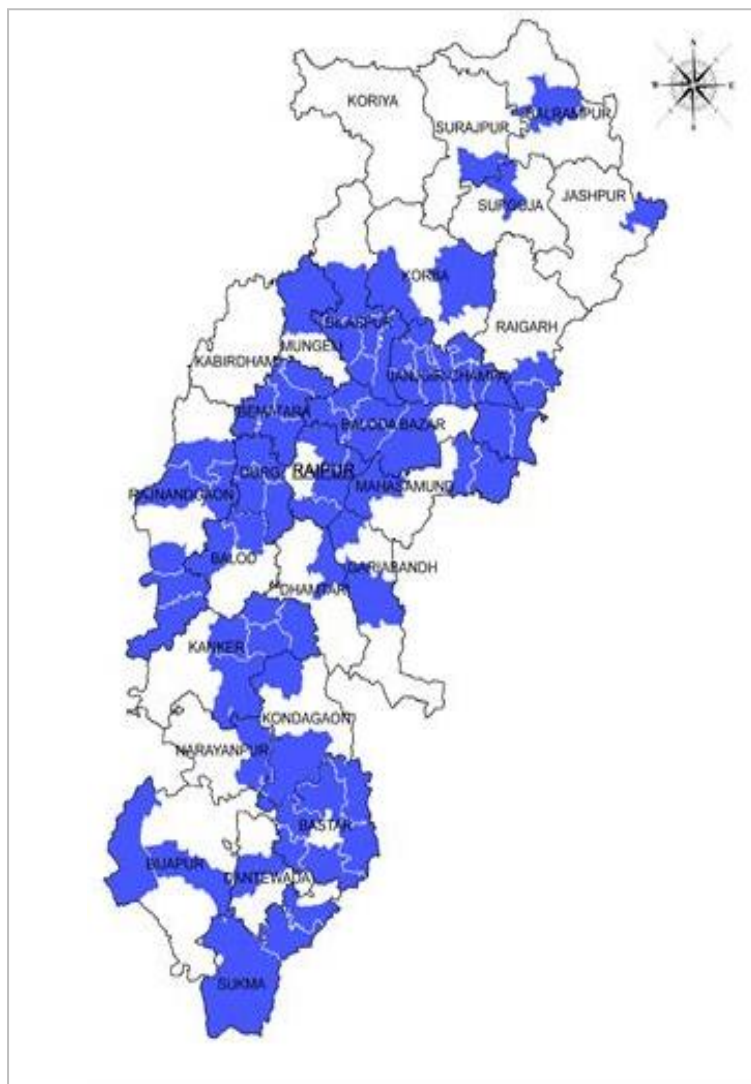
The immediate causes of flooding are heavy monsoon rains in flood plains and in neighbouring states, and rivers originating from other states of the country and waterlogging in urban areas. The highest likelihood of flooding is between July and August.

Key Concerns of the Sector

- **Adequate** capacity of the rescue and operations team at the local level to address climate change-induced disasters.
- Lack of additional funds to carry on Climate Change Adaptation and DRR activities in the State.
- The understanding and capacity (knowledge, attitude and skills) of government functionaries and other duty bearers at district and below the level on disaster risk reduction/ resilient development has still not taken roots. Further down, the capacity and knowledge of Gram Panchayats on DRR is still a distant dream and in some districts especially conflict-affected where Panchayati Raj Institutions are either weak or completely non- functional: - It will include **Sarpanch, Patwari, Secretary, Kotwar, Mitantin, medical officer and social worker of the village**. Similarly, nearby Tehsil, Panchayat Samiti and Gram Panchayat can also be as useful as the first response. At the local level, **Patwari, Secretary, Sarpanch, Secretary, Kotwar** are the basis of the entire system, which works during the disaster. At the time of disaster, local people/employees can give correct information about the remote location information, communication of information, assessment of the level of disaster, surveillance of disaster damage.

⁵⁷ Drought Memorandum 2017- Government of Chhattisgarh

Figure 29: Flood vulnerability map of Chhattisgarh



Source: Revenue and Disaster Management Department, Government of Chhattisgarh

- The principal capacity building institution for the state is the State ATI, which has a Centre for Disaster Management is in **Nimora Administrative academy Raipur**.
- In most of the districts some local NGOs exist, their capacity to engage in DRR, preparedness and response which we have done in COVID-19 time for food and shelter purposes with collaboration with Disaster management department.
- Weak disaster management structures at district and below: **Disaster Management cadre** at the district level and below are as follows: - **District Collector, Sub-Divisional Officer (Revenue), SDM, Tehsildar, Revenue Inspector, Patwari, Patel & Kotwar**. They are aided by Superintendent Land Record, Assistant Superintendent Land record and Official staff Revenue and Disaster Management Department
- The state has a robust data management system, there are enough resources available in the state to overcome any type of disaster.
- In our State Chhattisgarh Mock drills/Trainings are used to be done by State Disaster Management Authority (SDMA), State Disaster Rescue Force (SDRF), Department of Civil Defence and fire services & Home guard time to time.

Perceived Climate Impacts

Available evidence shows that there is high probability of increase in the frequency and intensity of climate-related natural hazards due to climate change and hence increase in potential threat due to climate change related natural disasters. Climate change has avoidable as well as unavoidable (e.g., extreme weather events) impacts on children, women and various population groups depending on their exposure, capacity and capability. Disaster risks further aggravate as climate change will contribute to rising temperatures and changing rainfall patterns which may have the following impact:

- Decline in food production, leading to more distress migration.
- It is likely to exacerbate the spread of vector-borne diseases such as malaria and dengue.
- Increase risk of respiratory disease as air pollution worsens.
- Increased drought risk
- Rapidly decreasing water quality due to arsenic, Iron and fluoride contamination (Arsenic- one district & Fluoride -17 districts).

4.1.12 Women and Child Development Sector

Gender Status in Chhattisgarh

Out of the total /population of 25,545,198 in Chhattisgarh as per the 2011 census, 12,712,303 is female population i.e., nearly 50 per cent of the total population is female population in the State. The various social indicators indicate that women in Chhattisgarh have been empowered as per the many development parameters as compared to national average, however growth in these sections of development has been recorded as compared to 2005-06, yet sustainable efforts are needed to overcome the poor performing areas. Some of the indicators are given below:

Table 58: Indicators on Women and Child Development

Indicators	2005-06	2015-16 ⁵⁸	India
Educational Development			
Women who are literate (%)	44.9	66.3	65.46
Men who are literate (%)	74.1	85.7	82.14
Gender Development			
Sex ratio ⁵⁹	1,015	1,019	943
Women having a bank account that they themselves use (%)	8.1	51.3	53%

Gender Distribution of Working Population Ratio in Chhattisgarh

Women in Chhattisgarh are predominantly engaged in farm-based activities as agricultural labourers and cultivators. While female labour and workforce participation (FLFPR and WFPR) continue to be higher than the national average and those of neighbouring states, the recent decade in keeping with national trends, saw a fall in the rural female labour force and workforce participation rates. In urban Chhattisgarh, unlike trends at the national level and those of neighbouring states, the female WFPR actually rose over time narrowing the gender gap in urban WFPR rates.

⁵⁸ NFHS 2015-16 Survey

⁵⁹ Census 2011

Table 59: Gender-Based Workforce Distribution

	Unorganised		Organised		Informal		Formal	
	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Male	86.9	86.5	13.1	13.5	94.4	96.1	5.6	3.9
Female	95.9	92.0	4.1	8.0	98.8	98.6	1.2	1.4
Total	90.7	88.7	9.3	11.3	96.2	97.1	3.8	2.9

Source: NSS

Whereas the quality of employment is concerned, the overall share of women in unorganised though high, declined over time. Their share in organised employment grew comparative to men. The overall rise in share of organised sector employment in total employment was entirely accounted for by women. Most of this employment was absorbed in Construction and Hotels, Trades and Restaurants and Public Administration, Health, education and community services. The last sector accounted for most of the above-mentioned rise in organised and formal female employment.

Political Representation

The representation of women of Chhattisgarh in the PRIs of the state is higher than the national average. It is also relatively high in Urban Local Bodies but is lower at the Vidhan and Lok Sabha levels.

Table 60: Political Representation

State	Lok Sabha	Vidhan Sabha	Panchayat	ULB
Chhattisgarh	27%	15.5%	54.50%	38.8 %

Source: Election Commission 2019

Key Concerns

To understand the impacts of climate change on women/ children, there is a need for focussed research and based on the outcomes, participatory planning should be done to design the policies/ programmes. Capacity Building of women should be done on Climate Change, adaptation, decision making, and entrepreneurship to address future challenges.

Perceived impacts of climate change on Gender

Climate change is gender-neutral, but the impact of climate affects men and women differently in areas of employment, health, food security and other developmental and livelihood related issues. In this context, the needs, knowledge, priority and capacity to tackle or cope with issues associated with climate change differ due to the differential position of the women and men towards the same. This could be attributed to the socially ascribed gender roles and responsibilities, education, access to information, and access to finance. Climate change also significantly impacts women and men with respect to their roles and responsibilities as well as the opportunities available to them. The poor and marginal group of people are the most vulnerable to the changing climate this is because they tend to live in such areas that are prone to flooding drought and their shelters are often of poor quality thus making them more open to risks because of the total dependency on the natural resources like forest products, land, water etc.

Women, being even more dependent on natural resources like firewood for cooking or water for the daily use (cooking, cleaning washing etc.) for the maintenance of their families are at the chances of being hit the hardest. In such situations Gender disparity are at the risk of being significantly widened, as climate change eventually increases the work burden on women, thus forcing them to spend more time in family care rather than personal health.

Table 61: Climate Change impacts and its gender implications

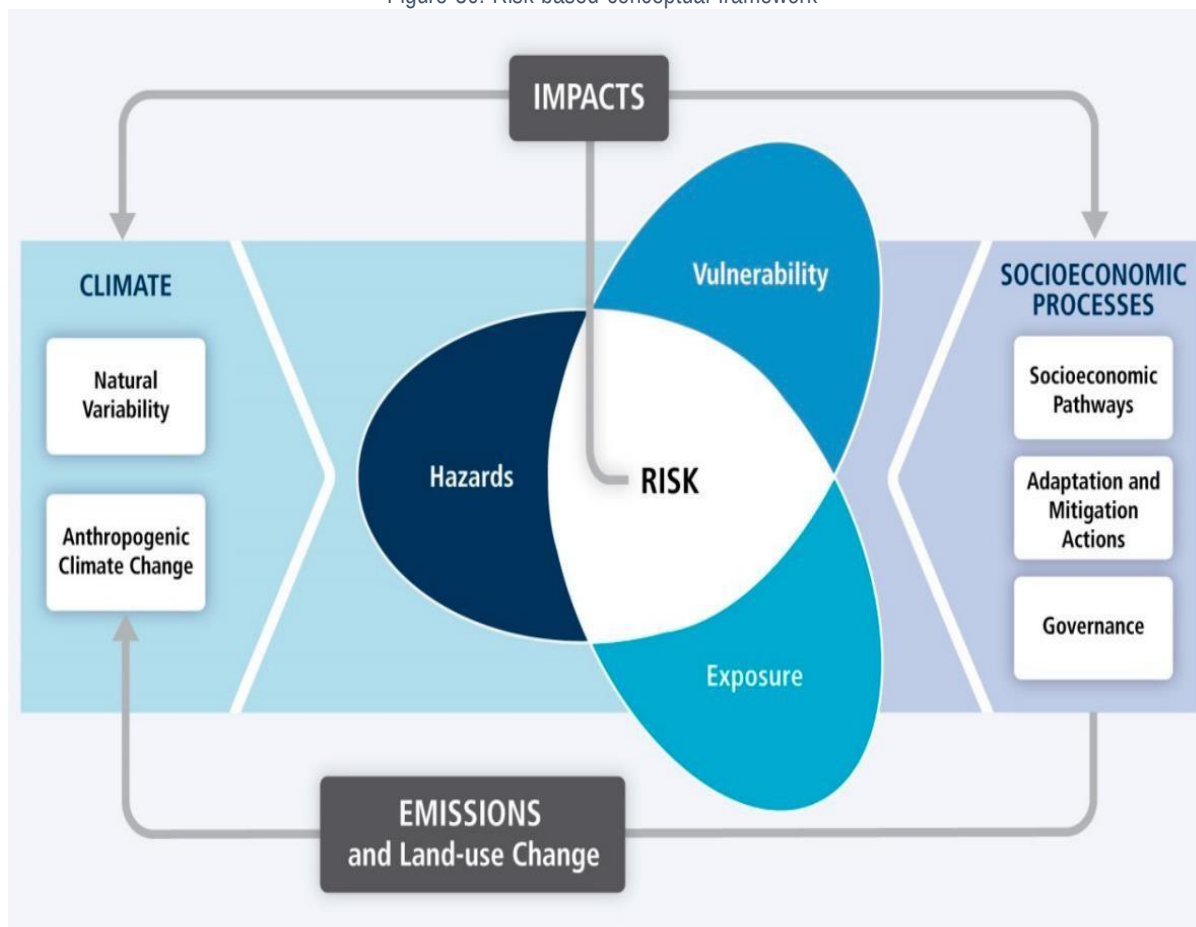
Climate Change Impacts	Implication on Gender Inequality
Crop Failure	Household food provision; increasing workload, Malnutrition to women in particular (women suffer worse as they have a tendency to go hungry while providing for the family, also termed as inequitable intra-household food distribution)
Fuel shortage	Household fuel provision; more time for fuelwood collection.
Water scarcity	Household water provision; contaminated water; More time and hard work required for water collection (Usually fetching water is a woman's job so during floods and drought becomes difficult to go for water collection for household needs)
Livelihood Disruption	Reduction of savings, the pressure to earn more, working under the hazardous condition, migration (loss of assets, increase in unemployment)
Disaster	Higher incidence of mortality, health and hygiene, safety issues
Forced Migration	Safety and security, the increased vulnerability of women, increased household burden

4.2 District Level Vulnerability Assessment

The objective of this assessment is to identify and rank the most vulnerable districts in the state of Chhattisgarh. This will assist in assessing not only the extent of vulnerability and providing a vulnerability profile of the State, but also identify the major drivers of vulnerability.

The risk management framework adopted by the IPCC in the Fifth Assessment Report (IPCC 2014) depicts the interaction of hazard, exposure and vulnerability resulting in risk within the overall climatic and non-climatic physical and socio-political environment (Figure 30). The present study has adopted this framework and has considered only sensitivity and adaptive capacity as the two factors that determine vulnerability.

Figure 30: Risk-based conceptual framework

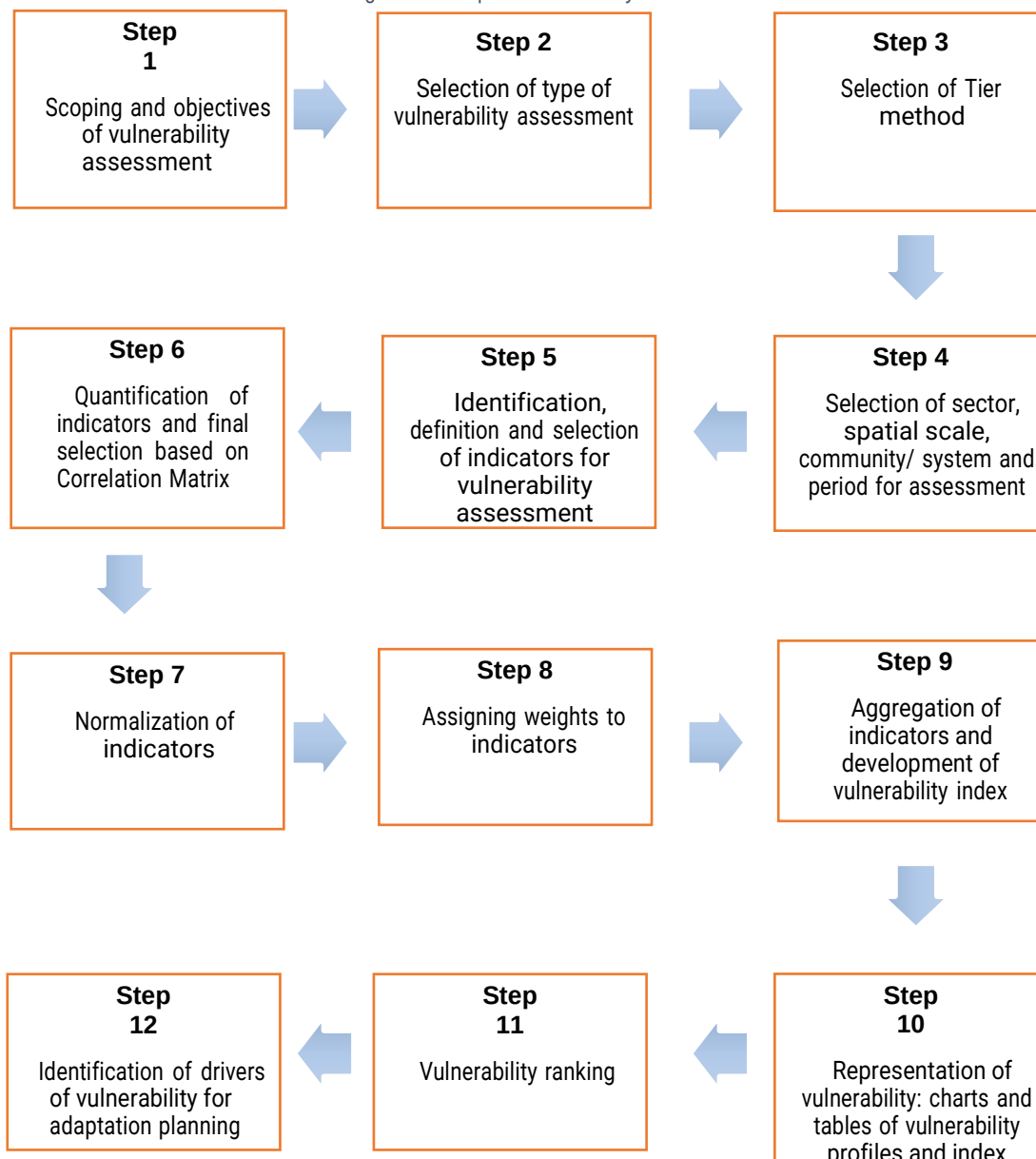


Source: IPCC, 2014

Based on this risk-centred framework, the approach and steps were adopted to conduct a vulnerability assessment at the district level for Chhattisgarh is given as Figure 31.

Conducting a vulnerability assessment is a multi-step exercise and requires identification of clear set of goals and objectives which will determine the type of vulnerability assessment, scale, tier, indicators and method to be adopted. As the objective of this study is to identify, rank and prioritise the inherently most vulnerable districts of Chhattisgarh state, an integrated vulnerability assessment using a Tier 1 method that quantifies indicators using secondary sources of information at the district level, is considered.

Figure 31: Steps in vulnerability assessment



A Vulnerability Index (VI), which is a metric that characterises the vulnerability of a system was used. Values of VI lies between 0 and 1, where 0 stands for lowest vulnerability and 1 for highest vulnerability. Arrangement of the assessed VI values in decreasing or increasing order allows for ranking of the districts. It must be noted that, the Vulnerability Index value only provides a sense of quantified status of vulnerability and remains largely conceptual in its utility, as this value does not have any stand-alone practical significance.

Table 62 presents the details of the assessment in a stepwise manner. As mentioned above, a Tier 1 methodology was adopted to assess vulnerability. This entailed use of secondary sources of information to quantify indicators and equal weights were assigned to the indicators.

Table 62: Method used for vulnerability assessment

	Steps in vulnerability assessment	Details
1	Scoping of vulnerability assessment	To identify and rank vulnerable districts in the State of Chhattisgarh
2	Selection of type of vulnerability assessment	Integrated vulnerability assessment using indicators representing biophysical and socio-economic characteristics of the districts. An integrated assessment is essential due to high dependence of majority of the population in Chhattisgarh on natural resources for their livelihood.
3	Selection of Tier methods	Tier 1
4	Selection of Spatial scale and period for vulnerability assessment	- Spatial scale: District-level assessment - Period: Based on availability of data (2011-2019)
5	Identification, definition, and selection of indicators for vulnerability assessment	Indicators were selected based on - Other district-level vulnerability assessments conducted for states in India (literature review) - State context and issues highlighted by the Chhattisgarh State Action Plan on Climate Change (SAPCC-1).
6	Quantification of indicators, Correlation Matrix, and final selection of Indicators	All indicators were quantified using secondary sources of data. Sources used to quantify the selected indicators are provided as Annexure I – Table A1. The quantified indicators were subjected to a correlation analysis, which allowed for exclusion of indicators that have high correlation with other selected indicators⁶⁰. Only those indicators that had no - low correlation ($r^2 < 0.5$) with other indicators were considered for this assessment.
7	Normalisation of indicators	Final indicators were normalised based on their functional relationship with vulnerability. Two types of functional relationships are possible: Positive relationship - vulnerability increases with increase in the value of the indicator. Equation 1 is used if the indicator has a positive relationship: $x_{ij}^P = \frac{X_{ij} - \text{Min } i \{X_{ij}\}}{(\text{Max } i \{X_{ij}\} - \text{Min } i \{X_{ij}\})}$ Negative relationship - vulnerability increases with decrease in the value of the indicator. Equation 2 is used if the indicator has a negative relationship: $x_{ij}^N = \frac{\text{Max } i \{X_{ij}\} - X_{ij}}{\text{Max } i \{X_{ij}\} - \text{Min } i \{X_{ij}\}}$

⁶⁰ This essential means that one or more indicators are representing the same system property and thus may be excluded.

		Where, X_{ij} is the variable that is being normalised and has the value of j th indicator for i th region and x_{Pij} (for positive relationship) and x_{nij} (for negative relationship) are the normalised value which will lie between 0 and 1.
8	Assigning weights to indicators	Equal weights were assigned to all indicators as Tier 1 method is being applied.
9	Aggregation of indicators and development of Vulnerability Index	When equal weights are assigned, Vulnerability Index is constructed by taking a simple average of all the normalized scores. Equation 3: $VI_i = \frac{\sum_j x_{ij}^p + \sum_j x_{ij}^n}{K}$ Where, VI is the vulnerability index of region i , x_{ij}^p and x_{ij}^n are normalised values of j th indicators [with positive and negative relationship with vulnerability respectively] in i th region and K is the number of indicators.
10	Representation of vulnerability	Vulnerability has been represented in the form of graphs and maps
11	Vulnerability ranking	Districts were ranked on a five-point scale of very high vulnerability to very low vulnerability and from 1 to 27.
12	Identification of drivers of vulnerability for adaptation planning	As equal weights have been provided, drivers of vulnerability were identified for districts that were ranked as very highly vulnerable.

Indicator Selection, Rationale and Source of Data

Selection of indicators is critical for vulnerability assessment. The last vulnerability assessment published for Chhattisgarh (INRM, 2014) and the SAPCC, 2014 were reviewed before proceeding with indicator selection. About 75 indicators were selected for the last vulnerability assessment representing different sectors. However, over the last few years, the selection of indicators for vulnerability assessments has evolved. Studies now focus on selection of fewer, more dynamic indicators that broadly capture the properties of a system⁶¹. This allows for more comprehensive identification of drivers of vulnerability.

The SAPCC highlighted several issues and priority sectors that this study has consciously focused on and has selected indicators to represent the same. Some of them are:

1. Low social and human development with high incidence of poverty - especially among women and tribal communities that create inequity in access to resources and services.
2. Sub-optimal economic productivity with poor social and physical infrastructure. Although the State has rich natural resources, particularly forests, these are locked by national policies.
3. The state scored among the least in terms of the Inequality-adjusted Human Development Index (HDI). Disparities among social groups in the attainment of key human development indicators suggested high variation within the State in terms of income, education, and health.
4. A significant population is dependent on rain-fed agriculture, animal husbandry, fisheries, and forest-based livelihoods. Any change in precipitation and temperature patterns could significantly impact the lives of communities dependent on the natural resource sectors.

⁶¹ Sharma et al., 2017

5. Within the primary sector, much of the growth has been fuelled by mining as compared to agriculture, with the mineral industry accounting for almost 80 per cent of total industrial units. Bulk of the profit from mining goes outside and the State exchequer receives only 7.5 per cent of the gross revenue earned by Central Public Sector Undertakings (CPSUs).
6. Nearly 44 per cent of the State's geographical area comes under forests and its economic growth is handicapped by limited availability of land for improving physical infrastructure (especially connectivity within and with neighbouring states) and for setting-up industrial zones. Road and rail infrastructure are the poorest among major States, which inhibits accelerated industrial development.

The SAPCC identified agriculture, forestry, mining, and energy as the most vulnerable sectors. However, to holistically represent the biophysical and socio-economic systems of Chhattisgarh, the following sectors were considered for vulnerability assessment:

1. Agriculture and allied activities (including crop cultivation, horticulture, livestock, and fisheries)
2. Forests
3. Water resources
4. Socio-economic (Rural) development
5. Transport
6. Energy
7. Industries and Mining
8. Human Health

Twenty-six indicators representing the above sectors were initially selected and this is not without its limitations. The biggest challenge for quantifying indicators selected was the availability of data for all 28 districts. As the State has added new districts over the years, several reports, and statistical publications still present data for 16 or 18 districts.

Indicators selected, rationale for selection are presented in the table below. A total of 11 sensitivity indicators and 15 adaptive capacity indicators were initially considered under the purview of 8 sectors. The sources used to quantify these indicators, along with the method used to calculate indicator values are provided as Annexure I, Table A1.

Table 63: List of indicators selected for vulnerability assessment, rationale for selection, functional relationship with vulnerability and sources of data

SN	Sector	Indicators	Rationale for selection	Sensitivity or Adaptive Capacity	Functional relationship with Vulnerability
1	Agriculture and allied sector	Crop, livestock, and fish yield variability	This is the coefficient of variation of the yield of food grains (major cereals) cultivated; livestock products (milk, eggs, and meat); and fish production. This is a direct reflection of the sensitivity of crop, livestock, and fish production to climate variability, especially the variability of rainfall and temperature and can also capture impacts of floods.	Sensitivity	Positive
2		Percentage net area cultivated under Horticulture trees	A more resilient source of farm-based income as tree crops are hardier than field crops to climate variability, particularly rainfall variability and droughts. Farmers cultivating horticulture tree crops thus are less sensitive than farmers who cultivate only field crops.	Adaptive Capacity	Negative
3		Livestock per 1,000 rural population	Livestock provide an alternate source of income and assists in crop production. Sale of livestock during distress provide households with a coping strategy.	Adaptive Capacity	Negative
4		Available water resources under fish culture	The state is actively developing water resources for fish culture and targeting poorer and more vulnerable sections of society by providing them with skills and technology for fish production. It is a lucrative source of income and provides a nutritious source of protein to rural communities, increasing their adaptive capacities. This indicator is measured as the percentage of available water resources under fish production.	Adaptive Capacity	Negative
5		Percentage of small and marginal farmers	Small and Marginal farmers are known to have low social and economic capital and agriculture production	Sensitivity	Positive

			on small and marginal land holdings are known to be sub-optimal, increasing the sensitivity of these farmers and agricultural production to climate hazards.		
6		Percentage of rain fed agriculture	Irrigation provides an essential buffer to crops against climate hazards. Lack of irrigation, or solely rain-fed agriculture is extremely sensitive to delayed rainfall, rainfall variation or droughts.	Sensitivity	Positive
7		Percentage gross cropped area covered under crop insurance (PMFBY, 2019)	Crop insurance assists farming households in mitigating losses due to climate hazards, thereby enhancing their adaptive capacity. Implies access to banks, cooperative societies and insurance providers. Provides a safety net in case of crop failure due to hazards.	Adaptive Capacity	Negative
8	Forests	Forest dependence of rural tribal communities	This is an important source of alternative livelihood and food. Forests also provide important ecosystem services that are essential for the sustainable productivity of rural economies. However, this dynamic indicator expresses availability of forest resources weighted by forest dependence of tribal communities and the pressures on forest resources brought about by this dependence.	Sensitivity	Positive
9		Number of approved Minor Forest Produce (MFP) Microenterprises	These Microenterprises provide members an opportunity to access socio-economic welfare schemes promoted by the state, including Minimum Support Price for MFPs, insurance, etc. Access to such formal platforms that promote the trade and development of MFP, enhances adaptive capacity.	Adaptive Capacity	Negative
10	Water	Stage of Groundwater Extraction (%)	Stage of Groundwater Extraction indicates scope to harness groundwater resources for irrigation and domestic use. A higher relative draft means less scope for development or over exploitation of this essential resource and hence higher sensitivity.	Sensitivity	Positive

11		Per capita water availability	Annual per-capita water availability of less than 1700 cubic meters is considered as water stressed condition, and below 1000 cubic meters is considered as a water scarcity condition. Districts with lower per capita water availability indicates higher sensitivity of population to water stress during climate hazards.	Adaptive Capacity	Negative
12	Socio-economic development	Percentage of rural households below the poverty line - adjusted for inequalities	Higher the proportion of rural population below the poverty line, higher is the sensitivity of the people in that district. It is measured as the number of rural households (SC, ST, women headed households and households with members living with a disability) having monthly income of highest earning household member less than Rs 5000.	Sensitivity	Positive
13		Access to basic amenities (safe drinking water, toilets, kitchen, and clean cooking fuel)	Access to basic amenities such as safe and potable water, toilets, kitchens and clean cooking fuel is an essential indication of general development and wellbeing of a household.	Adaptive Capacity	Negative
14		Inequality adjusted education index	Determines the extent of access to information enabling proactive adaptation to climate variability, as well as a gateway for non-climate sensitive skill development and employment for transformational adaptation. A component of the IHDI which the state of Chhattisgarh scored the lowest in the country.	Adaptive Capacity	Negative
15		Women participation in the labour force	Women are amongst the most vulnerable to the impacts of climate risks. An increased participation of women in the labour force implies access to information, empowerment at the household level, social and financial capital that would contribute to their adaptive capacity.	Adaptive Capacity	Negative
16		Dependency ratio	Used to represent social pressures on productive sections of the population, measured as the proportion of young, old, chronically ill, and unemployed members of the community. Higher the pressure, higher is the	Sensitivity	Positive

			sensitivity of the community to the impacts of any hazards.		
17		Access to an alternate employment source (MGNREGS)	MGNREGS is an important source of alternate income to rural households and provides relief during climate hazards enhancing a household's adaptive capacity. Measured as the average person days per household employed under MGNREGS.	Adaptive Capacity	Negative
18	Transport	Road connectivity	Measured as the percentage of villages in a district with access to transportation and roads which broadly indicates integration with the economy and the associated spread effects of development.	Adaptive Capacity	Negative
19	Energy	Percentage of villages electrified weighted by number of hours of electricity provided	Indicates overall development that positively influences the ability to adapt. Also has implications for access to irrigation (electricity for agriculture) and information such as Agromet services, early warning services and relief measures or funds available to mitigate impacts of climate hazards.	Adaptive Capacity	Negative
20	Industries and Mining	Variability of revenue from mining	As mining contributes most to the primary sector, variability in the revenue from mining can have serious implications for the output of this sector and also for industry, as mineral-based industry accounts for almost 80 per cent of the total industrial units in the state.	Sensitivity	Positive
21		Number of establishments (OAE, Estt., Micro, small and Medium)	Limited industrial development was a concern highlighted by the SAPCC. This indicator directly represents the status of industrial development among the districts of the state.	Adaptive Capacity	Negative
22	Human Health	Infant Mortality Rate (IMR)	Infant mortality rate is an important indicator of the overall physical health of a community. High infant mortality rates are generally indicative of unmet human health needs in sanitation, medical care, nutrition, and education.	Sensitivity	Positive

23		Number of functional Health Care Facilities/ 10,000 population	Access to functional health care facilities is pivotal for the wellbeing of households. Also broadly indicates the level of institutional development of a district.	Adaptive Capacity	Negative
24	Human Health	Cases of vector-borne diseases/ 1,000 Population (Malaria)	Temperature and rainfall variations have the potential to foster higher growth rates of vectors and increase the occurrence of vector-borne diseases. Identifying the current hotspots of vector-borne diseases is essential to put in place measures to mitigate the impacts of future climate risks in this regard.	Sensitivity	Positive
25		Persons suffering from water-borne diseases (diarrhoea/Dysentery)/ 1,000 Population)	Unsanitary conditions exacerbated by the frequent occurrence of extreme rainfall and floods has the potential to increase exposure to water-borne pathogens. Identifying the current hotspots of water-borne diseases is essential to put in place measures to mitigate the impacts of future climate risks in this regard.	Sensitivity	Positive
26		Households with any usual member covered by a health scheme or health insurance	Health insurance assists households in meeting emergency expenses brought on by illness or accidents. It highlights the capacity of households to plan and mitigate losses using financial schemes and safety nets. This is essential in the light of a changing climate and increased incidence of climate hazards.	Adaptive Capacity	Negative

Finalisation of Indicators for Assessment

Correlation Matrix

Post quantification of indicators, a correlation matrix was constructed and indicators with moderate to high correlation (> 0.5) were excluded from the assessment. The result of the Correlation Matrix is presented as Annexure I (Table A2). Out of 26 indicators, 14 indicators were excluded as they had moderate to high correlation with one or more indicators. The final 12 indicators are presented in Section 4.2.3.

Significance of Correlated Data

When interpreting results of the vulnerability assessment, it is important to also consider the indicators that were excluded for construction of the Vulnerability Index as all indicators initially considered reflect the State context and the State's priorities as per the SAPCC. The interpretation of the correlation matrix is provided as Annexure I (Table A3). Overall, irrigation and literacy rates seem to tie all the 26 selected indicators together and the state can be broadly divided into two regions Districts with High Irrigation and Literacy & Districts with High Rain fed Agriculture and Low Literacy:

Table 64: Division of the state into two regions based on significance of correlated data

Districts with High Irrigation and Literacy
- Districts with high irrigation observe higher land fragmentation (larger proportion of small and marginal landholders). They also observe higher literacy rates, better electrification (essential for irrigation), better access to crop insurance, and exploitation of groundwater resources (major source of irrigation) resulting in reduction in overall per capita water availability. - As these districts observe higher literacy rates, they unfortunately also observe the great Indian paradox, wherein more highly educated a woman, less likely is she to engage in the labour force⁶². This increases the dependency ratio of these districts. - However, increased literacy of women or literacy, in general, has led to increased access to basic amenities, including electrification, lower incidence of both vector and water-borne diseases, and lower infant mortality rates. It also provides the necessary skill required for mining, thereby lowering the variability in revenue from mining.
Districts with High Rain-fed Agriculture and Low Literacy
- Districts with higher proportion of rain-fed agriculture observe lower literacy rates. These districts also have a high population of tribal communities dependent on forest resources, greater livestock densities, higher number of women in the workforce and thus lower dependency ratios. - Unfortunately, these districts have lower levels of electrification; the proportion of households that have access to basic amenities is lower, leading to a higher incidence of vector and water-borne diseases and higher infant mortality rates. - The state of Chhattisgarh has obviously identified these districts and invested in improving transport and health care infrastructure, as these districts have better road connectivity and functional health care facilities, along with better coverage of households under health schemes or health insurance.

As such, the final indicators selected, for example, Dependency Ratio is linked to both literacy and irrigation and all the associated interlinkages described above.

⁶² Chatterjee et al, 2018

Indicators finalized for vulnerability assessment

The following 12 indicators were considered for the construction of a Vulnerability Index, their quantified values are provided as Annexure I (Table A4):

1. Crop, livestock, and fish yield variability
2. Percentage net area cultivated under Horticulture
3. Percentage of available water resources under fish culture
4. Forest dependence of rural tribal communities
5. Number of approved Minor Forest Produce (MFP) Microenterprises
6. Percentage of rural households below the poverty line - adjusted for inequalities
7. Dependency ratio
8. Access to an alternate employment source (MGNREGS)
9. Number of establishments (OAE, Estt., Micro, small and Medium)
10. Infant Mortality Rate (IMR)
11. Number of functional Health Care Facilities/ 10,000 population
12. Households with any usual member covered by a health scheme or health insurance.

Normalisation of Indicators

Prior to normalisation, presence of outliers among the data needed to be identified and considered as this influence the overall Vulnerability Index value. Using the Interquartile Rule, outliers were identified and excluded from the normalisation process. For each indicator, Quartile 1 (Q1), Quartile 2 (Median: Q2), Quartile 3 (Q3) and the Inter-Quartile Range (IQR) were calculated. Any value less than $Q1 - 1.5 \times IQR$ or more than $Q3 + 1.5 \times IQR$ is an outlier following basic statistical principle of outlier detection. See Annexure I, Section 1.3, Table A4. Normalisation was carried out based on functional relationship of the indicator with vulnerability. Positive relationship - vulnerability increases with increase in the value of the indicator. Equation 1 was used for indicators having a positive functional relationship (where vulnerability increases with increase in indicator value) and Negative relationship - vulnerability increases with decrease in the value of the indicator. Equation 2 was used for indicators having a negative functional relationship (where vulnerability increases with decrease in indicator value). See Annexure I, for normalised values of 12 finalised indicators. For the outlier values that were excluded from the normalisation process, depending on whether they were very low or very high outliers and their functional relationship, either 0 or 1 was assigned (see Annexure I for details).

Equal Weights and Aggregation (Vulnerability Index)

For this assessment, equal weights (equal importance) were assigned to all 12 indicators as their selection was based on State context and issues prioritised by SAPCC-1. Although several methods such as Pair-wise Comparison or Stakeholder Consultations may be used to assign weights to indicators, these methods often lead to subjective assignment of weights. More objective, statistical methods of assigning weights such as Principal Component Analysis (PCA) are also available, but these assign weights as a function of explained variance of the data, which for the purpose of this study is not so relevant, as only 12 indicators have been selected. When equal weights are assigned, Vulnerability Index is constructed by taking a simple average of all the normalised scores.

Vulnerability Profile and Ranking of Districts

The indicators selected represent both socio-economic and biophysical characteristics. Integrated assessments are required where known linkages, interactions and interdependencies exist between biophysical and socio-economic systems. Such assessments are required for designing strategies for reducing vulnerability of communities dependent on natural resources for their livelihood, i.e., agriculture, water, forests, minerals, etc.

Figure 32: Vulnerability index values and corresponding ranks of districts of Chhattisgarh

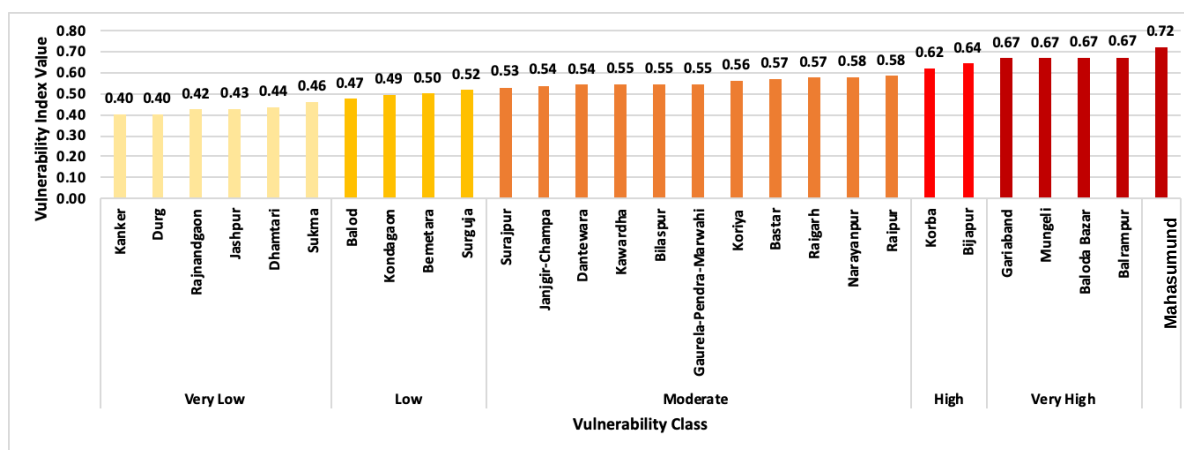


Figure 32 provide the vulnerability index values categorised into a 5-point vulnerability range of very low to very high vulnerability for the districts of Chhattisgarh. The assessment of integrated vulnerability shows that five districts – Gariaband, Balrampur, Mahasamund, Baloda Bazar, and Mungeli were ranked as very highly vulnerable. Kanker, Durg, Rajnandgaon, Jashpur, Damtari and Sukma districts were ranked as very low vulnerable category. The drivers of vulnerability for the very highly vulnerable districts are provided in the next section.

It can be observed figure 32, that there are no districts in Chhattisgarh that have vulnerability index value very close to 0 or very close to 1. The difference between each consecutive district in terms of vulnerability index value is low and ranges between 0.00 and 0.06, meaning that all districts are vulnerable, but a few are relatively more vulnerable than the rest.

Major Drivers of Vulnerability

Averages of the normalised values of indicators were considered to represent the drivers of vulnerability for the different vulnerability classes - very highly, high, moderate, low and very low. The major drivers of vulnerability for very high vulnerable districts are presented as a radar plot in the vulnerability index map. Here the significance of each indicator's contribution to vulnerability are represented by spokes of the plot – greater the significance, further away from the centre of the plot. See Annexure I, Table A6 which presents the drivers of vulnerability for all the different vulnerability classes.

Figure 33: Map of vulnerability ranking

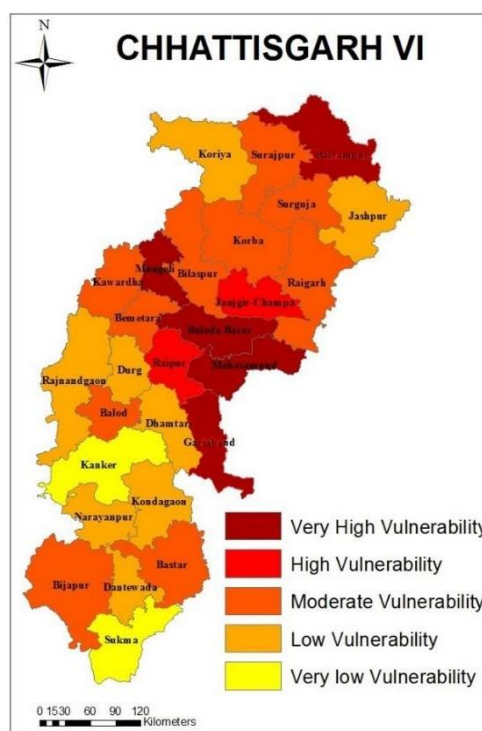
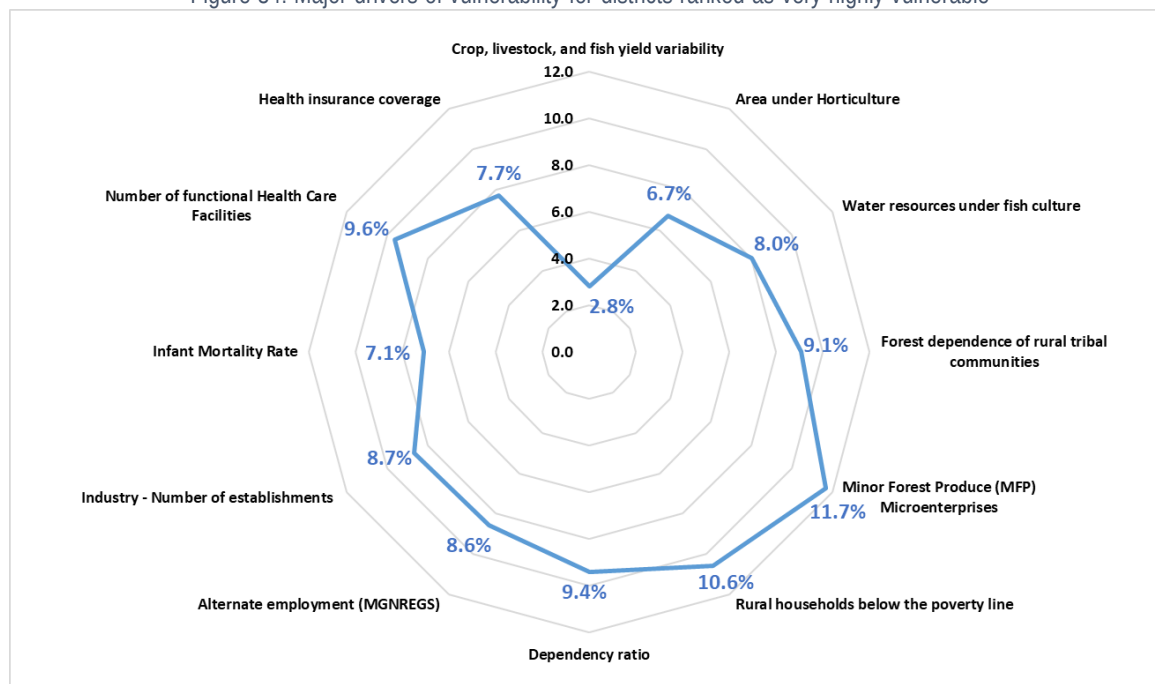


Figure 34: Major drivers of vulnerability for districts ranked as very highly vulnerable



For the districts of Mahasamund, Baloda Bazar, and Mungeli, the major drivers and possible strategies to address these drivers are provided in the table below.

Table 65: Major drivers for most highly vulnerable districts and possible strategies to address these drivers

Major Drivers of Vulnerability	Possible Strategies to Address Drivers
1. Limited minor forest produce (MFP) micro-enterprises even though these districts have tribal communities dependent on forest resources (11.7 per cent).	➔ Establishment of MFP micro-enterprises in regions with high tribal dependence on forest. There is a need to relook at the institutional development of these districts, as this indicator is correlated with availability of functional health care facilities, which is also a major driver.
2. High proportion of households below the poverty line, particularly those belonging to vulnerable sections of society such as SC, ST, women-headed households and households with persons with disability (10.6 per cent)	➔ Poverty alleviation measures may be considered, targeted at the vulnerable sections of society. ➔ Poverty has correlation with access to basic amenities, which in turn has correlation with literacy rates. ○ BPL households may be targeted for electrification, improved access to potable water, toilets, and clean cooking fuel. ○ This must be supported with information regarding the proper use of water and disposal of wastewater; mode of spread of vector and water-borne diseases, as the poor and marginalised are the most vulnerable to these impacts.
3. Limited functional health care facilities (9.6 per cent)	➔ Targeted investment in developing health care infrastructure in these districts and ensuring doctors and para medical staff are available at these hospitals. Need to ensure adequate number of

	medical, nursing and pharma colleges are available to build the human capital required to meet this demand.
4. High dependency ratio (9.4 per cent), and	➔ Create an incentivizing environment for educated women of working age to take up gainful employment opportunities.
5. High dependence of tribal communities on forest resources (9.1 per cent)	➔ Adequate measures must be put in place for the sustainable use and management of forest resources.

The vulnerability assessments provide vulnerability profiles of the districts of Chhattisgarh. It identifies five districts namely Mahasamund, Balrampur, Baloda Bazar, Mungeli and Gariabad as Very Highly Vulnerable, followed by Bijapur and Korba districts are as Highly Vulnerable Districts against adverse effect of climate change. This information may be used to:

1. Prioritise districts for investment in adaptation interventions; and
2. To develop targeted adaptation interventions to address the drivers of vulnerability identified.

4.3 Gender-Specific Impacts and Vulnerabilities, Gaps and Barriers

Women are highly vulnerable and susceptible to the impacts of climate change, owing to their intrinsic physical characteristics. The ability to cope up and adapt to various climate-related hazards is different for men and women in a similar circumstance.

Table 66: Climate Change Impacts on Women

Climate Change Impacts	Women's Vulnerabilities
Lower food production	- Least to eat; sleep on an empty stomach - Need to take on additional work as wage labour which also led to more feminisation of agricultural labour
More natural disasters – cyclones, floods, waterlogging and droughts; infrequent rains; intense rains	- Longer distances to walk to get water and fuelwood - Loss of fodder and livestock - Drought/infrequent spells of rains – harder ground to do agricultural work on - Intense rains – more weeds and weeding are a woman's job
Higher summer temperatures; longer summers	- Lower milk production among animals, so lower protein intake - More tiring work in fields - Longer waking hours to work in the field early morning and late evening to beat the heat
Social Impacts	- Higher indebtedness– women go to take loans and have the responsibility to pay off loans - Greater poverty and frustration among men leads to increase in domestic abuse/violence

(Source: *Engendering the Climate for Change, Policies and practices for gender-just adaptation by Aditi Kapoor*)

Key Issues and Challenges

Area	Issues/Challenges
Policy & Regulatory	Gender is a sector, which is not included in the Nationally Determined contribution of the country and therefore the State lacks any fixed targets for development in Gender equality
Socio economic/ Cultural	Women appraisal and inclusivity in the societal development is negligible and presence of inequality in rural areas of the State
Environmental	Women along with children and aged people are the most vulnerable to natural hazards owing to their physical strength and characteristics

Gap/ Barrier Analysis

- Need of awareness and capacity building regarding climate change.
- Need of gender-based research and participatory planning to design the policies and programmes
- Proper collection and mapping of gender-disaggregated data
- Lack of accepting the contributions of women as decision-makers, stakeholders and experts across sectors and at all levels can lead to long-term solutions to climate change
- Women hold the knowledge and understanding of what is required to adapt to changing climate conditions, and to arise with practical solutions but their knowledge is often not utilised.

4.4 Stocktaking on Vulnerability Reduction since Earlier Version of SAPCC

State has been implementing various climate change interventions since the development of earlier version of CGSAPCC, which has reduced the vulnerability of the state to an extent. The department wise key climate actions undertaken during 2014-2020 has been summarised below. It is also notable that there were no dedicated budgetary provisions were available to implement the CSAPCC-I. Therefore, activities carried out within existing budget of the concerned department has been mapped as 'Key Climate Change Initiatives' undertaken by the respective sectors.

4.4.1 Agriculture and Allied Sectors

Key Climate Change Initiatives Undertaken

Minor/Major Irrigation Initiatives under PMKSY – The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) has been conceptualised for providing irrigation to every field. The PMKSY may provide overarching management and governance for convergence amongst these programmes with additional support for some interventions which are not covered in the above programmes.

Table 67: Major Irrigation Programs

Programme	Activity	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
PMKSY (Per Drop More Crop)	Drip and Sprinkler Irrigation	8056	19227	13087	18929	27688	18634	105621
	Other Intervention (Structures)	80	490	676	586	656	1607	4095
Newly Created WHS under PMKSY	Farm Ponds, Check Dams, Nallah Bands, Percolation Tanks, Groundwater Recharge Structure	1122	997	1380	1095	1453	929	6976

Source: Directorate of Agriculture, Chhattisgarh

Crop Insurance⁶³ - Pradhan Mantri Fasal Bima Yojana (PMFBY) aims at supporting sustainable production in agriculture sector by providing financial support to farmers suffering crop loss/damage arising out of unforeseen events, stabilising the income of farmers to ensure their continuance in farming, encouraging farmers to adopt innovative and modern agricultural practices and ensuring flow of credit to the agriculture sector; which will contribute to food security, crop diversification and enhancing growth and competitiveness of agriculture sector besides protecting farmers from production risks. Crop insurance is considered as one of the key climate resilience building measures for the farming community.

Table 68: Major crop insurance programs

Year	Farmers Insured (No.)	Area Insured (ha)	Sum Insured (In Rs. Crore)	Farmers Benefitted Insured (No.)
Kharif 2016	1,399,189	2,273,723.00	6,928.89	96,966
Rabi 2016-17	143,260	221,063.87	543.24	38,647
Total	1,542,449	2,494,787	7,472	135,613
Kharif 2017	1,298,636	1,982,048.00	6,162.71	566,450

⁶³<https://pmfbby.gov.in/stateWiseDataPage>

Kharif 2017-18	165,087	226,429.00	652.95	80,324
Total	1,463,723	2,208,477	6,816	646,774
Kharif 2018	1,365,986	1,990,513.00	7,150.67	590,057
Kharif 2018-19	190,253	272,394.00	877.65	66,005
Total	1,556,239	2,262,907	8,028	656,062
Kharif 2019	1,692,709	2,208,401.00	8,216.09	509,289
Kharif 2019-20	159,715	238,766.00	775.36	148,618
Total	1,852,424	2,447,167	8,991	657,907
Kharif 2020	1,395,142	2,079,206.96	8,100.78	473,148
Kharif 2020-21	241,052	356,447.36	1,179.61	163,130
Total	1,636,194	2,435,654	9,280	636,278

Source: Directorate of Agriculture, Chhattisgarh, 2020

Soil Health Card – Soil Health Card Scheme is a scheme launched by the Government of India on 19 February 2015. Under the scheme, the government plans to issue soil cards to farmers which will carry crop-wise recommendations of nutrients and fertilisers required for the individual farms to help farmers to improve productivity through judicious use of inputs. All soil samples are to be tested in various soil testing labs across the country. Thereafter the experts will analyse the strength and weaknesses (micro-nutrients deficiency) of the soil and suggest measures to deal with it. The result and suggestion will be displayed in the cards. Providing soil health cards is also one of the key climate resilience building measures for the farming community in the state.

Table 69: Soil Health Card

Year	Soil Health Card	Sample Collection	
	Health Cards Distribution	Target	Achievement
2019-20	65341	59302	59302
2017-18 to 2018-19	5514560	949334	957060
2015-16 to 2016-17	4337595	703691	790002

Source: Directorate of Agriculture, Chhattisgarh, 2020

Table 70: Farmers Training

Year	Target for Demonstration and Farmers Training	Achievement	
		Demonstration	Farmers Training
2020-21	3125	3125	2038

Source: Directorate of Agriculture, Chhattisgarh, 2020

Agriculture Mechanisation – Sub-Mission on Agricultural Mechanisation (SMAM): The Mission objectives are to increase the reach of farm mechanisation to small and marginal farmers and to the regions where availability of farm power is low; Promote 'Custom Hiring Centres' to offset the adverse economies of scale arising due to small landholding and high cost of individual ownership; Create hubs for hi-tech & high value farm equipment's; Create awareness among stakeholders through demonstration and capacity building activities; ensure performance testing and certification at designated testing centres located all over the country.

Table 71: Agricultural Mechanization⁶⁴

Year	Number of Custom Hiring Centres Implements for Hiring	Number of Agriculture Machinery Distributed	
		Power operated	Hand/Bullock operated
2018-19	482	1924	9572
2019-20	743	1091	21692
2020-21	459	2068	18198

Source: Directorate of Agriculture, Chhattisgarh

Crop Water Demand and Irrigation Status - Assured irrigation is a critical input towards ensuring optimal agricultural productivity and managing the risk of crop failure due to erratic rainfall, moisture stress and even can drought conditions towards sustaining the burgeoning demands of food grain of the growing populations.

Table 72: Irrigation Potential Created⁶⁵

Programme	Activity	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
PMKSY (Per Drop More Crop)	Drip and Sprinkler Irrigation						
	Other Intervention (Structures)	80	490	676	586	656	1607
Newly Created WHS under PMKSY	Farm Ponds, Check Dams, Nallah Bands, Percolation Tanks, Groundwater Recharge Structure	1122	997	1380	1095	1453	929
Newly Created WHS under PMKSY (NREGA Convergence)		-	410	117	-	-	-

Source: Directorate of Agriculture, Chhattisgarh

Bringing Green Revolution to Eastern States (BGREI) – The Scheme of Government of India is being implemented in the State since 2010-11 and has very good impact in popularising hybrid paddy seed. In BGREI, besides demonstration of paddy in cluster approach, irrigation facilities like lift irrigation are promoted. Some assets like seed drills, conoweeder, Drumseeder, Manual sprayers, Threshers are distributed among farmers. Demonstrations are focussed on line transplanting, SRI technique, Stress tolerant variety and on cropping system-based approach. For achieving the goals of BGREI programme the following strategies are advocated:

- To promote improved production technology of rice on massive scale including popularizing of newly released HY cultivars and Hybrids.
- To bring rice fallow areas under cultivation through cropping system-based approach.
- To popularise adoption of stress tolerant rice varieties.
- To create irrigation structures like farm ponds, lift irrigation points etc. to improve irrigation potential.
- To promote use of farm machineries and implements suitable for small land holding.
- To create infrastructure such as godown, procurement centre, marketing infrastructure etc.

⁶⁴<https://agrimachinery.nic.in/GraphReport/SMAMFmtti/SMAMFmtti.aspx>

⁶⁵ Department of Agriculture, Chhattisgarh

Mapping of SDGs and NDCs relevant to Agriculture and Allied Sectors

Table 73: Relevant SDG's

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme
1	Goal 2: Zero Hunger	Seeks to end hunger and all forms of malnutrition, and double agricultural productivity in the next 15 years. Ensuring this sustainable access to nutritious food universally will require sustainable food production and agricultural practices.		Introduction of multi cropping with one catch crop/ relay crop between two main crops Selection of short duration crop variety for Kharif as well as Rabi season to accommodate double crop
2	Goal 12 Responsible Consumption & Production	Sustainable consumption and production are about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.	-	-
3	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities; mainstreaming climate measure in national policies; improving education and awareness about climate change; building capacities of individuals and institutions	Improve the genetic potential of the various crops by means of releasing new varieties and hybrids in association with Agriculture University	Develop and introduce climate resilient varieties for mitigating the risk of climate change

Table 74: Relevant NDC'S

S.N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme
1	NDC 1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.	-	-

2	NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.	-	-
3	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.	-	-

4.4.2 Forestry and Biodiversity Sector

Key Climate Change Initiatives Undertaken

Rehabilitation of Degraded Forests (RDF) and Rehabilitation of Degraded Bamboo Forests (RDBF): This scheme is to treat degraded forest areas and degraded bamboo areas through both ANR and gap plantations. This is one the key activity promoting growth of green stock and reducing forest degradation in the forest. The year wise plantation details are given below in the table.

Table 75: Status of RDF and RDBF Plantation

Year of Plantation	Area covered (in hectare)		
	RDF	RDBF	Total
2014-15	15660	8130	23790
2015-16	12700	7000	19700
2016-17	15000	10500	25500
2017-18	17350	14900	32250
2018-19	37619	29385	67004
2019-20	36000	18350	54350
2020-21	43053	28972	72025
Total	1,77,382	1,17,237	2,94,619

Source: Chhattisgarh State Forest Department, 2021

- 1. River Side Plantation Programme** – Riverbank plantations have been taken up to control soil erosion and associated problems, with a view to rejuvenate rivers of the State.

Table 76: Activities undertaken under River side plantation programme

Year of Plantation	Plantation Area (In hectare)	Number of Saplings Planted (In lakh)	Name of Species Planted
2014-15	350	3.85	Neem, Arjun, Jamun, Karanj, Aonla, Khamar, Sishu, Aam etc.
2015-16	102	1.12	
2016-17	310	3.41	
2017-18	140	1.54	
2018-19	402	4.42	
2019-20	475	4.75	
2020-21	457	5.02	
Total	2236	24.11	

Source: Chhattisgarh State Forest Department, 2021

- 2. Soil and Moisture Conservation Programme:** The programme has as its objective to increase the groundwater levels, plantations on barren lands - for soil conservation and flood control.

Table 77: Details of Soil and moisture conservation work by the department

Year	Area covered (in hectare)
2014-15	66,383
2015-16	57,622
2016-17	50,400
2017-18	67,660
2018-19	61,840
2019-20	81,471
2020-21	30,079
Total	415455

Source: Chhattisgarh State Forest Department, 2021

CAMPA: The major activities carried out from this fund are Compensatory Afforestation, Plantations and Forest Protection, Development of IT, Research and Training, Development of Medicinal Plants, Infrastructure development, Biodiversity and wildlife conservation, Forest Management and Monitoring and evaluation. The afforestation fund has been utilised in the state for plantation activities and below is the table with the details of activities undertaken under CAMPA from the 2014-15 to 2020-21.

Table 78: Activities Undertaken under CAMPA

Activities Undertaken	Plantation Details	Total Area Covered (in Ha.)	Name of the Species Planted
Plantation activities done under CAMPA	(i) Compensatory Afforestation	24,832.58	Teak, Bamboo, Aonla, Khamhar, Nilgiri, Arjun, Shishu, karanj & Others
	(ii) Creation of Safety Zone	185.16	
	(iii) Block Plantation	21,689.96	Teak, Bamboo, Aonla, Khamhar, Nilgiri, Arjun, Shishu, karanj, Sal, Bija, Kullu, Mundi, Haldu & Others
	(iv) Oxygen Plantation	1,128	Aonla, Shishu, Satvan, Pipal, Bargad & Others
	(v) Riverbank Plantation	3,644.12	Shishu, Khamhar, Khair, Mahua, Aonla, Arjun & Others
Establishment of Natural Forest	(i) ANR	1,45,529.2	-
	(ii) Cleaning of Bamboo	50,110.31	-
	(iii) Improvement of Growing stock	50,766.97	-
	(iv) Removal of Invasive Alien Species	3,29,279.53	-
Soil Conservation & Afforestation Plantation	Soil water conservation	15,126.64	-
	Soil moisture conservation	1,819 Nos.	-

Mapping Of SDGs and NDCs Under Forest and Biodiversity Sector

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to respective sectors with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 79: SDGs Relevant to Forests and Biodiversity

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the SDG targets /Goal
1	Goal 15 Life on Land	Conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands; maintaining the biodiversity, mobilising resources for forest management; sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation.	1. Implement Green India Mission activities 2. Review of forest working plans as per government of India's New Work Plan Code 2014, and incorporation of measures of forest sustainability, Climate Change	Green India Mission, RDF, RDBF etc.	1. There are variations in cover by forest type but there is evidently no change in the net forest cover matrix which is due to forest degradation leading to an increase in the open forest and scrub area. 2. In Chhattisgarh, during the period 1st January 2015 to 5th February 2019, a total of 3,793.05 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019)
2	Goal 6 Clean Water and Sanitation	Restoring water-related ecosystem including forests, wetlands, rivers, aquifers and lakes	Soil and moisture conservation through watershed management	Riverbank plantation, Soil and moisture conservation works under CAMPA.	The depletion of groundwater level especially during summer in the state has become a challenge due to

					overexploitation of groundwater in few areas during last few years.
3	Goal 12 Responsible Consumption and production	Sustainable management and efficient use of natural resources;	Distribution of LPGs under UJWALA Yojana and other energy efficient devices in forest areas.	CAMPA fund for Ujjawala Yojana implementation. Joint Forest management committee, Suraji Gaon Scheme (Narwa Garua Ghurwa Bari Scheme).	Destructive collection practices of NTFPs & medicinal plants and removal and collection of tubers, roots, bark fruits and seeds beyond the regenerative capacity causing forest degradation.
4	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities; mainstreaming climate measure in national policies; improving education and awareness about CC; building capacities of individuals and institutions	1. Promote research studies on forest related activities. 2. Access international support and benefits in sustainable management of forests through Reducing Emissions from Deforestation and Forest Degradation (REDD+), Clean Development Mechanism (CDM) projects on Forestry.	Establishment of Chhattisgarh State Centre for climate change, Chhattisgarh state action plan for climate change prepared in 2014, capacity building and awareness program organised and revision of SAPCC till 2030 is done.	Climate finance and budget availability for carrying out climate actions in the State.

Table 80: NDCs Relevant to Forests and Biodiversity

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the NDC targets/goal
1	NDC 5	Creating additional carbon sink through additional forest and tree cover.		Green India Mission, RDF, RDBF, Riverbank plantation activity	
2	NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.		CAMPA, JFM	
3	NDC 1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.		Suraji Gaon Scheme (Narwa Garua Ghurwa Bari Scheme).	

4.4.3 Water Resources Sector

Key Climate Change Initiatives Undertaken

Increased Water use Efficiency by Promoting use of Drip and Sprinkler Irrigation

Under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) extending the area of irrigation and improving the efficiency of water use '*More crop per drop*' in a focused manner with an end-to-end solution on source-creation, distribution, management, field application and extension activities.

Creation of Surface Water Sources

The main focus of surface water sources creation and management is to make existing irrigation network more efficient by reducing the gap between created irrigation potential (IPC) and utilised irrigation potential. Proposal for renovation, restoration and modernisation of the completed Major & Medium irrigation projects in phased manner is be taken up every year by the Water resources department, so that created irrigation potential (IPC) can be fully utilized. The thrust for these activities is more for Barrage/ series of Barrages/Ponds in place of Dams, so as to minimise land acquisition, displacement, rehabilitation and forest submergence. Till 2018-19, the total Irrigation Potential created through Major & Medium Irrigation Projects is 461.76⁶⁶ thousand hectares.

⁶⁶ As per the data from Water Resource department, Government of Chhattisgarh

Increased Irrigation Potential Created

The irrigation potential has now been raised to 1.844 million hectares at the end of March 2012 which is 33.15 per cent of gross sown area. It is a remarkable achievement of the state government and also contributes to enhancing the climate resilience of the farmers by reducing their dependency on rainfall. To increase the productivity of crops and bringing in more fallow land under cultivation, the state is committed to increase the net irrigated areas. To ensure the national vision of *har khet ko pani*, the state will provide water assurance through the completion of on-going minor, medium and long-term irrigation projects.

Table 81: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	Adaptation Action	State Implementing Agency
State Water Resources Development Policy, 2012	To make available water for drinking, agriculture and industries	Reduce GHG emission due to availability of water from nearby sources	CO ₂	Building resilience of industries, farmers and other water users from erratic rainfall and regular dry spells due to climate change	State Water Resources Department
Pradhan Mantri Krishi Sinchai Yojana	To improve water use efficiency, implementation of 'More Crop per Drop' in a focused manner with end-to-end solution on source creation, distribution, management, field application and extension activities	Reduce GHG emissions by promoting use of energy efficient pumping systems	CO ₂	Improved availability of water for farm use in the Context of erratic patterns of rainfall due to changing climate and thereby building climate resilience of the farmers.	State Water Resources Department

National water mission	To ensure integrated water resource management to help in conserving the water, minimise wastage and ensure more equitable distribution both across and within states	Reduced GHG emission due to increased water use efficiency	CO ₂	Improved availability of water for farm use in the context of erratic patterns of rainfall due to changing climate and thereby building climate resilience of the farmers.	State Water Resources Department
Accelerated Irrigation Benefit Programme (AIBP)	To Increase irrigation potential, from canal systems, and CAD works	Reduced GHG emission due to increase water use efficiency	CO ₂	Improved availability of water for farm use in the context of erratic patterns of rainfall due to changing climate and thereby building climate resilience of the farmers.	State Water Resources Department
Command Area Development and Water Management	Increased irrigation potential through canal systems, CAD works and diversions to feed new storage structures Improved performance of irrigation infrastructure from canal lining, strengthening and restructuring	Reduced GHG emission due to increase water use efficiency	CO ₂	Improved water availability and reduced leakage losses which will enhance the climate resilience of the farmers by increased farm incomes	State Water Resources Department

River Basin Management	To manage river basins for restoring river ecology and flood moderation, navigation, drinking and industrial water supply, fisheries, salinity and pollution control etc.	Enhancing Carbon sink from water resources and aquatic flora	CO ₂	Building adaptation of communities living near river basin from flood, revival of river ecosystem for enhancing resilience of fishing community's livelihood.	State Water Resources Department

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Water Resources sector with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 82: SDGs Relevant to Water Resources

S. N.	Description of SDGs	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving theSDG Targets /Goal
1	Goal 6 Clean Water and Sanitation	Universal & equitable access to safe and affordable potable water; water quality; water use efficiency, IWRM; restoring water related ecosystem.	By 2030, 100 per cent Rural and urban Households having main source of drinking water as "treated tap water".	Drinking water and sanitation program implementation ongoing under National Rural Drinking Water Programme and AMRUT	Difficulty in coming up with pipe water schemes to small and scattered habitations
2	Goal 12 Responsible Consumption and Production	Sustainable management and efficient use of natural resources including water; waste and chemical management to protect pollution of water resources.	By 2030, community-based management of aquifers, and providing a regulatory role for PRIs at the appropriate level. 2. Recycling of the used water in industrial	Projects undertaken by the state government for better utilisation and effective use of water resources include, a) Rural Infrastructure Development	Poor operation and maintenance of water supply infrastructure

			sector and urban area will be incentivised and regulated.	Fund (RFID) Programmes with an irrigation potential of 221166 ha, b) Accelerated Irrigation Benefit Programme (AIBP) major and minor projects that created an irrigation potential of 143030 ha and c) World Bank Associated "National Hydrology Project Phase-II	
3	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities	By 2030, Planning and management of water resource structures, such as dams, flood embankments in view of Climate Change	State is promoting micro-irrigation techniques (drip irrigation, sprinklers) to increase water use efficiency and apply water soluble fertilisers (fertigation) efficiently through assistance from Central Government	Rain-fed agriculture is prevalent in the State and it faces the challenge of frequent droughts caused by low and erratic rainfall leading to wide variation in production and productivity
4	Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems and	Protect and restore land degraded from floods and droughts; increase capacity of local communities to pursue sustainable	By 2030, Local bodies should install collection, treatment and disposal system of	Narwa Garuwa Ghurwa Baari scheme being implemented in the State to rejuvenate	Pollution in the inland water bodies and poor market linkages

	halt biodiversity loss	water-based livelihood opportunities	wastewater generated from their area to reduce fresh water consumption. • Rain water harvesting should be done on large scale to recharge groundwater	local water bodies.	

Table 83: NDCs Relevant to Water Resources

S. N.	NDCs	Relevant Focus	State Target	Initiatives in Terms of Existing Programme / Scheme	Gaps in Achieving the NDC Targets / Goal
1	NDC 6	Enhancing investments in water sector to adapt to Climate change		- Real-time weather-based agro-advisory information dissemination through the Gramin Krishi Mausam Sewa by IMD - Soil Health card - Pradhan Mantri Crop Insurance scheme - Fasal Bima Yojana 'Narwa, Garuwa, Ghurwa, Baadi' scheme that is aimed at developing micro-watershed structures for groundwater recharge and increasing surface water irrigation, livestock development, promoting vermicomposting and developing kitchen gardens to help develop climate resilience and encourage sustainable agriculture. - Pradhan Mantri Krishi Sinchai Yojana (PMKSY) - Micro Irrigation Scheme (Per Drop More Crop) - Small Scale Irrigation Scheme (Construction of	- Real-time weather-based agro-advisory information dissemination through the Gramin Krishi Mausam Sewa by IMD - Soil Health Card - Pradhan Mantri Crop Insurance scheme - Fasal Bima Yojana 'Narwa, Garuwa, Ghurwa, Baadi' scheme that is aimed at developing micro-watershed structures for groundwater recharge and increasing surface water irrigation, livestock development,

				ponds to irrigate a minimum of 40 acres of land) • Jan Jagran Abhiyan (promotes agriculture among people who are staying in relief camps (scheme applicable in Bijapur, Dantewada and Sukma districts)) • Kisan Samridhi Yojana (to increase the area under irrigation by using groundwater sources) • Dalhan, Tilhan and Corn Promotion Scheme • Promotion of riverside vegetable production • Promotion of Drip Irrigation • State Micro Irrigation Scheme • National Rural Drinking Water Programme (NRDWP)	promoting vermicomposting and developing kitchen gardens to help develop climate resilience and encourage sustainable agriculture. • Pradhan Mantri Krishi Sinchai Yojana (PMKSY) • Micro Irrigation Scheme (Per Drop More Crop) • Small Scale Irrigation Scheme (Construction of ponds to irrigate a minimum of 40 acres of land) • Jan Jagran Abhiyan (promotes agriculture among people who are staying in relief camps (scheme applicable in Bijapur, Dantewada and Sukma districts)) • Kisan Samridhi Yojana (to increase the area under irrigation by using groundwater sources) • Dalhan, Tilhan and Corn Promotion Scheme • Promotion of riverside vegetable production • Promotion of Drip Irrigation • State Micro Irrigation Scheme

					• National Rural Drinking • Water Programme (NRDWP)
2	NDC 1	Propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation	Practices to farm alternate crop, based on traditional knowledge systems in agriculture by 2040	• Loan waivers for drought-hit farmers • Crop insurance schemes (Pradhan Mantri Crop Insurance scheme) • Investments to improve irrigation efficiency • Alternative livelihood options • Solar pump irrigation scheme • Integrated watershed management schemes • Forest Rights Act	• Practices to farm alternate crop, based on traditional knowledge systems in agriculture by 2040
3	NDC 2	Adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development		• Increasing minimum support price (MSP) • Awareness, incentivising and promotion of efficient farming techniques • Solar pump irrigation scheme • National Green Corps Programme (NGC) in all Districts • MGNREGA (water augmentation – 1. 879 ponds cleaned and deepened in the entire district. • 4986 works approved in entire district under MNREGA. • 2a. 28 works of canal repairing • 2b. 576 works of well construction • 2c. 2229 works of small pond construction • 2d. 245 works of pond construction • 2e. 109 works of pond deepening • 2f. 1797 works of land repairing • Krishak Samagra Vikas Yojana (increase production of Ramtil (scheme applicable in Bastar, Dantewada, Kanker, Jashpur and Surguja districts)	

				• Compensatory Afforestation Fund Management and Planning Authority (CAMPA) - Eco - tourism development • Scheme for riverside tree plantation with the objective of preventing soil erosion • Scheme for Reforestation - encourage tree plantation and reforestation in the areas which are affected by habitations. Development of groundwater management with afforestation	

4.4.4 Urban Development Sector

Key Climate Change Initiatives Undertaken

Smart City Mission – The Raipur Municipal Corporation (RMC) and Bilaspur Municipal Corporation (BMC), have been selected through a competitive process for Smart City Mission under the Ministry of Urban Development (MoUD). The objective of the Smart Cities Mission is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is on sustainable and inclusive development and the idea is to look at compact areas, create a replicable model which will act like a light house to other aspiring cities. The Smart Cities Mission of the Government is a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country.

Accordingly, the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Area-based development will transform existing areas (retrofit and redevelop), including slums, into better planned ones, thereby improving liveability of the whole City. New areas (Greenfield) will be developed around cities in order to accommodate the expanding population in urban areas. Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive Cities. Naya Raipur came 2nd amongst the smart city mission cities with a score of 67.78 percent. In smart city mission budget allocated during 2014 to 2020 is around 740.00 crore in which 486.00 crore amount is expenditure till 31.01.2021

Street Light National Programme– SLNP is an initiative of the Government of India with an aim to replace 3.5 crore conventional streetlights with energy efficient LED lights, which is expected to result in annual energy saving of 900 crore units and the total cost savings of municipalities every year will be Rs 5,500 crore. At present, 3.72 lacs streetlights have been replaced and installed with energy efficient LED street lights and around 60,000 new LED lights have been installed in ULBs due to extra pole extension. As population increases day by day the demand of streetlight also increases.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)- AMRUT was launched on 25th June 2015 with the aim to provide basic amenities and services to urban households and to inclusively improve the quality of life. Cities with a population of more than 01 lakh have been covered under this mission.

The objectives are to ensure assured supply and access to tap water and a sewerage facility for every household, beautification and gentrification of cities by creating, maintaining and upgrading green spaces, parks, recreation centre sets and to trim down pollution levels by improving public transport facilities and promoting no motorised and pedestrian friendly transport. Under this mission, 33 Old inefficient pumps have been replaced with efficient pumps till date.

Total tap connections provided in all AMRUT Cities is around 2.00 lacs and tap connections provided in the year 2021-22 is around 50,000. In AMRUT, budget allocated amount is around 1807.00 crore in which 1347.00 crore amount is expenditure during last financial year.

AMRUT 2.0 (Jal JivanMission) have been launched recently, under which all remaining ULBs will be covered. Main motive of this mission is to provide safe and adequate drinking water through individual household tap connection.

The table below shows the amount invested in different activities under AMRUT in Chhattisgarh:

Table 84: Money invested in various districts of Chhattisgarh under AMRUT

Components	Name of the District (in crores)									Total
	Bhilai	Korba	Ambikapur	Rajnandgaon	Bilaspur	Jagdalpur	Raipur	Durg	Raigarh	
Water Supply Scheme	221.6	211.6	101.6	208.4	296.5	99.48	378.74	154.53	131.8	1804.4
Septage Management	0.19	0.9	0.43	12.46	1.3	55.91	268.58	0.21	58.64	398.6
Garden Development	10	8	8	9	11	11	11	6	4	78
	3.05	3.29	3.21	4.65	5.6	2.75	5.68	2.56	1.96	32.7

Water Supply Schemes - Under this scheme the WTP, intake well, extension pipeline & overhead tank are constructed. **At present, this scheme is running in 46 ULBs of the state and in remaining ULB's of state, there is already existence of Water Supply.** In this scheme there is around 306.76 crore of fund is allocated and whole allocated is utilised during last five year.

Rajya Pravartit Yojna – The purpose of this Scheme is providing basic facilities for the people who live in Urban local bodies, Like Sarovar Dharohar Yojna is based on saving Ponds, Gyan StaliyaYojna is Based on Repaing Schools Room, Mukti Dham Yojna is based on Developing burning shade, Puspvatika Yojna in based on Developing Garden for good Health, Etc.

Rejuvenation of Water Bodies – Under this scheme, the focus of state government is on holistic development of water bodies to ensure that there is no encroachment, and the water feeder channels are intact. This will help in increasing the water holding capacities of urban areas, thereby reducing the impact of urban flooding. The urban development department Rejuvenates the Water Bodies and the details are as follows: -

Table 85: Status of the Rajya Pravartit Yojna Project

S. No.	ULB's	No. of ponds for Rejuvenation	Financial Progress			Physical Progress	
			Approved Amount	Allocated Amount	Expended Amount	Complete	Under Progress/ To be started
1	Nagar Nigam	274	11,619.11	8,451.76	7,904.06	245	29
2	Nagar Palika	201	5,031.81	3,641.13	4,445.06	167	34
3	Nagar Panchayat	330	5,448.05	4,283.50	3,733.39	256	72
TOTAL		805	22,098.97	16,376.39	16,082.5	668	135

Hariyar Chhattisgarh – plantation plays a direct impact on harmful effect of climate change. Hariyar Chhattisgarh is a program where plantation is done in urban areas. In this scheme, the state government sets the target for each and every ULBs for plantation in urban areas. At present, 1,91,898 no. of plants were planted against a target of 2,11,917 by last year.

Mission water conservation (Roof-top Rainwater Harvesting) - Rainwater harvesting (RWH) is the collection and storage of rain, rather than allowing it to runoff. Rainwater is collected from a roof like surface and redirected to a tank, cistern, deep pit (well, shaft or borehole), aquifer, or a reservoir with percolation, so that it seeps down and restores the ground water. It is mandatory to make arrangement for rainwater harvesting in every land plot (above 150 metre square area). ULBs take security deposits before providing building permission and this security deposit will be released after complete inspection. ULBs takes necessary action by updating building byelaws and development control regulations. **The target is 60 per cent is achieved and around 26,000 nos. of building/households have Rainwater Harvesting technique.**

Deendayal Antyodaya Yojana – National Urban Livelihoods Mission (DAY-NULM) – National Urban Livelihoods Mission (NULM) was launched by the Ministry of Housing and Urban Poverty Alleviation (MHUPA), Government of India on 23rd September 2013 by replacing the existing Swarna Jayanti Shahari Rozgar Yojana (SJSRY). The primary target population group of NULM is the urban poor including the urban homeless. The NULM is meant to focus on organising urban poor in their strong grassroots level institutions, creating opportunities for skill development linked to market-oriented employment and promoting self-employment by ensuring easy access to credit. The mission also aims to provide shelter to the urban homeless along with basic services in a phased manner. The mission is also directed towards tackling livelihood concerns of the urban street vendors by facilitating access to suitable spaces, institutional credit, social security and skills to the urban street vendors for accessing emerging market opportunities. The target is to cover all districts headquarter towns (irrespective of the population) and all other towns with a population of 1 lakh or more as per Census 2011 under the 12th Five Year Plan. There are five components under DAY-NULM which are as follows: Social Mobilisation and Institution Development, Employment through Skills Training and Placement, Self-Employment Programme, Support to Urban Street Vendors and Scheme of Shelters for Urban Homeless.

Table 86: Status of NULM in Chhattisgarh as on November, 2021

State Name	No. of Men Shelters	Capacity of Men Shelters	No. of Women Shelters	Capacity of Women Shelters	No. of Family Shelters	Capacity of Family Shelters	No. of General Shelters	Capacity of General Shelters	No. of Special Shelters	Capacity of Special Shelters
Chhattisgarh	0	0	1	0	0	0	31	1496	0	0

Pradhan Mantri Awas Yojana – Housing for All by 2022 (PMAY-HFA) – Pradhan Mantri Awas Yojana – Housing for All (Urban) will be implemented during 17-06-2015 to 31-03-2022. This is a central sponsored scheme to implement in all 168 ULBs of the State. In PMAY a beneficiary family comprises of husband, wife and unmarried children. Eligibility Criteria for the scheme is as follows: 1) Should not own a pucca house either in his/her name or in the name of any member of his/her family in any part of India. 2) Should be a resident of that urban area before cut-off date 31-08-2015 & 3) Annual family income up to Rs.3 Lakh.

Figure 35: Divisional Progress Beneficiary-Led Individual House Construction (BLC)



Table 87: Status of PMAY in Chhattisgarh as on date

S.No.	Name Of Component	Target	Approved Accommodation	Completed Houses
1	Affordable housing project (AHP)	1,00,000	65,079	8,224
2	Beneficiary-Led Construction (BLC)	2,00,000	2,00,301	82,266
TOTAL		3,00,000	2,65,380	90,490

At present, 90490 number of houses are successfully completed, and department is still working to achieve targets.

Mission Clean City: The Govt. of Chhattisgarh launched the Mission Clean City (MCC) for providing efficient and less costly solutions for waste management based on Ambikapur Model in its 164 ULB's. Mission Clean city was conceptualized an aim of scientific disposal of waste in accordance with MSW rules 2016, involving SGH groups. It focuses on 4 R's of SWM which are reduce, reuse, recycle and recover. Since its launch it has been highly successful in achieving 100% source segregation, 100% door-to-door collection, 100% treatment and it has resulted in a drastic and highly visible change in the scenario of solid waste management in the state along with an everlasting impression in its citizen. Sufficient funds

have also been made available to each ULB to build infrastructure (358 SLRM Centre and 165 Compost sheds) for the scientific processing and disposal of MSW.

Integrated Municipal Solid Waste Management – Integrated Municipal Solid Waste Management (Waste to RDF, Composting, and Sanitary Landfill) model was implemented in **02 ULBs namely Sakari, Raipur Municipal Corporation (Around 67 Acre) and Kachar, Bilaspur Municipal Corporation (Around 25 Acre)**. In these 2 ULBs, source segregated municipal waste is collected on the door-to-door basis by M/s Delhi MSW Solutions Ltd. by utilizing 214 vehicles. After secondary segregation; organic waste is converted to Compost, and high calorific waste is issued to make RDF briquettes. The RDF briquettes will be sold to Cement, Steel, and power units in the State. The inert residue will go to the Landfill.

These objectives would be met through the following strategies:

Strategy 1 - Capacity building and institutional development: The Government emphasises capacity building of local institutions, especially the ULBs. This would be including building organisational as well as financial capabilities of ULBs to meet the challenges of urban development. The existing role of ULBs would be strengthened in light of the 74th Constitutional Amendment.

Strategy 2 – Stress on operational efficiency: Delivery of municipal services like water supply, sewerage and sanitation, street lighting, transportation and housing would be strengthened. Emphasis would be laid on adoption of appropriate technology along with sustainable management of urban environment. Needs of the urban poor would receive special attention and service delivery to urban poor would be strengthened.

Strategy 3 – Strengthening Urban Planning: Urban planning would be reflective of the economic development in the region. The ULBs would play a pivotal role in urban planning. The ULBs would play a pivotal role in development and strengthening strategies of urban planning

Strategy 4: Information, Education, and Communication (IEC): IEC programs launched with a vision to create awareness and create a spark among the youth to adopt best sanitation practices and at the same time improve the social status of the workers involved in the grassroots level.

Strategy 5: Enabling Public-Private Partnerships: Public-private partnerships involve collaboration between a government agency and a private sector, NGOs, Community Representatives, Citizen groups, etc. in various aspects of urban management. The involvement of private sectors results in improving the quality of services and additional support to the government.

Achievements:

- 1st Prize in National Ranking for “Swachh State” in India for Swachh Sarvekshan 2019 & 2020.
- 3rd Prize in National Ranking for Most Emerging State in Swachh Sarvekshan 2018.
- Recognized as Best Performing State in IEC Activities.
- 1st Position in HUDCO National Awards for IEC –Chhota Bheem, Captain Clean Campaign

Table 88: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	State Implementing Agency
National Mission of Sustainable habitat	Aims at encouraging sustainable urban planning in India with the help of policy, infrastructural and research interventions in sectors such as buildings, waste management, water resources and transportation	Encouragement of policies and intervention for sustainable urban planning	CO ₂ , N ₂ O & CH ₄	Department of Urban Development
Swachh Bharat Mission	Community toilets and waste management for all	Creating awareness for proper sanitation and better waste management	CO ₂ & CH ₄	Central Public Works Department
National Heritage City Development and Augmentation Yojana (HRIDAY)	Aims to preserve and revitalise soul of the heritage city to reflect the city's unique character by encouraging aesthetically appealing, accessible, informative & secured environment.	Encouraging secured environment and preservation of heritage of a city		Tourism Department
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	The objectives are to ensure assured supply and access to tap water and a sewerage facility for every household, beautification and gentrification of cities by creating, maintaining and upgrading green spaces, parks, recreation centres etc and improving public transport facilities.	Proper facility for disposal of waste and sewerage and trimming down pollution levels by improving the public transport facilities and promoting non-motorized and pedestrian friendly transport.	CO ₂ , N ₂ O & CH ₄	Department of Urban Development
Dindayal Antoday Yojana-National Urban Livelihood Mission (DAY – NULM)	To reduce poverty and vulnerability of the urban poor households by enabling them to access gainful self-employment/skilled wage employment opportunities along with providing shelters to the homeless.	Better waste management	CO ₂ , N ₂ O & CH ₄	Department of Urban Development

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Urban sector with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 89: SDGs Relevant to Urban Sector

S. N.	Description	Relevant focus	State Target	Initiatives in terms of existing programme/ scheme
1	Goal 9 Industries, Innovation and Infrastructure	Basic infrastructure like roads, information and communication technologies, sanitation, electrical power etc.	100 per cent coverage of individual household latrine, 100 per cent coverage of community toilets in urban areas by 2019	SBM- U PMAY AMRUT
2	Goal 11 Sustainable Cities and Communities	Safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport.		AMRUT
3	Goal 7 Affordable and clean energy	Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.	24x7 power supply by 2021	24x7 Power for All, Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Rajeev Gandhi Grameen Vidyutikaran Yojana (RGGVY), Atal Gram Jyoti Yojana, UDAY, State Rural Electrification Plan, Tilka Manjhi Krishi Pump Yojana
4	Goal 12 Responsible consumption and production	Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment.	100% coverage of individual household latrine, 100% coverage of community toilets in urban areas by 2019	Swachh Bharat Mission – Urban (SBM- U) Pradhan Mantri Awas Yojana Atal Mission for Rejuvenation and Urban Transformation (“AMRUT”)

5	Goal 13 Climate Action	Integrate climate change measures into national policies, strategies and planning; Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.		

Table 90: NDCs Relevant to Urban Sector

S.N.	Description	Relevant focus	State Target	Initiatives in terms of existing programme /scheme
1	NDC 2	To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.		
2	NDC 3	To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.		
3	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.		

4.4.5 Transport Sector

Key Climate Change Initiatives Undertaken

E- Mobility initiative - National E-Mobility Program has been launched in the country supporting the central government's vision to achieve 100 per cent e-mobility by 2030. India is targeting the deployment of 5 million to 7 million EVs across the country by the end of 2020 under the revised National Electric Mobility Mission Plan (NEMMP) 2020. Committee have been formalised at the state level for development of electric vehicles policy.

Bus Rapid Transit System & Rapid Mass Transport Solution – A Bus Rapid Transit System (BRTS) is under implementation under World Bank Support as a demonstration city for World Bank's Sustainable Urban Transport Project. A Light Rail Transit System (LRTS) also proposed. Other plans for Naya Raipur include a pedestrian corridor, golf course, luxury hotels and convention centres, shopping malls and multiplexes, a cricket stadium, and demarcated areas for Special Economic Zones (SEZs), townships, and etc. Rapid Mass Transport Solutions: Metro Rail, Greater Raipur (Raipur, Naya Raipur, Durg and Bhilai) is fast emerging as a metropolitan city. This gives urgency to appropriate mass rapid transport solutions. Metro Rail is one option that is being explored. The track length between Rajnandgaon and Raipur is estimated at around 93 Kms. The State has engaged Delhi Metro Rail Corporation (DMRC) to conduct a

pre-feasibility study of the Metro Rail project in the State. The State is forming an Urban Metropolitan Transport Authority (UMTA) to facilitate and support efforts to realise mass rapid transport solutions for Greater Raipur.

The **Transport Nagar Yojana** formulated to simplify and streamline the transport system in the state has been started in eight urban bodies. Two projects have been completed and work is in progress in the rest. The Bhagirathi Nal- Jal Yojna, a new programme to provide improved water supply service levels through piped water to nearly 2.5 lakh poor families live in slums situated in various urban centres free of cost has been started. These are only examples of a range of other such initiatives being undertaken in the State. The State has also decided to adopt a well-defined urban development policy to meet the challenges of urbanisation. The objectives of this urban development policy are to ensure:

- Improvement in the quality of urban living;
- More accountability of Urban Local bodies towards urban citizens;
- Planned urban development
- Better quality, access and efficiency of service;
- Alleviation of urban poverty and equal access of services to the urban poor;
- Financial sustainability of local institutions; and
- People's participation in local governance

Table 91: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	State Implementing Agency
Inspection and certification centre	Aims to reduce emission	Encouragement to form laws and policies to reduce emission from transportation	CO _x	Transport Department
Institute of Driving, Training and Research	To improve R&D in the sector		CO _x	Transport Department
Provision of Weigh Bridge to control overloading of goods vehicle	Aims to reduce emission		CO _x	Transport Department
EV Policy and subsidy	Aims to improve energy efficient transportation		CO _x	Transport Department
Initiative for emission control	To control violations in the pollution control norms		CO _x	Transport Department
National Mission of Sustainable habitat	Aims at encouraging sustainable urban planning in India with the help of policy, infrastructural and research interventions in sectors such as buildings, waste management, water resources and transportation	Encouragement of policies and intervention for sustainable urban planning and Transportation	CO ₂ , N ₂ O & CH ₄	-Department of Urban Development

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	The objectives are to ensure assured supply and access to tap water and a sewerage facility for every household, beautification and gentrification of cities by creating, maintaining and upgrading green spaces, parks, recreation centres etc and improving public transport facilities.	Proper facility for disposal of waste and sewerage and trimming down pollution levels by improving the public transport facilities and promoting non-motorised and pedestrian friendly transport.	CO ₂ , N ₂ O & CH ₄	Department of Urban Development

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Transport sector with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 92: SDGs Relevant to Transport Sector

S.N.	Description	Relevant focus	State Target	Initiatives in terms of existing programme /scheme
1	Goal 9 Industries, Innovation and Infrastructure	Basic infrastructure like roads, information and communication technologies.		Atal Mission for Rejuvenation and Urban Transformation ("AMRUT")
2	Goal 11 Sustainable Cities and Communities	Safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport.	100 per cent cities with developed comprehensive mobility plan by 2021	AMRUT
3	Goal 12 Responsible consumption and production	Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.	100 per cent cities with developed comprehensive mobility plan by 2021	Atal Mission for Rejuvenation and Urban Transformation ("AMRUT")

4	Goal 13 Climate Action	Integrate climate change measures into national policies, strategies and planning; Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.		

Table 93: NDCs Relevant to Transport Sector

S.N.	Description	Relevant focus	State Target	Initiatives in terms of existing programme /scheme
1	NDC 2	To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.		
2	NDC 3	To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.		
3	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.		

4.4.6 Energy Sector

Key Climate Change Initiatives Undertaken

In addition to the initiatives already outlined above, the State has an overarching Energy Policy aimed at accelerating the pace of development of the State and make at par with other developed states. Key focus areas under the Energy Policy include:

- In the government owned properties and housing boards, electric geysers are prohibited, and solar water heating systems are mandatory
- For village electrification, the CREDA initiated implementation of micro-grids for big, concentrated villages and solar home lighting systems for village with scattered hamlets.

Major achievements of the department during 2014-

2021UJALA Scheme (Source EESL, Raipur)

- 1,04,59,876 nos. LED bulbs have been distributed in Chhattisgarh which contributes annual energy saving of 14,04.65 MUs.

- 2,81,743 nos. LED Tube lights have been distributed in Chhattisgarh which contributes on annual energy saving of 12.37 MUs.
- 64,810 nos. Ceiling fans have been distributed in Chhattisgarh which contributes on annual energy saving of 6.05MUs.

Streetlight national program (Source EESL, Raipur)

- Under streetlight national program 3,72,155 nos. of street lights have been installed in Chhattisgarh which contributes annual energy saving of 73.26MUs.

Off- grid Renewable Energy Programmes (Source Creda, Raipur)

- Total 322.6973 MW capacity of solar photovoltaic systems (SPV) have been installed in Chhattisgarh.
- 12,941 nos. of biogas plant of total capacity 27,445 Cu.m have been installed.
- 777 nos. of solar heating system of total capacity 4,65,600 LPD have been installed in Chhattisgarh

On-Grid Renewable Energy Programmes (Source Creda, Raipur)

- Total 247.3003 MW capacity of grid connected SPV, 10 MW capacity of biomass and 48.75 MW capacity of small hydro have been installed in the State.
- 14MW capacity of Co-generation power plants have been installed in Chhattisgarh.

Figure 36: 100 KW SPV Power Plant Installed at SEML, Siltara, Raipur (Left) Solar Drinking Water Pump at Siyarinali, Dist. Dhamtari (Right)



Figure 37: Biomass Gasifier Installed at, Vill Banki, Block Bodla, Dist. Kawardha (Left) CREDA Building: 1st Energy Plus Building Located at Raipur, Chhattisgarh (Right)



- The CREDA has developed an Energy Education Park in Raipur to create awareness on renewable energy source
- Hindustan Petroleum Corporation Limited has signed a MoU with the government and CREDA for the formation of joint venture company to undertake Jatropha plantation on 15,000 hectares of land in the state.
- Indian Oil Corporation Limited and CREDA have established a joint venture company, Indian Oil – CREDA Bio-fuels Ltd to produce 30,000 MT of biodiesel per annum from energy crop plantation on 30,000 hectare of revenue wasteland.⁶⁷
- Demand Side Management (DSM) – DSM has gained unprecedented importance and has become an integral part of almost all the central and state missions on promotion of energy efficiency. BEE has categorised DSM as Municipal DSM and Agriculture DSM. The activity under the initiative involves:
 1. Identification of energy saving potentials (building, street lighting & water pumping system)
 2. Demonstration of best practices and new technologies
 3. Creating awareness among officials of ULBs, technicians and engineers.

A DSM cell has been working in Chhattisgarh State Power Distribution Company Limited (CSPDCL) with the support of Bureau of Energy Efficiency (BEE). The function of the cell is to execute the activities as per the DSM regulation set up BY CSERC. The activities such as formulating DSM plan, load survey, end consumer management, peak load management activities & execution of projects on loss reduction of DISCOMS.

- Energy Efficiency Initiatives under Building, Pumping and MSME Sectors – The state has promoted the usage of energy efficient appliances, equipment, pumping systems for different energy consuming sectors. The state has also prepared a plan for the implementation of Energy Conservation Building Codes (ECBC). The ECBC cell was established in September 2016, to provide technical assistance for ECBC notifications and implementations in Chhattisgarh state. The cell also provides technical assistant to make commercial buildings energy efficient and provide awareness programs across the state. The CREDA is working closely with the Bureau of Energy Efficiency (BEE) for the implementation of energy conservation programs for MSMEs in the state. The major emphasis is on the adoption of efficient motor system and solar powered pumping systems to conserve the energy.
- The Standards and Labelling Programme of the Bureau of Energy Efficiency is providing an informed choice about the energy performance to a customer at the time of purchase of an appliance. The energy saving potential by using or retro fitting star labelled energy efficient appliances is tremendous. Procurement and fittings should be given to 5 star rated appliances to reduce energy consumption.

Table 94: Following are the Expected Deemed Energy Savings per Annum from these Projects

Project	Items Used	Quantity Installed(No's)	Expected Energy Saving per Annum (Million Units)
SLNP	LED Street Light	3,72,155	73.26
UJALA	LED Bulb	1,04,59,876	1,404.65
	Energy Efficient Fans	64,810	6.05
	LED Tube Lights	2,81,743	12.37
Building Energy Efficiency Program (BEEP)	Building Projects	754 Buildings	12

⁶⁷ Indian Oil: www.iocl.com/AboutUs/GroupCompanies%28CREDA%29.aspx

- Under the PAT scheme of Bureau of Energy Efficiency, Ministry of Power, GoI, has notified 38 Designated Consumers (DCs) under PAT cycle I, 44 DCs under PAT cycle II, 13 DCs under PAT cycle III, 11 DCs in PAT cycle IV and 13 DCs under PAT cycle V in Chhattisgarh. Under this scheme, reductions in specific energy consumption targets are assigned to Designated Consumers (DCs) in a time period of three-year cycle to save energy in the energy intensive sectors. Under PAT I cycle, 6.31 lacs tonnes of oil equivalent energy have been saved against the energy saving targets of 6.08 lacs tons of oil equivalent in the State.
- The Ministry of New and Renewable Energy and the Ministry of Power started a new scheme under the name of Kisan Urja Suraksha Ewam Utthan Mahabhiyan (KUSUM) on March 8, 2019. Through this scheme, the farmers can be provided solar power-based irrigation pumps and income, which will ultimately be helpful in doubling their income.
- Ujjwal DISCOM Assurance Yojana (UDAY) was approved by Union Cabinet on 5th November 2015. The scheme envisages financial and operational turn-around of power distribution utilities of the country. The ATC loss as of February 2020 stands at 26.86 per cent with Average Cost of Supply – Average Revenue Realised (ACS-ARR) Gap of Rs. 0.21 per unit. This scheme is focused on reducing the ATC losses by reforming the conventional transmission and distribution into a manageable segregated feeder system based on their usage, location and demand.

Figure 38: Impact of UDAY scheme



Source: UDAY State Health Card Chhattisgarh, 2022 (<https://www.uday.gov.in/health-card-state.php?id=7>)

Table 95: Policy/Program Landscape

Action /Policy	Brief Objective	Mitigation Action	GHG Coverage	Adaptation Action	State Implementing Agency
Standards & Labelling	Usage and Promotion of Energy Efficient Appliances	Mandating manufacturers to display star rating on select products, enabling users to identify energy efficient appliances	CO ₂ Emissions		CREDA

ECBC	EE in buildings, Notification and amendment of state building bye laws	Amending state bye laws of the buildings	CO ₂ Emissions		CREDA, Urban Local Bodies, Municipal Bodies
DSM (AgDSM and MuDSM)	Bringing Efficiency in DISCOMs and Utilities	Improving efficiency of the existing infrastructure	CO ₂ Emissions		ULBs
Clean Energy Generation	Grid Tied or Stand-alone Solar Power Plants	Introducing net metering and feed in tariffs	CO ₂ Emissions		CREDA JBVNL
Perform, Achieve and Trade	Reductions in specific energy saving targets are assigned to Designated Consumers (DCs) for a three-year cycle. The target reduction for each DC is based on their current levels of Specific Energy Consumption (SEC), so that energy efficient DCs will have lower target of percentage reduction, as compared to less energy efficient DCs which will have higher targets	Mandating DCs to reduce their carbon footprint within stipulated timeframe.	CO ₂ Emissions		CREDA
UJALA	EE in indoor lighting	Distributing low-cost energy efficiency solutions to residential consumers	CO ₂ Emissions		ULBs
SLNP	EE in municipal street lighting	Installing LEDs in street lighting systems	CO ₂ Emissions		ULBs

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Energy sector with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 96: SDGs Relevant to Energy Sector

S. N.	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme / Scheme
1	Goal 7 Affordable and Clean Energy	Universal access to affordable, reliable and modern energy services, increasing share of renewable energy, improve energy efficiency, expanding infrastructure and facilities for modern and sustainable energy	24x7 power supply by 2021	24x7 Power for All, Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Rajeev Gandhi Grameen Vidyutikaran Yojana (RGGVY), Atal Gram Jyoti Yojana, UDAY, State Rural Electrification Plan, Tilka Manjhi Krishi Pump Yojana
3	Goal 12 Responsible Consumption and production	Promoting resource and energy efficiency	Consumer metering, PAT targets to industries, ECBC implementation	Grid Connected Solar Rooftop Programme, PAT, DSM programmes, ECBC implementation

Table 97: NDC's Relevant to Energy Sector

S. N.	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme / Scheme
1	NDC 3	Reduce emission intensity of GDP	Reduce AT&C loss to 14 per cent by 2021, 11 per cent by 2025 and 8 per cent by 2030.	24x7 Power for All and UDAY, Restructured Accelerated Power Development and Reform Program (RAPDRP), Integrated Power Development Scheme (IPDS)
2	NDC 4	Increase in non-fossil fuel-based energy ratio to 40 per cent of total installed capacities	100 per cent government buildings, offices and hospitals with solar rooftop by 2020	Grid Connected Solar Rooftop Programme
3	NDC 2	To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.		PAT, DSM programmes

4	NDC 7	To mobilise domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap		
5	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies		

4.4.7 Industry Sector

Key Climate Change Initiatives Undertaken

1. **Inventorisation and Categorisation of Hazardous Waste (HW) generated from Industries in State of Chhattisgarh-** Chhattisgarh Environment Conservation Board (CECB) has undertaken inventorisation of hazardous wastes generating units as per amended Hazardous and Other Wastes (Management and Trans-boundary Movement) Amendment Rules, 2016. This inventorisation information is important for better regulation and planning, the estimation of waste generation factors for these industry segments and will help the CECB in framing a realistic policy for waste management in these industries.
2. **Prepared Action Plan for restoration of environmental qualities of industrial clusters Urla, Silatara, Korba and Bhilai-** An action plan to improve the environment quality has been prepared by CECB following the order of Hon'ble NGT Principal Bench dated: 13.12.2018. Under this action plan activities like plantation, controlling vehicular pollution from industrial vehicles and road infrastructure improvement etc. have been planned with timeline and department responsible for the execution of the activities mentioned in the action plan in the highly polluted industrial clusters of State.
3. **Action Plan for Rejuvenation of Polluted River Stretches in Chhattisgarh-** In compliance of the order dated 20/09/2018 of Hon'ble National Green Tribunal, Principal Bench, New Delhi 'Action Plan for execution, monitoring and development of requisite infrastructure for management of municipal sewage and industrial effluent for rejuvenation of polluted river stretches in Chhattisgarh has been prepared by CECB. The untreated municipal sewage of towns situated across the polluted stretches are the main source of pollution of river Kharoon, Seonath, Mahanadi, Hasdeo and Kelo respectively. All the urban local bodies have been directed by CECB for the installation / commissioning of Sewage Treatment Plant on or before 17 February 2020 in compliance of the order of Hon'ble Supreme Court. As far as industrial effluent is concerned, all the large and medium scale water polluting industries have provided Effluent Treatment Plant. In compliance of the aforesaid order of Hon'ble Supreme Court, a special drive was launched by CECB against the water polluting industries by issuing closure directions, which have not installed

ETP. These efforts have brought successful result. Now all operating water polluting industries have provided ETP

4. **Online pollution monitoring systems** – The online monitoring equipment has been installed in 17 types of industries and in total 163 industries of the State for regular control and monitoring of air pollution from these industries.
5. **Institutionalisation of Perform, Achieve & Trade (PAT)** –Chhattisgarh Renewable Energy Development Agency (CREDA), the state nodal agency for promotion of energy conservation measures in the state. In collaboration with the Bureau of Energy Efficiency (BEE) 37 industries in aluminium, iron & steel, cement and thermal power plants of Chhattisgarh have been covered under the PAT scheme. The need to move towards building bye laws promoting environmental conservation given the recent spurt in construction activity around urban and industrial centres has been recognised and a draft for adoption of Energy Conservation Building Codes [ECBC] was prepared.

Policy/Programme Landscape

The policy landscape for Chhattisgarh is focused on creating an industry friendly administration and ecosystem, maximising employment opportunities and promoting resource efficient and sustainable industrial development in the state. The changing policy regime also depicts about increasing interest towards promoting green energy like decentralised roof top application as a viable and sustainable alternative to electricity produced from fossil fuel and improving the energy efficiency of the industrial sector apart from the central sector scheme like PAT, Technology and Quality Upgradation (TEQUP) and Zero Defect and Zero Effect (ZED).

Table 98: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	Adaptation Action	State Implementing Agency
Industrial Policy 2019-24	Promoting higher capital formation, raising wage incomes and absorbing surplus workforce to bring about equitable development throughout the state and establish state-of-the-art infrastructure, promote manufacturing, enhance inclusivity, foster innovation and create employment opportunities across sectors.	Adoption of cleaner technology under innovation in technology and reduced GHG emission.	CO ₂ , CH ₄ , N ₂ O, and PFCs	Developing climate resilience of the marginal workers by providing alternative livelihood and skilled human resources for handling the innovative technology.	Department of Industry, Government of Chhattisgarh
Credit Linked Capital Subsidy for Technology Upgradation (CLCSS)	CLCSS provides 15 per cent subsidy for additional investment up to ₹ 1 Crore for technology up gradation	Resource Efficient and Cleaner Production (RECP)	CO ₂ , CH ₄ , N ₂ O, and PFCs	Reduced raw material consumption Reduced	Department of Industry, Government of Chhattisgarh

	by MSMEs. Technology up gradation would ordinarily mean induction of state-of-the-art or near state-of-the-art technology. In the varying mosaic of technology covering more than 7,500 products in the Indian small-scale sector.			waste, water treatment, recycling etc.	
Technology and Quality Upgradation Support to MSMEs	The scheme advocates the use of energy efficient technologies (EETs) in manufacturing units so as to reduce the cost of production and adopt clean development mechanism.	Adoption of cleaner technology and reduced GHG emission	CO ₂ , CH ₄ , N ₂ O, and PFCs	Low carbon growth and climate resilient industry	CREDA, CECB, Department of Industry, Government of Chhattisgarh
Zero Defect and Zero Effect (ZED)	The objectives of the scheme include inculcating Zero Defect & Zero Effect practices in manufacturing processes, ensuring continuous improvement and supporting the Make in India initiative	Resource Efficient and Cleaner Production (RECP)	CO ₂ , CH ₄ , N ₂ O, and PFCs	Improved material efficiency and product yield	Department of Industry, Government of Chhattisgarh

Table 99: SDGs Relevant to Industry Sector

#	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving theSDG Targets /Goal
1	Goal 9 Industries, Innovation & Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	By 2030, Catalyse Innovation, harness research and technology and enhance environmental performance as a means of developing competitive advantages of the state, preserving its ecological balances, improving the quality of life of its citizens and promoting inclusive growth.	Industrial Policy 2019-24 focusses on promoting industries with innovation and better employment opportunities for the people of Chhattisgarh. The policy also focusses on promoting food processing and	Existence of physical infrastructure in terms of road, rail and air transport still needs to be improved to achieve this goal.

2	Goal 12 Responsible Consumption and production	Sustainable management and efficient use of natural resources	Invest in promoting inclusive and sustainable industrial development to effectively address major challenges such as growth and jobs, resources and energy efficiency, pollution and Climate Change, knowledge-sharing, innovation and social inclusion	other agriculture- related industries with top priority to organic fuel from paddy, ethanol refinery, and horticulture product processing.	Lack of physical infrastructure and trained human resources in backward areas.
3	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities; mainstreaming climate measure in national policies; improving education and awareness about CC; building capacities of individuals and institutions	By 2030, invest in sustainable and resilient infrastructure, including transport, energy, water and sanitation for all through enhanced financial and technical support. It shall ensure that such infrastructure is capable of meeting the near and long- term challenges and opportunities of population change, new technology, the transition to a low carbon economy and the impacts of Climate Change	Action plan on polluted river rejuvenation, environment quality improvement in industrial clusters.	Lack of sufficient fund to support the implementation of the action plan.

Table 100: SDGs Relevant to Industry Sector

#	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving theSDG Targets /Goal
1	Goal 9 Industries, Innovation & Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.	By 2030, Catalyse Innovation, harness research and technology and enhance environmental performance as a means of developing competitive advantages of the state, preserving its ecological balances, improving the quality of life of its citizens and promoting inclusive growth.	Industrial Policy 2019-24 focusses on promoting industries with innovation and better employment opportunities for the people of Chhattisgarh. The policy also focusses on promoting food processing and other agriculture-	Existence of physical infrastructure in terms of road, rail and air transport still needs to be improved to achieve this goal.

2	Goal 12 Responsible Consumption and production	Sustainable management and efficient use of natural resources	Invest in promoting inclusive and sustainable industrial development to effectively address major challenges such as growth and jobs, resources and energy efficiency, pollution and Climate Change, knowledge-sharing, innovation and social inclusion.	related industries with top priority to organic fuel from paddy, ethanol refinery, and horticulture product processing.	Lack of physical infrastructure and trained human resources in backward areas.
3	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities; mainstreaming climate measure in national policies; improving education and awareness about CC; building capacities of individuals and institutions	By 2030, invest in sustainable and resilient infrastructure, including transport, energy, water and sanitation for all through enhanced financial and technical support. It shall ensure that such infrastructure is capable of meeting the near and long-term challenges and opportunities of population change, new technology, the transition to a low carbon economy and the impacts of Climate Change.	Action plan on polluted river rejuvenation, environment quality improvement in industrial clusters.	Lack of sufficient fund to support the implementatio n of the action plan.

Table 101: NDCs Relevant to Industry Sector

#	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving the NDC Targets/Goal
1	NDC 2	To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development			Existence of physical infrastructure in terms of road, rail and air transport still needs to be improved to achieve this goal
2	NDC 3	To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level			Increased coordination with CREDA is required.

3	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies			Capacity building trainings and knowledge sharing is required.

4.4.8 Mining Sector

Key Climate Change Initiatives Undertaken

Compliance of Mines and Mineral (Development & Regulation) Amendment Act 2015

The Mines and Minerals (development and regulation) Amendment Act 2015 has been notified on 27 March 2015. The act removes discretion by allowing the grant of all mineral concessions through auction thus bringing greater fairness and transparency.

According to this Act, geological assessment including identification of mineral, establish continuity, quality, quantity of deposit and metal content in ore, its mining viability their economics, feasible parameters must be assessed.

District Mineral Foundation Trust⁶⁸-

In pursuance of Section 9(b) of Amended Mines and Mineral Act, for the persons affected by mineral activities and for the development of the area District Mineral Foundation (DMF) has been established on 2.1.2016 in all districts. Account has been opened in all districts for DMF in which around 4722 crore rupees has been contributed till 30.11.2019. The amount received in the Trust is used as per Pradhan Mantri Khanij Khetra Kalyan Yojana (PMKKKY) for physical infrastructure, road, rail, electrification, irrigation and watershed development etc. apart for drinking water in affected villages, environment preservation, health, skill development, education, agriculture, sanitation, welfare of women, children and disabled development.

The total DMF spent is Rs 3135.38 crores till the end of November 2019. The major budget from the DMF has been spent on works like – Developing Physical infrastructure, education, health and drinking water and sanitation and agriculture etc. Korba, Dantewada and Jangjir-Chapa are the districts with highest amount of DMF expenditure till November 2019. The table below explains the expenditure pattern of DMF in the State.

⁶⁸ Department of Geology and mining, Government of Chhattisgarh, 2019

Table 102: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	Adaptation Action	State Implementing Agency
District Mineral Foundation Trust	Development of the mining affected people and areas.	Promoting green growth and reduction of GHG emissions.		Environment preservation and pollution control measures: effluent treatment plants, prevention of pollution of streams, lakes, ponds, groundwater, other water sources in the region, measure for controlling air and dust pollution caused by mining operations and dumps, mine drainage system, mine pollution prevention technologies, and measures for working or abandoned mines and other air, water & surface pollution control mechanisms required for environment- friendly and sustainable mine development. Intensive plantation on riverbanks and other public places, streams/ rivulets (Narwa) improvement & conservation works	By DMFT in all 28 Districts.

Table 103: Relevant SDGs

S. N.	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving the SDG Targets /Goal
1	Goal-9: Industry Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.	-	-	-

2	Goal-12: Responsible Consumption and Production	Sustainable management and efficient use of natural resources.	1. Develop overall management system of mines and organisational platform named 'Chhattisgarh Integrated Mines and Minerals Management System' (ChiMMS) to curb illegal mining. 2. Develop a robust rail network and 100 percent connectivity with all-weather roads and all mining villages.	Khanij online monitoring system formed-	-
3	Goal 13: Climate Action	Combating climate change and its impacts Strengthening resilience and adaptive capacities	1. Automated and transparent system of mine management to address issues of illegal mining 2. Continue working under the framework of the Mineral Policy, 2001 and build on the gains achieved so far.	-	-

Table 104: Relevant NDCs

S. N.	Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving the NDC Targets/ Goal
1	NDC 2	To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development		Mining Rehabilitation Programs	Need to align with NDC targets
2	NDC 3	To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level		Environment management and natural resources management programs are being implemented	Integrated planning approach is required.
3	NDC 8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies	-	-	-

4.4.9 Health Sector

Key Climate Change Initiatives Undertaken

- **National Health Mission in Chhattisgarh** – The NHM encompasses of two Sub-Missions, the National Rural Health Mission (NRHM) and the National Urban Health Mission (NUHM). The main objective of NHM is to achieve universal access to equitable, affordable and quality healthcare services that are accountable and responsive to people's needs.
- **Janani Suraksha Yojana** – Implemented under the National Rural Health Mission (NHM), it is an important scheme for pregnant women living in villages as well as in urban areas of Chhattisgarh. The main objective of Janani Suraksha Yojana (JSY) is to reduce maternal and neonatal mortality, by promoting institutional delivery. Women in urban areas are given Rs. 1000, while those in rural areas are given Rs. 1400. This scheme is said to have benefitted many women.
- **Ayushman Bharat** – A flagship scheme of Government of India was launched as recommended by the National Health Policy 2017, to achieve the vision of Universal Health Coverage (UHC). This initiative has been designed on the lines as to meet SDG and its underlining commitment, which is "leave no one behind". Ayushman Bharat adopts a continuum of care approach, comprising of two inter-related components, which are – Health and Wellness Centres (HWCs) and Pradhan Mantri Jan Arogya Yojana (PM-JAY).
- **Cold Chain System** – The cold chain system in Chhattisgarh consists of 1,391 working cold chain equipment. Out of these 10 are solar refrigerators. The Universal Immunization Programme in Chhattisgarh aims to immunise a target population of 6.8 lakh children and 7.5 lakh pregnant women, every year.
- **Disease Surveillance** – Weekly disease surveillance data on epidemic-prone diseases are being collected from reporting units such as sub-centres, primary health centres, community health centres and hospitals including government and private sector hospitals and medical colleges. Mapping of districts to identify the hotspots for climate sensitive diseases.
- **Strengthening of laboratories** – 3 state referral labs are functional in Raipur, Bilaspur and Jagdalpur medical college. State has also linked them with adjoining districts providing diagnostic services for epidemic-prone diseases during outbreaks. 8 District laboratories are being strengthened for diagnosis of epidemic-prone diseases.

Table 105: Policy/Program Landscape

Action/Policy	Brief Objective	Adaptation Action	State Implementing Agency
National Health Mission (NHM)	To achieve universal access to equitable, affordable and quality healthcare services that are accountable and responsive to people's needs.	Identifying the disease prone areas and focusing on preventive health care. Further closely working with departments like Mining and State Pollution Control Board about the various diseases which can occur due to working in the mines or due to the pollution.	Health Department
Ayushman Bharat	Aims at making interventions in primary, secondary and tertiary care systems, covering both preventive and promotive health, to address healthcare holistically.	Early warning systems are in most instances, timely surveillance systems that collect information on epidemic-prone diseases in order to trigger prompt public health interventions.	Health Department

National Vector borne disease control programme	To manage and control vector borne diseases.	The Surveillance for disease and outbreaks, Early diagnosis and prompt case management, Vector control through community participation and social mobilisation and Capacity building of the staff and the community is needed.	Directorate of National Vector Borne Disease Control Programme
Integrated disease surveillance programme	The key objective of the programme is to strengthen/ maintain decentralised laboratory-based IT enabled disease surveillance system for epidemic prone diseases to monitor disease trends and to detect and respond to outbreaks in early rising phase through trained Rapid Response Team (RRTs).		Health Department

Table 106: SDGs Relevant to Health

Description	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme
Goal 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture	End hunger and ensure access by all people, the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round; end all forms of malnutrition.	Children under 5 years who are underweight and Children under 5 years who are stunted: Target for 2021 – 40 per cent, Target for 2025 – 20 per cent & target for 2030 – less than 10 per cent.	State will focus on enhanced service delivery of nutrition services in the 12 nutritionally high-burden districts.
Goal 3 Good Health and Well Being	Not only does disease impact the wellbeing of an individual, it burdens family and public resources, weakens societies, and squanders potential. The health and wellbeing of people at all ages therefore lies at the heart of sustainable development. Protection from disease is not only fundamental to survival, but it enables opportunity for everyone and strengthens economic growth and prosperity.	National Vector Borne disease control program target for 2020 – 4 cases, Target for 2025 – 1 & target for 2030 – 0 cases.	Strengthen diagnostic and treatment services for communicable diseases for early diagnosis and treatment and reducing morbidity/mortality. Diagnostic and treatment for vector borne diseases will be made available in all public health facilities. Co-opting private facilities will be used as alternative to ensure early diagnosis and treatment.

Table 107: NDCs Relevant to Health

Description	Relevant focus	State Target	Initiatives in terms of existing programme /scheme
NDC 1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation		
NDC 2	To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development		
NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources.		

4.4.10 Rural Development Sector

Key Climate Change Initiatives Undertaken

Deendayal Antyodaya-State Rural Livelihood Mission

Chhattisgarh State Rural Livelihood Mission named as **Bihan** is formed under the aegis of Rural Development Department to serve as a special purpose vehicle for the smooth implementation of poverty reduction schemes (DAY-NRLM and others) in the state. Chhattisgarh State Rural Livelihood Mission, Rural Development Department is working in 113 blocks⁶⁹ in which 12.58 lakh poor families are benefitted and 1,16,732 self-help groups have been made. Revolving fund for intra group credit and community investment for group activities is made available through credit linkage from banks.

MGNREGA- Natural Resource Management Works

MGNREGA has been providing wage-employment to the villagers, which is especially helpful during the non-farming seasons. The trust of department of rural development through this scheme is construction of permanent and productive assets like community ponds, wells and livestock shelters. Under the convergence of schemes MGNREGA has been able to provide unskilled and semi-skilled work and promote income generating activities through creation of supportive infrastructure.

⁶⁹ Annual Report 2018-19, Department of Panchayat and Rural Development, Government of Chhattisgarh

Note: Rural Development Sector, Disaster Management Sector and Women and Child Development Sector were not part of the CSAPCC-I, but considering the uniformity, the major initiatives taken by these department during 2014-2020 has been incorporated in this section.

Table 108: Work undertaken under MGNREGA

1 (a)	Natural resources management works taken up under MGNREGA in FY 2014-19	Taken up 4.67.155 works	
I (b)	Water Conservation and Water Harvesting works taken up under MGNREGA in FY 2014-19	Taken up 95.140 works	
8 (a)	Gauthans under Garuwa Scheme	Phase - I	Sanctioned: 1889
			On Completion: 1665
			Ongoing: 194
		Phase – II	Sanctioned: 3246
			On Completion: 28
			Ongoing: 1942
8 (b)	Narwa Treatment works under Narwa Scheme	Sanctioned Works: 18.947	
		Ongoing Works: 3792	
		Nala (Narwa) in which works has been sanctioned 861	

Source: Department of Panchayat Raj Development, Government of Chhattisgarh

Suraji Gaon Yojana (Narwa Garuwa Ghurwa Bari Scheme) - Chhattisgarh Government has come up with an innovative vision to revive the rural economy by striking a balance between modernity and tradition at the grassroots. The Government has introduced a Scheme in the name of "Narwa, Garuwa, Ghurwa, and Bari". This means the collective action to ensure water conservation (Narwa), livestock development (Garuwa), use of compost (Ghurwa) and cultivation of vegetables and fruits in the backyard (Bari). The mission is called 'Suraji Gaon Yojana' (or Well Governed Villages). The scheme is supposed to achieve the four objectives through an integrated approach to the primary sector with the best use of native resources along with the benefits of the government's modern schemes in agriculture, water resources, energy, forest, and rural development.

Chief Minister's Comprehensive Rural Development Scheme – Its objective is to build infrastructures according to local needs for basic facilities in rural areas like pond rejuvenation, seasonal river bridge construction etc. Gram Panchayat can be given up to a maximum of Rs 20 lakhs per year for this development work. Till the financial year 2018-19, 39250 works have been completed.

Table 109: SDGs Relevant to Rural Development

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the SDG targets /Goal
1	Goal 1 End Poverty in all its form everywhere	By 2030, build the resilience of the poor and those in vulnerable situations	By 2030, reduce poverty level by 2/3 ^d	Rural Livelihood schemes and programmes like Bihaan are benefiting the marginal communities in the state	Higher dependence on farm-based livelihood and low farm productivity

2	Goal 10 Reduce Inequalities	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	By 2024, Housing for all as per Pradhan Mantri Awas Yojana (PMAY) norms.	Ongoing implementation of PM Awas Yojana, and Direct cash transfer schemes to benefit the poorest of the poor	Poor educational and skill base for income generation activities amongst youths for self-employment
3	Goal 12 Responsible Consumption and production	Sustainable management and efficient use of natural resources;	By 2030, Providing sustained livelihood to farm labourers and small & marginalised farmer	Under MGNREGA and PM Krishi Sinchai Yojana water conservation related works such as check dams, dobhas, wells, etc are done	Undulating topography and non-trained manpower in natural resource management work
4	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities	Development of social entrepreneurship through skill building of youth to create employment opportunities in the area of disaster preparedness, mitigation, green solutions etc. Government schemes will be offered opportunities to young boys and girls to build career in green job, environment protection, environmental planning etc	Under DDU-GKY scheme state will focus on providing training for green jobs.	Poor educational and skill base

Table 110: NDCs Relevant to Rural Development

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the NDC targets/goal
1	NDC 2	To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development			
2	NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.			

4.4.11 Disaster Management Sector

Key Climate Initiatives Undertaken

Table 111: Policy/Programme Landscape

Action/Policy	Brief Objective	Mitigation Action	GHG Coverage	Adaptation Action	State Implementing Agency
State Disaster Management Plan 2011	To assess the hazard risk and vulnerability status To increase capacity of the line departments, institutions in combating disasters	Reduce GHG emission from loss of natural resources due to fire, flood or earthquake	CO ₂ , Methane, Water vapour, Ozone	Early warning and preparedness along with following the measures to reduce the impacts of disasters can develop the resilience of the people from any climate-induced disasters	State Disaster Management Agency
Sendai Framework	To put emphasis on improving the governance for disaster risk reduction			By strengthening capacities to support the integration of disaster reduction and climate change in the national and state level policy,	

				thereby increasing the adaptive capacity of the institutions.	
CGSDMA-DRR Programme	Mainstreaming Disaster Risk Resilience into development planning			By promoting a sustainable level of wellbeing for local communities and to increase the resilience of communities coping with multi-origin hazards.	

4.4.12 Women and Child Development Sector

Key Climate Initiatives Undertaken

Children are the future human resource of the country. Ministry of Women and Child Development is implementing various schemes for welfare, development and protection of children. Launched on 2nd October 1975 the Integrated Child Development Services (ICDS) Scheme is one of the flagship programmes of the Government of India. The beneficiaries under the Scheme are children in the age group of 0-6 years, pregnant women and lactating mothers. The ICDS Scheme offers a package of six services, viz

- Supplementary Nutrition
- Pre-school non-formal education
- Nutrition & health education
- Immunisation
- Health check-up and
- Referral services

The last three services are related to health and provided by Ministry/Department of Health and Family Welfare through NHRM & Health System. For better governance in the delivery of the Scheme, convergence is, therefore, one of the key features of the ICDS Scheme. This convergence is in-built in the Scheme which provides a platform in the form of Anganwadi Centres for providing all services under the Scheme.

On-going Schemes in the State for Welfare of Women

The government of Chhattisgarh through its department for Women and Child Development and Social Welfare has consistently striven to focus on women's development and empowerment through a host of schemes and policies dedicated to women and children and has begun gender budgeting. Some of the key schemes are:

Supplementary Nutrition Program: The Supplementary Nutrition is one of the six services provided under the Integrated Child Development Services (ICDS) Scheme which is primarily designed to bridge the gap between the Recommended Dietary Allowance (FDA) and the Average Daily Intake (ADI). Supplementary Nutrition is given to the children (6months – 6 Years) and pregnant and lactating mothers under the ICDS Scheme.

SAKHI – One STOP Centre: This centre runs 24x7 for any needy woman. Short-term shelter for women is available in the One Stop Centre and offers all the basic facilities such as housing/ food / medical / legal assistance etc. are being provided free. One Stop Centre is being operational in all districts of Chhattisgarh. The objective of the Scheme is to provide integrated support and assistance to women affected by violence, both in private and public spaces under one roof. Aggrieved women facing any kind of violence due to attempted sexual harassment, sexual assault, domestic violence, trafficking, honour related crimes, acid attacks or witch-hunting who have reached out or been referred to the OSC will be provided with specialized services.

Pradhan Mantri Matru Vandana Yojna: This is a centrally sponsored scheme which targets the pregnant and lactating mothers who get ₹5000 for the first live birth through a conditional cash transfer. The scheme is running successfully in all the districts of Chhattisgarh and has brought relief to a lot of expectant mothers in meeting their expenses.

Swadhar Greh: A Scheme for Women in Difficult Circumstances was launched by the Department of Women and Child Development in 2001-02. The scheme through the provisions of shelter, food, clothing, counselling, training, clinical and legal aid aims to rehabilitate such women in difficult circumstance. Under the Scheme, Swadhar Greh is being operational in Bilaspur and Surguja districts.

The objectives of the Scheme are:

- a) To cater to the primary need of shelter, food, clothing, medical treatment and care of the women in distress and who are without any social and economic support.
- b) To enable them to regain their emotional strength that gets hampered due to their encounter with unfortunate circumstances.
- c) To provide them with legal aid and guidance to enable them to take steps for their readjustment in family/society.
- d) To rehabilitate them economically and emotionally.
- e) To act as a support system that understands and meets various requirements of women in distress.
- f) To enable them to start their life afresh with dignity and conviction.

Working Women Hostel: The State is being concerned about the difficulties faced by such working women for providing hostel facilities to working women in cities, smaller towns and also in rural areas where employment opportunities for women exist. Working Hostel is being run in four districts of Chhattisgarh. The objectives of the Scheme are to promote availability of safe and conveniently located accommodation for working women, with day care facility for their children, wherever possible, in urban, semi urban, or even rural areas where employment opportunities for women exist.

Protection of Women from Domestic Violence Act 2005 (Rule 2006) (Nava Bihan Yojna): The Protection of Women from Domestic Violence Act 2005 is a central act and rules have been made by the central government for its implementation. As per the provisions of the Act, services of medical, shelter, legal aid, counselling, filing of Domestic Incident Report (DIR) are to be made available to the victim of domestic violence as per the requirement. The responsibility of implementing the Act rests with the states. For the implementation of the Act in the state, Nava Bihan Yojana is being operated with 100 per cent state funds.

For the implementation of the Act in the districts under the Nava Bihan scheme, a woman protection officer, who is a law graduate has been posted at each district on contractual basis. Also, an assistant grade-3 and a peon have been posted on a contract basis to support her. At present, women protection officers are working at the district level in all the districts except the newly formed district-Gourela.

Beti Bachao Beti Padhao Abhiyan: This centrally funded scheme seeks to address the issue of decline in child sex ratio through a mass campaign in the selected districts targeted at changing the awareness

about the seriousness of the issue, focused intervention and multi sectoral action. The Department of Women and Child Development, Chhattisgarh, is implementing Beti Bachao Beti Padhao in 2 districts of Chhattisgarh i.e., Bijapur and Raigarh.

Mukhyamantri Amrut Yojana: Under this scheme 100 ml scented/flavoured sweetened milk is provided every Monday for 03 to 06 year's age group children attending Anganwadi Centres. This program discontinued from 2019-2020.

Sabla Scheme: This scheme aims at mainstreaming out of school adolescent girls between the age group of 11 to 14 school dropouts and 14 to 18 school going and school dropouts by empowering them through nutrition, non-nutrition & components & training on different issues with life skills. This scheme is implemented in 10 districts- Raipur, Baloda Bazar, Gariyaband, Bastar, Kondagaon, Raigarh, Rajnandgaon, Balrampur, Surajpur and Sarguja. The scheme has been renamed to "Scheme for adolescent girls" from 2018. Now its aims at mainstreaming out of school adolescent girls between the age group of 11 to 14 school dropouts.

Kishori Shakti Yojana: This scheme is implemented in remaining 17 districts where sabla is not functional. Under this scheme, 300 adolescent girls from each ICDS project are imparted 06 days training on issues like nutrition, Health and adolescent reproductive sexual health issues, life skills etc.

Noni Suraksha Yojna: Noni Surksha Yojana is implemented with an objective to improve declining sex ratio and to create positive attitude towards girls in the society and improvement in educational and health status of girls. Under this scheme, an amount of Rupees One Lakh or maturity amount as fixed by government at that time will be given to eligible girl on completing 18 years of age with condition of not marrying till age of 18 years and completing education up to class 12th.

Mahila Jagriti Shivir: The objective of Mahila Jagriti Shivir is to make women aware of their legal rights, provisions to awaken and organise women against various social malpractices and to motivate them to take advantage of the schemes by giving information about various schemes. It is a (100 per cent) operated scheme from the state fund. Under the scheme, there is a provision to organise camps, workshops, exhibitions, etc. to make women aware of their legal rights at the state level, district level, project level and panchayat level.

Chhattisgarh Mahila Kosh: Chhattisgarh Mahila Kosh was formed in 2003 with the objective of empowering women socially and economically in the state of Chhattisgarh. Through this, following schemes are being operated: -

- Loan Scheme of Chhattisgarh Mahila Kosh: To provide loan to women self-help groups on easy terms, at 3 percent annual simple interest rate.
- Eligibility and Loan: - Loan of 04 to 10 times of their savings amount to self-help groups of 10 to 12 women or maximum 50 thousand rupees (recovered in 24 instalments) in the first time and up to Rs. 2 lakhs in the second time (recovery in 36 instalments) are provided under the scheme.

Swavalamban Scheme: Swavalamban Scheme has been started by Chhattisgarh Mahila Kosh in 2009-10. Under this scheme, skill training is provided to widow, divorcee, unmarried women of 35 to 45 years of age. From the year 2017-18 onwards, the beneficiaries of sexual harassment, HIV positive and third gender also eligible to take advantage of the scheme. Training is provided to eligible women through VTP (Vocational Training Programme) from 2015-16 under Chief Minister Skill Development Scheme.

Saksham Scheme: Saksham scheme has been started by Chhattisgarh Mahila Kosh in 2009-10. Under this scheme loan is provided to poor widow, divorcee, unmarried women of 35 to 45 years of age. From the year 2017-18 onwards, the beneficiaries of sexual harassment, HIV positive and third gender also

eligible to take advantage of these schemes. Loan up to Rs.1.00 lakh is provided to women on easy terms to start the own business. The said loan is repayable in instalments in 5 years at 6.5 percent simple interest rate.

Grants for voluntary organisations working in the field of Women and Child welfare:

Objective of the scheme is to encourage the participation of voluntary organizations in the field of development and welfare of women and children. Also, to promote voluntary organizations working in this field and to provide them support/financial assistance in conducting various women and child welfare activities.

- Provisions: - Creative work for the welfare/development of women/children such as Jhulaghar/creche, Women Helpline cum Women's Counselling Centre, Women's Home for destitute women/mentally challenged women, Vocational Training for women.
- Eligibility: - Such voluntary organisations which are registered with the Firms Society and NGO Darpan Portal of NITI Aayog and have conducted the activities for about three years on their own and are recognised by the Department of Women and Child Development.
- For the above activities, financial assistance is provided to voluntary organizations in recurring and non-recurring heads. The grant is sanctioned 90 percent of the recurring expenditure and 75 percent of the non-recurring expenditure, the remaining 10 percent of the recurring expenditure and 25 percent of the non-recurring expenditure has to be borne by the voluntary organization concerned.

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Women and Child sector with existing state initiatives and targets to assess the gaps in the policy landscape.

Table 112: SDGs Relevant to Women and Child Development Department

Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the SDG targets /Goal
Goal 5 Achieve gender equality and empower all women and girls	Achieve gender equality and empower all women and girls.	Eliminate all forms of violence against all women and girls in the public and private sphere, including trafficking and sexual and other type of exploitation. Eliminate all harmful practices such as, child, early and forced marriage and female genital mutilation Adopt and strengthen sound policies and enforceable legislation for the promotion of gender	Centrally Sponsored Schemes (CSS) 1. Beti Bachao Beti Padhao 2. Swadhar Greh (Rehabilitation of women in difficulty) 3. Ujjawala 4. One Stop Centre 5. Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (SABLA) State Sponsored Schemes 1. Shakti Swaroopa Yojna 2. Sabla Yojna 3. Gramin Mahila Disha Darshan Yojna	

		equality and the empowerment of all women and girls at all levels.	4. Mukhya Mantri Kanyadan yojana 5. Noni Surksha Yojna 6. Kishori Shakti Yojna 7. Mahila Kosh Yojna 8. Sakhi- One Stop Centre 9. Mahila Jagriti Shivar 10. Saksham Yojna 11. Swawlamban Yojna 12. Mahtari Jatan Yojna	

Table 113: NDCs Relevant to Women and Child Development Department

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the NDC targets/goal
1	NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.			

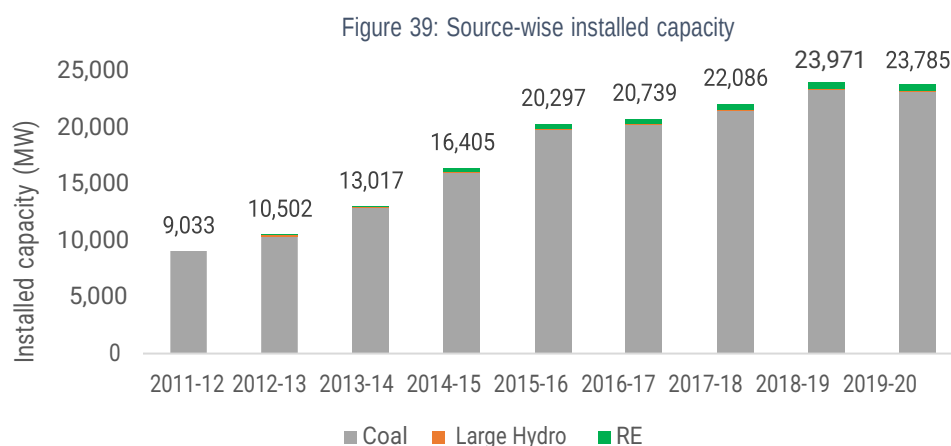
Chapter 5 - Mitigation

5.1 Overview

Power

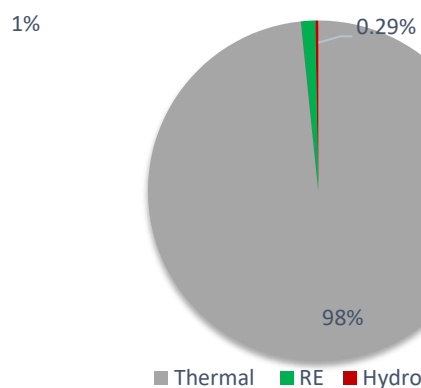
The total installed power generation capacity of Chhattisgarh is 28557.3 MW as of March 2021. It is a power-surplus state exporting about 75 per cent of its electricity generation (CEA, 2018). The actual electricity generation in the state was 1,19,843 GWh in 2019-20, and the state's consumption was only 30,107 GWh during the same period. The total installed capacity increased from 10,460 MW in 2012 to 23,513 MW in 2018 (CAGR of 15 per cent) to cater to the demand within the state as well as outside. The sector is mainly coal-driven, owing to the cheap availability of domestic coal.

The total RE-installed capacity in the state has gone up from 298 MW in 2012 to 535 MW in 2018 (2.3 per cent of the total installed capacity to share in 2018). During this period, the highest capacity addition has been in solar-based power, from 4 MW in 2012 to 219 MW in 2018. Other RE sources included 231 MW of biomass, 13 MW of solar RTPV, and 76 MW of small hydro-based power plants in 2018. While the state has all other major renewable technologies present, wind power has been missing from its energy palette. This is mainly attributed to the lower wind potential, which is one of the lowest among Indian states (77 MW at 100m hub height) (MoSPI, 2020).



Source: (CEA, 2007, 2012b, 2017, p. 2, 2020b; MNRE, 2019b)

Figure 40: Source-wise share of electricity generation in 2019-20



Source: (CEA, 2020a, 2020c, 2020d)

Out of the total 19.7 GW of RE potential, solar accounts for 18.27 GW. The state also has a small hydro potential of 1.1 GW as of March 2019 (MoSPI, 2020). Under the National Solar Mission, the state has a target of 1,783 MW solar-power-installed capacity by 2022. In its efforts to decarbonise the sector, the state introduced policies and programmes to promote RE-based electricity generation.

The major policies to promote RE-based electricity generation in the state are Chhattisgarh Wind Policy 2006, Chhattisgarh Solar Policy 2012-17, Chhattisgarh Solar Policy 2017-27 and the National Solar Mission. These policies focus on attracting RE investments in the state by removing various transmission charges, reducing procedural delays, developing the grid infrastructure for power evacuation, resource potential assessment, etc. The policies also set targets for installed-capacity addition. The Solar Policy 2012-17 targeted 500-1,000 MW of solar-installed capacity by 2017. However, the state could achieve only 194 MW of solar -installed capacity by that period.

Under the National Solar Mission, the state is given a target to install solar rooftop PV (RTPV) of 700 MW by 2022 (MNRE, 2016; NITI Aayog, 2015). The state also has similar targets for RTPV under the Mukhyamantri Saur Shakti Yojana, which aims to achieve grid-connected solar-rooftop power plants of capacity 600 MW by 2022. As of March 2020, the total capacity of solar RTPV was only 16 MW (MNRE, 2020; MoSPI, 2020).

The key factors that affected the solar installation in the state were a lack of robust action plans for achieving policy targets, absence of solar-PV manufacturing facilities, land availability issues, lack of innovative investment models, poor equipment supply chain, and market conditions (Das, 2015). In the State Rooftop Solar Attractiveness Index (SARAL) on setting up of RTPV-based projects (2018-19), Chhattisgarh could achieve only the 14th position (MNRE et al., 2019). Even so, the state recently invited bidders to install RTPV in government buildings under the RESCO model (CREDA, 2020). In addition, the Industrial Policy 2014-19 covered some of the key regulatory changes to promote the manufacturing of RE machinery and equipment (Department of Commerce and Industries, 2016).

Along with the state policies, Renewable Energy Purchase Obligations (RPO) were also notified for increasing the RE share in the state's energy mix. As per the State Electricity Regulatory Commission, the RPO targets for the DISCOMs have been mandated to 15 per cent of the total power procurement (6.5 per cent for solar and 8.5 per cent for non-solar RPO) for 2020-21, with a trajectory of scaling it up to 21% by 2022⁷⁰. However, past trends show that Chhattisgarh could not meet RPO targets in the recent years (CREDA, 2018b).

The transmission and distribution (T&D) and aggregated technical and commercial (AT&C) losses in the state are some of the highest in the country. Long power distribution lines and challenges faced in powering remote villages are stated as the key loss-making factors in the state. Chhattisgarh aimed at reducing its AT&C losses from 21 per cent in 2015-16 to 15 per cent in 2018-19 as per the Ujjwal DISCOM Assurance Yojana (UDAY) scheme and has managed to get it down to 15.85 per cent as of March, 2020. The T&D losses was 22.5 per cent in 2014-15 and 18 per cent in 2018-19 (Deore, n.d.; Power & Energy Division, Planning Commission, n.d.). Key activities carried out under the UDAY scheme are feeder segregation, feeder metering, rural feeder audits, and rural/urban distribution transformer (DT) metering (UDAY, 2020). The UDAY dashboard data indicates that the feeder-segregation and DT-metering numbers are low in the state and need to be paced-up.

The state had also received central funds as part of Re-structured Accelerated Power Development and Reforms Programme (R-APDRP) and Integrated Power Development Scheme (IPDS) to reduce AT&C and T&D losses. Over INR 750 crore has been sanctioned for various activities like system strengthening,

⁷⁰ Data from line department

smart metering and IT enablement of distribution sector under R-APDRP (MoP, 2020b). Extensive work has been done for rural electrification under the DeenDayal Upadhyaya Gram Jyoti Yojana (DDUGJY) scheme. About 99.67 per cent of urban and rural households have been electrified as of March 2019, with Sukma, Bijapur, Narayanpur, and Dantewada being the only districts yet to be 100 per cent electrified (MoP, 2020a).

The State had also undertaken activities to improve the energy efficiency of coal-based power plants in 2012-18. Nine thermal Power plants (TPP) of Chhattisgarh with capacity of nearly 8.7GW were part of BEE's Perform Achieve & Trade-1 (PAT-1) Cycle, and further plants of capacity 9.5GW are added in PAT-2 for the period of year 2016 to 2019. In PAT cycle 1, target for thermal power plants was to reduce energy consumption by 0.142Mtoe (Million Tonnes of oil equivalent) during the year 2012-2015 and the achievement was 0.011 MToE.

Industries

Industry is a key sector driving Chhattisgarh's economy; it has contributed about 47 per cent to the state GSDP in 2017-18 (Chhattisgarh State Industrial Development Corporation, 2017). Emissions from industries constituted about 26 per cent of the total emissions from the state in 2015 (GHG Platform India, 2018). Iron and steel, cement, and aluminium industries are some of the largest and most energy- and emissions-intensive sectors in the state, contributing to about 92 per cent of the emissions from all industries in Chhattisgarh (GHG Platform India, 2018). While industries are key sectors in the developmental agenda of Chhattisgarh, measures to improve energy efficiency and mitigate emissions in this sector are mainly directed by national schemes and policies, such as PAT. The PAT-I cycles had about 21, five, and one designated consumer (DCs) in steel, cement, and aluminium sectors, respectively. The cumulative energy-reduction targets for these DCs were set to about 0.4 MToE. The industries achieved an energy saving of about 0.62 MToE, overshooting the target.

Transport

Of the total motor vehicles registered in India, only 2 per cent are registered in Chhattisgarh (MoRTH, 2017). However, the state's registered motor vehicles have shown an annual growth of about 12 per cent between 2009 and 2016, higher than the national average of 10 per cent. Within the various vehicles, private modes of transport such as two-wheelers and cars witnessed a very high growth—of about 13 per cent and 17 per cent, respectively, between 2009 and 2016 (MoRTH, 2017). This clearly indicates a steep upward trend in the demand for transportation. The transport sector contributes about 2% of the total emissions in the state. Due to its continued reliance on roadways for passenger and goods transport, emissions from road transportation accounted for about 95 per cent of the total transport emissions in 2015, with the rest being accounted for by rail and aviation (GHG Platform India, 2018). Upto year of 2008, vehicle registration was 7,33,733, and until March 2020 vehicle registration is 51,61,908. Total growth of about 603.52 per cent between 2008 to 2020.

Since the formation of the state in 2000, intercity and intracity transport in Chhattisgarh have mainly relied on private transport, because of the absence of a reliable public transport service (Government of Chhattisgarh, 2014). In the past decade, the state government has made efforts to revive public transport, with support from the central government and the World Bank, especially in urban centres like Raipur and Naya Raipur (STUP, 2012). Implementation of the Bus Rapid Transit System (BRTS) in Raipur and improved connectivity with the upcoming Naya Raipur has enhanced the public transport scenario, in the past two-three years. Further, about 200 buses were also procured under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) Phase I and II in 2012 and 2016 to operate between these cities (Action on Climate, 2015). These activities have substantially reduced GHG emissions from road transportation.

The government has also taken steps to institutionalise the development of public transport in the state, by setting up special-purpose vehicles like Raipur Nagar Nigam Transport Limited and Naya Raipur Mass Transport Limited (Action on Climate, 2015). In addition, the implementation of Faster Adoption and Manufacturing of Hybrid & Electric Vehicles scheme (FAME) under National Enhanced Electric Mobility Mission has also led to the uptake of 5,360⁷¹ electric vehicles by 2019 (EVs) including two-wheelers, three-wheelers, and four-wheelers in the state, resulting in significant emission savings (DHI, 2019).

Buildings

Key policies in the buildings sector include the Mukhyamantri LED Vitaran Yojana (part of the national Unnat Jyoti by Affordable LEDs for All – UJALA – scheme), which was a huge success and sold more than 1.07 crore LED bulbs in the state as of July 2020. The failure rate of the supplied LED bulb was only 1.4 per cent as on 31st August 2018 (EESL & MoP, n.d.). Under the same scheme and period, 64,510 energy-efficient fans and 2.81 lakh LED tube lights were also sold in Chhattisgarh. The Energy Efficiency Services Limited's (EESL's) Street Lighting National Programme (SLP) replaced 3.7 lakh streetlights with energy-efficient LED tube lights.

The Standards and Labelling programme, a Central government scheme, was intended to reduce the energy consumption of appliances without affecting consumer convenience. As of November 2019, the star-labelling programme covers 10 mandatory and 13 voluntary appliances. Most of the appliances sold under this scheme were 3 or 4-star labelled, helping achieve higher energy savings. Meanwhile, Chhattisgarh has taken steps to amend the Energy Conservation Building Code (ECBC) 2017 guidelines for the commercial sector, but they are yet to be notified in the building by-laws (AEEE & BEE, 2019).

As 77 per cent of Chhattisgarh's population resides in the rural region, there is quite a dependence on biomass for energy needs (Census 2011, n.d.). According to NSSO 2011-12 data, about 97 per cent of the rural households and 43 per cent of urban households in Chhattisgarh depend on firewood for cooking. About 40% of the urban population used LPG for cooking in 2011-12 (NSSO, 2014). With the introduction of Pradhan Mantri Ujjwala Yojana (PMUY), new LPG connections were provided to 29.97 lakh BPL (below poverty line) households in Chhattisgarh, as of September 2019 (PPAC, 2019). This increased the share of LPG-based cooking in the state.

To utilise its abundant biomass potential, the state installed 54,754 new plants as of 2017-18 under the New National Biogas and Organic Manure Programme (NNBOMP). The scheme, with a total budget of INR 100 crore (for all states), aims to provide biogas as a clean fuel for cooking, lighting, and other thermal and small power needs in remote, rural and semi-urban areas of the country (CREDA, n.d.).

Agriculture

Agriculture constitutes around 14 per cent of the annual electricity demand in the state (via ~3.5 lakh pumps as of 2015). Under Krishak Sahaj Bijli Bill Yojana, a part of the national Saubhagya scheme, a flat power rate of INR 200-300/HP for irrigation pumps (irrespective of capacity and consumption) has been fixed by the state (Sarkari Yojana, 2018). Saur Sujala Yojana (2016)—a Central government initiative directed towards welfare of the farmers in Chhattisgarh—provides solar pumps to farmers at subsidised rates. Under the scheme, 11,000 solar-powered irrigation pump sets were to be installed in Chhattisgarh in the fiscal 2016-17, of which 4,000 were 3 HP pumps and 7,000 were 5 HP pumps (ETEnergy World, 2017). Financial assistance of INR 171 crore was provided to the Chhattisgarh government by the National Bank for Agriculture and Rural Development for this scheme (ETEnergy World, 2017). After the huge success of the scheme, phase 2 and phase 3 were also launched, subsequently selling over 36,000 solar irrigation pumps by 2018 (Dupta, 2018). In addition to this, about 20,000 solar pumps have been sanctioned to Chhattisgarh State Renewable Energy Development Agency (CREDA) for distribution to state farmers

⁷¹Official Website, Transport Department, Government of Chhattisgarh

under the Pradhan Mantri Kisan Urja Suraksha Utthan Mahabhiyan (PM KUSUM) (MNRE, n.d.). To sum up, nearly 76,000 solar pumps were installed in Chhattisgarh between 2012-13 and 2019-20⁷². However, the state does not have any projects to replace old pumps with energy-efficient pumps⁷³. Meanwhile, Karnataka and Andhra Pradesh have tested pilot programmes to replace old pumps with new energy-efficient pumps (FICCI, 2017).

The state had also introduced Sahaj Bijli Bill Yojana as an extension to the Krishak Sahaj Bijli Bill Yojana, extending the benefits of free electricity to people under BPL. Under this scheme, beneficiaries get up to 30 units of free electricity and a choice to pay only INR 100 for using more than 30 units (MoP, 2017). The total cost to state for this scheme is nearly INR 500 crore, and it is expected to benefit about 1.2 million people (Sarkari Yojana, 2018).

Waste

The population of Chhattisgarh is currently estimated to be 28.8 million, with about six million urban dwellers. There are 169 urban local bodies (ULBs) in the state (14 Nagar Nigams, 43 Nagar Palika Parishads, and 112 Nagar Panchayats)⁷⁴. The urban areas of the state generate about 1,650 tonnes per day (TPD) of municipal solid waste, which is managed by the urban local bodies. The state is implementing the Solid Waste Management Rules, 2016 by adopting Mission Clean City Model (Ambikapur Model) in 164 ULBs and integrated waste management facility model in two ULBs (Bilaspur and Raipur Municipal Corporations) (Anisha Bhatia, 2018). Further, under the Swachh Bharat Mission, the state has actively participated in Swachh Survekshan and was awarded for its urban waste management (PIB, 2019). Under the 14th Finance Commission and Swachh Bharat Mission, INR 1,075.53 crore (from the allocated INR 1,163.8 crore) was utilised for various waste-management activities in the state from 2014-15 to 2019-20.

Table 114: Policies in Chhattisgarh between 2012 and 2020

Sector	Sub-Sector	Major Policies/Programmes and Schemes	NDC Link	SDG Link
Power	RE-based electricity generation	Chhattisgarh Wind Policy 2006 Chhattisgarh Solar policy 2012-17; 2017-27 National Solar Mission Renewable Purchase Obligation Mukhyamantri Saur Shakti Yojana Industrial Policy 2014-19	NDC 1 NDC 2 NDC 3 NDC 4 NDC 8	SDG 7 SDG 11 SDG 12
	Transmission and distribution	UDAY, R-APDRP IPDS, PAT DDUGJY	NDC 3	SDG 7
	Plant efficiency of coal-based power plant	PAT Renovation and modernisation activities	NDC 2 NDC 3	SDG 7 SDG 12
Transport	EV	FAME policy	NDC 2,7	SDG 11
	Public transport improvement	Implementation of BRTS between Raipur and Naya Raipur Procurement of buses under JNNURM	NDC 3, 5, 7	SDG 11

⁷² Based on data from line department

⁷³ Based on data from line department

⁷⁴ Official website of Urban Development Department, Govt. of Chhattisgarh

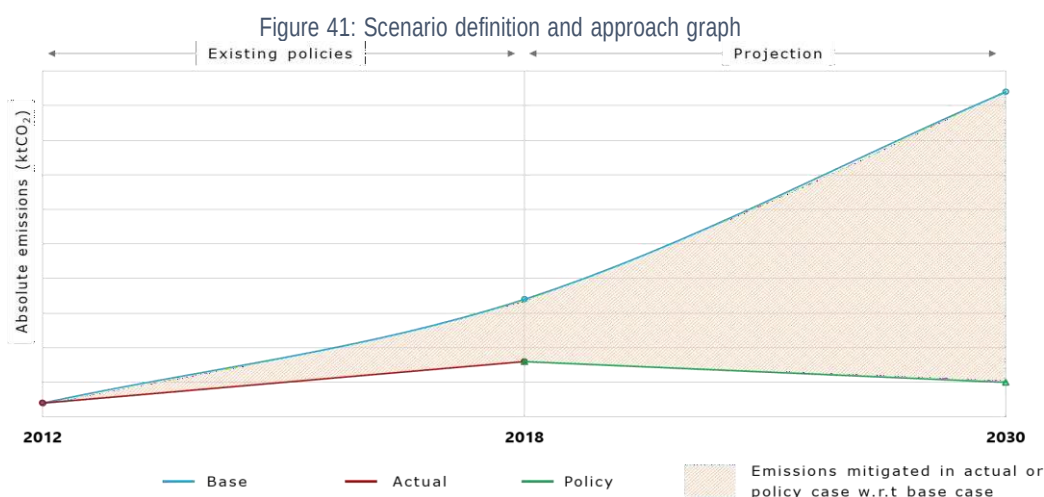
Industries	Energy efficiency improvements in large energy-intensive industries	PAT Industrial Policy 2014-19	NDC 1,2,7,8	SDG 12
Buildings	Lighting and energy- efficient appliances	UJALA Standards and Labelling Streetlight National Programme	NDC 3	SDG 7 SDG 12
	Cooking	PMUY		SDG 7 SDG 12
Agriculture	Irrigation pump sets	KUSUM Pradhan Mantri Krishi Sinchayee Yojana Krishak Sahaj Bijli Bill Yojana Saur Sujala Yojana DDUGJY Bihaan Yojana	NDC 1 NDC 6	SDG 7 SDG 12 SDG 13
Waste	Solid-waste management	Swacch Bharat Mission Integrated waste management	NDC 3	

5.2 GHG Implications of Current Policies and Programs

GHG implications of some major current policies and programmes were estimated in terms of emission mitigated with respect to the base scenario. The broad scenario definitions for the 'base' and the 'actual' or 'policy' scenarios have been provided below. There were significant data gaps while carrying out the assessment. Wherever possible, we have used suitable proxies from national-level reports, India Energy Security Scenarios (IESS) 2047 calculator, expert consultations, and interpolations/extrapolations based on the available data. The analysis will be refined once the remaining data is received from line departments for increasing the accuracy of the analysis.

Base scenario: In this scenario, existing carbon-intensive technologies continue to dominate the energy sector. The historic trend prior to 2012 on implementation of solarization measures is continued.

Actual/Policy scenario: This scenario is termed as the 'actual' scenario while conducting emission-mitigation analysis between 2012 and 2018. We used data on the actual achievement of policies/programmes (collated from literature review and line departments) in the analysis. In the case of projections, from 2021 to 2030, this scenario is termed as 'policy' scenario, wherein the state targets and aggressive solarization measures (more ambitious than the current programmes) were considered. Figure 41 depicts the two scenarios considered for estimating the emission savings.



Power

The three major activities undertaken in the state to solarise the power sector are increasing RE-based electricity generation, improving the plant efficiency of TPPs and improving T&D infrastructure. The emission mitigated with these activities and programmes are estimated for the 2012-18 period. We collated the requisite input data via literature review and consultation with line departments. For emission analysis in the power sector, a consumption-based approach is adopted. This is because, in the past five years, 65 per cent–75 per cent of the electricity generated in the state was exported to other states and the trend is likely to continue. Therefore, only those emissions are considered in the analysis that result from power consumed in the state.

To estimate the emission-mitigation potential and achievement of the policies and programmes, a base scenario is defined; it represents the use of existing and high-carbon-footprint technologies. For the lever increased electricity generation from RE, marginal electricity generation from RE-based sources was considered. The remaining demand is met with coal-based power plants. The RE-installed capacity

addition trend between 2008 and 2011 were considered and is continued till 2018⁷⁵. For the 'actual' scenario, actual source-wise generation is considered.

In the improved T&D infrastructure lever, T&D losses are evaluated as they are a good parameter to represent the increased emissions due to energy losses than AT&C loss⁷⁶ (CEA, 2015). The base scenario for improved T&D infrastructure considered a marginal reduction in T&D loss at a CAGR of -1 per cent (lower than PAT scheme targets for DISCOMs) with nominal maintenance activities (BEE, 2016). The actual scenario considered the real T&D loss trajectories between 2012 and 2018⁷⁷ (CSERC, 2020; MoP, 2011, 2012, 2014, 2015).

For the lever energy-efficiency improvement of coal-based TPPs, a marginal annual reduction in gross heat rate (GHR) of 0.1 per cent is considered for the base scenario. This assumption is based on various plant-level studies on nominal improvement and degradation of GHR with regular annual maintenance. A nominal annual increase in GHR of 0.2 per cent due to aging and a nominal annual decrease in GHR (0.3 per cent) with maintenance activities are observed (CEA, 2019; CERC, 2013; Korellis, 2014). For the actual scenario, real plant-wise GHR data is used⁷⁸. Based on the data shared by line departments for 10 TPPs, seven were able to reduce GHR at an annual rate greater than 0.1 per cent.

The increased RE-based electricity generation mitigated 311 ktCO₂ of cumulative emissions with respect to base case during the 2012-18 period. The T&D loss reduction and energy-efficiency improvement in coal TPPs decreased emissions by 1,797 ktCO₂ and 116 ktCO₂⁷⁹ of GHG emissions, respectively, with respect to base scenario during the same period.

Transport

Chhattisgarh's transport sector is guided by existing national policies such as the FAME policy and the National Urban Transport Policy. Under the FAME policy, the total registered EVs in the state has seen a CAGR of about 40 per cent between 2015 and 2017. To estimate the emissions mitigated due to the FAME policy, in the base scenario, it was assumed that the total stock of EVs registered until 2018 was conventional vehicles. Meanwhile, in the policy scenario the actual sales of EVs in the state were considered. Based on the estimation, the FAME policy resulted in the total emissions savings of about 4.7 ktCO₂ between 2015 and 2018 with respect to the base case.

The introduction of BRTS and buses under JNNURM helped in improving the public-transport scenario in Raipur. In the base scenario for improved public transportation, it is assumed that the urban development and public transport in Raipur will follow the existing trends from 2012 onwards and the proposed BRTS corridor is fully implemented, giving an impetus to public transport in the city. With increasing urban sprawl and inadequate focus on non-motorised transport (NMT) infrastructure, a shift to motorised

⁷⁵ In case of base case (2012-18), the installed capacity of biomass-based power projects after 2012 is kept constant. This is because the state has already met its potential on agro-residue based power generation (MNRE, 2013). It is assumed that forest/waste land-based biomass power projects' supply chain is unlikely to improve without additional policy intervention. In case of small hydro, the installed capacity was increased from 44 MW in 2012 to 54 MW in 2018 (CAGR of 3.4%). For solar ground-mounted, installed capacity is increased from 4 MW in 2012 to 10 MW in 2018, based on historical trend

⁷⁶ T&D losses are due to energy dissipated during transmission and distribution of power. These losses also include losses due to pilferage by hooking, bypassing meters, defective meters, errors in meter reading and un-metered supply of energy. T&D loss excludes the billing efficiency (BEE's definition).

⁷⁷ T&D loss % data from 2016-17 to 2017-18 and 2019-20 was not available. The T&D loss % is linearly interpolated between 2016-17 and 2017-18 and extrapolated to 2019-20.

The analysis will be updated, once T&D loss% data is received from the line department.

⁷⁸ GHR data of only a few plants were available between 2012 and 2018. Wherever plant-level data is not available, a GHR of 2,600 kcal/kWh (equivalent to 33% plant efficiency) is considered for 2012. GHR is linearly reduced by 0.23% and 0.1% in policy and base scenario respectively.

⁷⁹ A generic coal emission factor (IPCC) is used irrespective of the type of coal used in each TPP.

transport is assumed in this scenario. The policy scenario is considered taking into account the National Urban Transport Policy, which suggests electrification of public transport (PT) and NMT. It also acknowledges the vision of the state government to achieve transit-oriented development (ToD) of Raipur and Naya Raipur. This is assumed to be achieved by measures such as creating dedicated non-motorised zones, procurement of buses and increasing public-transport infrastructure in the city. With the implementation of these measures, it is estimated that about 1.7 ktCO₂ savings have been achieved between 2012 and 2018.

Industry

Though the industry sector is one of the largest contributors to the GSDP, energy-efficiency and emission-mitigation measures and policies are mainly guided by national-level policies (like in the transport sector). The State Industrial Policies 2014-19 and 2019-24 fall short of mentioning any measures to improve energy efficiency or emissions intensity of industries at the state level. The PAT I cycle (2012-15) covered about 25 per cent of the state's steel manufacturers and 75 per cent of the cement manufacturers. In the base scenario for improved energy efficiency lever, an annual autonomous energy-efficiency improvement of 0.2 per cent in steel, cement, and aluminium sectors was considered. This reduction is possible with voluntary efficiency improvements undertaken across the industrial sector. This scenario does not take into account the targets prescribed under the PAT mechanism. Under the policy scenario, the targets prescribed under PAT cycles for each industrial sector have been considered with energy-efficiency improvements of about 4 per cent, 3 per cent, and 5 per cent for the steel, cement, and aluminium sectors (including non-DC industrial units) respectively in the state for PAT cycles I and II. The estimated emission savings from the entire steel, cement, and aluminium manufacturing sectors (including the units covered under the PAT cycles I and II) are 4,232 ktCO₂ between 2012 and 2018⁸⁰.

Buildings

In the absence of the LED lighting programme, the lighting demand would have been met using a mix of incandescent bulbs, fluorescent tube lights and a marginal share of CFLs. The UJALA scheme has saved around 1,218 GWh between 2017 and 2018 with high-wattage devices being replaced with LED bulbs, tube lights and energy-efficient fans⁸¹. The emissions mitigated during this period were 1,022 ktCO₂ (over two years).

SLNP was launched at the national level from January 2015. As part of the SLNP, Chhattisgarh installed 3.47 lakh LED street lights by 2018-19. The resultant energy saving is calculated using the number of streetlights replaced and energy savings per streetlight, with data from the SLNP Dashboard (670 kWh energy savings/annum/streetlight). Annual operational hours were considered as 11 hours per day for 365 days. The programme helped in mitigating about 302 ktCO₂ from 2016 to 2018.

Agriculture

The key solarisation activity in the agriculture sector was the installation of solar pumps for irrigation. The state government implemented various subsidy schemes to increase solar-pump uptake. Between 2012 and 2018, nearly 53,000 solar pumps were installed in Chhattisgarh⁸². For evaluating the emission mitigated with solar pumps, a base case is defined as an electric pump of motor efficiency 58 per cent (also assuming a mild efficiency improvement of 0.2 per cent). The cumulative emission mitigated with solar pumps between 2012 and 2018 is 911 ktCO₂ with respect to the base case.

⁸⁰ Data on PAT cycle II achievements is not available and annual fuel usage statistics industry wise are also unavailable and awaited from line departments.

⁸¹ LED and fan distribution data was available only from December 2017

⁸² Data from line department

Table 115: GHG implications of current policies and programmes

Sector	Sub-Sector	Major Policy/ Programmes	GHG Mitigation Potential (2012-18) with respect to base case	Cumulative Achievement ⁸³	Barriers to Achieving the Potential
Power	RE-based electricity generation	- Chhattisgarh Solar Policy 2012-17 - Chhattisgarh Solar Policy 2017-27 - National Solar Mission	2,207 ktCO ₂ (solar policy target of 1000 MW in 2017)	286 ktCO ₂ saved with solar-ground mounted installation (2012-18) 311 ktCO ₂ of emissions mitigated with total RE-based electricity generation	- Absence of solar-PV manufacturing facilities - Land-availability issues - Lack of innovative investment models - Poor supply chain and market conditions - Cheaper coal-based technologies
	T&D infrastructure	- UDAY - IPDS - R-APDRP	No targets for T&D loss	1,797 ktCO ₂ (2012-18)	- Feeder segregation process is slow - Distribution transformers are not metered - Slow progress in the strengthening of sub-transmission and distribution networks
	Coal-based TPP	- PAT scheme - R&M activities	392 ktCO ₂ ⁸⁴ (equivalent to PAT-1 target of 0.128 MtoE for 2014-15)	27.8 ktCO ₂ (PAT-1 achievement) 116 ktCO ₂ of emissions mitigated between 2012-18	Absence of state-level policy encouragement for improving energy efficiency

⁸³ Since the start date is different for each policy, the time period for emission mitigated is provided against each policy/lever

⁸⁴ 1 tonne of oil emits 3.06 tonne of CO₂

Transport	FAME	Implementation of demand-incentive scheme for purchase of EVs in the state	No policy targets	4.7 ktCO ₂	- State-level EV policy and targets to encourage adoption - Absence of financial incentive at the state level - Absence of adequate charging infrastructure
	Public transport improvement	- Implementation of BRTS between Raipur and Naya Raipur - Procurement of buses under JNNURM	No policy targets	1.7 ktCO ₂	- Lack of an integrated approach to transport planning in the cities - Public transport systems owned and operated by private contractors - Lack of data on travel-demand growth in state
Industry	PAT Scheme	Energy-efficiency improvements in large energy-intensive industries		4,232 ktCO ₂	- Absence of state-level policy encouraging energy efficiency in Industries - No state-level targets for industries that were not covered under PAT
Buildings	Lighting	UJALA	09 ktCO ₂ /annum	511 ktCO ₂ /annum 1,022 ktCO ₂ (cumulative reduction for 2017 and 2018)	Challenges in replacing fused bulbs within the warranty period as most of the kiosks were closed
	Streetlight	SLNP	No policy targets	303 ktCO ₂ (2016-18)	-
Agriculture	Irrigation pump sets	Saur Sujala Yojana; National Solar Mission	No policy targets	911 ktCO ₂ (Cumulative reduction for 2012-18)	- Unmetered irrigation pump sets - Higher cost of solar pumps - No schemes to replace old pumps with star-rated ones

Source: CSTEP analysis

5.3 Proposed Sectoral Mitigation Activities and Programmes

5.3.1 Agriculture and Allied Sector

The mitigation measures in the agriculture sector comprise three key levers: replacement of old pumps with EE pumps, installation of solar pumps and dedicated solar-based agriculture feeders in 2021-30.

The number of electric pumps is assumed to grow at a CAGR of 6.8% between 2021 and 2030. This is based on the growth rate calculated with 2012-18 data. Currently, Chhattisgarh has only 7 per cent of its sown area under double cultivation. The vision of the State Agricultural Department is to develop irrigation resources to raise cropping intensity and productivity. For the **energy efficiency lever**, the base case efficiency improvement trajectory was taken from IESS 2047 Level 1 projection, wherein the overall efficiency of pumps improves from 60 per cent in 2018 to 62 per cent in 2030 (IESS, 2015). For the policy scenario, the overall efficiency of the pumps in the state was increased from 60 per cent in 2018 to 69 per cent in 2030 (based on IESS Level 2 trajectory)⁸⁵.

The **solarization lever** has two sub-levers: (1) Stand-alone solar pumps and (2) EE pumps connected to solar-powered dedicated feeder. We determined the number of **solarized** pumps from a linear trend based on installations across the years. Farmers at low-water-table regions experience operational difficulties with 3-5 HP pumps. Even though higher capacity solar pumps could help with this, the cost is prohibitively high. Given the situation, a dedicated solar-based feeder would be a viable solution⁸⁶. Karnataka and Maharashtra have installed pilot-scale RE-based feeders for irrigation energy (PSU Connect, 2020; Rural Marketing, 2018). Towards this lever in the policy case, we assume that an increasing fraction of solarisation efforts in agriculture sector (0 per cent in 2020 to 60 per cent in 2030) will be EE pumps connected to dedicated solar-powered feeder. The base scenario for this lever does not have any solar pump or solar-based feeder, and all the pumps are electric. For the policy scenario, 3.5 lakh solar stand-alone pumps (2.7 lakh new installations in the 2021-30 period) and 1.6 lakh EE pumps connected with solar-powered feeder (with a total capacity of 1,255 MW) are considered.

The installation of EE pumps in the policy scenario needs INR 2,057 crore between 2021 and 2030. For the solarization lever, INR 18,870 crore is required in 2021-30. The total emission savings from EE lever is estimated as 1,066 ktCO₂ and from solarization lever is around 5,800 ktCO₂ in 2030.

The key hurdles in solarization of the agriculture sector are the high capital cost of solar pumps, receding groundwater levels, infrastructure cost, and time involved in achieving feeder separation for agricultural purposes.

Installation of 10 HP solar pumps sets in irrigation scheme to offset emission from fuel combustion in motors – A solar water pump is used for extracting water from ponds, rivers, borewells or other sources of water which are then used to meet the water requirements for irrigation, community water supply, livestock and other purposes. Electricity shortage is one of the major issues of the state thus these are the best alternative to the conventional pump set. Thus, existing diesel-based systems should be replacement and solar pumps should be promoted. While solar pumps contribute to mitigation,

⁸⁵ There are no pilot projects for replacing pumps / direct policies mandating the adoption of EE pumps. There is no historical data or target for the number of EE pumps that will be operating in the period. However, there is an AgDSM initiative incentivising adoption of EE pumps through electricity bill rebates. Therefore, an overall efficiency improvement is likely to happen. We took the trend from IESS 2047 - trajectory 1 for the base case (0.33% CAGR for the period 2012-2047); and trajectory 2 for the policy case (0.9% CAGR for the period 2012-2047).

⁸⁶ The KUSUM scheme has components towards solarisation of grid-connected agricultural pumps as well as setting up of decentralised solar plants, in addition to stand-alone solar pumps. The KUSUM scheme has components towards solarisation of grid-connected agricultural pumps as well as setting up of decentralised solar plants, in addition to stand-alone solar pumps (MNRE, 2019a).

adaptation co benefits arrived to lower irrigation cost and less dependence on grid electric supply which can be erratic.

Table 116: Sectoral Mitigation Activities – Agriculture and Allied Sector

Project/ Programme	Scale (Size)	Mitigation Potential in 2030 (ktCO ₂)	Total Investment Required (INR Crore)	NDC Link	SDG Link
Efficiency improvement	69 per cent average efficiency by 2030 (~50 per cent EE pumps by 2030)	1,066	2,141 (Including cost for conventional pumps); 2,057 (only EE pumps)	NDC 6	SDG 6 SDG 12 SDG 13
Solar stand-alone pumps	~3.5 lakh solar pumps	3,980	13,056	NDC 1 NDC 6 NDC 8	SDG 7 SDG 12 SDG 13
Solar-powered dedicated feeder	~1.5 lakh EE pumps + 1,255 MW solar capacity	1,825	5,815		

Source: CSTEP analysis

Proposed Climate Change Mitigation Activities

- 1. Research on exploring potential of Carbon Sequestration in agriculture sector** – It complements two other major approaches for greenhouse gas reduction, namely improving energy efficiency and increasing use of non-carbon energy sources. Interest has been increasing in the carbon sequestration option because it is very compatible with the large energy production and delivery infrastructure now in place. All the approaches will need to make significant contributions in order to meet the objective of the United Nations Framework Convention on Climate Change, that is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Thus, research should be undertaken on exploring potential of Carbon Sequestration in agriculture sector. However, research on exploring potential of carbon sequestration in agriculture has both mitigation and adaptation co-benefit.
- 2. Cold Chain Development using Renewables** - Promotion of solar micro cold storage in Chhattisgarh is with the following objective (1) poor cold chain network (2) lack of cold storage facilities at the decentralised level (3) existing cold storage are technically designed for a fixed type of product. Cold storages require reliable power supply to maintain the desired temperature required for the storage of produce as fruit and vegetables are easily perishable and with the increased temperature and varied humidity cold storage becomes a necessity for the farmers in Chhattisgarh.
- 3. Management of Soil Health and Fertility**
It is important to keep an eye on soil health and fertility by conducting soil tests before every sowing season. The following strategies can be suggested for improved management of soil health and fertility.
 - Promote Straw mulching through reincorporation in soil for improvement in soil health in areas where soil is degraded due to residue burning
 - Promote integrated nutrient management in soils to auger for the degrading soil health status in the state and avoid further degradation due to climate change
- 4. Install 10 HP solar pumps sets in irrigation scheme to offset emission from fuel combustion in motors** – A solar water pump is used for extracting water from ponds, rivers, borewells or other sources of water which are then used to meet the water requirements for irrigation, community water supply, livestock and other purposes. Electricity shortage is one of the major issues of the state thus

these are the best alternative to the conventional pump set. Thus, existing diesel-based systems should be replacement and solar pumps should be promoted.

5.3.2 Forest and Biodiversity Sector

Chhattisgarh has 45.80 per cent of the area under the forest which implies that there is availability of large tracts of forest areas serving as one of the major sources of livelihoods. Forest is providing vital environmental services and thus any degradation of forests in the state is to be considered as highly sensitive issue. Increasing demand for mitigation of climate change through carbon sequestration is the need of the hour as India gears up to meet its NDC commitments. This might pre-empt changes needed in forestry practices. This entails immediate and intensive steps to reduce the vulnerability of forests and forest dependent communities. Constant or increasing stocks of all forest capital like natural, plantation and human over time with natural capital not dipping below critical levels for any ecosystem, there is a need to look at forestry as both an ecological and an economic resource for the welfare of the local population. To achieve this, it is important to bring the focus back to comprehensive forestry in which economic productivity and returns from the forests should get equal weightage as ecological benefits.

Proposed Climate Change Mitigation Activities

1. **Continuing assisted natural regeneration and thereby fostering growth of native species that are adapted to the prevailing ecological and climatic conditions** – The physical and financial target under this activity till 2030 is mentioned in the climate strategies table after this section. With ANR activity, forests grow faster than they would naturally, resulting in a significant contribution to carbon sequestration efforts. It also serves as a cheaper alternative to reforestation due to decreased nursery needs. During performing the ANR activities and preparing a local level forest protection task force the livelihood of the forest dwellers and forested area inhabitants can also be enhanced by engaging them in these activities, hence contributing to building the climate resilience of the most vulnerable groups.
2. **Better offset of fire incidences due to increased temperature** – Forest fire is a major cause of degradation of forests. With the change in climate, forest fires will increase because a warmer climate means more fires. The Fire Information System is technologically quite advanced in the state, but both the field response mechanism and preventive measures leave much to be desired because of lack of resources. However, this also has adaptation co-benefits.
 - a. A strategy of fire forecasting, fire prevention and firefighting needs to be developed with some additional budgetary allocations.
 - b. Modern technologies should be used to locate fires and forecast fires. Based on satellite images, fire-prone zones need to be digitised and monitored.
 - c. Community participation in fire prevention and firefighting should be encouraged through incentives.
 - d. An improved communication network through equipment such as VHF radios /mobiles, vehicles, as well as camp sheds and watchtowers are needed to facilitate the protection and conservation of forests and wildlife.
3. **Enhancing Tree outside Forests (TOF)** – The increased tree cover will serve as the additional carbon sink and contribute to the NDCs commitment for creating additional carbon sink.
 - a. Enhancement of tree outside forests can be done by undertaking plantation activities on river sides which will conserve the river ecology and enhance soil and water conservation.
 - b. Increasing areas under agro forestry

- c. Plantation activities on roadside, canal, courtyards, office premises, state highways, revenue land etc. can be undertaken.
 - d. Promotion of private tree farming to be encouraged by the department some steps like exempting few tree species grown on the private land from the felling and transit permit can be taken to promote private tree farming. The department can also plan to take measures which entails a sustained and efficient marketing structure to ensure adequate rates to the tree growers at harvesting, which will lead to increased climate resilience of the farming community by providing alternative livelihood and also support carbon sequestration due to new plant growth from tree farming.
4. **Review of working plans for incorporation of climate concerns** (based on sectoral and area specific vulnerability assessment) – There are already many climate resilient activities implemented by the Forest Department, and it's important that the climate change Impact Assessment of these activities is conducted to understand the climate relevance and sensitivity of these schemes, which then can be incorporated in the working plan in alignment with climate actions.
5. **Implementation of the REDD+ strategy in Chhattisgarh** – Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) was negotiated under the United Nations Framework Convention on Climate Change (UNFCCC) in 2005, with the objective of mitigating climate change through reducing net emissions of greenhouse gases through enhanced forest management in developing countries.

Chhattisgarh has 16,345.29 sq.km of open forest and 32197.56 sq.km of moderately dense forest in which carbon density can be enhanced by fire prevention, pest and disease management, and invasive species management, gap seeding and planting. These activities require trained staff for short periods, but the department does not have adequate staff. The temporary and discontinuous nature of work does not lend itself to regular forest staff. A large workforce of temporary staff will be required for intensive forest management. Therefore, engaging suitable tribal youth from neighbouring communities as Community Forest Officers, and training them under MRV (Monitoring, Reporting and Verification) provisions of REDD Plus and using their services for 5 months in a year will ensure not only local employment but also conservation of our forests. These temporary CFOs shall work under Ranger and get paid from REDD+ funds. It will also develop a sustained behaviour in the communities in conservation and protection of the forests and they will engage directly in forest management and yet the forests shall have the benefit of technical management by the forest department.

5.3.3 Urban Development Sector

Proposed Climate Change Mitigation Activities

Chhattisgarh is undergoing rapid urbanization, as a result of the state government's efforts to provide necessary amenities and improve the standard of living. With increased access to electricity and rise in household income levels, the number of appliances like air conditioners, ceiling fans, televisions, and refrigerators will increase in future. Such a scenario calls for green-growth strategies. On the demand side, this can be mainly achieved by adopting energy-efficiency measures in lighting and other appliances.

The UJALA scheme has helped in initiating the use of LED bulbs and tube lights in the state. Assuming all the LED bulbs sold in the state are used by the domestic sector, the state has achieved about 30 percent LED penetration in the domestic sector⁸⁷ by 2020. With the current LED-use trend, at least 50 per

⁸⁷ Assuming five lighting points per house

cent⁸⁸ of the lighting points in the domestic sector will be LED by 2030 (based on IESS version 2.2. Level 3 projection at national level). This is identified as the policy scenario for the current analysis. The base case assumed for LED lighting will be the use of incandescent bulbs

The use of energy-efficient appliances is linked to the various classes of monthly per capita expenditure (MPCE) in the state. Based on the latest NSSO consumer-expenditure data (2011-12), most homes had ceiling fans—93 per cent in urban areas and 60 per cent in rural areas of the state. Ownership of other appliances like air conditioners and refrigerators were found to be quite low in Chhattisgarh (NSSO, 2014). With rising income, the number and types of appliances owned by each household are going to increase. The share of highly energy-efficient appliances is likely to increase to 10 per cent in the policy scenario (compared with 1 per cent in the base scenario) in 2030 (based on IESS version 2.2. Levels 1 and 3).

Similarly, the commercial sector is assumed to increase its adoption of highly energy-efficient appliances, especially in lighting and HVAC, by at least 50 per cent in 2030 (while the base case will have just 30 per cent penetration) (based on IESS version 2.2. Levels 2 and 3).

Though Chhattisgarh has taken steps in amending the ECBC within the state, it has not yet been notified and incorporated in the building by-laws. It is expected to be notified soon. In the policy scenario, about 10 per cent of the commercial floor area and 10 per cent of the residential floor area in high-rise buildings are assumed to be ECBC-compliant by 2030.

The mitigation levers in buildings have the **potential to reduce 3,265 ktCO₂ in 2030** with an additional investment of INR 5,936 crore for energy efficiency. All of these policies contribute to the NDC goal 3 of reducing India's emission intensity of GDP. These indirectly link to SDGs 7 and 12 to ensure clean and responsible consumption of energy.

Proposed Mitigation Activities for the Sector are listed below:

1. **Update building byelaws and development control regulations to incorporate Climate Change and DRR considerations** – The rule and regulations of the building byelaws must be updated in accordance with the climate change and disaster risk reduction factor. This is much needed to reduce the impact of climate change due to infrastructure projects. If a proper DRR is in place there will be a gradual reduction in falling of building thus waste generated because of the fall will be reduced. Locally available material can be used thus material sourcing problems will also be reduced.
2. **Incorporate policy framework to encourage non-polluting or “green” economic activities in cities Master Plan** – The climate proofing of the cities apart from the smart cities are integral to the city planning & policy framework. Especially, the state pollution control board and SDA will work together to have green space pollution controlling plant & water fountain to reduce the adverse impact of climate change. This should be in part of the master plan.
3. **Development of integrated MSW Management (such as waste to compost, waste to energy etc.)** – The objective of solid waste management is to reduce the amount and toxicity of material entering the waste flow, reuse as much material as possible, waste recycling and residue disposal in a scientifically sound way. The effective management of waste in environmentally sound manner will reduce methane emission. Methane is one of the major contributors for Global Warming and Climate change. Chhattisgarh has two ‘waste-to-energy’ power plants proposed with a total installed capacity of 10 MW. The Chhattisgarh government has decided to set up a ‘Waste to Energy’ power generation plant in Durg district.
4. **Urban Transport and Transit Oriented Development** – The Urban Development and Housing Department, Government of Chhattisgarh has proposed the implementation of various bus stand

⁸⁸ Because of the lack of data on state-level targets for future years, NITI Aayog's IESS projection at the national level is used.

projects in different ULBs of the state which include the class-I cities. Invest in public transport and infrastructure that promotes walking and cycling.

Table 117: Sectoral Mitigation Activities – Urban Development Sector

Project/ Programme	Scale (Size)	Mitigation Potential in 2030 (ktCO ₂)	Total Investment Required (INR Crore)	NDC Link	SDG Link
Efficient lighting	53 per cent of lighting points in the residential sector	2,083	63	NDC Goal 3	SDG 7 SDG 12
Efficient appliances	Penetration of efficient appliances Low:Medium:High= 60:30:10	1,093	5,151	NDC Goal 3	SDG 7 SDG 12
Adoption of ECBC	10 per cent of commercial floor area and 10 per cent of high-rise building floor area	88	723	NDC Goal 3	SDG 7 SDG 12

Source: CSTEP analysis

5.3.4 Transport Sector

Proposed Climate Change Mitigation Activities

In the transport sector, FAME policy and public-transport improvement guided by the National Urban Transport Policy are assumed to continue until 2030. For the implementation of the FAME policy, it is assumed that the existing annual rate of growth of 40 per cent in EVs in the state is going to continue until 2030. The base and policy-scenario assumptions remain similar to those mentioned in the earlier section.

For the lever **improvement in public transport**, the base scenario is assumed to follow the past trends in urban development and transport, with the BRTS reaching the full operation level. This is based on the public-transport scoping study for Raipur, implementation completion and results report for sustainable urban transport project in Raipur, and the Naya Raipur Development Plan 2030 (Action on Climate, 2015; Naya Raipur Development Authority, 2019; World Bank, 2019). However, because of inadequate infrastructure support for NMT, the share of NMT in the base scenario is assumed to reduce to 28 per cent by 2030 (from 55 per cent in the base year) (Action on Climate, 2015; Ministry of Urban Transport, 2008). Accordingly, the share of PT increases to 32 per cent in 2030 from about 12 per cent in the base year, under this scenario.

In the policy scenario, a more comprehensive and robust public bus system is envisioned, combined with the full electrification of the buses procured under JNNURM Phases-I and II. This scenario also represents the conditions of ToD envisioned under the Naya Raipur Development Plan 2030. Under this scenario, the PT share in 2030 is assumed to increase to 40 per cent and the NMT share is expected to increase to 35 per cent by 2030 (Action on Climate, 2015; Naya Raipur Development Authority, 2019). Based on these assumptions, the estimated emissions mitigated in 2030—with the implementation of the FAME in Chhattisgarh and improvement of public transport in Raipur—is about 367 ktCO₂ and 2 ktCO₂ respectively. The enhanced implementation of FAME scheme would lead to an increase in the overall EV fleet, leading to an investment requirement of about INR 20,091 crore between 2021-2030. The improvement in public transport in Raipur would require an augmentation of the existing bus

fleet, from about 205 buses in 2016 to about 728 buses in 2030 under the improved public transport scenario; this necessitates an additional investment of about INR 76 crore between 2021-2030.

These policy measures are within India's NDC commitments to create a safe, smart, and sustainable green-transportation network, linking to SDG 11 of creating sustainable transport. However, the lack of baseline travel-demand statistics covering total trips and mode share at the state level and in cities in Chhattisgarh is a key barrier. It hinders the attempt to formulate robust policy measures to improve public transport in the state. Additionally, in order to promote public transport, an integrated approach from the entire ecosystem comprising civil infrastructure, municipal planning, transportation planning, traffic planning, and parking management is crucial.

Proposed Mitigation Activities for the Sector are listed below:

1. **Inspection and certification Centre (Central Gov.)** – With the help of the Central Government, there is a plan to set up an Inspection and Certification Centre (I & CC) at the Regional Transport Office, Raipur, Chhattisgarh. Central Plan under Regional Transport Office, Raipur, the work of main building of Inspection and Certification Centre has been completed by construction agency Public Works Department 92 percent. The work of the machine and foundation is pending from the operating agency International Centre for Automotive Technology.
2. **EV Policy and Provision of Subsidy** - EV Vehicle policy preparation for state is in process. At present exemption from motor vehicle tax is being provided for electric vehicles.
3. **Initiative for emission control** - Pollution testing centres: 338 are running in entire state to monitor, and to control violations on pollution controlling measures, irrespective of government vehicles or commercial or private vehicles. The fitness certification needs to be revised every six months. Penalty is imposed on those vehicles which are violating the pollution control norms.

Table 118: Sectoral Mitigation Activities – Transport Sector

Project/ Programme	Scale (Size)	Mitigation Potential in 2030 (ktCO ₂)	Total Investment Required (INR Crore)	NDC Link	SDG Link
Continuation of FAME India Policy	Continuation of demand incentive for Evs until 2030	367	20,091	NDC 2,7	SDG 11
Improvement in public transport	Improve the share of bus transport in Raipur to 34 per cent by 2030	2	76	NDC 3, 5, 7	SDG 11

5.3.5 Energy Sector

Proposed Climate Change Mitigation Activities

In the power sector, the same Solarisation levers are continued till 2030 (see section 4.1). A policy scenario and a base scenario are defined for each lever, between 2021 and 2030. Subsequently, the mitigation potential with respect to the base scenario is estimated.

Key inputs to the power-sector projection framework are (1) year-wise electricity demand projections for two scenarios; (2) new conventional power-plant capacity share to state; and (3) source-wise RE targets.

Owing to demand-side management, the electricity-generation requirement for the policy scenario is lower than that for the base scenario. The electricity demand required between 2021 and 2030 for the major energy sectors (such as industries, transport, buildings, and agriculture) were estimated. The remaining sectors such as public lighting, waterworks, and railways were taken from CEA 19th EPS projection⁸⁹. As mentioned in section 4.1, a consumption-based analysis is carried out for the power sector. This analysis excludes electricity generation for exporting power to other states. The projected electricity-generation requirement to meet the state demand in 2030 in base and policy scenarios is 70 TWh and 47 TWh, respectively⁹⁰. New capacity of 418 MW of coal and 706 MW of large hydro allocated to the state will be operational between 2021 and 2030.

In RE-based electricity generation, the state has a target of 1,783 MW of solar (including 700 MW of RTPV), 25 MW of small hydro and 118 MW of biomass power in 2022, put forth by the Ministry of New and Renewable Energy (MNRE) in line with NDC targets. Chhattisgarh has also set its own target for RTPV-installed capacity of 600 MW by 2022. To increase RE-based electricity generation, the state targets an RPO target of 21 per cent in 2020-21.

The broad scenario definitions of the three levers are provided below:

- For the lever **increased RE-based electricity generation**, state and national targets were accounted for in the policy scenario. The solar target of 1,683 MW (including 600 MW of RTPV) is considered till 2022. Further, the annual capacity addition between 2019 and 2022 to meet the target is continued till 2030. A small-hydro capacity addition of 25 MW, and waste-to-energy plant of 10 MW are also considered in 2022⁹¹. For the base scenario, marginal RE-capacity addition is considered based on historic trend prior to 2012 (same as existing policy analysis). Any power deficit to meet demand is met with coal-based power plants. In the base scenario, RE-installed capacity is increased from 314 MW in 2018 to 341 MW in 2030.
- The installed capacity of RE increased from 552 MW in 2018 to 4,415 MW in 2030 in the policy scenario. The share of electricity generation from RE increased to 17 per cent in the policy scenario⁹². With increased RE-based electricity generation, GHG-emission mitigation of 6,227 ktCO₂ with respect to the base case can be achieved in 2030. The increased RE-based electricity generation is linked to NDC goals 1,2,3,4 and 8 and SDG 7, 11 and 12. The grid emission factor is likely to decrease from 0.84 kgCO₂/kWh in 2018 to 0.71 kgCO₂/kWh in 2030, owing to an increase in RE and large hydro-based electricity generation.
- For the lever **improved T&D infrastructure**, the T&D loss trend between 2012 and 2018 is continued till 2030 in the policy scenario, assuming that the current schemes such as UDAY and IPDS continue till 2030. The base scenario is kept the same as the existing policy analysis. The T&D loss would reduce to 18.6 per cent and 8.8 per cent in base and policy scenarios, respectively, in 2030. This reduction in T&D loss could avoid 2,003 ktCO₂ with respect to the base case in 2030.
- For the **energy-efficiency improvement** lever, the base scenario definition is kept the same as the existing policy analysis. For the policy scenario, the gross heat rate of the power plants is reduced and the deviation of the heat rate from the design heat rate is limited to 7.5 per cent. The energy-efficiency improvement as per the policy scenario could reduce emissions by 864 ktCO₂ with respect to the base case in the 2030. The improved T&D infrastructure is linked to NDC goal 3 and SDG 7, while the energy-efficiency improvement is linked to NDC goals 2 and 3 and SDG 7 and 12.
- An investment of around INR 24,600 crore is required to decarbonise the power sector as per the policy scenario, between 2021 and 2030 (excluding the O&M cost). Of this amount, INR 15,193 crore

⁸⁹ CEA's 19th EPS projection provides state-wise electricity demand of all the sectors between 2015-16 and 2026-27. After 2026-27, the electricity demand is linearly projected till 2030-32.

⁹⁰ Needs validation from Energy Department

⁹¹ Because data on allotted capacity is not available, the MNRE 2022 targets of small hydro, biomass and waste-to-energy plant were considered. This assumption needs to be validated with line departments.

⁹² The planned wind-solar hybrid of installed capacity 400 MW is not considered in this analysis

is required for installing RE projects: 1.7 GW of solar ground-mounted (estimated at INR 4 crore/MW), 1.3 GW of RTPV (INR 4.5 crore/MW), 10 MW of waste-to-energy (INR 15 crore/MW) and 63 MW of small hydro (INR 8 crore/MW) between 2021 and 2030 (CSERC, 2020). Even though the capital cost of RE technologies is expected to decrease in future, the cost decline and the O&M cost during the operational years were not considered in this analysis. Also, because consumers or developers will make the necessary investment, the state should focus on attracting investment by making regulatory changes.

- The investment required to reduce T&D loss will depend on activities undertaken for the same. Based on secondary literature review, a ballpark investment of around INR 300 crore is needed to reduce the T&D loss by 1 per cent per DISCOM. In the policy scenario, 7.5 per cent reduction in T&D loss from 2021 level is proposed and INR 2,235 crore is required for the same. To improve the energy efficiency of coal TPP, those commissioned before 2008 (3,189 MW) need to undergo Renovation and Modernisation (R&M) activities at INR 1 crore/MW (cost for R&M activity as per CERC). Those plants that are of recent vintage (2008-2019) would need INR 0.2 crore/MW for improving energy efficiency. This sums up to around INR 7,187 crore for R&M activities (CERC, 2009).

Proposed Mitigation Activities for the Sector are listed below:

1. **Generation of Power through Clean Coal Approaches** – "Clean coal" usually means capturing carbon emissions from burning coal and storing them under the earth. Some clean coal technologies reduce the Sulphur compounds in the flue gases coal after it burns. One type of coal preparation, coal washing, removes unwanted minerals by mixing crushed coal with a liquid and allowing the impurities to separate and settle. Other systems control the coal burn to minimize emissions of sulfur dioxide, nitrogen oxides and particulates. Wet scrubbers, or flue gas desulfurization systems, remove sulfur dioxide, a major cause of acid rain, by spraying flue gas with limestone and water. The mixture reacts with the sulfur dioxide to form synthetic gypsum, a component of drywall. Carbon capture and storage works but is expensive to build or to retrofit onto old plants. We need to do a lot more capturing and storing to make a difference in battling worldwide carbon emissions. Emissions of the furnaces may be checked to see the percentage of unburnt coal and accordingly the efficiency of the combustion of the furnaces may be monitored and improved. Moreover, installation of supercritical technologies which operate at higher temperatures and pressures than subcritical units increase turbine efficiency and power output, so less coal is used to produce the same amount of electricity.
2. **Develop a state-level energy efficiency standard through effective implementation of ECBC, PAT, etc. and through SDA** – Supporting clean energy transition in MSME sector including adoption of energy efficiency and technology upgradation measures and renewable energy technology measures - Facilitate walk thorough/detailed energy audit at the unit. Facilitate access to concessional finance for implementation of energy conservation or technology upgradation measures. Establish and strengthen supply chain base (local service provider and technology suppliers) in the cluster for provisioning and maintenance of the energy efficient appliances. Undertake training need analysis and training of industrial worker in association with ITI and MSME tool room on the energy efficient appliances.
3. **Maximize Solar Energy Generation Potential** – The policy of roof top Photo voltaic power plant should be promoted by digital and print media. In addition to that Government may acquire wasteland to build concentrated solar or Photo voltaic power plants so that Chhattisgarh meets not only its domestic demand but also supply energy to its neighbouring states.
4. **Installation of Waste to Energy Plant of 10 MW** – Municipal and Urban bodies may be assigned the task to establish Waste to Energy Plant. At a rural level, workshops and training programmes may be organised to create awareness of harnessing energy with the help of bio-gas plants. Interest free loans may also be provided to people to build such bio-mass plants.
5. **Installation of Small Hydro Power Project of 25 MW** – Chhattisgarh State Renewable Energy Development Agency (CREDA) sanctioned 50 SHP projects of 612.25 MW and identified about 70

potential sites for development of SHP/Mini Hydro Power (MHP) projects of 2,997 kW but none had been commissioned till December 2014 because of delay in obtaining No Objection Certificate (NOC), local issues and non-execution of Power Purchase Agreement (PPA). As per the report of MNRE, Chhattisgarh has the potential to produce 1107 MW of energy from hydel power plants. Dams may be constructed in perennial rivers and the hydel energy may be suitably tapped.

6. **Design and Implement Utility Level DSM and EE Programs** – Efficient Motors and star labelled appliances and equipment may be mandated by the Government to utilise the energy optimally. The national DSM programmes of Agricultural and Municipal DSM (Ag-DSM and MuDSM) programmes are planned for the state. AgDSM would focus on replacement of old agricultural pumps with energy efficient pumps, while MuDSM would focus on replacement of municipal water and sewage pumps with energy efficient pumps.
7. **Build capacity of energy auditors, strengthen the energy conservation cell** – Routine surveys and studies should be conducted to evaluate the measure and potential of energy saving in the state of Chhattisgarh. Training programme to target professionals in the energy conservation cell by the Energy Auditors may be routinely conducted. Government may consult BEE certified Energy Auditors at the time of formulation of new policies.
8. **Increase energy efficiency in drinking water pumping systems and lift irrigation systems** - Water pumping for drinking purpose may be scheduled to off peak hours and accordingly tariff may be set for the same. Solar Water pumping stations may be promoted.

Table 119: Sectoral Mitigation Activities – Energy Sector

Project/ Programme	Scale (Size)	Mitigation Potential in 2030 (ktCO ₂)	Total Investment Required (INR Crore)	NDC Link	SDG Link
RE-based electricity generation	3.1 GW	6,227	15,193	NDC 1 NDC 2 NDC 3 NDC 4 NDC 8	SDG 7 SDG 11 SDG 12
Improve T&D infrastructure	Reduce T&D loss to 8.8 per cent	2003	2,235	NDC 3	SDG 7
Improve EE of Coal TPPs	Heat rate within 5 per cent-7.5 per cent of design heat rate	864	7,187	NDC 2 NDC 3	SDG 7 SDG 12

Source: CSTEP analysis

5.3.6 Industry Sector

Proposed Climate Change Mitigation Activities

To mitigate emissions from the industries sector in Chhattisgarh, the ongoing PAT scheme is assumed to continue over the horizon period compared to the base scenario of autonomous energy-efficiency improvements in the industry. An autonomous energy-efficiency improvement of 0.2 per cent based on the voluntary measures undertaken by the industries is considered in the base scenario. For the policy scenario, improvements prescribed under the notified PAT cycles are continued till 2030, as there are no prescribed state-level policies or energy-efficiency improvement targets. The efficiency improvements in the policy scenario are based on the improvement targets set by the PAT scheme and the voluntary targets of manufacturing units such as Steel Authority of India's (SAIL's) Bhilai Plant (SAIL, 2015). After

the notified PAT cycle period that extends beyond 2023, an annual efficiency improvement of about 1.5 per cent has been considered until 2030, in line with the overall efficiency-improvement trend over the years. An annual efficiency improvement of 0.7 per cent is considered for other small-scale iron and steel industries (IESS, 2015).

The key industrial sector outputs are assumed to grow at a CAGR of about 4 per cent, taking into account the capacity-expansion plans of larger industrial units (such as the Bhilai Steel Plant) (Business Line, 2019). For cement and aluminium, growth rates based on historical growth in production output has been considered due to the lack of data on production-expansion plans. These measures in the industries lead to an estimated emissions savings of about 14,302 ktCO₂ in 2030, with an overall investment requirement of about INR 65,802 crore by 2030. The energy-efficiency measures considered in the industries contribute to India's second NDC goal of enhancing energy efficiency and the 12th SDG of ensuring sustainable consumption and production patterns. One of the key challenges to achieving these goals is the lack of mention of energy-efficiency and emissions-mitigation goals in the state industrial policy. The lack of sector-specific targets for efficiency improvement in industries not covered under PAT is another barrier.

Proposed Mitigation Activities for the Sector are listed below:

1. **Devise a mechanism for green belt development and maintenance in industrial clusters:** Under this initiative activities like Industrial waste management using more efficient technologies and strict implementation of norms, plantation activities, increased use of solar energy as part of the CSR activities and adoption of water harvesting structures can be undertaken. There is also a need to encourage industries to align CSR activities towards GHG reduction like development of villages in the CSR area as climate smart villages. Green belt development contributes both mitigations.

2. **Energy Profiling, Performance benchmarking and GHG Profiling of State's Industrial Sector –**

The key strategies include

- (a) Establishing sectoral (both at macro level and enterprise level) energy usage and GHG profile of industrial sector and periodically conducting of the aforesaid exercise in order to determine industrial performance improvement. Similar study will help to prioritise the categories of industries where more action on emissions reduction can be pursued.
- (b) Advocating for mandatory energy audits
- (c) Advocating for enterprise level energy consumption data reporting programme and extending support industrial facilities in energy performance benchmarking
- (d) Enabling coordinating with the units in establishing best practice of energy performance management and resource efficiency.

Aforesaid exercise will help in enterprise/macro level management of energy consumption and complying with the associated GHG emission target. Such profiling will also help in policy level decision making and budgetary allocation.

3. **Scaling up clean energy transition across industrial sector with specific emphasis on MSME Sector –** MSME units owing to its smaller scale of operations and lower capital base typically opts for the readily available low-cost technology solution which in most cases are both resource and energy inefficient solutions and results in disproportionately higher costs as against largescale units opting on state of art technology options. Such disparity is over and above the reasons for environmental degradation and driving climate change cause. It is therefore suggested to advocate for suitable policy and regulatory regime towards –

(a) Increasing the share of clean energy in industrial energy mix: These include actions which reduce carbon emissions per unit of output, by switching to renewable energy for e.g. roof top solar etc.

(b) Improving energy efficiency of industrial processes: These are actions which reduce the amount of energy used to produce an output, such as process efficiency in manufacturing

(c) Institutionalising innovative pilot: Piloting of hybrid- solar PV grid as an innovative solution to cater MSME electricity requirement

(d) creating awareness and capacity building: The shift to cleaner energy in these units will contribute to the climate mitigation by reducing GHG emission from conventional sources of energy.

Table 120: Sectoral Mitigation Activities - Industries Sector

Sector	Project/ Programme	Scale (Size)	Mitigation Potential in 2030 (ktCO ₂)	Total Investment Required (INRCrore)	NDC Link	SDG Link
Industry	Energy efficiency improvement across Industries	Improvement in specific energy consumption across steel, cement, and aluminium industries by 18 per cent in 2030	14,302	65,802	NDC 1,2,7, 8	SDG 12

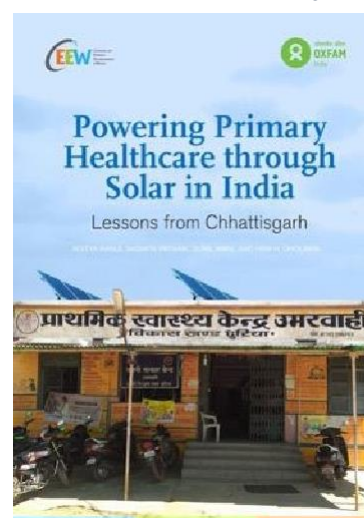
Source: CSTEP analysis

5.3.7 Health Sector

Proposed Climate Change Mitigation Activities

Solar (Clean and Renewable energy) – for Green and Climate Resilient Public Health Sector in the State of Chhattisgarh: Chhattisgarh is the leader in the country in solarizing its health centres. Solarization of public health facility is not new to the state of Chhattisgarh. It started from 2001. The Chhattisgarh Renewable Energy Development Authority (CREDA) has so far achieved more than 90 per cent solarizing targets for PHCs and CHCs in the state. Solarizing the health centers make them energy independent and helps reduce their carbon footprint and hence truly climate resilient. CREDA is a partner for the Department of Health and Family Welfare of the State in making our health infrastructure more climate resilient. Chhattisgarh is currently on track to achieve 100 per cent solarization of the health centers.

Figure 42: Report on Powering Primary Healthcare through Solar in India: Lessons from Chhattisgarh



Rural healthcare infrastructure – PHCs and particularly sub-centres, is a critical link in ensuring success outcomes envisaged in the National Health Mission. Even as several states continue to lag behind on basic metrics pertaining to maternal mortality or vaccination rates, areas where the PHCs and sub-centres don't have access to grid electricity are particularly under-equipped. The enhancements being planned in the rural health infrastructure in the aftermath of the COVID-19 breakout accords a unique opportunity to direct critical public funding towards electrifying the Sub Health Centres.

Energy security is key to better and uninterrupted health services, given that it helps in improving equipment functionality, better delivery system, more functional neonatal care units and finally retention of staff.

The Council on Energy, Environment and Water (CEEW) conducted a first-of-its-kind quantitative and qualitative study⁹³ on the impacts of electricity access via distributed solar on rural healthcare services in Chhattisgarh. The study found that solar-powered primary healthcare centres (PHCs) in Chhattisgarh admitted over 50 percent more patients and conducted almost twice the number of child deliveries in a month compared to power-deficit PHCs that lacked a solar system. The ability of solar powered PHCs to operate cold chain, storing vaccines and drugs, and new-born care equipment also improved significantly in Chhattisgarh. It is clear that overall solarization has increased most of the status of the health care indices in the State.

Figure 43: An image of one of the primary health centres



The assessment report of public health facility in association with solarization in Chhattisgarh: Assessing the functionality and utilization' by State Health Resource Centre, Chhattisgarh 2021, reveals that from the solarized public health facilities in Chhattisgarh around 90 per cent of public health facilities were functional and were using the solar energy for daily health care chores also indicating a slightly better percentage of functionality at rural health facilities compared to urban health facility.

Smaller centres have shown better utilization of solar energy. The area with scarcity of power supply shows good results for the utilization of the solar energy. Smaller centres have shown better utilization of solar energy. Partial usage of solar energy is identified as a gap; it can be addressed by facilitating an orientation of development. Health facility human resources would need the orientation for solar energy for its utility: monitoring and maintenance to establish sustainability for 100 per cent solarization of health facilities in Chhattisgarh.

Table 121: Health Facility and Equipment utilized on Solar energy

SI No	Health Institutions	Capacity of Plant	Uses
1	District Hospital	10 KW (50 KW, Connected to Grid)	All equipment including life supporting devices with small battery bank
2	Community Health Centre	8 KW	Vaccine Refrigerator, OT, auxiliary Units, In/Out door light, fan, computers, other equipment etc.
3	Primary Health Centre	2 KW	Vaccine Refrigerator, In/Out door light, Fan, Computers etc.
4	Sub Centres	1 KW	Light, Fan, Vaccine Refrigerators

Table 122: Details of solar installed in health centres

Utilization in Health Facility	Solarized Public Health Facility	Light and Fan	Per cent for lights and fans (n=984)	Freezer /ILR / Refrigerator	Per cent for freezer / ILR / Refrigerator (n=984)	Computer / Printer	Per cent Comp / Printer (n=984)
DH	10	5	50	3	30	0	0
CHC	95	78	82.11	68	71.58	60	63.16
PHC	509	413	81.14	305	59.92	247	48.53
SHC	370	249	67.3	138	37.3	84	22.7
Total	984	745	75.71	514	52.24	391	39.74

Source: CREDA

Table 123: Percentage of health centres energized by solar as on 31-08-2019

SI No	Health Institutions	Operational Centres	Energised by Solar	Percentage energized by solar
1	District Hospital	27	24	88 per cent
2	Community Health Centre	173	160	92 per cent
3	Primary Health Centre	793	694	87 per cent
4	Sub Centres	5144	309	6 per cent
Total		6137	1189	

Source: CREDA

Challenges: In the current phase of solarization the priority is being the selected frontline health institutions in climatically vulnerable (regions that are flood and landslide prone etc.), geographically remote areas, Adivasi regions and regions with challenges of power supply related to frequent and long power failure, voltage fluctuation. It is usually seen that health centres in geographically remote areas usually either do not have constant power supply or long power cuts or experience voltage fluctuation thus making it difficult to address healthcare needs of the community. The other important challenge is retaining the professional health care staff and their family to stay at the health

Figure 44: Solar E rickshaws used for health-related



(Image source: Shri Sanjeev Jain, Chief Engineer, Chhattisgarh Renewable Energy Development Authority)

centre is in order to provide uninterrupted health care facility for the communities. One of the most emerging challenges is the public health facility infrastructure in order to not only consider installation of solar panels in their infrastructure but also to have climate resilience approach for new buildings.

The three main opportunities that need to be addressed in the future in association with solarization are

1. Climate vulnerability
2. Geographical remoteness
3. Public Health facility Infrastructure

Considering the current COVID outbreak, the State's solarization of health centres was also effective and assisted in reliable management of cold chains for medicines and vaccines, and efficient care services for vulnerable populations like pregnant women, new-borns, elderly, non-communicable diseases, and also maintain internet and thus data sharing/ communication and information systems even in times of power disruption.

Future Involvement: Learning from the recommendations made through the evaluation and assessments Chhattisgarh has a well-balanced and integrated approach planned for development keeping in mind health as a priority, for both preventive and curative. In the long run, the view on solarizing is not just ensure a stable electricity supply to the hospitals and health centres but to provide resilience in the health system and workforce capacity to be able to provide quality health care to the last mile and to every resident in this state. The future plans in collaboration with CREDA are to

1. 100 per cent solarization of Public Health Facility.
2. Improving the utilization of solar energy through capacity building of health care staff for maintenance and monitoring.
3. Guidance document for 'Solarization of Public Health Facilities.'
4. Solar transportation ambulances/mobile clinics

Bridging Gaps between Health Professionals, Community Health Workers and Communities through Panchayat Raj Institution (PRI): Chhattisgarh to emerge as resilient and competent communicators on Climate Change and Human Health

National Program for Climate Change and Human Health (NPCCHH) and State Health Resource Centre (SHRC), Chhattisgarh (Additional Technical Capacity to Health Dept. Govt. of Chhattisgarh). Integrally implemented the program in the state of Chhattisgarh, India. The focus is on 'Impact on Human Health in association with Climate Change and Air Pollution'

Introduction: Over the last 50 years, the global climate is changing as the Earth becomes warmer. Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. Human activities have released sufficient quantities of carbon dioxide and greenhouse gases to affect global climate. **Climate change** is essentially the change in the global temperatures, precipitation, wind pattern and other measures of climate that occurred over several decades or longer which leads to sea level rising, ocean acidifications, and severe impacts on health etc.⁹⁴

Chhattisgarh is located in the centre-east of the country. It is the ninth-largest state in India, with an area of 135,192 km² (52,198 sq mi), with a population of 32.2 million as of 2020. Chhattisgarh is the 17th-most populated state in the country. The climate of Chhattisgarh is tropical. It is hot and humid because of its

⁹⁴ *Climate Change Terms and Definitions - Science and Climate [Internet]. [cited 2019 Jun 25]. Available from: <https://climatechange.ucdavis.edu/science/climate-change-definitions/>*

proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer temperatures in Chhattisgarh can reach up to 49 °C (113 °F).⁹⁵

In recent years we are facing extreme threats of Climate Change, especially due to erratic weather and rainfall. This is greatly affecting the lives of people. As per several studies, Chhattisgarh is one of the most vulnerable areas to the impacts of Climate Change.⁹⁶

Chhattisgarh is a state with highest mines and mineral based industries and **Air Pollution** is one of the biggest threats to the health of the population. Air pollution has a wide range of health effects, such as – cardiovascular diseases, respiratory diseases, hypertension, diabetes, and obesity. Air pollution has also been linked to have a detrimental impact on food productivity – for instance, increase in ground level ozone pollution affects the crop yield. Similarly traditional methods of food preservation like sun drying of vegetables for use in lean seasons, is no longer viable in coal mining and power plant areas due to coal dust and fly-ash pollution.

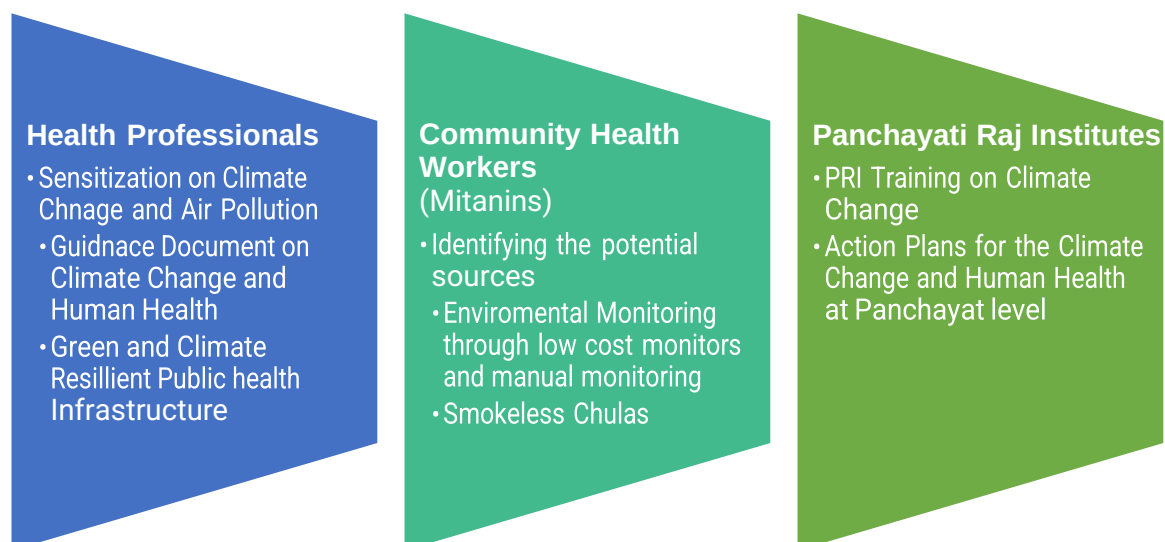
The Process of the Program: Chhattisgarh has been involved in the environmental health impacts work through research and studies since 2016 which was formally got shaped from 2018. Initially the approach was limited to research and studies for evidence with time the learnings and recommendations from that were transformed in the Interdepartmental approach, Sensitization workshops, IEC Material, Training Modules for PRI, Community mobilisation for environmental monitoring. The adaptation of resilient measures for identifying the threats (Air pollution and Climate Change) and the potential sources of PM2.5 and PM 10, impacts and solutions for Climate Change and Air Pollution in association with Human



Health were identified with the communities through Focus Group Discussion (FGD's) and modules for training program and resilient plans to implement to reduce the impacts and combat the threats were prepared with the participatory approach with the key stake holders: health professionals, Community Health Workers (Mitans- apparently played the most important role), Panchayati Raj Institute (PRI Members). The advocacy and communication on health for climate change and air pollution moved in hand in hand in coordinated way with the three-dimensional approach. This is strategically designed as follows:

⁹⁵ Chhattisgarh | Institute. chtnvis.nic.in. Archived from the original on 13 August 2018. Retrieved 5 October 2018.

⁹⁶ <http://cgclimatechange.com/nodal-officer-message/>



Outcomes:

IEC for Air Pollution: *The IEC material reflects the content of the FGD's which were done with the key stakeholders; health professionals, community health workers and Communities. The posters were released by the Honourable Health Minister of Chhattisgarh. The posters were distributed in all twenty-eight (28) districts of Chhattisgarh.*

Training Module for PRI Members: *The PRI training module was prepared with contents on AIR, WATER and LAND Pollution leading to Climate Change impacting Human Health. More than two thousand PRI members have been trained covering around 144 blocks out of 146 blocks of twenty-eight (28) districts.*

Building capacities for Health Care Workers:

Area Coordinators are being trained for manual air sampling from Raipur and Korba, Chhattisgarh.

Low-Cost Air Quality Monitor at UNICEF Office Raipur: *Low-Cost air quality monitor has been installed in UNICEF Office Raipur since January 2019 for real time air quality monitoring.*

Mitigation Activity: Mitans/Community Health Workers promoting 'Smokeless Chula' in the communities. Around one lakh smokeless chulas have been promoted and are being used by families in the communities from twenty-three districts of Chhattisgarh.

Trainings on Air Pollution

Health Professionals demanded training on climate change and air pollution. They seek more guidance on documenting / diagnoses and treatment of diseases related to climate change and air pollution. Communities are becoming more vigilant to raise concerns and take small measures to reduce emission at domestic levels co-benefitting health and climate mitigation measures of which smokeless Chula's are big example. They understand the relation of epidemics and Climate Change, also realizing the severity of COVID 19 with poor air quality. Voluntarily decisions



that PRI members took in order to reduce emissions of PM_{2.5} and PM₁₀ are

- Burning single incense in temple/home instead of burning the whole packet.
- Not burning the waste outside homes but proper disposal.
- Willingly choosing for smokeless Chulas, leading to behavioural change.
- Panchayats promising to serve food in leaf plate (*pattal*) instead of using plastic plates and glasses for his daughter's wedding.
- Understanding the overutilization of fertilizers for agriculture and raising concerns to plan organic manures.
- Panchayats have taken the oaths to ban the use of plastics.



With the process it has been realized to actively address extending the work with the department of urban development and disaster management. The work is continued. The key lessons come from the communities who are conveying the measured change in climate in their own way of understanding the nature, weather and climate and offering solutions to lead studies and make appropriate interventions. Community participation and mobilisation for policy advocacy is one of the main learnings.

The initial understating of human health has widened from COPD and malnutrition. The health impacts on maternal and child health, mental health, health strokes, lightening burns, dermatology, and snake bites are being identified as the potential impacts of climate change on human health.

5.3.8 Mining Sector

Proposed Climate Change Mitigation Activities

Mineral Resources Department is actively engaged in systematic mineral exploration in the state as well as in the mineral administration. Department auctions various mineral concessions, process them within stipulated time and grant the leases to the applicant. Apart from this they also assess and realize the royalty on the minerals produces. Strict checks on illegal extraction of minerals, pilferage of mineral revenue, implementation of rules and regulations by the lessee are being carried out by departmental MO/AMO's through mining inspectors of the concerned districts. The reconnaissance permit granted by Govt. is also monitored by this wing. As per mining lease deed and EC required forestation.

Proposed Mitigation Activities for the Sector are listed below:

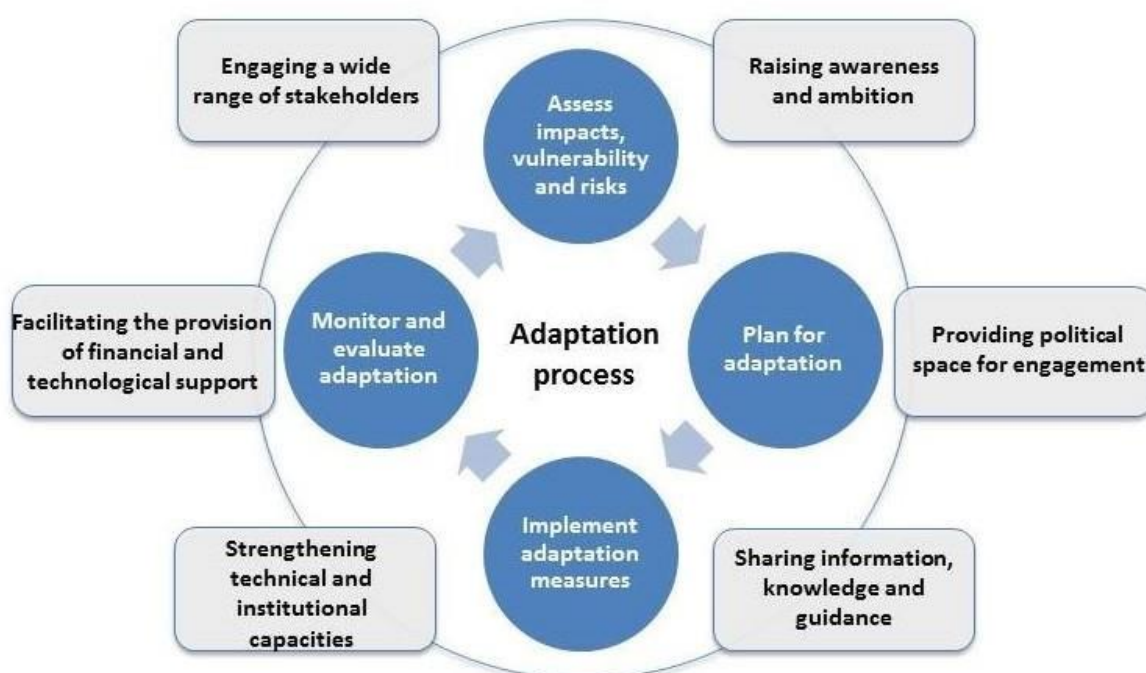
1. **Study on the impact of mining on climate change-** Chhattisgarh specific study on the impact of various mines on climate change and its impact felt on the state should be done to develop a department specific climate resilient mining plan.
2. **Explore cleaner technologies and best practices in coal mining-** Many advanced technologies are now available for sustainable mining of coal. Some of the best practices, and others practiced in the State or other coal mining industries should follow suit.
3. **Capacity building and awareness generation-** Offer training on clean development mechanisms, sustainable mining practices and climate change to the district and field level staff of mining department, officials /engineers from key mining industries in the state.

Chapter 6 – Adaptation

6.1 Overview

Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. In simple terms, countries and communities need to develop adaptation solution and implement action to respond to the impacts of climate change that are already happening, as well as prepare for future impacts⁹⁷.

Figure 45: Adaptation Process recommended by UNFCCC



Source: UNFCC – adaptation cycle under the UN climate change regime, including four general components (<https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean>)

Adaptation in human systems is defined by the IPCC as “the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities”⁹⁸. In the light of the observed and anticipated changes and vulnerability information, adaptation to the consequences of climate change constitutes the cornerstone of the state’s action on climate change.

⁹⁷ UNFCC - What do adaptation to climate change and climate resilience mean?

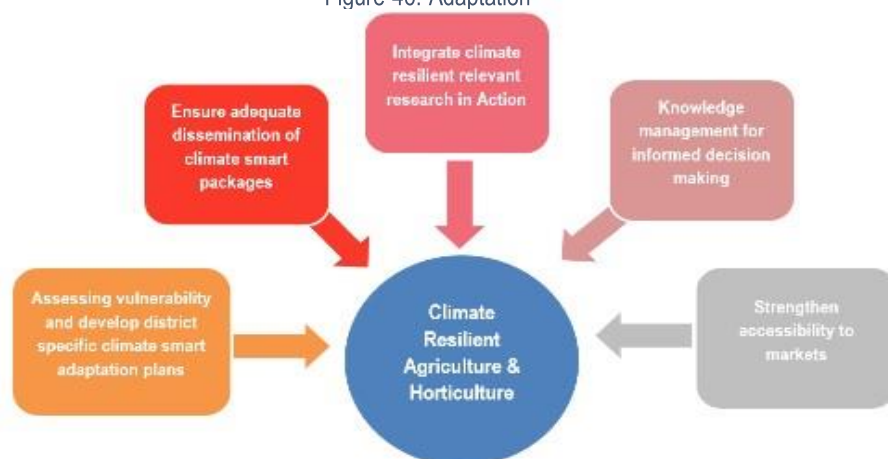
⁹⁸ https://www.ipcc.ch/site/assets/uploads/2018/11/sr15_glossary.pdf

6.2 Proposed Sectoral Adaptation Strategies

6.2.1 Adaptation Strategies for Agriculture and Allied Sector

1. **Development of Climate Resilient Agriculture (CRA) action strategies & its mainstreaming** at decentralized planning and programme design level – Collecting gender-segregated data to develop strategies through stakeholder consultation workshops for districts considering the agro-climatic zones of the State – Making Agriculture climate resilient has the potential of uplifting rural poverty and enhancing the adaptive capacity of the sector as a whole. Concerted efforts are required to realize the untapped potential of this sector. Therefore, an integrated adaptation approach is suggested as a way forward for ensuring sustainability of agriculture crops and horticulture in the State. The adaptation pathway is indicated below.

Figure 46: Adaptation



2. **Assessing and Broadcasting knowledge on appropriate seed rate, soil moisture conservation activities, water efficient technologies including drip irrigation and village operations, Massive and repetitive Climate Awareness programs** – Massive and repetitive Climate Awareness programs. Suitable IEC Material for promoting CRA should be developed. Care should be taken that targeted communication and its documentation are for both genders.
3. **Strengthening the farmers by establishing Farmer Producer Organisations (FPOs) and finding market linkage** – Support formation of Farmer Producer Organisations (FPOs) by creating awareness about FPOs and providing initial handholding support to farmers. Support FPOs in drawing up business plans that include incorporating climate-resilient crops into cropping practices and ensuring that FPC's business plans are of sufficiently good quality that they can be used in negotiating loans with credit providers. Further enable FPCs access financing and credit linkage from banks, financial institutions, donors and government. This initial handholding support is a requirement as the current pace of the development of this scheme is low and more resources are required. Support formation of Farmer Producer Organisations (FPOs) by creating awareness about FPOs and providing initial handholding support to farmers. Support FPOs in drawing up business plans that include incorporating climate resilient crops into cropping practices and ensuring that FPC's business plans are of sufficiently good quality that they can be used in negotiating loans with credit providers. Further enable FPCs access financing and credit linkage from banks, financial institutions, donors and government. This initial handholding support is a requirement as the current pace of the development of this scheme is low and more resources are required.
4. **Develop Water-Efficient Micro-Irrigation methods: individual and community farm ponds** – Groundwater, a reliable resource for drinking purpose and agricultural crop production, has become a major natural resource contributing to the water supply system. Due to its continued withdrawal, it

requires replenishment through recharge. Artificial recharge of groundwater through recharge bores is an important strategy that helps in improving both the groundwater level and quality. In the absence of assured irrigation supply, majority of the crops face water shortages leading the crop failure or reduced crop yields. To tackle this problem, artificial groundwater recharge structures should be installed. These structures will help in improving the groundwater levels and soil moisture enhancement. Thus, improving the overall crop yield.

5. **Establishment of Seed Bank at village level (involve women SHG Group)** – Community Seed Banks fulfils diverse purposes of sustainable agriculture for small and marginal farmers. These seed banks serve as focal point in maintaining indigenous genetic diversity on farm involving farmers community. Community seed banks, therefore, play a vital role in ensuring seed security and improving farmers' access to seeds, conserving agricultural biodiversity and the associated traditional knowledge, providing options for adapting to climate change. It is important to involve women SHG Groups in the seed bank activities at village level.
6. **Establish scientifically designed community-based shelters in all blocks to accommodate at least 300 cattle of small and marginal farmers-with plantations around for reducing temperature of the surrounding microclimate, and water harvesting structure** – With plantations around for reducing temperature of the surrounding microclimate, and water harvesting structure. Livestock is very important for the farmers during the times of distress they depend on livestock. It is another form of income and thus a shelter for cattle will be beneficial for small and marginal farmers.
7. **Organic farming:** State Organic Farming Mission is currently under practice in the State and through which 24,950 farmers have been completed three years on farming 9,980 Ha within this time period. Furthermore, 6,000 Ha area is under the process of conversion to organic farming.

IGKV Action Plan on Climate Change

In view of unforeseen consequences of climate change on agriculture, the greatest challenge lies in providing adequate food to burgeoning population in order to combat hunger and malnutrition. Degrading natural resources, depleting water quality and difficult access to energy confront agriculture with severe challenges in the state of Chhattisgarh. Climate change poses monumental risks for agricultural systems there by impacting economic growth and development, poverty reduction, food and livelihood security. The impact of higher temperatures and erratic rainfall are particularly being felt by the poorest and the most vulnerable section of society. Increasing incidence of climate extremes such as flood, droughts and storms is resulting in loss of life, livelihoods and financial cost.

It is estimated by the Inter-governmental panel on climate change (IPCC) that higher temperatures and greater temperature extremes will hit the country. Furthermore, rainfall is likely to become more erratic with some areas more than they do now and others suffering more frequent and serious droughts. Coupled with rapid economic growth and urbanisation and the effects of climate change, this will be a great challenge for Chhattisgarh seeking sustainable agricultural development. Following the historic Paris Summit on climate change, where in for the first time in the history of mankind nearly 192 countries agreed to take effective and corrective measures to thwart the adverse impact of climate change on human welfare in general, and agriculture in particular. Consequently, the government of India had initiated a number of plans and actions on climate change. In this connection, the state of Chhattisgarh has formulated the State Action Plan on Climate Change (SAPCC). In this regard, the Indira Gandhi Krishi Vishvidhyalaya Action Plan on Climate Change (IAPCC) is being proposed as per the guidelines of the SAPCC as under.

The only agricultural university of the state is mandated to undertake Teaching, Research and Extension activities in the field of agriculture and allied sectors throughout the state.

TEACHING:

The university has in all, 12 constituent Agriculture colleges, two Horticulture colleges and two Agricultural Engineering Colleges where as there are 9 Private Affiliated Agriculture colleges, 4 Private Affiliated Horticulture and two Private Affiliated Agriculture Engineering Colleges offering a total of 1345 intake in Agriculture, 362 in Horticulture and 249 in Agriculture Engineering in the Under Graduate program in Faculty of Agriculture, Faculty of Horticulture and Agricultural Engineering, respectively. Besides, the university also has Postgraduate and Doctoral programs in different subjects of the above faculties. There by, the university is involved in producing quality human resources in field of agriculture and allied sectors since 1987.

As part of Undergraduate, Postgraduate and PhD programs, the Curriculum covers fundamental and dynamic theoretical constructs on various aspects of climatology, global warming and its impact on agriculture and allied sectors, which need to be strengthened with respect to changing climate scenario.

The state of Chhattisgarh has three distinct agroclimatic zones i.e., the Chhattisgarh plain, Northern hills and Bastar Plateau. Looking to the need of creating more and better-quality human resources in agro meteorology, the IAPCC proposes to initiate Post graduate programs in the remaining two zones Northern hills and Bastar Plateau education campuses. Further, the department of agrometeorology at the main campus Raipur shall be strengthened by incorporating multi-disciplinary approach using state of the art modern sciences including GIS, Remote sensing, modelling etc. to broaden the understanding of the impact of climate change on agriculture.

RESEARCH:

The research is organised at the zonal, regional and station level basis. All the three agroclimatic zones of the state are under the jurisdiction of the University. To combat with the agro-climatic zone wise problems it has Zonal Agriculture Research Station in each zone. Some of which derive further strength from regional and other research stations. To combat agro-climatic zone wise problems, it has set up zonal research stations cum colleges in each zone which are made further stronger with regional and research stations keeping all the lead and verification functions assigned to them. The major areas of research in the University consists of weather-based agro advisory service, yield forecasting, crop improvement, crop production, crop protection, identifying new varieties of field crops, vegetables, fruits and flower, forestry, medicinal and aromatic plants, developing agricultural implements, land and water management in different climatic zone.

The University has made great contribution in varietal releases and development of technology packages for crop production especially, for tribal and economically backward farming communities. It has evolved and released more than 52 varieties of different crops, given many recommendations in the areas of varietal selection and crop production and protection, etc.

Under the research activities, the IAPCC proposes the following strategies to address the impact of climate change.

Strategies:

1. Analysing the results of sectoral and zonal climate risk and vulnerability studies (as indicated in the overarching state strategy SAPCC).
2. Building and strengthening International and national institutional linkages with and leveraging the National Initiatives on Climate Resilient Agriculture (NICRA), ICAR institutes including Central Research Institute for Dryland Agriculture (CRIDA), Indian Agriculture Research Institute (IARI), Indian Institute of Horticulture Research (IIHR), Central Institute of Agriculture Engineering (CIAE) and other collaborating centres for technical advice, capacity building and research support including state and sector specific vulnerability analyses, etc.;

3. Providing technical and advisory support to AWS networks (Automatic Weather Stations) to be established by the state department at panchayat level to facilitate Weather Based Crop Insurance Schemes (WBCIS), National Agriculture Insurance Scheme (AIS) and related activities.
4. Developing strategic action plan at the zonal and regional level in the areas of varietal evaluation, crop diversification, appropriate agro-techniques, conserving resources and increase input use efficiency, bridging the yield gaps, and through customized interventions such as use biotechnology to develop improved and diversified varieties of crops (including flood and drought tolerant varieties) and livestock, promoting efficient irrigations systems, especially sprinkler and Drip method.
5. Development and promotion of eco-friendly renewable source of energy in the field of agriculture and allied sectors.
6. Development of capacity building strategies for students, technical staff, and other stakeholders by synergising traditional knowledge, agriculture heritage and modern technology and research.
7. Establishment of meteorological services centre at university head quarter observatory at district level and strengthening of existing observatory with financial and manpower support from state government for providing effective and timely weather services and for development of early warning system with the help of advancement going on in the field of agro meteorology.
8. Development of women friendly equipment and implements to reduce drudgery in agriculture and allied sector.
9. Establishment of Resource Centre for Climate Resilient Agriculture for the State.
10. Identify areas and genotypes suitable for climate-resilient agriculture and allied sectors and develop appropriate agro-techniques interventions.
11. Develop a model for climate-resilient agriculture to address scientific questions on attribution and projection of regional climate change.
12. Develop sector-specific plans for developing early warning forecasting system for increasing crop productivity.
13. Study the impact of climate change on forests and agricultural biodiversity and develop conservation and management approaches.
14. Study the impact of climate change on farm incomes, livelihood and food security and provide alternatives for mitigation strategies.
15. Documentations and validation of traditional and indigenous knowledge related to climate resilient agriculture In Chhattisgarh.
16. To carry out economic analysis of climate resilient agriculture across the agro ecological zones of Chhattisgarh.
17. Mapping the potential of growth: – The biodiversity of agricultural and horticulture would be mapped by the systemic collection, classification, and conservation of the existing, rare and underutilised species.
18. Diversification of agriculture: In view of climate change and increasing climatic variability, diversification of agriculture is imperative. In order to ensure sustainability as well as economic viability promotion of crop diversification and production and high value crop, high yielding varieties and value addition of existing agriculture produce would neutralize the adverse impact of climate change on state agriculture to a great extent.
19. Development of bio-fortified nutritional varieties of rice and millets along with root and tuber crops for nutritional security under changing climate scenario.
20. Identification of suitable area as well as crops for organic farming and development of appropriate organic farming methods.
21. Identification of suitable crop varieties to increase tolerance to water and heat stress and development of agro-techniques and coping strategies for crop production such as SRI, aerobic, direct seeding, frost management in horticulture, nurseries for delayed monsoon, custom hiring centres for timely planting, location specific intercropping systems with high sustainable yield index.
22. Modification and strengthening of traditional methods and agro-technologies.

23. Sustainable Nutrient management: Development of integrated plant nutrient management system (IPNS) for major crops, increasing fertiliser use efficiency and improving soil organic matter.
24. Soil and water conservation: Development of soil water conservation techniques through permanent soil cover, conservation agriculture, increasing cropping intensity and application of zero tillage. Soil health testing and appropriate recommendations, micro watershed management.

C. EXTENSION

Extension activities relating to the transfer of improved technologies, front line demonstrations, advisory services, training, publicity and documentation, diagnostic services, adaptive research, crop surveys, refresher courses for extension workers and farmers etc. are coordinated by the Directorate of Extension. Trainings, demonstrations of improved technologies, exhibition, melas, gosthi etc. conducted under various projects and colleges are however the boundaries of this Directorate in addition to activities performed by Krishi Vigyan Kendras (KVKs). The extension activities are based on the feedback received from the ground level as per need of the farmers. The Directorate has 20 Krishi Vigyan Kendras (KVKs) located as Ambikapur, Bhatapara, Bilaspur, Dantewada, Dhamtari, Durg (Anjora), Jagdalpur, Janjgir- champa, Jashpur, Kanker, Korba, Korea, Kawardha (Kabirdham), Mahasamund, Rajnandgaon, Raigarh, Narayanpur, Balrampur, Gariyaband and Bijapur. These KVKs would serve as focal points for the effective execution of IAPCC in the state. Promotion and creation of awareness and skilled development of farmers, young educated unemployed youth and women on climate-resilient agriculture. Collating, disseminating and demonstration of appropriate climate-resilient crop production technologies and skill development.

6.2.2 Adaptation Strategies for Forests and Biodiversity Sector

1. **Continuing “Sustainable Forest Management” practices** – These actions including restoration of forest landscape, enrichment of vegetal cover, conservation of water bodies & recharging of groundwater within forest areas towards managing soil moisture will help enhance biomass production and organic carbon content in the soil, thus, combating desertification and combat climate change.
 - a. Adoption of a wide range of locally suited soil moisture conservation measures including stone and vegetative check-dams and contour trenches on slopes through planning at the micro-watershed scale with the community participation. This approach will build the resilience of the community to climate change by supporting their natural resource dependent livelihood and will also increase the water availability during the dry seasons.
 - b. Already practised in watershed areas, investment in soil and moisture conservation measures would have to be significantly higher and such higher provisions have to be made in regular RDF schemes and through Suraji Gaon Scheme so as to cover a larger area. This scheme has mitigation and adaptation co-benefits.
2. **Climate change related sensitisation, awareness generation and capacity building of forest department staff and allied sectors** – The front-line staff and the policy makers of the various key sectoral departments including forest should be updated about the changes in the climate and measures to tackle climate change at the ground level, for this to happen regular training and awareness building will be undertaken by the Chhattisgarh State Climate Change Centre under the Forest Department.
3. **Conserve wildlife and its habitat, assessing the threats to biodiversity and wildlife** – Effective implementation of management plans is needed to conserve and improve the status of wildlife and biodiversity in the state.
 - a. A research study on the long-term effects of climate change on plant species and wildlife is needed in Chhattisgarh.

- b. Steps will be taken to augment the water available to wild animals, more water bodies will be created in forest and protected areas. The existing water bodies will also be renovated regularly.
- c. The fragmented forest landscapes will be linked through corridor development measures in order to maintain their connectivity to facilitate movement of long-ranging wild animals.
- d. An improved communication network through equipment such as VHF radios /mobiles, vehicles, as well as camp sheds and watchtowers are needed to facilitate the protection and conservation of forests and wildlife.

4. **Increasing and realising livelihood opportunities near forest area** – There are tremendous works which have already been taken by the forest department to provide livelihood/ income generation activities through Joint Forest Management and Minor Forest Produce based initiatives. These initiatives will need to continue in more scientific manner to ensure sustainable support to local communities. This will help adopt the adverse effects of Climate Change. There is also scope to develop new research-based initiatives such as tea plantations in Jashpur Forest Division. Additionally, promotion of eco-tourism will focus on a better understanding of nature and wildlife conservation along with climate change while generating income and opportunities for the local communities thereby also building their climate resilience. There is opportunity to promote eco-friendly practices around the tourist spots within or nearby the forest areas.

Additionally, as per forest sector vulnerability assessment carried out by Prof. Dr N H Ravindranath, IISc Bengaluru (report attached as Annexure II), large parts of forests, in the southern and central parts of Chhattisgarh are not likely to be impacted by climate change, under the climate change scenarios and the vegetation model used. In a few northern districts of the state, climate change may impact various aspects of forest ecosystems, including shifts in vegetation types, loss of biodiversity and forest dieback. The impacts of projected climate will be visible over decades. However, there is a need for evolving and initiating the adaptation strategies now to minimise the potential adverse impacts of climate change, as adaptation measures take time to establish and become effective. Forest adaptation strategies can be considered under three broad categories as a precautionary measure in all regions:

- Silviculture practices
- Conservation oriented measures
- Policy and institutions

The precautionary adaptation strategies under the three categories are elaborated in the following sections.

i) Silvicultural Practices for adaptation

- Promote natural regeneration and mixed species planting in the afforestation programmes to enable risk spreading, and also to increase genetic diversity.
- Anticipatory planting of tree species across latitudinal and altitudinal gradients, in particular identification of species from warmer districts and their promotion in districts projected to become warmer.
- Develop and adopt climate resilient silvicultural practices.
- Climate-resilient afforestation and reforestation programmes and practices that seek to establish natural potential vegetation with native species and complex structure.

ii) Conservation oriented policies and measures for adaptation

- Assisted migration to maintain or improve migration corridors, including active management to improve survival along the shifting vegetation especially in the transitional zones and by translocation of species.
- Linking of Protected Areas, Corridors and Fragmented Forests; Maintain large-scale landscape connectivity through a network of strict conservation areas

- Identify critical forest corridors and fragmented forests and promote ecosystem restoration through climate-resilient afforestation and by managing non-climate disturbances.

iii) Policies and Institutions

- Promote social forestry, farm forestry and urban forestry to reduce dependence on remnant natural forest areas and thereby maintain and strengthen their long-term resilience.
- Build resilience in communities through agroforestry and plantation forestry, incorporating climate-resilient practices such as promotion of mixed species and native species.
- Conserve forest biodiversity, promote agroforestry and plantation forestry on farmlands, and community lands incorporating multiple tree species providing:
 - Diverse livelihood opportunities: economic products (fruits, seeds, etc.), apart from timber and fuelwood to build resilience among the farmers by supplementing their income and to reduce their dependence on natural forests.
- Adopt the strategy recommended in Greening India Mission to promote synergy between climate change mitigation and adaptation.
- Undertake long term monitoring of changes in forest vegetation to changing climate, particularly focusing on biodiversity.
- These measures also contribute to mitigation.

Adaptation Projects; Examples

Adaptation projects will have to be selected by the state Forest Department, through a consultative process. However, a few titles of projects for promoting adaptation are listed below for Chhattisgarh, since only a small part of the forest in the state is at risk of being impacted by climate change.

Table 124: Examples of Adaptation Projects

Project title	Location	Activities
1. Climate-resilient afforestation and reforestation in Northern districts of Chhattisgarh (These activities also contributing for mitigation)	Koriya, Bilaspur, Janjgir-Champa and Raigarh; pockets or grids identified to be impacted by climate change by modelling.	1. Develop afforestation and reforestation modules or models for the identified districts 2. Develop silvicultural practices for different afforestation and reforestation modules or models; especially tree species choice and mix. 3. Implement and monitor the afforestation and reforestation projects
2. Monitoring the impacts of climate change on forests and biodiversity in Chhattisgarh through long term forest plots;	Sample Districts or Forest Divisions or forest types (to be selected by the Forest Dept.)	1. Define the objectives of long-term monitoring of impact of climate change on forests and biodiversity. 2. Develop ecological, soil and vegetation monitoring protocols and methods 3. Select locations for laying the long-term monitoring plots. 4. Identify institutions for monitoring the identified parameters.

3. Linking Forest corridors to bridge forest fragments and promote migration of plant and animal species.	Based on FSI maps identify or select districts and forest divisions with maximum potential for linking forest fragments by Forest Dept.	1. Identify and map corridors and locations for forest regeneration to bridge or link the forest fragments. 2. Develop Forest regeneration models or modules for different districts. 3. Develop silvicultural and vegetation management practices to link corridors. 4. Implement Forest regeneration measures. 5. Develop community participation strategies in the corridors.
4. Refining the State's policies and initiatives for eco-tourism (especially in protected and other wilderness areas) and bio-cultural tourism through a critical re-examination/appraisal of existing plans, programmes, and activities	National Parks	The eco-tourism policy will focus on promoting better understanding of nature and wildlife conservation along with climate change while generating income and opportunities for the local communities thereby also building their climate resilience. Focus will be to promote eco-friendly practices around the tourist spots (such as promotion of carbon neutral zones, ban on plastics etc.) and adopting low impact tourism that protects ecological integrity of relatively undisturbed areas. Educational material and posters on climate change should be developed for general public/tourist awareness on climate change and its potential impact on the local ecology.

6.2.3 Adaptation Strategies for Water Resources Sector

Some of the key climate adaptive strategies that will be relevant for the state are listed and explained below.

1. **Increase Water use Efficiency in the Irrigation Sector** – The National Water Mission on Climate Change proposes enhancement of water use efficiency in the irrigation command areas by 20 percent. The state government has proposed lining of canals and undertaking canal rehabilitation work under the rehabilitation of canal networks, including lining/ construction of the field channel. Upgrading / rehabilitating will be given higher importance, many water storage infrastructures suffer from excessive sediment / silt accumulation that result in reduced storage capacity. Rehabilitation of the embankments and other repairs should necessarily be accompanied with removal of sediment / silt.
2. **Groundwater Conservation Measures** – Given the hydrogeology of Chhattisgarh, any plan for groundwater conservation and recharge must be long term and well-conceived. Aquifer mapping would be required and should be a part of the integrated river basin management. In areas identified as over-exploited, intensive programmes for groundwater recharge will be undertaken by introducing rainwater harvesting, recycling and re-using of water. Rejuvenation and restoration of water bodies and groundwater shall be taken on priority. Efforts should also be made to change the cropping patterns by introducing less water intensive crops so that pressure on groundwater can be eased.

3. **Watershed Management Interventions** – Considering the hilly and undulating topography of certain regions and the high rate of surface runoff, implementation of projects following 'Ridge to Valley Concept' for integrated water management will be given priority and watershed management interventions such as contour bunds, check dams and gully plugs would serve to arrest the soil erosion as well as improve the yield of rain-fed crops grown during the Kharif season.
4. **Special Plan for Augmenting Drinking Water Facilities** – For long term security of drinking water supplies, it is important to move away from bore well based individual village and hamlet schemes to large surface water systems that can provide reliable supplier of high-quality water, as the former cannot guarantee source dependability and chemical quality for portability. The demand for safe and clean drinking water is increasing with the increasing population, both in rural as well as in urban areas. In order to meet the increasing demand of safe and clean drinking water for the people of Chhattisgarh, a serious effort with time bound action plan shall be worked out to augment the live capacity of existing reservoirs dedicated for supplying drinking water through debilitation or by adopting other effective technical interventions including saving water by checking leakages in drinking water supply pipeline are short-term measures. In view of growing urban demand for drinking water, the Government will take initiative for the construction of large reservoirs near thickly populated cities for the supply of drinking water.
5. **Research, Development and Promotion of State-of-Art Technologies in Water Sector for Improved Irrigation Techniques** – Introduction and promotion of new technology for more efficient and productive water-use namely drip and sprinkler shall be undertaken. The reuse of water for non- irrigation and non-drinking purposes by recycling and effluent treatment should be promoted. The State shall undertake to promote the development, adaptation and dissemination of affordable and appropriate water and agricultural technology and expand the knowledge base through its various institutions.
6. **Capacity Building and Awareness Generation on the Sectoral Impact of Climate Change** – There will be a need to enhance the capacity of the State water resource department on identifying, addressing and resolving conflicts that could arise out of water availability and associated allocation issues due to climate-induced events such as droughts. Such capacity will be particularly required in the line departments that are involved with the water related issues in the river basin. This includes the departments responsible for water resources management, agriculture, rural development, urban development and industries.
7. **Research on Basin Wise Impact of Climate Change** – It is important to undertake basin wise analysis to identify impacts of climate change on precipitation and other hydrological components in the basin especially in terms of extreme events of floods and droughts so that appropriate adaptation options can be devised. Efforts shall be made to undertake these studies.
8. **Institutional Reforms to Address Water Distribution and Use Issues in Climate Change Context** – Establishment of Chhattisgarh State Water Management Institute will be completed for surveying, research, consultation and evaluation of water management schemes in the state, reviving 'Water User Associations' to effectively manage irrigation systems and transfer of management functions to the Water User Associations will be systematically done to improve system-wide efficiency within each basin.
9. **State Water Policy Reforms** – Inclusion of sectoral climate change-resilient policy in the State Water Policy, 2012 and preparation of the 'Action Plan for Water on Climate Change'. This action plan will serve as the roadmap for climate-resilient planning of water resources activities in the state.

10. **Early Warning System (EWS)** – Drought is a usual occurrence in virtually all regions of the Chhattisgarh. Floods and droughts are natural hazards that cause damage and extensive human suffering. The situation shall be even worst under future climate scenarios. Managing flood and drought risks in an informed and effective way is of utmost importance to reduce damages. The flood and drought risk management, including the development of monitoring and early warning systems is need of the hour. EWS shall help the farmers as well as policy makers in taking time.

6.2.4 Adaptation Strategies for Urban Development Sector

1. **Augmenting water availability in urban area by focusing on expediting the laying of pipelines for providing drinking water supply within all premises & Provide uninterrupted availability of safe water to meet the per capita norms of water supply** – For long term security of drinking water supplies, it is important to move away from bore well based individual village and hamlet schemes to large surface water systems that can provide reliable supplies of high quality water, as the former cannot guarantee source dependability and chemical quality for portability. The demand for safe and clean drinking water is increasing with the increasing population, both in rural as well as in urban areas. In order to meet the increasing demand of safe and clean drinking water for the people of Jharkhand, a serious effort with time bound action plan shall be worked out to augment the live capacity of existing reservoirs dedicated for supplying drinking water through debilitation or by adopting other effective technical interventions including saving water by checking leakages in drinking water supply pipeline is under short-term measures. In view of growing urban population demand for drinking water, the Government will take initiative for the construction of large reservoirs near thickly populated cities for the supply drinking water. Furthermore, maximised use of surface water for drinking purposes through strategies aimed at promoting wider adoption of rainwater harvesting system is also considered as a strategy.
2. **Increase plantation on non-forest land. Urban and Peri Urban Plantation Programs** – To dissipate heat in open areas built up due to heat island effect design landscapes dotted with greens that can cool the microclimate (focus on 3 cities that have very high temperatures in summers w.r.t. other cities in Chhattisgarh).

Solid Waste	• Operationalising waste to energy and compost plants • 100 per cent segregated door to door waste collection • Scientific closure of dumpsites, construction of sanitary landfills • Regulation, mechanisms and facilities for construction and demolition (C&D), plastic waste, and recyclables management
Domestic Wastewater	• Setting up decentralised wastewater treatment systems and adopting methane recovery for energy generation and performance efficiency in sewage treatment plants • Sewerage network expansion in sync with augmentation of treatment capacity • Connecting septic tank systems to sewer network • Promote recycling/reuse of wastewater

3. **Rejuvenate the Water Bodies** – Focus of Government is on holistic development of water bodies to ensure that there is no encroachment, and the water feeder channels are intact. This will help in increasing the water holding capacities of urban areas, thereby reducing the impact of urban flooding.
4. **Promoting use of electric vehicle** – Considering the climate change impacts, promotion usage of electric vehicles is being carried out by planning for charging stations. **EV for government usage on pilot basis at Raipur.**

5. **Promotion of Solar rooftop system on Government building** – in order to promote clean energy withingovernment buildings or to make the buildings energy efficient or sustainable it is under planning process to establish solar rooftop systems on government buildings under the jurisdiction of ULBs.

6.2.5 Adaptation Strategies for Transport Sector

1. **Institute of Driving Training and Research (Central Gov.)** – There is a plan to set up Driving Training and Research Institute (IDTR). The work construction has been completed by the construction agency Public Works Department in Tenduwa (New Raipur). For the said project,purchase of furniture and other materials, A Five- member Central Purchase Committee has been constituted under the chairmanship of Additional Transport Commissioner. Also, the mechanization work is under process.
2. **Provision of Weigh Bridge to control overloading of goods vehicle** – Purchase and installationof wave-bridges to check overload of vehicles: - At present 16 border check posts have been started. Wave-bridges are being procured for effective control over illegal operation of vehiclesand overloaded vehicles of other states. Similarly, the enforcement staff operating under the Transport Department can take effective action against overloading of vehicles and check these vehicles and get the vehicle weighed by wave-breeze immediately in front of them. For this, 42places in the state have been identified for setting up way-bridges, along with a budget provision of Rs. 9.006 crore for this work. A seven-member committee has been constituted under the chairmanship of Additional Transport Commissioner to implement the said scheme. Proceedings for purchase of wave-breeze are under process.

6.2.6 Adaptation Strategies for Energy Sector

Adaptation in human systems is defined by the IPCC as “the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities”. In the light of the observed and anticipated changes and vulnerability information, adaptation to the consequences of climate change constitutes the cornerstone of the state’s action on climate change. In line with the sectoral and vulnerability information presented throughout chapter 4, the following areas can be considered as the key adaptation strategies for the state of Chhattisgarh.

Improve distribution infrastructure is the focus of relevant department. This is being done to ensure development of resilient distribution infrastructure that can withstand extreme climatic conditions. Energy conservation building codes are being implemented in the state. Primary ECBC implementation is a mitigation measure but has adaptation co-benefit. For example, better insulation for energy conservation, also contributes to protecting home dwellers extreme heat and cold conditions south side.

6.2.7 Adaptation Strategies in Industry Sector

1. **Review of Chhattisgarh State Industrial Policy 2019-24 to address CC Concerns:** As the industrial sector is a large emitter of Green House Gases; Climate Change aspects could be integrated in the industrial policy to promote low carbon technologies.
2. **Devise an integrated water management plan for industrial clusters:** Industrial sector is among one of the largest consumers of water and effective measures should be taken to enhance

efficiency, recycle and reuse of water to reduce the current consumption pattern. As the vagaries of weather continue to rise, particularly precipitation, water conservation is becoming increasingly necessary. In order to control the excessive extraction of groundwater during times of drought, industries must increasingly rely on water from harvested sources. This is particularly true of industries and industrial clusters that consume significant quantities of water for their production and manufacturing.

Through this initiative, a mechanism would be devised in order to encourage industrial clusters either singly or collectively to plan and adopt water conservation measures like rainwater harvesting, installing water saving equipment, building water conservation structures, repairing drainage pipe leakages etc. This step will build the climate adaptation capacity of the industries during the drought years by storing and supplying water from the water conservation practices without depending on the external water sources.

3. **Capacity Building and Awareness programmes on climate resilience:** Capacities of different industries should be built for better decision making and efficient operations. Awareness program should be focused on carbon and water footprints and devising audit systems in all organisations for monitoring their sages per unit of production. Involve State Industrial units in a dialogue on Climate Change issues by emphasising on the cost effectiveness of the initiatives taken in this direction.
4. **Research and Development:** Industries should pool the resources in research activities to develop state-specific eco-friendly and climate-resilient technologies. Stress should be laid on developing industrial networks based on recycling and reuse of the materials. Energy-efficient technologies should be developed and adopted to reduce the energy usage.

6.2.8 Adaptation Strategies for Mining Sector

1. **Prepare mineral centric (example-coal or iron) sustainable mining plan-** Chhattisgarh has large reserves of coal, iron and bauxite mines; and mining closure plan is the pre-requisite before granting lessee to the mining companies, yet it has been observed that many mining companies fail to comply and abandon these sites after mining, mostly to cut the cost involved in restoration. Preparation of mineral specific sustainable mining plan will provide a roadmap to these mining companies for ensuring that restoration and rehabilitation actions of these sites are done parallel to the mining activities, so that additional time and cost can be brought down, and better compliance can be ensured.
2. **Prepare an action plan for reclamation and rehabilitation of old abandoned mines -** Under this exercise mapping of the abandoned mines in the state should be done, after which a detailed restoration plan for these mining should be prepared in convergence with the other key sector departments like forest, rural development tourism etc.
3. **Conduct heat Island study in mining areas and Construct rest shelters with plantations in mining areas to provide shelter during heat wave conditions-** Most of the mining areas are suffering from heat wave conditions. It is essential to provide workers with shelter as well as their families in the area. In order to understand the scale of the issue, it is important to conduct a heat island study in these areas which can done under corporate social responsibility (CSR) with the respective mining companies in the area.

6.2.9 Adaptation Strategies for Health Sector

1. **Institutionalise studies to understand the possible impact of Climate change on health in context of Chhattisgarh (Focus on Women and Child)** – A detailed and systematic study on the climate sensitivity of diseases outbreak with focus on both vectors borne and water borne diseases including assessment of climate vulnerability of individuals, groups, communities and health system is required. The study should focus on historical data availability in different climatic zones and identify trends and find a link between climatic conditions and spread of diseases. The international research on disease outbreak and climate patterns should be studied 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. Standardised reporting system for reporting and periodic sharing of state health reports with relevant departments.
2. **Integrate Climate Change considerations into the state Health Policy** - This activity includes a compressive review of state health policy and assessment of climate-stressed areas to make provisions of dedicated trained staffs and labs, as well as the placement of buffer resources. The policy would ensure to have judicious placement of the staff needed for diagnostic, referral, and transport services in the stressed areas. They must be equipped with adequate consumables to enable them to undertake early detection, prevention, and recovery measures.
3. **Develop mobile-based application on disease outbreak forecast and prevention measures-**
A quick, hands-on application can be designed to help primary health centre workers and other health professionals to identify the evidence-based disease outbreak reports at a decentralised manner. This will enable the health workers to access data directly from the residents under the jurisdictions of primary health centres.
4. **Strengthen the approaches to managing water & vector-borne diseases that have worsened because of the impacts of climate change** – This activity would expedite disease surveillance, entomological study, vector control measures, and environmental engineering.
5. **Strengthen the approaches to dealing with the heat wave conditions exacerbated by the impacts of climate change** - Mapping and documenting the current initiatives and activities undertaken against Heatwaves in Chhattisgarh. Further assessment of the magnitude of the Heatwave related morbidity and mortality should be conducted. The assessment should cover the community vulnerability assessment to identify the most vulnerable sections of the society to Heat Wave and suggest alternate models for resiliency building which are contextual. The state should then prepare a Heat action plan by incorporating the economically weaker section, alternate livelihood strategies for vulnerable populations and involvement of various stakeholders/ sectors to support in the implementation of the plan.
6. **Sensitisation and capacity building for state health department officials** – Plans would be designed to sensitise hospital staff, rapid response teams, and the five-member quick reaction team from each village to the issue of disaster response and climate change. Plans would be designed to train staff in the use of renewable energy such as solar water heating, rainwater harvesting, and energy efficiency measures to reduce the carbon footprint of hospitals.

6.2.10 Adaptation Strategies for Rural Development Sector

1. **Developing and institutionalizing mechanisms for regular maintenance and management of the assets created under the MGNREGA** – A key focus area of MGNREGA is to implement works that creates durable assets to augment land and water resources and generate ecosystem services that strengthen the livelihood resource base of rural communities. However notwithstanding, the emphasis on NRM under the MGNREGA, several factors impede the realisation of their full benefits. NRM structures themselves are vulnerable to climate shocks. Due to increasing drought severity, for example, water levels in dug wells is reducing significantly and farm ponds are drying up much faster. In this situation it is crucial to provide adequate management and protection of these assets and plan the infrastructure based on the current and projected climatic situation of the location.
2. **Preparation of community led action plan on climate change and integration of climate resilient planning in the GPDP** – This action aims at encouraging public participation at the village level for environmental protection, water conservation and adopting natural resources like hills, rivers, etc. This would require awareness and capacity building and forming people's committees/groups in each village to protect the surrounding natural resources by adopting them. Village Panchayat would be the focal point for this activity to bring the villagers together for initiating proactive measures for environmental protection.
3. **Increased incomes for target households through alternate livelihood options** – This action is proposed under the State Rural Livelihoods Mission. This mission aims to create sustainable livelihood opportunities in rural areas for poor farmers, landless labourers and others. Some of the programs under this mission are supported to increase incomes of poor households who entirely rely on rain-dependent agriculture. The calculations undertaken here will focus on sustainable agriculture as part of this mission (which has direct climate change relevance) as well as alternate livelihood options. The alternate livelihood options considered here are based on the existing good practices and case studies. These are the options which are less vulnerable to climate change than traditional farming as a livelihood option.
4. **Continue the livelihood focused, people-centric integrated watershed development programmes in rain-fed areas vulnerable to climatic variations** – This action has a clear adaptation benefit as sustainable livelihoods will reduce vulnerability of rural poor to climate risks of unseasonal variations in rainfall and temperature and give greater capacity to cope with future water shortages etc. This benefit becomes very important as climate change impacts become more intense in future. The important co-benefits of this action are soil and water conservation through sustainable agricultural practices and gender benefits on account of woman participant from a vulnerable household. Rural women are the most important beneficiaries of this activity. They are empowered with alternate sources of livelihoods and occupations, increased incomes and greater decision-making authority at the family and village level with this action.

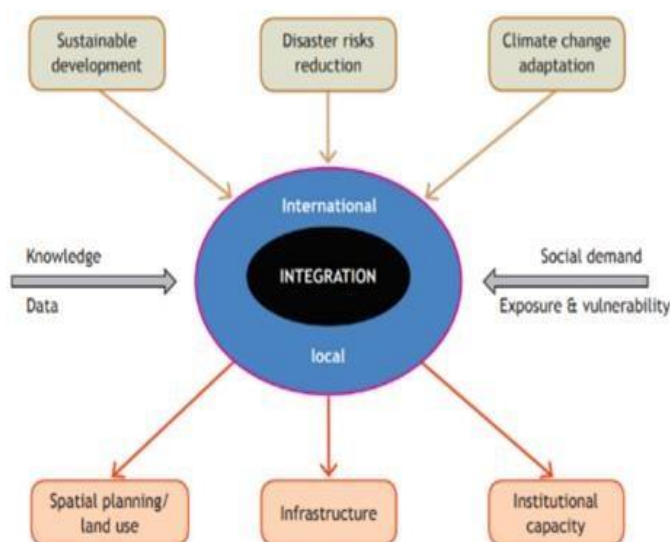
6.2.11 Adaptation Strategies for Disaster Management Sector

1. **Develop district level management plans to deal with multiple hazards including flash floods, fire, lightning, heat waves etc.:** In a changing climate context and identification of key sectors with the highest concentration of risk and prepare concrete measures for Disaster Risk Reduction. This planning at the decentralised level will improve the climate change resilience of the climate- vulnerable locations of the state.
2. **Development of Drought Mitigation Action Plan:** To identify the drought vulnerabilities in the state and develop an action plan for these areas to improve farmers' resilience. Actions like using water more efficiently and developing more drought-resistant crops will help prepare for both future

droughts due to climate change and will improve the adaptive capacity of the climate vulnerable farming community.

3. **Develop an integrated flood, erosion, and sediment management Action Plan for the major river basins:** This work should be done in convergence with the Water resources department for the management of the river basins and development of climate resilient infrastructure for prevention of flooding in the river basin area.
4. **Set up an integrated capacity-building protocol covering shelter and a self-help group under the Community-Based Disaster Risk Reduction Framework (CBDRF), including college and school volunteers and officials at the state and district levels:** The role of capacity development in disaster risk reduction has been well proven in many states. The investment in institutions and processes to manage disasters has helped reduce casualties and aid in quick recovery. Therefore, plans to build the capacity of the community from the shelter level to the decision-making members

Figure 47: CCA & DRR Integration Framework



of the Panchayats, teachers and students in schools and colleges, and district and state officials through an integrated framework needs to be prepared. The capacity building will be attempted in areas such as early warning, precautions related to health and hygiene, and livelihood restoration.

5. **Mainstream CCA-DRR in flagship schemes:** Mainstreaming Disaster Risk Reduction & Climate Change Adaptation (DRR & CCA) concerns into development means radically implementing DRR & CCA measures through development plans, ongoing schemes and projects under the aegis of various departments/sectors, so that it becomes a normal practice for emanating risks of natural hazards to be fully institutionalised within an agency's activities and developmental agenda of a district/region and not just mainstreamed but also decentralised for better management. In this step, concerns related to disaster management have to be addressed by the departments. Also, concerns which could be addressed through the ongoing schemes have to be identified. Strengthening Climate Resilience through Disaster Risk Reduction is an important aspect in this activity.
6. **Strengthen Training Institute (ATI) at state level with enough training resources (search & rescue equipment's, First Aid. Human Resources, literatures etc):** As line departments are not much aware about the impact's climate change and DRR issue, their disaster management plans are more response centric than addressing preparedness and mitigation measures. It is essential to sensitize and train them in certain aspects of DRR and CCA. This platform can also be used to collect the data related to history of hazards/disasters, frequent & prominent disaster of the concerned district, corrective measures taken by the departments and their response/management plans.

Furthermore, all Districts Disaster Management plan (DDMP) and State Disaster Management Plan (SDMP) has been made available on various public libraries and uploaded on the official website: <https://revenue.cg.nic.in>. OR (<http://sdma.cg.gov.in/>). Revision and Updation of DDMP and SDMP 2021 is in progress.

6.2.12 Adaptation Strategies for Women and Child Sector

1. Ensuring participation of at least 33% of women in farmer's training and capacity building program.
2. Gender disaggregated data collection in different beneficiaries' schemes for better gender analysis.
3. Training and involvement of women SHGs for climate resilient agriculture (CRA) practices promotion and value chain development of the CRA crops.
4. Weather based agro-met advisory through SMS to women farmer and in alignment with smart phone distribution scheme with focus on women farmers.
5. Improve Women representation in Water user associations, water management and off-farm livelihood initiatives
6. Knowledge Management
7. While formulating REDD+ projects, analyse and design gender aspects in management and profit sharing of the projects.
8. While including specific climate concerns in the forest plan and the development of biodiversity plans, include separate sections highlighting the disproportionate effect of climate change on women and different social groups and align the plans to address such effects.
9. Encouraging women operated e-rickshaws in cities and peri-urban areas by providing additional subsidies to women.
10. Subsidised public transport fare for women to encourage use of public transport.
11. Involve women SHGs in waste to energy projects (like Ambikapur model in Chhattisgarh)⁹⁹
12. Women health workers, Anganwadi workers should be made aware about various mitigation measures prescribed by public health specialists to manage climate stress.
13. Focus on women's need, especially pregnant and lactating women, special enclosures in disaster relief camps for privacy and sanitation
14. Promotion of skills and employment of women work force in food processing, textile and other MSME sector industries which can reduce their economic vulnerabilities to climate change.
15. Promoting off-grid solar systems, training may be provided to women and marginalized sections to install and maintain the systems by themselves. This will generate livelihood options among the local population as well, the same can be done with bio-fuel generation.

Furthermore,

1. Women and child development is implementing Integrated Child Development Scheme (ICDS) schemes and various other schemes. Providing supplementary nutrition to lactating mothers, pregnant women and children up to 6 years. Supplementary nutrition is a major part which covers of population living in rural and tribal area. Any climate change affects women and children primarily. Women and child development can provide food and shelter in any difficult situation due to climate change.
2. Women and child development is implementing various central government and state government schemes for women living in difficult circumstances. A woman, suffering from sexual harassment, any type of violence or domestic violence can take shelter at SAKHI One Stop center.
3. Women and child development also run different types of Homes for women. These homes can be used as a shelter at time of emergency.

⁹⁹Waste away, Ambikapur shows way; <https://www.indiawaterportal.org/articles/waste-away-ambikapur-shows-way>

4. At root level Mahila Jagruti Shivar are organised. In this shivar legal guidance, government schemes and financial guidance are given to women. This forum will be used for propagating climate change and its effects on women and children.

Gender Specific Climate Strategies

It becomes equally important to include gender-sensitive adaptation measures in the State climate change action plan. This is because a large number of poor, rural women depend on climate-sensitive resources for survival and their livelihoods, they are also less likely to have the education, opportunities, authority, decision-making power and resources they need to adapt to climate change. Though SDGs are gender-sensitive in their composition but in order to implement it so that gender-sensitivity is maintained and/or is addressed collecting gender-segregated data, doing gender-budgeting and developing monitoring indicators focusing on gender remains the key.

If more women are engaged in farming due to extensive male migration (seasonal or permanent), more adaptation funds must be targeted for women and accounted for. Again, adaptive measures to augment water sources must be directed towards women's involvement (as owners, workers, managers, etc.) if women shoulder the responsibility of accessing water. Gender-based budgeting also allows for a robust monitoring, evaluation and reporting tool to address gender-imbalances. Some of the key actions which can be adopted to develop a gender inclusive climate strategy in the state are mentioned below:

Sector	Gender Mainstreaming action points
Agriculture	- Ensuring participation of at least 33 per cent of women in farmer's training and capacity building program. - Gender disaggregated data collection in different beneficiaries' schemes for better gender analysis. - Training and involvement of women SHGs for climate resilient agriculture (CRA) practices promotion and value chain development of the CRA crops. - Weather based agro-met advisory through SMS to women farmer and in alignment with smart phone distribution scheme with focus on women farmers.
Water	- Women representation in Water user associations, water management and also off-farm livelihood initiatives should be given priority - Women PRI members should also be trained about various mitigation measures and mandatory mitigation provisions required to be met by urban and rural local bodies on waste management, water management and land use change under different regulatory framework.
Forestry	- Study on the increased benefits of PM Ujjawala Yojana to women and forest. - While formulating REDD+ projects, analyse and design gender aspects in management and profit sharing of the projects. - While including specific climate concerns in the forest plan and the development of biodiversity plans, include separate sections highlighting the disproportionate effect of climate change on women and different social groups and align the plans to address such effects.

Urban & Transport	• Encouraging women operated e-rickshaws in cities and peri-urban areas by providing additional subsidies to women. • Subsidised public transport fare for women to encourage use of public transport. • Involve women SHGs in waste to energy projects (like Ambikapur model in Chhattisgarh)¹⁰⁰
Health	• Women health workers, Anganwadi workers should be made aware about various mitigation measures prescribed by public health specialists to manage climate stress.
Industry & Mining	• Promotion of skills and employment of women work force in food processing, textile and other MSME sector industries which can reduce their economic vulnerabilities to climate change. • Heat stress action plan implementation in mining areas.
Energy	• Promoting off-grid solar systems, training may be provided to women and marginalised sections to install and maintain the systems by themselves. This will generate livelihood options among the local population as well, the same can be done with bio-fuel generation.
Rural Development	• Training, capacity building and promotion of women SHGs in climate resilient livelihood activities. • Build the capacity of women and gender-focused community-based organisations, SHG groups, women PRI members on climate change impacts and local adaptation planning.
Disaster Management	• Focus on women's need, especially pregnant and lactating women, special enclosures in disaster relief camps for privacy and sanitation

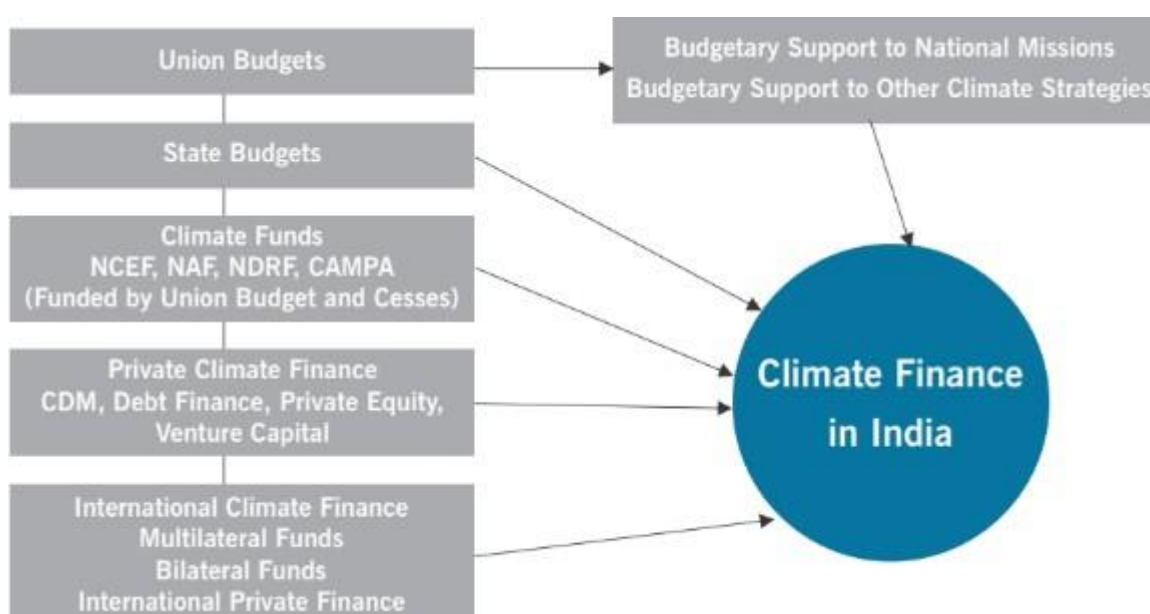
¹⁰⁰ <https://www.indiawaterportal.org/articles/waste-away-ambikapur-shows-way>

Chapter 7 - Financing Roadmap

7.1 Introduction

Climate finance refers to funding that is above the business-as-usual investment from budgetary sources of the state or central sector schemes. Climate Finance in India comes from multiple international (multilateral and bilateral aid agencies, and multinational private firms) and national (domestic budgets and private funds) sources. These funds flow either through the government budgets at the national and subnational level to be managed by the government departments and agencies, or take “off budget” routes or can even be in form of direct project funding to be managed by the private players and non-government organisations at the project level. The biggest portion of climate related funding comes from the domestic

Figure 48: Climate finance architecture in India



budget, both at the national and the subnational level. International and private climate financing sources, while anticipated to play an important role in the future, do not play a very significant role at present. It is important not only to mobilise climate finance, but also to build robust, transparent and accountable public finance system to ensure that funds both domestic and international are used more effectively and efficiently. It is also important to ensure that allocation of funds is more sensitive to the needs of the people, particularly the marginalised and vulnerable. All this is possible through effective public engagement and oversight of the public spending process. It is also important to assess the “climate relevance” of development interventions to assess the financial allocation made towards climate action.

The Revised version of Chhattisgarh SAPCC has focussed on allocating budgets for many identified climate activities from its own sources or existing schemes of the centre and the state. The scheme and budgetary level linkages of the sector-wise climate strategies have been provided in the climate strategies list at the end of every sectorial chapter. In the list, name and details of accessing finances from the State Budgeted scheme and other National Schemes through convergence has been given.

Measures for Mainstreaming Climate Actions in the State Budgets

Most of the actions proposed under the SAPCC are routed through ongoing departmental schemes, flagship national and state-level programmes, it has been observed that significant finances have been

provided under – Smart Cities, Mission for Rejuvenation and Urban Transformation (AMRUT), Mahatma Gandhi Swachh Bharat Mission, MGNREGA, PMKSY, PMAY, PMKKKY, CAMPA, DMF etc. which can be earmarked for the proposed climate actions.

For the additional requirement of funds to support many of the climate actions proposed in the revised SAPCC, the State will seek financial and technical support from the international organisations, bilateral agencies and private parties to fulfil the climate finance requirements for the SAPCC implementation.

Climate Budget Tagging/Coding

Climate Budget Tagging (CBT) is a tool for identifying, classifying, weighing and marking climate-relevant expenditures in a government's budget system, enabling the estimation, monitoring and tracking of those expenditures. CBT is used by a growing number of countries and Indian States to identify and routinely measure climate relevant expenditure within the existing budget system. The tracking of cross-cutting goals such as climate change adaptation and mitigation present challenges to traditional budget management, which is typically structured around organisational, economic and programmatic classifications. Traditional budget management does not normally allow for capturing spending on cross-cutting issues like climate change. CBT has been designed to overcome this constraint, building on the experience from other thematic budget measurement tools, such as for gender, poverty reduction, or children – and also itself providing a platform and body of experience for developing other cross-cutting budget tools. In particular, CBT may provide an entry point to support governments' efforts towards tracking resources for SDGs, bearing in mind that the crosscutting goals of climate adaptation are linked to a number of SDGs. Firstly, CBT can help monitor the progress towards SDG 13 in particular ("Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy"), as well as the climate change aspect that cuts across other SDGs such as SDG 7 (affordable and clean energy). Secondly, beyond its climate focus, CBT can serve as one component of a conceptual model for the State that considers introducing SDG budgeting or budget tracking.

7.2 Possible Sources of International Finance for Implementation of Adaptation and Mitigation Activities

Green Climate Funds – The Green Climate Fund (GCF) aims to become the leading mechanism for delivering the public-sector element of the objective of delivering USD 100bn per year in Climate Change related financing for developing countries. Although the early experience is proving to be challenging, especially for the funding of adaptation projects, the objective is still to deliver USD 10bn of support through the GCF by 2020. India currently gets 11 per cent of global funding for CC, which suggests that it may receive about USD 1.1bn from the GCF.

Adaptation Fund – The Adaptation Fund helps developing countries build resilience and adapt to Climate Change. It was established under the Kyoto Protocol of the UNFCCC. The World Bank is an Interim Trustee for this Fund. Project proposals are submitted to a National Implementing Entity (NIE) accredited by the Adaptation Fund Board (AFB). As of September 10, 2018, the Fund Balance is USD 404.78 million out of a total contribution of USD 737.68 million. Since 2010, it has committed US \$12 million including for 77 concrete localized Adaptation projects. The Adaptation Fund has been providing about USD 7 Million per year to India.

Official Development Assistance (ODA) – India currently receives about 3 billion USD of ODA per year, of which about two thirds are from bilateral sources and one third from multilateral sources. The balance is likely to shift from bilateral to multilateral sources, as India consolidates its position as a middle-income

country. According to the OECD DAC method of reporting Climate Change finance, most bilateral and multilateral sources of ODA devote between 10 per cent and 20 per cent of their funding to actions that address Climate change, as a primary, secondary or implicit objective. Many international partners are seeking to increase this. ADB, for example, has a target of making 30 per cent of its lending related to Climate Change. This could mean that as much as 900 million USD of ODA could contribute to adaptation and/or mitigation by 2020.

Multilateral agencies, like FAO, IFAD, EC, The World Bank Group, etc., are governed by their access modalities and approval system. The countries submit their projects through multilateral implementing agencies (such as the World Bank, the UN Development Programme, UN Environment Programme or regional development banks) for access to multilateral funds.

7.3 Possible Sources of National Level Finance to Implement Adaptation and Mitigation Activities

National Adaptation Fund for Climate Change – The National Adaptation Fund for Climate Change (NAFCC) was established in August 2015 to meet the cost of adaptation to climate change for the State and Union Territories of India that are particularly vulnerable to the adverse effects of climate change. Government has set up a budget provision of Rs.350 crores for the year 2015-16 and 2016-17, with an estimated requirement of Rs. 181.5 crores for the financial year 2017-18 for NAFCC. The project under NAFCC prioritises the needs that builds climate resilience in the areas identified under the SAPCC (State Action Plan on Climate Change) and the relevant Missions under NAPCC (National Action Plan on Climate Change). Chhattisgarh State Centre for climate change has already accessed funding under NAFCC and received a grant approval of Rs. 21.47 Crore for a project on 'Climate Adaptation in Wetlands along the Mahanadi River Catchment area in Chhattisgarh'.

National Mission on Strategic Knowledge for Climate Change – The mission seeks to build a dynamic and vibrant knowledge system that informs and supports national policy and action for responding effectively to climate change challenges, while not compromising on the nation's growth goals. Chhattisgarh State Centre for Climate Change has accessed the fund of Rs. 2.78 crore under this mission for strengthening of the centre.

Green India Mission – National Mission for a Green India or the commonly called Green India Mission (GIM), is one of the eight Missions outlined under India's action plan for addressing the challenge of climate change. The GIM was launched in February 2014 and it is aimed at protecting, restoring and enhancing India's diminishing forest cover and responding to climate change by a combination of adaptation and mitigation measures. Chhattisgarh State Forest Department has already received the funding under GIM, and the department has plans to increase the scope of work for accessing additional funding under the forest sector climate strategies.

7.4 Innovative Climate Financing Instruments

- **Green Bond** – Green bonds are one of the largest and most well-known of the recent innovations in finance. "Green bonds" are instruments that tie the proceeds of a bond issue explicitly to environmentally friendly investments. These include clean transportation, energy efficiency, sustainable energy investments, waste management and climate change adaptation. The Climate Bonds Initiative estimates that bonds explicitly labelled as "green" which earmark 100 per cent of their proceeds to a specific environmental purpose exceeded US\$ 118 billion in 2016. Issuers

of bonds can be supranational institutions (such as multilateral development banks), public entities (municipal, state or federal) or private companies. Several large emerging economies such as Brazil, China, India, Mexico and South Africa have built dynamic green bond markets at the domestic level over recent years.

- **Weather Derivative** – A weather derivative is a financial instrument used by companies or individuals to hedge against the risk of weather-related losses. The seller of a weather derivative agrees to bear the risk of disasters in return for a premium. If no damages occur before the expiration of the contract, the seller will make a profit. In the event of unexpected or adverse weather, the buyer of the derivative claims the agreed amount. This financing instrument can be applicable for projects on introducing climate-resilient agriculture in the State, where the losses due to extreme weather events can be covered by Weather derivative.

7.5 Budget Estimation – CSAPCC-II

The projected budget estimates are given below in the table. The estimates are based on department's existing budgets. The existing budget for 2020-2021 has been considered as base year for budget estimates. The projected estimates showing tentative budget requirement for 2020-21 to 2029-30 for existing department wise climate actions. **A tentative requirement of Rs. 2,75,688.97 Crores** will be required to continue the existing climate actions of the departments. However, there will be requirement for additional budget for special climate change-oriented projects, which can be accessed from different national & international funds or funding agencies as indicated in Summary of Sectoral Action Plans (Annexure IV). The departments are also encouraged to mobilize climate finance from domestic as well as international sources to scale up their climate centric activities. The state centre for climate changewill continue the technical support to the departments for the same as per requirement.

Table 125: Climate Action Budget Overview

Climate Change Action Budget-Overview			
Amount in Crores			
Sl no	Sector	2020-2021 Budget	Projected Budget for 2020-21 to 2029-2030
1	Agriculture and Allied Sectors	9198.73	90344.67
2	Forests and Biodiversity	1364.56	14941.53
3	Water Resources	329.81	3611.33
4	Urban Development	1678.63	18380.53
5	Transport	5261.93	57616.67
6	Energy	895.13	9801.42
7	Rural Development	5292.21	57948.24
8	Mining	29.19	319.63
9	Women and Child Development	863.73	9457.63
10	Industries	412.58	4517.62
11	Disaster Management	717.31	7854.30
12	Human Health	571.96	895.41
Total		26615.77	275688.97

Department wise budgetary projections are attached as Annexure V.

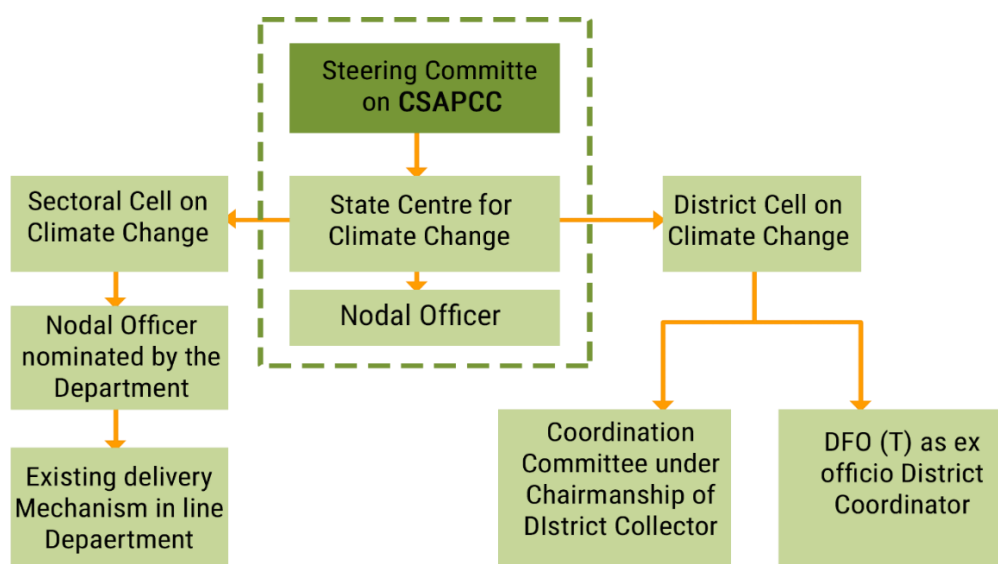
Chapter 8 - Institutional Mechanisms

A state-wide implementation of the state climate change action plan is only possible through the highest order of convergence. This section covers the institutional arrangement for the implementation of the revised Chhattisgarh State Action Plan on Climate Change (CSAPCC). The main principles of this arrangement are to mainstream climate change actions into policies, strategies and programs at the state, district and local level across departments. The revised CSAPCC will be implemented by multiple sectoral departments with the overall coordination responsibility of the nodal department of climate change. This chapter also highlights the steering mechanism through which proposed interventions will be planned, operationalised, and monitored.

8.1 Implementation Arrangement of CSAPCC 2014

The Government of Chhattisgarh has established a Chhattisgarh State Centre for Climate Change (CGSCCC) in August 2015. The State Centre on Climate Change is the apex/nodal body to implement, coordinate and monitor the Chhattisgarh State Action Plan on Climate Change (CSAPCC). The Centre is guided by a high-level Steering Committee, which has already been constituted by the State Government under the chairmanship of the Chief Secretary with members; Additional Chief Secretary / Principal Secretary / Secretary from concerned departments, special invitees / NGO institutions / experts. The Nodal Officer of State Centre for Climate Change is the member secretary of this Steering Committee.

Figure 49: Existing Institutional Structure of CSAPCC 2014 Implementation



The State Centre for Climate Change under the guidance of the Steering committee coordinates with the Department Climate Change Cell in preparation and implementation of department specific action plans. The Department Climate Change cell at each of the identified departments has Nodal Officer who coordinates in the implementation within the department using the existing delivery mechanism and resources. The Centre also coordinates with the District Climate Change Cell, which has been constituted under the chairmanship of District Collector and Divisional Forest Officer (DFO) is ex officio Coordinator in this cell for implementation of Climate Change related activities / plans at District level.

8.1.1 Major Achievements of the CGSCCC (2015 – 2021)

The project is providing manpower support to the State Centre for Climate Change and is being implemented in a comprehensive way to achieve the objectives mentioned in DPR. Some of the major achievements of the project are indicated below:

- A. **Pilot project on “Climate Adaptation in Wetlands along Mahanadi River Catchment Area in Chhattisgarh”**- The pilot project has been sanctioned by MoEF&CC under National Adaptation Fund for Climate Change. The project is being executed by Chhattisgarh State Centre for Climate Change in three districts, namely, Baloda Bazar, Mahasamund and Dhamtari. The pilot project aims to identify impacts of climate change in ecosystems and communities in three wetland sites along the Mahanadi River catchment area in Chhattisgarh and promote climate adaptation through water conservation and demand management and improve the adaptive capacity of farmers and other wetland dependent vulnerable communities. The results of this project will be helpful to plan the Climate Change Adaptation strategies not only to the State but also to similar adjoining States as well.
- B. **Strengthening the State Centre for climate change under National Mission for Strategic Knowledge on Climate Change [SCCC-NMSKCC]**- Under the vision to establish knowledge on climate change in the state with respect to its impact on various sectors and to assess different associated vulnerabilities, project for establishment of Knowledge Management Cell in Climate change center was developed and has received financial support under the National Mission for Strategic Knowledge Management on Climate Change (NMSKCC) mission of the Government of India by Department of Science and Technology
- C. **Streamlining the Climate Actions**
The centre is continuously working on establishment and strengthening of well organised functioning structure for Climate Actions in the State. The State Centre for Climate Change is being established three tier implementation structure in the State with support of this project:

At State Level - The Centre –

- For conducting Studies / Research
- Projects / Programme implementation
- Training & Capacity Building for sectoral departments
- Awareness creation & Knowledge dissemination

At Department Level - Sectoral Climate Change Cell

- For preparation & implementation of Department specific Action Plan
- By nominating Nodal Officer
- Formed in 08 Departments
- Nodal officer nominated by 12 departments

At District level - District Level Climate Change Cell

- Under Chairmanship of District Collector
- Member secretary - DFO
- District officers of concern Departments as member
- Formed in 28 Districts
- To ensure planning & coordination of Climate Actions at District level

D. Strengthening of knowledge and dissemination

Chhattisgarh State Centre for Climate Change (CSCCC) and Knowledge Management Cell is continuously working on strengthening of scientific knowledge base and its dissemination through various interventions under this project. Some of the major initiatives in this regard are as under:

- **Lecture series on Climate Change**

Chhattisgarh State Centre for Climate Change has successfully organised two lectures under the Lecture Series on Climate Change to disseminate the knowledge among local people and government officials.

- In this series eminent scientists, national and international level speakers were invited to share their views and current status on climate change.
 - Two lectures have been organised till date under this series.
 - The inaugural lecture of the series was delivered by Prof. N. H. Ravindranath of IISc, Bangalore on “Impacts of Climate Change on Forest & Biodiversity of Chhattisgarh”, 14th July 2017.
 - The second lecture series delivered on “Climate change biodiversity and sustainable development”, by Dr. Ram Bhooj, Programme Chief, Natural Science Unit, UNESCO Cluster Office for South Asia in New Delhi, on 09th Oct. 2017
 - Participants from various sectors of state departments, policy makers, research & academic institutions, scholars/students from various universities and representatives from different NGOs attended the programme.
- **Website preparation**
Chhattisgarh State Climate Change Centre (CSCCC) launched its official website on 9th October 2017, with the vision to wide dissemination of knowledge on climate change and the initiative of the centre. The website will be in interactive manner, where the visitors can post their questions and suggestions. The link to the website is <http://cgclimatechange.com>.
 - **Publication of newsletter**
Publication of bilingual newsletter is another good practice of the Centre adopted under this project. We have published 16 issues of newsletter till date. The newsletter is based on local, national & international updates in the field of Climate Change and also disseminates the initiatives and good practices of the centre. We also offer to different experts, institutions to submit their views by providing the articles for the newsletter.

E. Documentation of Traditional Knowledge

- Baseline Survey - Documentation of existing scenario, natural resources and their uses, Effect and community perception about Climate Change has been documented in a detailed baseline survey in three forest divisions i.e., Dhamtari, Mahasamund and Baloda Bazar of the State followed by documentation of NTFP resources and their importance under NAFCC project.
- Traditional Knowledge Documentation - Medicinal plants are not only the supplement of the health care system but also plays important role in livelihood security of the Tribal & Rural Peoples. They are the seasonal income-generating commodities in the Country. In this way, medicinal plants can play a crucial role in climate change adaptation. A project on Documentation of Traditional Knowledge of Pahadi Korwa Tribe of Chhattisgarh about the Conservation, Harvesting & Utilisation of Medicinal Plants has been completed successfully by the centre with financial support from Regional cum Facilitation Centre, Jabalpur. Medicinal plants are major plant of Traditional Health Care system in the world. They are being used traditionally to treat different ailments of mankind as well as animals. They are playing a vital role in Ayurveda, which is the most ancient healing system of the Country. Modern societies as well as Tribal societies are used to about the importance and uses of medicinal plants. Unfortunately, due to over exploitation and unsystematic harvesting the medicinal plant treasure of the Country is being degraded now days. The importance like medicinal uses, role in livelihood etc has been documented in the project.

F. Training and Capacity Building

Regular training and capacity building programmes / events were organised by the centre to build the capacity and knowledge base in the project. Total 32 trainings / seminars / workshops were organised by the centre from 2016-17 till date and total 3140 participants got benefitted through these events. The list of these events is given below –

Table 126: List of Training and Capacity Building Activities Conducted

Sn	Training / workshop	Theme / objective	Date	No of Participants
1	New initiative in forestry opportunities & challenges	Capacity building	Sep-16	24
2	Workshop on "India's Intended Nationally Determined Contribution"	Capacity building	26.04.2017	45
3	Training to game guards on Climate Change in Biodiversity	Capacity building	01.05.2017	54
4	Lecture on "Impact of Climate Change on Forest & biodiversity" of Chhattisgarh by Prof. N.H. Ravindranath, IISc Bangalore	Capacity building & awareness creation	14.07.2017	81
5	Training of Trainers on Climate Change	Capacity building	06.10.2017	65
6	Lecture on "Climate Change, Biodiversity & Sustainable Development" by Dr. Ram Bhooj, Programme Chief, Ecological Science, UNESCO New Delhi.	Capacity building & Awareness creation	09.10.2017	68
7	Climate Change Conclave	Capacity building & knowledge sharing	19-20 Dec 2017	123
8	Workshop on "New Initiatives in Forestry - Opportunities & Challenges" for Senior IFS Officers, nominated by MoEF & CC, Govt of India	Capacity building & knowledge sharing	29.01.18 to 02.02.2018	11
9	Traditional health Awareness Camp- NAFCC Project	Promotion of traditional health care practices	21.05.18 to 26.05.18	264
10	Workshop & Field visit for local govt. departments and community peoples for planning of adaptive measures	Capacity building & Departmental collaboration	12.06.2018	70
11	Workshop & Field visit for local govt. departments and community peoples for planning of adaptive measures	Capacity building & Departmental collaboration	10.07.2018	66
12	Workshop & Field visit for local govt. departments and community peoples for planning of adaptive measures	Capacity building & Departmental collaboration	25.07.2018	64
13	Training on Carbon Stock estimation	Capacity Building	30.01.2018	16
14	Trainings on Scientific Non-destructive harvesting and collection pattern of NTFP	Capacity building and Awareness creation NTFP base & Livelihood	August/September 2018	97

15	Traditional health Awareness Camp- NAFCC Project	Promotion of traditional health care practices	20.02.2019 to 26.02.2019	146
16	Brainstorming session for revision of SAPCC	Revision of SAPCC	31.05.2019	65
17	Wetland, Restoration and Enhancement	Wetland Restoration	02.08.2019 to 03.08.2019	25
18	Training Programme on Public Finance Management System	Capacity Building	07-09-19	27
19	Workshop on Building climate Resilient of Central dry lands	Capacity Building	24-09-19	180
20	Role of Forestry in Sustainable Development of people	IFS Training	14.10.2019 to 15.10.2019	22
21	India's National REDD+ Strategy and strengthening REDD+ in Districts	Capacity Building of govt Officials	20.02.2020	25
22	Green Tribunal Authority and Procedure, Forest Conservation Act.	Capacity Building of govt Officials	20.02.2020	33
23	Green Tribunal Authority and Procedure, Forest Conservation Act.	Capacity Building of govt Officials	20.02.2020	18
24	Green Tribunal Authority and Procedure, Forest Conservation Act.	Capacity Building of PWD Officials	20.02.2020	13
25	Workshop on GHG Inventory Capacity Building and Stocktaking	Capacity Building of govt Officials	22.01.2020 to 23.01.2020	48
26	Training on primary health care	Capacity Building	02.03.21	292
27	Prioritization workshop for revision of SAPCC	Revision of SAPCC	25.02.2021	29
28	Primary health care camp	Support in climate adaptation	03.03.21	454
29	Training on Sustainable collection, primary processing and marketing of NTFP	Support in climate adaptation	05.03.21	225
30	Training on Sustainable collection, primary processing and marketing of NTFP	Support in climate adaptation	06.03.21	227
31	Training on Sustainable collection, primary processing and marketing of NTFP	Support in climate adaptation	08.03.21	229

32	1 st Prefinalization workshop for revision of SAPCC	Revision of SAPCC	08.10.2021	34
33	2 nd Prefinalization workshop for revision of SAPCC	Revision of SAPCC	29.10.2021	30
Total				3170

G. Research & Scoping Studies

The centre is regularly working to develop a strong scientific knowledge base by carrying the research and scoping studies. Following studies have been completed as on date i.e.

- Forestry sector review of Chhattisgarh action plan on Climate Change
- Scoping study on Public Transport in Raipur
- Scoping study on climate-smart agriculture in Chhattisgarh
- Baseline survey in three forest divisions of Chhattisgarh under NAFCC Project
- Analysis of Temperature and Humidity in the SFRTI campus and four other sites of Raipur City Chhattisgarh
- Main streaming Climate Sensitive Planning of Budgetary Schemes for Water Resources Department
- Main-streaming Climate Sensitive Planning of Budgetary Schemes for Forest Department
- Mainstreaming Climate Sensitive Planning of Budgetary Schemes for Agriculture Department
- Community-led action plan on Climate Change in Chhattisgarh for Chuhari village in Mahasamund District
- Analysis of Gender and social inclusion in the Chhattisgarh State Action Plan on Climate Change.
- Climate resilient agriculture Training Manuals for farmers in Bastar plateau
- Climate Resilient Agriculture Training Manual for officer level training
- Climate Resilient Watershed Management Training Manual
- Climate Resilient agriculture Training Manual for farmer in central plain, Chhattisgarh
- Climate Resilient Forestry practices in Chhattisgarh Training Manual
- Climate Resilient agriculture Training Manual for farmer in northern hills, Chhattisgarh
- NTFP survey in three forest divisions of Chhattisgarh under NAFCC Project

All reports and manuals are available on our official website (www.cgclimatechange.com) for wide dissemination and use.

H. Other Initiatives

In addition to earlier achievements, the CSCCC is continuously promoting the efforts made by the centre as well as best practices by joining / representing in different **international forums** as mentioned below-

Joining the Under2⁰ Coalition: - A Global Sub-National Initiative: Chhattisgarh State Government has become the second state after Telangana in India to sign the **Under2⁰** MOU on 7th June 2017. **Under2⁰** is a commitment by Sub-national governments to reduce their greenhouse gas (GHG) emissions toward net-zero by 2050. The then PCCF and Head of Forest Force & Nodal Officer on Climate Change, Govt of Chhattisgarh have participated in Under2⁰ Coalition at Beijing, China.

Participation in CoPs (Conference of parties): The Nodal officers of the centre also participated in the CoP-21 at Paris in Dec. 2015 and CoP -23 at Bonn, Germany in Nov 2017 and presented the initiatives taken by the Government of Chhattisgarh in the field of Climate Change.

Participation in International Conferences: The then PCCF & Head of Forest Force and Nodal officer of the centre have participated in International Conference on Climate Change in Heidelberg,

Germany in May 2019 and Under2Coalition General Assembly at Madrid, Spain in December 2019 and made a presentation on efforts taken in the field of Climate Change in the State.

8.1.2 Review of the Institutional structure of the CSAPCC 2014

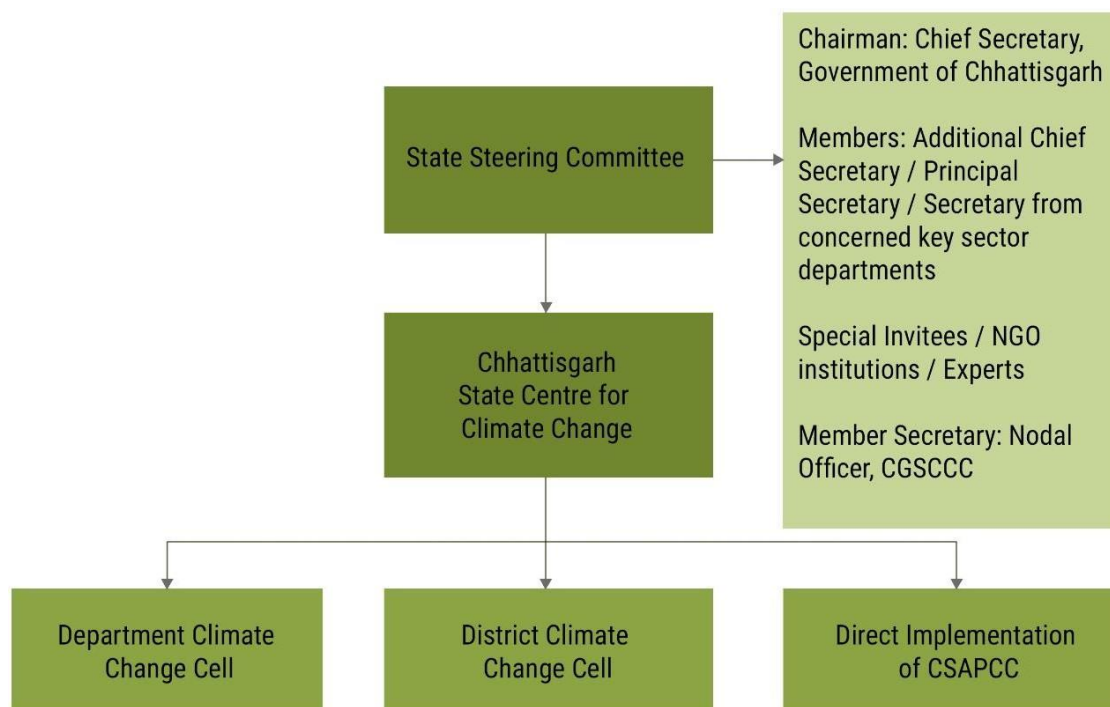
The review exercise was completed in consultation with the stakeholder departments and the Chhattisgarh State centre for climate change. Following were the main observations from the institutional arrangement point:

- The institutional framework is vertically integrated down to the district level administration and horizontally integrated across the stakeholder departments for better convergence across sectors.
- Non-defined structure, roles and responsibilities of the sector and district climate change cell.
- Lack of an annual work plan-based working for the Department and District Climate Change Cell.
- Limited availability of human resources and financial resources for implementation of SAPCC at all three levels.
- The Department and District Nodal Officers don't have a dedicated experienced staff to support in climate change works implementation.
- Limited technical understanding on climate change within the State Departments has constrained the implementation of SAPCC.
- Some of the key departments like rural development, women and child development, disaster management were not part of the key sectors in the previous CSAPCC 2014. These departments are very important to implement the plan at the grassroots level and are being included in the process of revised CSAPCC preparation.

8.2 Proposed Steering & Institutional Mechanism for the Revised CGSAPCC

Based on the challenges and gaps in the previous CSAPCC's institutional frameworks, the following framework is proposed for the revised CSAPCC's implementation-

Figure 50: Proposed Institutional mechanism for the Revised CSAPCC



Apart from the existing eight sectors three more departments have been included in the revised CSAPCC i.e., Rural Development, Disaster Management and Women & Child Development Department making it a total of 12 key sectors that will be involved in the implementation of the revised CSAPCC in Chhattisgarh State. Below is the list of the departments identified as key sectoral departments for the revised CSAPCC implementation in the state-

1. Department of Agriculture and Allied Sectors
2. Forest Department
3. Water Resources Department
4. Urban Development Department
5. Transport Department
6. Energy Department
7. Industry Department
8. Mining Department
9. Health Department
10. Revenue & Disaster Management Department
11. Women and Child Development Department
12. Panchayati Raj & Rural Development Department

8.2.1 Proposed composition and responsibilities of the institutions in the Revised CSAPCC

Institutional Structure	Composition/Membership	Role and Responsibility
State Steering Committee	Chief Secretary is the Chairman with Additional Chief Secretary / Principal Secretary / Secretary from concerned departments, special invitees / NGO institutions / experts. Nodal Officer of State Centre for Climate Change will be the Member Secretary for this committee.	Provide guidance and direction to the CSAPCC activities and identify policy level issues that can be fed to relevant departments for policy development.
State Centre for Climate Change	Headed by the Nodal officer, State Centre for Climate Change, the centre will have a team of climate change subject experts, knowledge management, monitoring & evaluation expert and administrative staff.	To set a platform for interdepartmental coordination on implementation of CSAPCC. To act as knowledge management centre, by strengthening existing knowledge and information base on climate change. To provide a platform for Stakeholder engagement to develop climate adaptation and mitigation in a participatory manner. To ensure direct implementation of projects on climate change adaptation and mitigation in the state. To act as a Monitoring and Evaluation agency in the implementation of CSAPCC. To promote capacity and skills among State Government officials to mainstream climate change issues in development activities, raise awareness on climate change & risk reduction in development activities. To conduct and co-ordinate research and technology development on climate change related subjects.
Department Climate Change Cell	This cell will comprise of Nodal Officer along with sectoral nominees and supported by dedicated trained staff.	It will be the nodal body for informing and supporting various divisions within the department to embed adaptation and mitigation measures within their action plans and their annual budgetary proposals as per the CSAPCC.

		Coordinate the preparation of annual programmes with targets and assigned responsibilities for implementation of the actions identified in the CSAPCC; Monitor and evaluate the implementation of various climate change activities Introduce consideration of climate change issues and risk mitigation as a basic parameter in planning various department activities. Explore possible financing opportunities from National and International climate funds. Co-ordinate and partner with various agencies and technical institutions to prepare vulnerability assessment and data sets pertaining to climate change in the sector. Create awareness on climate change and sector issues within the department and various external stakeholders Provide trainings and capacity building activities at various stakeholder levels to promote climate-resilient development.
District Climate Change Cell	District Collector as Chairman, and district level officials from various Departments as a member. The Divisional Forest Officer of the district will be the ex officio coordinator.	Facilitate project implementation at the district level. Facilitate coordination between different departments for the smooth implementation of activities at the project level. Monitor the project activities and assess the benefit and impacts. Provide trainings and capacity building activities at various stakeholder levels (PRIs, JFM, and SHGs etc.) to promote climate resilient development.

8.2.2 Chhattisgarh State Centre for climate change (CSCCC)

An effective Government Climate Change program needs; leadership, institutional organisation, stakeholder involvement, climate change information, appropriate use of decision analysis techniques, explicit consideration of barriers to adaptation, funding, technology development and diffusion, and climate research. The role of the State Centre for Climate Change is:

- I. Coordination and Implementation
- II. Technology Development and Diffusion
- III. Monitoring and Evaluation
- IV. Capacity Building
- V. Knowledge Management
- VI. Planning and Budgeting

The overarching administrative set up of the State Centre for Climate Change would be as follows: Nodal Officer Climate Change, Govt. Of Chhattisgarh, will be the Head of State Centre for Climate Change, who will be supported technically and administratively supported in the Centre by a team of climate change subject experts, knowledge management expert, training and capacity building expert, monitoring & evaluation expert and administrative staff.

The broad functions of Chhattisgarh State Centre for Climate Change under Direct Implementation of climate activities-

The Chhattisgarh State Centre for Climate Change apart from coordinating with the Department and District climate change cell; will engage in direct implementation of climate-relevant activities which will ensure better implementation of the CSAPCC at the State Level. Following are the proposed functions-

- To act as a nodal agency for overall climate actions in the state
- Preparation and implementation of CSAPCC with interdepartmental co-ordination.
- Conduct and co-ordinate research, technology development and dissemination for strengthening existing knowledge and information base on climate change
- Develop platform for stakeholder engagement to implementation climate adaptation and mitigation projects in participatory manner
- To act as a Monitoring and Evaluation agency in the implementation of CSAPCC.
- To promote capacity and skills among State Government officials to mainstream climate change issues in development activities.
- Raise awareness on climate change & risk reduction in development activities.
- Plan and budget the activities to effectively utilize the available resources and coordinate on accessing international climate funds.
- Coordinate in accessing international climate funds for the state.
- Anchoring of the state climate initiatives at different national and international platforms.

The budget provision for the functioning of the State Centre for Climate Change will be made under the State Budget.

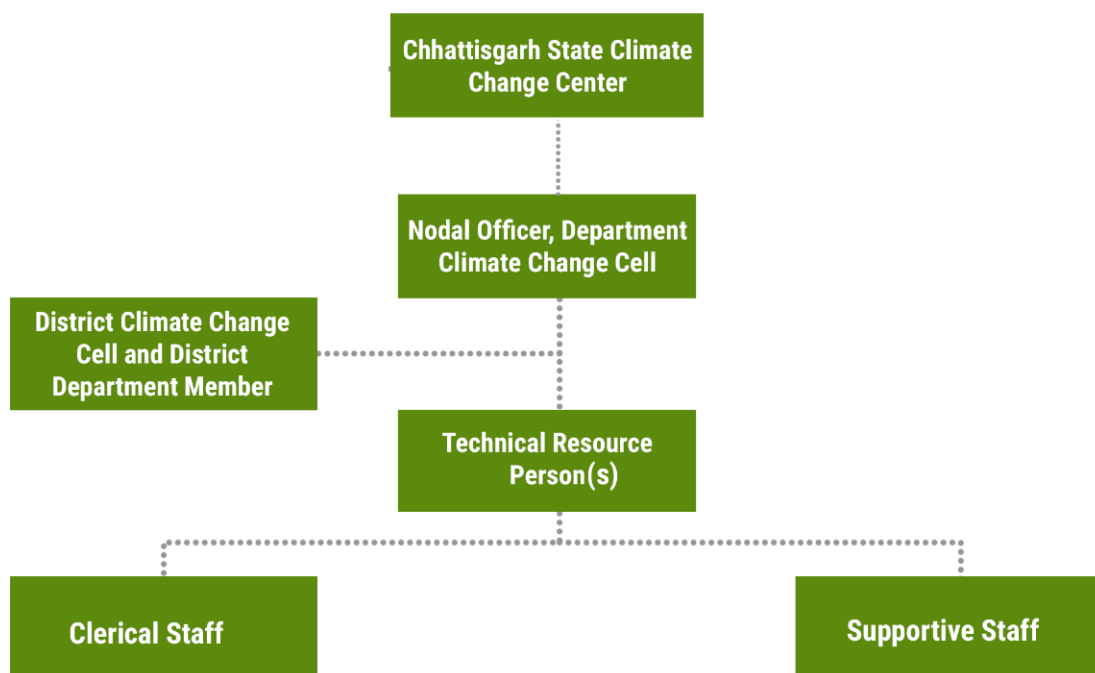
8.2.3 Proposed Department level institutional mechanism

The department level Climate Change cell will be the nodal body for informing and supporting various divisions within the department to embed adaptation and mitigation measures within their action plans and their annual budgetary proposals. It is expected to evolve itself as a Centre of Excellence and knowledge hub on climate change in the state for the specific sector.

The overarching institutional structure of the Department climate change cell would be as follows: Department level Nodal Officer, climate change will be the overall in-charge of the Climate Change cell in

the department. At the Department Climate Change cell, the Nodal officer will be technically supported by technical resource person/s as a coordinating officer for the regular activities of the Department climate change cell. The technical resource person/s can be nominated from the existing human resources in the department or can be recruited separately. To support the administrative functions of the cell it is suggested to make provision of sufficient clerical staff along with support staff as per need of the department.

Figure 51: Proposed Institutional Structure of the Department Climate Change Cell



The broad functions of the Department Climate Change cell could include the following:

1. Review and implementation of the activities identified in the CSAPCC and prepare a state-level work plan specifically for the department in coordination with CGSPCCC;
2. Coordinate the preparation of annual programmes with targets and assigned responsibilities for implementation of the actions identified in the CSAPCC
3. Monitor and evaluate the implementation of various climate change activities
4. Introduce consideration of climate change issues and risk mitigation as a basic parameter in planning various department activities
5. Explore possible financing opportunities from National and International climate funds
6. Co-ordinate and partner with various agencies and technical institutions to prepare vulnerability assessment and data sets pertaining to climate change sector.
7. Create awareness on climate change and sector issues within the Department and various external stakeholders
8. Provide trainings and capacity building activities at various stakeholder levels to promote climate resilient activity management

The budget provision for the Department Climate Change Cell's functioning and CSAPCC activities implementation should be made from the department budget. In the initial stage, to set up the Cell within department, a budget provision must be set apart for procurement of necessary equipment including computers and allied parts, human resources and recurring expenses. Initial setting up of the cell will involve only minimum capital expense with minimum creation of post. As activities increase and projects are taken up, the Cell can engage more staff with required expertise as required.

The Department levels Nodal Officer will co-ordinate with the Chhattisgarh State Climate Change Centre for climate-related activities implementation in the respective department and will appraise the Centre on the climate-relevant activities undertaken at the department level. The nodal officer will also co-ordinate with the all-district level officers nominated for climate change actions at the district level (who will be the member of the district climate change cell) to monitor the CSAPCC implementation at the district level.

The Technical resource person will provide technical guidance and direction for various activities of the climate change cell and will be overall responsible for the day-to-day functioning of the cell.

8.2.4 Proposed District level institutional mechanism

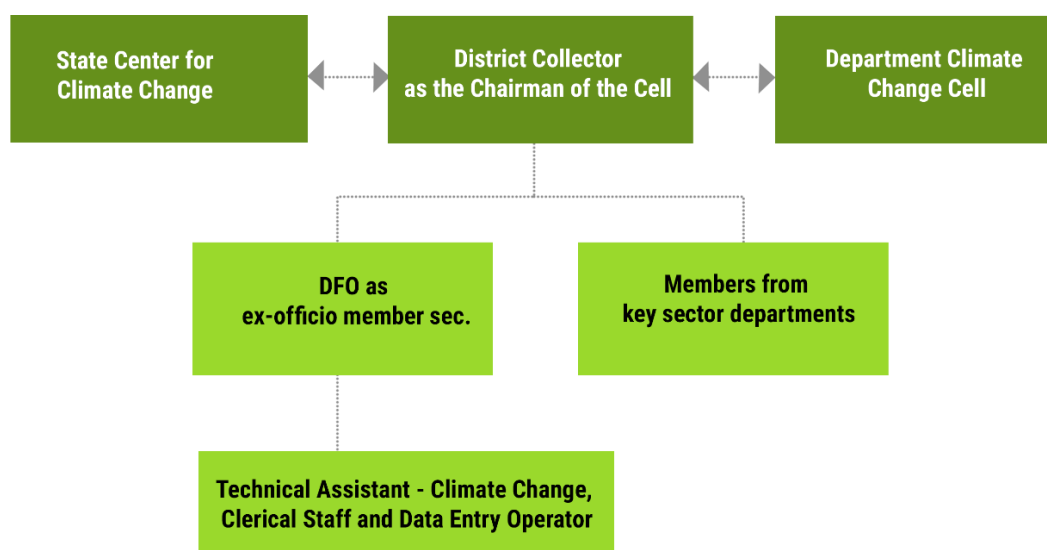
The district climate change cell will be the nodal body for co-ordinating and implementing climate change activities at the district and local levels. District Collector will be the Chairman of this cell and Divisional Forest Officer of the district will be the ex officio coordinator. The cell under the chairmanship of District collector will comprise of DFO, members from all the key sector departments i.e. 11 key sectors proposed in the state institutional mechanism and a group of advisors on climate change who will meet from time to time for co-ordination and implementation of climate activity at the district level. The department level members can be nominated by the key sector departments at the district level and will be climate resource persons for better co-ordination in their respective departments.

The district climate change cell should be based at the DFO office at the district level and should have a dedicated staff for better functioning of the district cell. The staff should comprise of One Technical Assistant on climate change, one clerical staff and Data Entry operator for administrative work.

The budgetary provision for the district climate change cell's functioning will be made by the District collector from the District level budget and funds (like DMF).

The Chhattisgarh State Centre for Climate Change and Department Level Climate Change cell will co-ordinate with the district climate change cell for CSAPCC activities implementation and monitoring purposes.

Figure 52: Proposed Institutional Structure of the District climate change cell



The broad functions of the district climate change cell will be-

1. To regularly coordinate with the Chhattisgarh State Centre for climate change for planning and implementation of the CSAPCC.
2. To facilitate climate adaptation and mitigation project implementation at the district level.
3. To facilitate coordination between all key sector departments at the district level and conduct regular meetings of all the members of the cell.
4. The cell will monitor the CSAPCC climate activities implementation and any other climate project activities implementation; and assess the benefit and impacts of the same.
5. The cell will facilitate and conduct trainings and capacity building activities on climate change at various stakeholder levels (Gram Sabha, PRIs, JFM, and SHGs etc.) to promote climate-resilient development at the local governance level.
6. To facilitate in conducting ground-level research and studies on climate change impacts (like sector-wise research, District level climate vulnerability, GHG inventory etc.).
7. To develop District Climate Resilience Plan in line with revised CSAPCC and in co-ordination with the key sector department with provision for budget for the planned activities.

Recommended capacity building for strengthening the recommended institutional mechanism

Strengthening the capacity of key sector departments to adapt to climate change:

The state department requires building awareness and sensitization on climate change issues across various departments, which would help in expediting the implementation of climate actions as per the CSAPCC. Some of the sector-specific training and capacity building materials are already prepared by the CSCCC like agriculture, forest and watershed; further up-gradation of the existing training modules and preparation of training modules for other sectors (like transport, energy, water, industry etc.) should be done which can be referred for regular training of the officials at the department level.

Developing education materials, training and public awareness on climate change-

Media Professionals Training Under this activity, training module/course for media professionals on climate change reporting at the state level should be developed. This training should be provided as a regular certificate course to encourage participation of all media sources (print, visual etc.).

Climate sensitive education at the state schools and university level In coordination with the Chhattisgarh State Council for Education Research & Training teachers training module on climate change education should be developed for developing understanding on climate change at different education levels. This can be further institutionalised by involving curriculum development team for designing climate-sensitive education curriculum for school textbooks in Chhattisgarh. Similarly, state universities can be involved in training and capacity building. The training on climate change should be provided with credit score to encourage more teachers and student participation.

Climate Change awareness at the political level Training and capacity building on climate change awareness for the political representatives in the State, preparation of policy brief and handbooks on climate change should also be prepared to ensure better political representation of the issue at various governance levels.

Capacity Building on financial resource mobilisation towards CSAPCC implementation

financial resources available at present for implementation of CSAPCC strategies are minimal and are single sourced through the State's budget. This clearly will prove to be insufficient for supporting the number of activities that are planned under CSAPCC; including the very functioning of the proposed Climate Change Cells in the key departments and district level. Hence, the capacity of the nodal agency and other key

departments should be built in accessing climate finance for project specific interventions and financial resource mobilisation for the implementation of CSAPCC Strategies.

This is possible through useful guidance and handholding for an initial period on the following lines -

- i. Tracking of national and international climate finance opportunities
- ii. Coordinate with National Implementing Entities for climate finance (like NABARD)
- iii. Liaise and coordinate with external funding agencies for accessing climate finance
- iv. Coordinate with different stakeholder departments and agencies in the state for the development and monitoring of climate finance projects
- v. Develop innovative climate funds options from within the state budgets
- vi. Provide inputs and actions to embed climate change in the state's planning and budgeting processes

Training of government officials on climate smart technology adoption, energy efficiency and green energy generation:

Another area of priority is tapping of opportunities for alternative energy use. State capacities would require to be built for providing energy supply to villages, public facilities and other localities which are either not connected to grid electric supply or receive dismal services. Several capacity needs are identified for extending alternative energy supply through hybrid grids, and mini grids for remote areas. Developing options for green-energy generation would also require appropriate training of officials. Enhancing energy-use efficiency is undoubtedly an important area where there remains a significant capacity gap. The State nodal agency, Chhattisgarh Renewable Energy Development Agency (OREDA) has been identified for various projects under SAPCC.

Building capacity in utilisation of decision support system tools and techniques:

Enhancing capacity in utilisation of decision support system tools and techniques is deemed to be essential. The use of remote sensing technology for assessment of heat-islands phenomenon could be very well planned for appropriate urban planning. There is need to develop basin level assessments, which would require specific skill building among the State officials. Environmental assessment for forecasting, future climate scenarios building, projections of resource availability, etc –these newer developments require relevant skills to be developed among technical personnel in the State agencies.

Chapter 9 - Monitoring and Evaluation

9.1 Introduction

Each department covered under the SAPCC is fully conversant in tracking the key priorities they are undertaking. The Chhattisgarh State Centre for Climate Change which is the nodal agency tasked with compiling the information will send the formats from time to time to line departments.

Each department has identified sectoral vulnerability and developed actions pertaining to both adaptation and mitigation. Indicators from national missions have been used if needed for reporting purposes in order to ensure alignment with those missions. Some of the process indicators such as reinvestment and policy actions are tracked as well. Financial allocations to the key activities are also tracked, along with the physical process. However, ex-post analysis of actions has not yet been undertaken. This will be gradually built up in the departments, and the departments will share with the Chhattisgarh State Centre for Climate Change periodically report on the outcomes of climate-related investments in the key priorities.

Developing such a system is critical because the state must create its own protocols based on the context, and especially because many of the tasks are multidisciplinary in nature. In the context of climate change, it is important to understand the definitions to be used and the process that must be undertaken for monitoring, evaluation, and verification.

Monitoring is a process that has taken the form of a state-developed mechanism to capture emissions reductions and other associated economic, social, and environmental benefits and activities that occur as a result of the implementation of each action within the CSAPCC. By itself, monitoring does not involve the calculation of specific impacts (e.g., a reduction in emissions), nor does it involve comparisons with previous baseline measurements. For example, monitoring would involve measuring the kilowatts produced by a solar energy project, or the number of hectares of land reforested by the Department of Forest and Environment. Therefore, the objectives of monitoring are to use the assessments to inform stakeholders and interested parties about the project, propose modifications, propose measures to improve impact, achieve cost-effectiveness and enhance the knowledge of all stakeholders.

Evaluations of projects or investments usually involve conducting a comparative assessment using information from outside sources and context for example, the calculation of emissions reductions will be a part of the evaluation process. Therefore, in the context of climate change, project evaluation would include the GHG impacts, environmental impacts, economic and social impacts, and estimation of losses. The main purpose of the evaluation of projects is to understand the SAPCC actions as implemented over a period and not just the proposed actions.

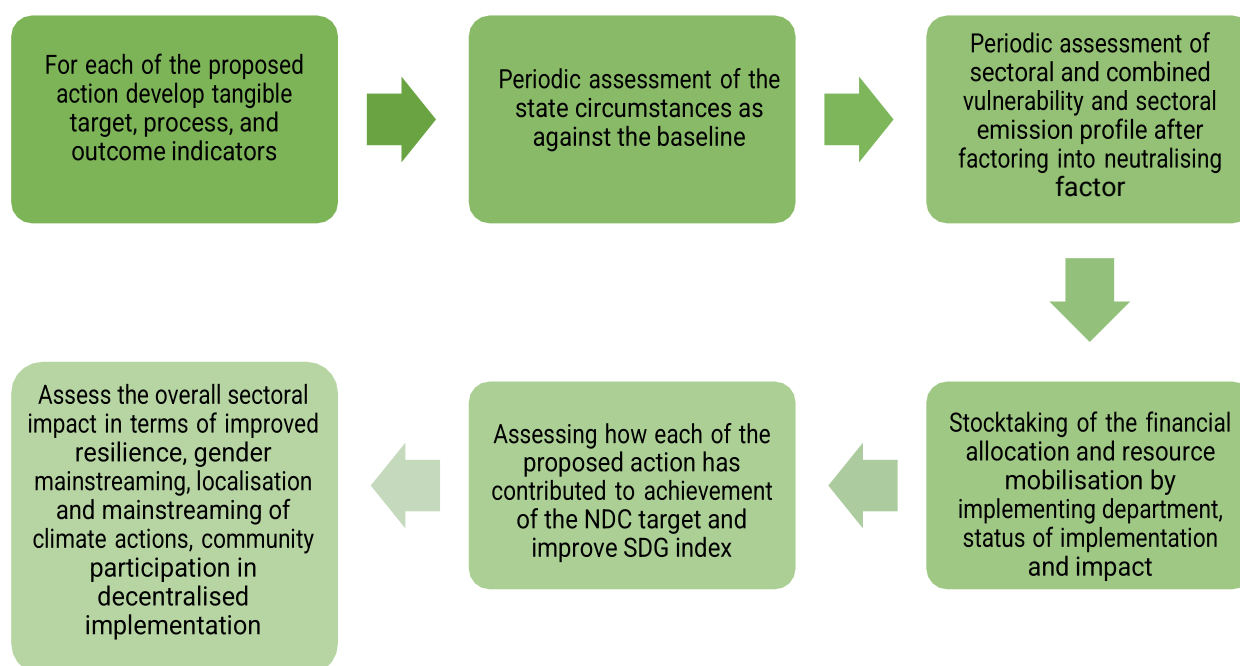
Verification is a process by which it is established whether the measured impacts occurred. This process is like an audit performed by a certified entity. Verification activities may have different objectives and timing and therefore the state must develop a system that is acceptable to all stakeholders. For the state the goal of monitoring, evaluation and verification is to understand the current levels of emissions in the state, to measure and verify the impact of mitigation programs and to develop a system, of accountability for emissions reducing and climate change adaptation activities.

The state will customise and internalise the MEV processes (as shown in diagram below). Such a process will require apportioning responsibilities to an independent entity so that knowledge and unbiased services are transferred to the various departments in a timely manner. This need reaffirms in turn the

need to develop a robust climate change cell as the internal arm of the state to deliver the following aspects of the MEV systems:

- Design and publish an MEV framework that will address the scopes, objectives, principles, roles, and responsibilities of the institutional structures that will take part in the state's climate change action plan implementation system.
- Provide services to departments that will range from developing emissions accounting methods and baselines at all levels within the state to analysing the impacts of projects in all sectors.
- Develop tools and methods that can be used to capture carbon counts and other related metrics that can be used internally for measuring targets and externally to validate the effectiveness of investments.
- Develop online tools to publish progress and generate real-time reports.
- Managing MEV system will be the responsibility of the Chhattisgarh State Centre for Climate Change. Using the action plans and implementation schedules from various departments, each department will provide their customised MEV framework that will be provided for setting up reporting protocols. Each department will share the MEV report with the Chhattisgarh State Centre for Climate Change who will monitor that the departments are conducting climate change activities and how much finance is being spent by the state on such activities.

Figure 53: Monitoring Tangible indicators



Other than the above tangible indicators there are some non - tangible indicators such as capacity building and institutional development.

9.2 Broad indicators for monitoring and evaluating climate change interventions

A tentative list of indicators is presented below. However, sector specific indicators can be developed as per requirement during the implementation of CSAPCC-II.

Indicators for Climate Change Adaptation:

India's NDC has a non-quantifiable goal on adaptation which highlights that it is essential to better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management. In order to measure the SAPCCs' contribution towards climate change goals of India's NDC and SDGs, eight aggregate indicators have been designed which are as follows:

1. Stability/Increase in Income Levels:

Stability in farmer incomes over time is an important indicator for measuring the effectiveness of adaptation efforts. Stability in farm incomes could imply:

- Knowledge to use weather advisories for better agriculture/water practices
- Better irrigation facilities
- Crops resistant to extreme climate change (drought, flood etc.)
- Implementing crop diversification
- Coverage of crop insurance

2. Number of Government schemes that have been climate-proofed:

This indicator measures the interest generated in the state for considering climate change while planning and implementing various schemes (also called Mainstreaming of Adaptation Strategies into development planning).

3. Reduced Migration of local population directly and indirectly dependent on climate-sensitive sectors for their livelihoods:

High migration levels are a sign of agricultural distress and degradation of the natural resources base in a region even if adaptation measures are being implemented. Decreasing levels in migration might reflect:

- Community having potable water available for domestic use
- Communities in a food-secure situation
- Community having alternative livelihood options

4. Enhanced climate resilience of communities towards climate risks:

As it is often the most marginalised that are most vulnerable to the impacts of climate change, it is essential to enhance the resilience of these communities to enhance their adaptive capacity. Examples of indicators which can be measured are listed below:

- Community capacitated to use weather advisories for planning activities (food, water etc.)
- Community having potable water available for domestic/occupation use during extreme events

5. Mainstreaming of women and other vulnerable sections in adaptation activities:

Climate change has an impact on those sections of the population that are mostly reliant on natural resources for their livelihoods and/or who have the least capacity to respond to natural hazards, such as droughts, landslides, floods and hurricanes. Vulnerable population such as women, children, elderly people etc. commonly face higher risks and a greater burden from the impact of climate change than men. Further, members of indigenous communities, due to lack of access to resources such as forest produce, loss of forest rights due to biodiversity loss and poor application of laws are more vulnerable to

climate risks. Examples of indicators which can be measured are listed below:

- Women/vulnerable sections of the population trained on adaptation measures
- Women/vulnerable communities taking part in project planning processes
- Women/vulnerable communities are nominees in insurance cover due to loss in activities because of extreme climatic events (drought, flood etc.)

6. Community/Farmers having diversified sources of income

An increase in the percentage of farmers who have diversified sources of income is a step towards increasing the resilience of households depending on agriculture/livestock etc. for their incomes to face climate change risks. Diversified sources of income could be stemming from government programmes such as MGNREGA, Pradhan Mantri Fasal Bima Yojana etc. Examples of indicators which can be measured are listed below:

- Farmers having their source of income from agriculture and allied sector
- Farmers having their source of income from rearing animals
- Farmers having source of income from forest use.

7. Capacity building of farmers for implementing CCA measures:

Local communities need support to re-orient water management & agricultural systems to counter the risks posed by climate change. Climate change is accompanied by increased weather uncertainty and individuals and communities, especially smallholder farmers, are vulnerable to these fluctuations. Availability of real time weather advisories and other extension services helps them take timely action to deal with these fluctuations and improve their adaptive capacity. This indicator can be disaggregated by Gender to understand the degree of gender mainstreaming in adaptation. Examples of indicators which can be measured are listed below:

- Farmers trained on planning activities based on extreme weather events (drought, flood etc.)
- Farmers trained on climate friendly practices e.g.: water conserving techniques, knowledge of climate resilient cropping etc.

8. Rise in groundwater levels:

Healthy groundwater levels in a region reflect the prevalence of sustainable agricultural practices, effective and sustainable management of watersheds and awareness levels among members of communities in the region about climate change and its effects.

- Enhanced groundwater depth from surface,
- Enhanced groundwater quality i.e., salinity reduction

In order to measure these eight aggregate level indicators, an excel-based Management Information tool highlighting strategy/project-wise indicators has been developed.

Aggregate indicators for climate change mitigation:

India's NDC has three quantified goals on mitigation which includes:

- To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level.
- To achieve about 40 per cent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance.
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.

In order to measure the SAPCC's contribution towards climate change mitigation goals of India's NDC and SDG, eight aggregate indicators have been designed which are as follows:

1. Enhanced green cover

Extending green cover contribution to the achievement of a climate-resilient low-emission pathway. Examples of indicators which can be considered to be measured are listed below:

- Setting up of parks
- Increase in forest cover
- Increase in road-side green pathways.

2. Increase of renewable energy mix in the total electricity consumption

Switching to renewable energy instead of fossil fuel-based resources leads to a carbon emission-free, healthier environment. Examples of indicators which can be considered to be measured are listed below:

- Establishment of new renewable resources plants/units like solar, hydro, biomass etc.
- No. of buildings adopting renewable resources
- No. of vehicles shifted from non-renewable to renewable resources (electric, cycle etc.)

3. Reduction in waste generation

Waste generation is a major challenge every state is facing which creates an unhealthy environment and has a direct impact on the environment. Managing waste efficiently is an asset for a healthy and sustainable lifestyle. Examples of indicators which can be considered to be measured are listed below:

- No. of households segregating waste at source
- Amount of waste segregated at source
- Amount of waste reused and recycled

9.3 Institutional Mechanism for M&E

Key to an effective M&E system is the proper institutional arrangement for facilitating and operating it. The M&E system should be grounded in the existing institutional framework driven by the Chhattisgarh State Centre for Climate Change. Chhattisgarh State Centre for Climate Change will act as the technical secretariat and interface with executing departments/line departments for proper implementation of CSAPCC-II. Proper monitoring through periodic review, data collection and reporting will be carried out. As indicated earlier, each department may constitute a small working group with required supporting staff. The working group can be headed by a nodal officer who will interface with the climate change cell for data/MIS updation.

Annexures

Annexure I: Relevant for District Level Vulnerability Assessment

1.1: Data Sources of Indicators

Twenty-six indicators were quantified using different sources. Based on the source, the indicators have been quantified for a period between 2011 to 2019. The table below provides the details of the sources used and the calculations used to arrive at each of the selected indicator values.

Table A1: Data sources for all the quantified indicators

S N	Sector	Indicator	Data Source
1	Agriculture and Allied Sector	Crop, livestock, and fish yield variability	Crop Yield Variability – was assessed for 12 years (2005-17) considering yield for major cereals cultivated in the State. These include Jowar, Maize, Ragi and Rice. Data was compiled using the Area Production and Yield Information System, a database set up by the Ministry of Agriculture and Farmers Welfare (District wise crop production statistics, accessible at https://aps.dac.gov.in/APY/Index.html). Livestock yield was compiled using the Chhattisgarh Statistical Abstract 2017 (accessible at http://descg.gov.in/pdf/publications/latest/Abstract_2017-18.pdf). Data was compiled for 3 years (2015-2017), for milk (Cow, Buffalo and Goat), eggs and meat (Goat, Sheep, Pig and Poultry). Instead of considering variation in actual production, variation in total value of livestock yield (in Lakh rupees) was considered. Fish production data was compiled for four years (2015-2018). Data for 2015 was extracted from the Chhattisgarh Statistical Abstract 2017 and data for 2016-2018 was extracted from Fish Production Statistics, Department of Fisheries, Government of Chhattisgarh (accessible at https://agriportal.cg.nic.in/fisheries/pdf/Statistics_per_cent202018-19_per_cent20Fish_per_cent20production_per_cent20eng.pdf). The three sub-indicators were aggregated by assigning weights based on their contribution to the agricultural sector's gross state domestic product (2018-19) at constant price (2011-12). Contribution by crops, livestock and fisheries are 75.8 per cent, 9.9 per cent and 14.2 per cent, respectively.
2		Percentage net area cultivated under Horticulture trees	Percentage of net area cultivated under horticulture fruit trees was computed for the year 2016 from Land Use Statistics Information System , a database set up by the Ministry of Agriculture and Farmers Welfare (Area under crops, District wise land use statistics - accessible at https://aps.dac.gov.in/LUS/Index.htm)
3		Livestock per 1,000 rural population	Quantified using the 19th Livestock Census (2012) (accessible at http://dadf.gov.in/sites/default/files/Volume_per_cent201.pdf). Animal Units Equivalent published by the Ministry of Statistics and Programme Implementation in their manual - Animal Husbandry Statistics (2011) (accessible at

			http://www.mospi.gov.in/sites/default/files/publication_reports/Manual per cent20on per cent20Animal per cent20Husbandry per cent20Statistics.pdf), was used to aggregate different type of livestock. This total livestock number was then standardized for each district by dividing it by the rural population of that district.
4		Available water resources under fish culture	The percentage of available water resources under fish production was computed using the Chhattisgarh Statistical Abstract 2017 for the year 2017.
5		Percentage of small and marginal farmers	Quantified using Number & Area of Operational Holding in Chhattisgarh State - Agriculture Census 2010-11 , (accessible at https://agriportal.cg.nic.in/agridept/AgriEn/AgriCensus.html)
6		Percentage of rain-fed agriculture	Percentage area under rain fed agriculture was computed for the year 2016 from Land Use Statistics Information System , a database set up by the Ministry of Agriculture and Farmers Welfare - District wise land use statistics, Classification of Area (accessible at https://aps.dac.gov.in/LUS/Index.htm)
7		Percentage gross cropped area covered under crop insurance	Pradhan Mantri Fasal Bima Yojana – Dashboard (accessible at https://pmfby.gov.in/ceo/dashboard?error=true). Data was collected for Rabi and Kharif seasons (2019) and standardized using gross cropped area reported for each district (2016)
8	Forests	Forest dependence of rural tribal communities	Total area under forests for all districts was extracted from the Chhattisgarh Statistical Abstract 2017 . ISFR 2019 provides data only for 18 districts. Rural SC & ST Population (Census 2011) was used to estimate the per capita forest availability in Hectare. Location quotients was calculated based on tribal population and this was then used to weigh the per capita availability of forest area. A low negative correlation exists between per capita forest area availability to tribal communities and their location quotients. Meaning that districts with large number of tribal communities have lower per capita availability of forests, indicating higher pressure.
9		Number of approved Minor Forest Produce (MFP) Microenterprises	A list of Approved Microenterprises provided by the Chhattisgarh State Minor Forest Produce (Trading and Development) cooperative Federation Ltd (accessible at https://www.cgmfpfed.org/new/pdf/Microenterprises.pdf) was used. The number of MFP Microenterprises in each district was weighted with the amount of financial aid released to them.
10	Water	Stage of Groundwater Extraction (per cent)	National Compilation on Dynamic Groundwater Resources of India, 2017 (accessible at http://cgwb.gov.in/GW-Assessment/GWRA-2017-National-Compilation.pdf)
11		Per capita water availability	Estimated using Annual Extractable Groundwater Resources (National Compilation on Dynamic Groundwater Resources of India, 2017) and District Wise Area of River Basins in Chhattisgarh (accessible at https://cgwrd.in/water-resource/wr.html). Area of River basin was used to estimate the potential utilisable flow through extrapolation (accessible at http://mospi.nic.in/sites/default/files/reports_and_publication/statistical_publication/social_statistics/comp_SECTION per cent206_16mar16.pdf)

12	Socio-economic development	Percentage of rural households below the poverty line - adjusted for inequalities	To incorporate inequalities, different household types (SC, ST, Women headed households, households with PwDs and others) were considered. The percentage of these households having highest earning member's income less than Rs. 5,000 was considered as a proxy to measure poverty. Socio Economic and Caste Census 2011 - (accessible at https://secc.gov.in/) was used to quantify this indicator.
13		Access to basic amenities (safe drinking water, toilets, kitchen, and clean cooking fuel)	National Family Health Survey, NFHS-4 (2015-16) was used to quantify the percentage of households with access to improved drinking-water source (which includes households that have access to piped water into dwelling/yard/plot, public tap/standpipe, tube well or borehole, protected dug well, protected spring, rainwater, or community RO plant) and households using improved sanitation facility (which includes households that have access to flush to piped sewer system, flush to septic tank, flush to pit latrine, ventilated improved pit (VIP)/biogas latrine, pit latrine with slab, twin pit/composting toilet, and which is not shared with any other household). Census 2011 was used to quantify the percentage of households that have kitchens and that are using clean cooking fuel/electricity (LPG/PNG, biogas, kerosene, and electricity). The sub-indicators were aggregated using the geometric mean of normalized values of individual sub-indicators.
14		Inequality adjusted education index	This indicator is composed of two sub-indicators - Mean years of schooling and Expected years of schooling which were adjusted for inequalities using the Atkinson inequality measure and aggregated using geometric mean. Census 2011, Table C-8 Educational Level by Age and Sex for Population Age 7 and above was used to quantify this indicator.
15		Women participation in the labour force	Census 2011 was used to quantify this indicator.
16		Dependency ratio	Census 2011 was used to quantify this indicator. Young (0-14 years of age), old (>65 years of age), people with disability (10-65 years of age) and the total working population were considered for the calculation of this indicator
17		Access to an alternate employment source (MGNREGS)	MGNREGA MIS was used to quantify this indicator. An average of 5 years (2015-19) was considered.
18	Transport	Road connectivity	Census 2011 data was used to quantify this indicator. It is an indexed value combining available transportation infrastructure (percentage villages with public and private bus services, auto, car and van taxi services) and road connectivity (percentage of villages with National Highways, State Highways, Major District Roads, Other District Roads, Black Topped (pucca) Roads, Gravel (kuchha) Roads, and All-Weather Road connectivity).
19	Energy	Percentage of villages electrified weighted by number of hours of electricity provided	The overall percentage of villages electrified was computed using data from the Chhattisgarh Statistical Abstract 2017 . This was then weighted by the percentage of villages with at least 12 hours of electricity supply for domestic use and percentage of villages with at least 6 hours of electricity supply for agriculture use extracted from Census 2011 .

20	Industries and Mining	Variability of revenue from mining	District-wise and year-wise mineral revenue receipts in the state (from 2000-01 to 2016-17) accessed at http://chhattisgarhmines.gov.in/sites/default/files/districtwise-revenue-060617.pdf was used to calculate variability in revenue from mining.
21		Number of establishments (OAE, Estt, Micro, small and Medium)	The number of Own Account establishments, establishments having at least one hired worker, micro, small and medium establishments were aggregated from the Chhattisgarh Statistical Abstract 2017 . Aggregation was based on weights dependent on the size of each establishment = (OAE & Estt*0.1)+(Micro*0.2)+(Small*0.3)+(Medium*0.4)
22	Human Health	Infant Mortality Rate (IMR)	Data provided by SRS Statistical Report 2017 for natural divisions of Chhattisgarh (accessed at https://censusindia.gov.in/vital_statistics/SRS_Report_2017/12_per_cent20SRS_per_cent20Statistical_per_cent20Report-Detailed_per_cent20tables-2017.pdf), IMR data for Chhattisgarh State published by Niti Aayog (accessed at http://niti.gov.in/content/infant-mortality-rate-imr-1000-live-births) and district level IMR data for 16 districts published by the Annual Health Survey 2012 , was used to compute district level IMR for 2017 based on annual rate of change observed for the state.
23		Number of functional Health Care Facilities/ 10,000 population	Number of Health Care Facilities/10,000 rural population weighted by number of Doctors/10,000 rural population was quantified using Census 2011 data. Health care facilities considered include: Community Health Centre, Primary Health Centre, Primary Health Sub Centre, Maternity and Child Welfare Centre, TB Clinic, Allopathic Hospitals, Alternative Medicine Hospitals, Dispensary, Mobile Health Clinic and Family Welfare Centres. The number of doctors and para medical staff in position at these health care centres were used to weigh the number of health care facilities to highlight functionality.
24		Cases of vector borne diseases/ 1,000 Population (Malaria)	Epidemiological Situation Report of Chhattisgarh 2018 , Directorate of National Vector Borne Diseases Control Programme (accessed at https://nvbdcp.gov.in/Doc/Annual-Report-2018.pdf) was used. Average of Slide Positivity Rate (Total positive x 100 / Total slides examined) and Slide Falsiparum Rate (Total positive PF x 100 / Slides examined) was weighted by the total deaths due to Malaria.
25		Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population)	Quantified using data published by the Annual Health Survey 2012 (Persons suffering from Acute Illness (Per 100,000 Population) - Diarrhoea/Dysentery - Person - Total)
26		Households with any usual member covered by a health scheme or health insurance	National Family Health Survey, NFHS-4 (2015-16)

1.2: Correlation Matrix

The 26 indicators used for the correlation matrix: **1** - Crop, livestock, and fish yield variability; **2** - Percentage net area cultivated under Horticulture; **3** - Livestock per 1,000 rural population; **4** - Percentage of available water resources under fish culture; **5** - Percentage of small and marginal farmers; **6** - Percentage of rain fed agriculture; **7** - Percentage gross cropped area covered under crop insurance (PMFBY 2019); **8** - Forest dependence of rural tribal communities; **9** - Number of approved Minor Forest Produce (MFP) Microenterprises; **10** - Stage of Groundwater Extraction; **11** - Per capita water availability; **12** - Percentage of rural households below the poverty line - adjusted for inequalities; **13** - Access to basic amenities (safe drinking water, toilets, kitchen and clean cooking fuels); **14** - Inequality adjusted education index; **15** - Women participation in the labour force; **16** - Dependency ratio; **17** - Access to an alternate employment sources (MGNREGS); **18** - Road connectivity; **19** - Percentage of villages electrified weighted by number of hours of electricity provided; **20** - Variability of revenue from mining; **21** - Number of establishments (OAE, Estt, Micro, small and Medium); **22** - Infant Mortality Rate (IMR); **23** - Number of functional Health Care Facilities/ 10,000 population; **24** - Cases of vector borne diseases/1,000 Population (Malaria); **25** - Persons suffering from water borne diseases ((Diarrhoea/Dysentery)/1,000 Population); **26** - Households with any usual member covered by a health scheme or health insurance.

Table A2: Correlation matrix showing correlation coefficients between each of the 26 indicators

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	1.0																									
2	0.1	1.0																								
3	0.0	0.1	1.0																							
4	0.0	-0.4	0.0	1.0																						
5	0.0	-0.2	-0.9	0.1	1.0																					
6	-0.2	0.2	0.6	-0.1	-0.7	1.0																				
7	0.3	-0.2	-0.6	-0.1	0.6	-0.6	1.0																			
8	-0.1	-0.1	0.9	0.0	-0.8	0.6	-0.5	1.0																		

9	0.2	- 0.1	0.1	0.2	- 0.1	0.3	- 0.3	0.1	1.0																		
10	0.2	0.0	- 0.8	0.0	0.8	- 0.7	0.7	- 0.8	- 0.3	1.0																	
11	- 0.1	- 0.1	0.9	- 0.1	- 0.8	0.5	- 0.4	1.0	0.0	- 0.7	1.0																
12	- 0.4	0.0	0.0	- 0.1	0.1	0.2	- 0.4	0.0	0.2	- 0.3	0.0	1.0															
13	0.2	- 0.1	- 0.6	0.0	0.5	- 0.5	0.6	- 0.5	- 0.1	0.6	- 0.5	- 0.5	1.0														
14	0.1	- 0.1	- 0.9	0.0	0.8	- 0.6	0.5	- 0.8	0.0	0.7	- 0.8	- 0.1	0.7	1.0													
15	- 0.2	0.1	0.7	0.0	- 0.7	0.4	- 0.5	0.5	0.0	- 0.5	0.5	0.1	- 0.7	- 0.8	1.0												
16	- 0.1	- 0.1	- 0.3	0.0	0.5	- 0.2	0.1	- 0.2	- 0.1	0.2	- 0.2	0.4	0.2	0.4	- 0.6	1.0											
17	- 0.1	- 0.2	0.3	- 0.1	- 0.3	0.4	- 0.2	0.4	0.0	- 0.3	0.3	0.0	- 0.2	- 0.3	0.4	0.0	1.0										
18	- 0.2	- 0.2	0.7	0.1	- 0.5	0.5	- 0.4	0.8	- 0.1	- 0.6	0.8	0.0	- 0.4	- 0.5	0.4	0.0	0.2	1.0									
19	0.1	- 0.2	- 0.6	0.1	0.5	- 0.5	0.6	- 0.7	- 0.2	0.6	- 0.6	- 0.3	0.5	0.6	- 0.4	- 0.1	- 0.3	- 0.5	1.0								
20	- 0.1	0.0	0.7	0.0	- 0.6	0.3	- 0.2	0.7	0.1	- 0.5	0.7	0.0	- 0.4	- 0.6	0.4	- 0.2	0.0	0.6	- 0.5	1.0							

21	0.3	-0.2	-0.4	0.2	0.4	-0.3	0.3	-0.3	0.2	0.3	-0.4	-0.1	0.3	0.3	-0.4	0.2	-0.1	-0.3	0.1	-0.2	1.0					
22	0.0	0.0	-0.1	-0.1	0.1	0.1	-0.1	-0.1	0.0	0.0	-0.1	0.4	-0.5	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	1.0				
23	0.0	0.1	0.5	-0.2	-0.4	0.5	-0.2	0.4	0.4	-0.4	0.4	-0.1	-0.2	-0.3	0.3	-0.4	0.2	0.2	-0.1	0.2	-0.2	-0.2	1.0			
24	-0.1	0.1	0.9	0.0	-0.9	0.5	-0.5	0.8	0.0	-0.8	0.8	-0.1	-0.3	-0.8	0.6	-0.3	0.2	0.6	-0.5	0.6	-0.3	-0.3	0.2	1.0		
25	0.0	0.0	0.6	0.4	-0.5	0.2	-0.4	0.5	0.0	-0.4	0.4	-0.2	-0.4	-0.7	0.7	-0.4	0.2	0.4	-0.1	0.3	-0.1	0.1	0.2	0.6	1.0	
26	0.0	0.0	0.5	-0.1	-0.3	0.2	-0.2	0.4	0.0	-0.2	0.5	-0.1	-0.4	-0.4	0.7	-0.5	0.1	0.3	-0.2	0.4	-0.3	0.0	0.5	0.2	0.3	1.0

The cells highlighted in red have correlation coefficients greater than 0.5. The corresponding indicators that have been excluded from the analysis as a result are: 3: Livestock per 1,000 rural population; 5 - Percentage of small and marginal farmers; 6 - Percentage of rain-fed agriculture; 7 - Percentage gross cropped area covered under crop insurance (PMFBY 2019); 10 - Stage of Groundwater Extraction; 11 - Per capita water availability; 13 - Access to basic amenities (safe drinking water, toilets, kitchen and clean cooking fuels); 14 - Inequality adjusted education index; 15 - Women participation in the labour force; 18 - Road connectivity; 19 - Percentage of villages electrified weighted by number of hours of electricity provided; 20 - Variability of revenue from mining; 24 - Cases of vector borne diseases/1,000 Population (Malaria); and 25 - Persons suffering from water borne diseases ((Diarrhoea/Dysentery)/1,000 Population).

1.3: Interpretation of the Correlation Matrix

Fourteen indicators are correlated with one or more other indicators, meaning that these correlated indicators are representing similar or interlinked system properties. The manifestation of these interlinkages is presented in the table below.

Table A3: Interpretation of the correlation matrix for correlation coefficients greater than 0.5, from left to right of the matrix.

SN	Indicator	Correlation With other Indicators and its significance
1	Crop, livestock, and fish yield variability	Low positive correlation with the indicator Percentage gross cropped area covered under crop insurance ($r^2=0.329$), which is expected, as areas with higher crop yield variability are more likely to consider applying for and accessing crop insurance. Moderate negative correlation with the indicator Percentage of rural households below the poverty line - adjusted for inequalities ($r^2=-0.425$), which is probable, as households with low financial capital (SC, ST, women headed households and households with PwDs) are less likely to own land or take up agriculture, pursuing other livelihood options. Alternatively, this could be a spurious correlation. <i>This indicator was selected as correlation with the above 2 indicators is Low-Moderate, $r^2 < 0.5$</i>
2	Percentage net area cultivated under Horticulture trees	Low negative correlation with the Percentage of available water resources under fish culture ($r^2=-0.351$). Likely, as districts investing in horticulture trees could potentially be diverting water resources for the maintenance of orchards instead of fish production. <i>This indicator was selected as correlation with the above indicators is Low, $r^2 < 0.5$</i>
3	Livestock per 1,000 rural population	Extremely high negative correlation with the indicator Percentage of small and marginal farmers ($r^2=-0.909$). Districts with high livestock densities have low arable land fragmentation, i.e., land holding sizes are larger. Could potentially be highlighting the purchasing power or capacity of larger land holders to invest in livestock and their understanding of the importance of livestock for holistic and sustainable agriculture and/or the need to diversify income sources. Moderate positive correlation with the indicator Percentage of rain-fed agriculture ($r^2=0.593$). A common trend observed across the country - regions with higher percentage of risky rain fed agriculture, tend to have higher livestock densities as a safety net or alternate source of income in case crop yields are impacted by climate variations or hazards. Moderate negative correlation with Percentage gross cropped area covered under crop insurance ($r^2 = -0.562$). Likely, as investment in one safety net (livestock) is potentially offsetting the need for investment in crop insurance. Also, predominance of rain-fed agriculture in regions with high livestock densities is going to disincentivize insurance coverage, as rain-fed farmers rarely invest in crop insurance. High positive correlation with Forest dependence of rural tribal communities ($r^2 = 0.888$). Forest dependent tribal communities in Chhattisgarh generally do not own land, or if they do, they are smaller and predominantly rain-fed

		when compared to the general population. As such, they could potentially have higher dependence on livestock for their livelihood. 5. High negative correlation with Stage of Groundwater Extraction ($r^2=-0.802$). Regions with high groundwater extraction have higher area under irrigation, already explained above in inverse for point 2 (high livestock density is positively correlated with high rain-fed agriculture). 6. High positive correlation with Per capita water availability ($r^2=0.889$). Logically, high water availability in a region could support larger populations of livestock. 7. Moderate negative correlation with Access to basic amenities (safe drinking water, toilets, kitchen and clean cooking fuel) ($r^2=-0.554$). Households with access to basic amenities, which may be considered "basic" in a more urban setting, may be considered as a "luxury" depending on the overall development of a rural community. Rural households with access to such amenities may be more financially well off, not needing livestock as a safety net or income source. 8. High negative correlation with Inequality adjusted education index ($r^2=-0.861$). Livestock rearing is an unskilled income source, thus persons with lower education and skill levels are more likely to take up livestock rearing. 9. High positive correlation with Women participation in the labour force ($r^2=0.714$). In India, and Chhattisgarh being no exception, livestock production is largely in the hands of women. In fact, animal husbandry is becoming feminized, with most of the animal farming activities such as fodder collection, feeding, watering, and health care, management, milking and household-level processing, value addition and marketing being performed by women¹⁰¹. 10. Moderate positive correlation with Road connectivity ($r^2=0.698$) - Road connectivity is essential to make livestock production profitable – shifting it from subsistence consumption of livestock products to value addition and marketing, which would require easy access to markets, brought about only by access to good roads and transportation infrastructure. Thus, districts with better road and transportation infrastructure observe higher livestock densities. 11. Moderate negative correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=-0.585$), same justification as points 5 and 2 as this indicator considers electricity used for irrigation. 12. Moderate positive correlation with Variability of revenue from mining ($r^2=0.675$) – mining requires some level of skill. Low literacy rates prevalent in districts with high livestock population densities, could potentially lead to this variability in revenue of mining. 13. High positive correlation with Cases of vector borne diseases/1,000 Population (Malaria) ($r^2=0.858$) - Based on the above correlations of livestock rearing, lack of access to basic amenities and low education level, one could assume

¹⁰¹ <http://livestockscience.in/wp-content/uploads/gender-livestock.pdf>

		that the districts with high livestock densities have low sanitation and awareness among households regarding the management of vector borne diseases such as Malaria. 14. Moderate positive correlation with Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population) ($r^2=0.609$) - Same as above. <i>This indicator was excluded due to Moderate - High correlation with 14 other indicators ($r^2 > 0.5$)</i> Overall picture of the system from the above correlations - Districts with relatively high livestock densities have higher a proportion of rain fed farmers, low crop insurance coverage, high participation of women in the work force, high proportion of tribal communities, high per capita water availability, and better road connectivity. But they also have low access to basic amenities, low literacy rates, low electrification, higher variability of mining revenue, and high incidence of vector and water borne diseases.
4	Available water resources under fish culture	• Low positive correlation with the indicator Persons suffering from water borne diseases (Diarrhoea/Dysentery)/1,000 Population) ($r^2=0.404$) indicating that surface water resources that are used for fish production might be consumed without purification, leading to higher incidence of water borne diseases. This is a good entry point for health policy makers to ensure that communities engaging in fish production are also provided with water purification technology or at least asked to boil water before consumption. <i>This indicator was selected as correlation with other 2 indicators is low ($r^2 < 0.5$)</i>
5	Percentage of small and marginal farmers	1. Moderate negative correlation with Percentage of rain fed agriculture ($r^2=-0.694$) - A peculiar correlation that signifies coupling of increased land fragmentation with increased irrigation. However, this trend is observable across the country.¹⁰² 2. Moderate positive correlation with Percentage gross cropped area covered under crop insurance (PMFBY 2019) ($r^2=0.561$) small and marginal farmers in Chhattisgarh are likely to have irrigation and higher irrigation warrants crop insurance coverage as irrigated crops have a higher investment. 3. High negative correlation with Forest dependence of rural tribal communities ($r^2=-0.819$) - either forest dependent tribal communities in Chhattisgarh own larger pieces of land, do not own any land or own rain fed agricultural lands. 4. High positive correlation with Stage of Groundwater Extraction ($r^2=0.801$) - same as points 1 and 2 as groundwater extraction is mostly used for irrigation. 5. High negative correlation with Per capita water availability ($r^2=-0.785$) - inverse of the above point, larger the extraction of groundwater for irrigation by small and marginal farmers, lower per capita water availability due to exploitation. 6. High positive correlation with Inequality adjusted education index ($r^2=0.839$)

¹⁰² <https://www.news18.com/news/india/hard-row-to-hoe-why-the-farmers-cost-of-irrigation-needs-attention-in-india-2285197.html>

		7. Moderate negative correlation with Women participation in the labour force ($r^2=-0.661$) – another peculiar but not extraordinary correlation that is observed across the country – with increase in female literacy, there is a decrease in participation of women in the labour force¹⁰³. 8. Moderate positive correlation with Dependency ratio ($r^2=0.504$) as the percentage of women in the labour force reduces, dependency ratio increases. 9. Moderate negative correlation with Road connectivity ($r^2=-0.543$) 10. Moderate positive correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=0.512$) – as this includes electricity for irrigation 11. Moderate negative correlation with Variability of revenue from mining ($r^2=-0.620$) 12. High negative correlation with Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=-0.890$) – higher literacy rates create awareness to manage and lower risk from vector borne diseases. 13. Moderate negative correlation with Persons suffering from water borne diseases (Diarrhoea/Dysentery)/1,000 Population ($r^2=-0.540$) – same as above. <i>This indicator was excluded due to Moderate - High correlation with 14 other indicators ($r^2 > 0.5$)</i> Overall picture of the system from the above correlations - Districts with higher percentage of small and marginal farmers have higher irrigated area (thus higher area under crop insurance), higher literacy rates and thus low livestock density, low incidence of both Malaria and other water borne diseases and lower participation of women in the labour force which increases the dependency ratio. These districts also have good electrification and must be rich in minerals as variability in mining revenue is lower in these districts. However, these districts have lower road connectivity.
6	Percentage of rain fed agriculture	1. Moderate negative correlation with the indicator Percentage gross cropped area covered under crop insurance (PMFBY 2019) ($r^2=-0.557$) – rain-fed farmers rarely invest in crop insurance as the insurance claims are usually calculated by considering the guaranteed yield, which maybe too low due to high variations in rain fed crop yields. Furthermore, the investment in rain fed crop cultivation is lower when compared to irrigated crops, and thus does not warrant crop insurance coverage. 2. Moderate positive correlation with the indicator Forest dependence of rural tribal communities ($r^2=0.605$) – Forest dependent rural tribal communities have predominantly rain fed agrarian based livelihoods¹⁰⁴. 3. High negative correlation with the indicator Stage of Groundwater Extraction ($r^2=-0.723$) as groundwater is extracted mostly for irrigation 4. Moderate positive correlation with the indicator Per capita water availability ($r^2=0.542$), no or reduced irrigation increases per capita water availability.

¹⁰³ E. Chatterjee, S. Desai and R. Vanneman, 2018, 'Indian paradox: rising education, declining womens' employment', *Demogr Res.*, vol. 38: pp. 855–878, accessed at <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6424343/>

¹⁰⁴ <http://documents.worldbank.org/curated/en/81687146872763380/pdf/multi0page.pdf>

		5. Moderate negative correlation with the indicator Access to basic amenities (safe drinking water, toilets, kitchen and clean cooking fuel) ($r^2=-0.528$) 6. Moderate negative correlation with the indicator Inequality adjusted education index ($r^2=-0.553$) 7. Moderate negative correlation with the indicator Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=-0.523$) 8. Moderate positive correlation with the indicator Number of functional Health Care Facilities/ 10,000 population ($r^2=0.494$) 9. Moderate positive correlation with the indicator Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.494$) <i>This indicator was excluded due to Moderate - High correlation with 10 other indicators ($r^2 > 0.5$)</i> Overall picture of the system from the above correlations – Districts with predominantly rain fed agriculture have higher density of tribal communities, low literacy rate and generally low overall development (lack of access to basic amenities, electrification and functional health care infrastructure). Due to low literacy and inefficient health care, prevalence of vector borne diseases is high (Malaria) in these districts.
7	Percentage gross cropped area covered under crop insurance	1. Moderate negative correlation with the indicator Forest dependence of rural tribal communities ($r^2=-0.528$) 2. High positive correlation with the indicator Stage of Groundwater Extraction ($r^2=0.744$) 3. Moderate positive correlation with the indicator Access to basic amenities (safe drinking water, toilets, kitchen and clean cooking fuel) ($r^2=0.625$) 4. Moderate positive correlation with the indicator Inequality adjusted education index ($r^2=0.512$) 5. Moderate positive correlation with the indicator Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=0.578$) 6. Moderate negative correlation with the indicator Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=-0.533$) <i>This indicator was excluded due to Moderate - High correlation with 9 other indicators ($r^2 > 0.5$)</i> High correlation between irrigation availability and crop insurance coverage is observed above, districts that have high crop insurance coverage have low tribal populations, higher literacy rates, higher access to basic amenities, high electrification and low incidence of vector borne diseases – generally more socially and institutionally developed communities access crop insurance.
8	Forest dependence of rural tribal communities	1. High Negative correlation with the indicator Stage of Groundwater Extraction ($r^2=-0.824$) 2. High positive correlation with the indicator Per capita water availability ($r^2=0.974$) 3. High Negative correlation with the indicator Inequality adjusted education index ($r^2=-0.785$) 4. Moderate positive correlation with the indicator Women participation in the labour force ($r^2=0.505$) 5. High positive correlation with the indicator Road connectivity ($r^2=0.801$)

		6. High Negative correlation with the indicator Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=-0.703$) 7. Moderate positive correlation with the indicator Variability of revenue from mining ($r^2=0.692$) 8. High positive correlation with the indicator Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.806$) This indicator was Selected as all 12 other indicators that have Moderate to High correlation with this indicator were excluded
9	Number of approved Minor Forest Produce (MFP) Microenterprises	1. Low negative correlation with Stage of Groundwater Extraction ($r^2=-0.319$) - Districts with higher levels of irrigation potentially have lower dependence on forests as they are likely to focus on agriculture production. 2. Low positive correlation with Number of functional Health Care Facilities/ 10,000 population ($r^2=0.404$) - districts with generally higher levels of development infrastructure are logical options to set up Microenterprises as they will have access to the necessary infrastructure to be more profitable. Or this could very well be a spurious correlation. Selected as correlation with other indicators is Low, $r^2<0.5$
10	Stage of Groundwater Extraction (per cent)	1. High Negative correlation with the indicator Per capita water availability ($r^2=-0.748$) 2. Moderate positive correlation with Access to basic amenities (safe drinking water, toilets, kitchen, and clean cooking fuel) ($r^2=0.558$) 3. High positive correlation with the indicator Inequality adjusted education index ($r^2=0.721$) 4. Moderate Negative correlation with the indicator Women participation in the labour force ($r^2=-0.509$) 5. Moderate Negative correlation with the indicator Road connectivity ($r^2=-0.587$) 6. Moderate positive correlation with the indicator Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=0.617$) 7. High Negative correlation with the indicator Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=-0.756$) Excluded due to Moderate - High correlation with 12 other indicators ($r^2 > 0.5$) From all the above correlations it is apparent that districts with higher proportion of irrigation are generally more developed. Communities have higher literacy rates, better electrifications, better access to basic amenities and low incidence of diseases.
11	Per capita water availability	1. High Negative correlation with the indicator Inequality adjusted education index ($r^2=-0.762$) 2. Moderate positive correlation with Women participation in the labour force ($r^2=0.517$) 3. High positive correlation with the indicator Road connectivity ($r^2=0.848$) 4. Moderate Negative correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=-0.647$) 5. High positive correlation with the indicator Variability of revenue from mining ($r^2=0.734$) 6. High positive correlation with the indicator Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.762$) Excluded due to Moderate - High correlation with 11 other indicators ($r^2 > 0.5$)

		Districts with lower irrigation logically have higher per capita water availability in Chhattisgarh given high annual rainfall observed along with the flow of several perineal rivers in the state. These districts, however, are plagued with low social development manifesting in the form of low literacy rates and electrification, and high disease incidence.
12	Percentage of rural households below the poverty line - adjusted for inequalities	1. A moderate negative correlation with Access to basic amenities (safe drinking water, toilets, kitchen, and clean cooking fuel) ($r^2=-0.503$) a logical correlation, as poorer households rarely have access to basic amenities (Excluded). 2. A low positive correlation with Infant Mortality Rate (IMR) ($r^2=0.427$) which is another logical correlation, strongly associated with the above indicator. Selected as correlation with other indicators is Low, $r^2<0.5$
13	Access to basic amenities (safe drinking water, toilets, kitchen, and clean cooking fuel)	1. Moderate positive correlation with Inequality adjusted education index ($r^2=0.680$) 2. High Negative correlation with Women participation in the labour force ($r^2=-0.705$) 3. Moderate positive correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=0.517$) 4. Moderate negative correlation with Infant Mortality Rate (IMR) ($r^2=-0.501$) Excluded due to Moderate - High correlation with 9 other indicators ($r^2>0.5$) Districts with higher literacy rates have higher access to basic amenities including electrification and as a result they have lower infant mortality which can be considered a general indication of good health of the community.
14	Inequality adjusted education index	1. High Negative correlation with Women participation in the labour force ($r^2=-0.800$) – explained above 2. Moderate Negative correlation with Road connectivity ($r^2=-0.542$) 3. Moderate positive correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=0.576$) 4. Moderate Negative correlation with Variability of revenue from mining ($r^2=-0.624$) 5. High Negative correlation with Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=-0.789$) 6. Moderate Negative correlation with Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population ($r^2=-0.695$) Excluded due to Moderate - High correlation with 12 other indicators ($r^2 > 0.5$) Districts with high literacy observe lower incidence of diseases, and lower variability of revenue from mining which requires some degree of skill. These districts, however, do not have good road connectivity¹⁰⁵.

¹⁰⁵ The state of Chhattisgarh lacks an adequate road network to efficiently support the required mobility across areas with natural resources, social services, industrial centres, and economic development zones. As of 2015– 2016, road density in Chhattisgarh is only 72.1 km per 100 square km, which is significantly below the national average of 139.1 km per 100 square km (https://www.adb.org/sites/default/files/project-documents/52002/52002-001-iee-en_22.pdf)

15	Women participation in the labour force	1. Moderate Negative correlation with Dependency ratio ($r^2=-0.552$) 2. Moderate positive correlation with Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.565$) 3. Moderate positive correlation with Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population ($r^2=0.662$) 4. Moderate positive correlation with Households with any usual member covered by a health scheme or health insurance ($r^2=0.668$) Excluded due to Moderate - High correlation with 9 other indicators ($r^2 > 0.5$) Districts with higher number of women participating in the labour forces have lower dependency ratio as this indicator also considered women (and men) of working age who are unemployed. Unfortunately, districts with higher women in the workforce observe lower literacy rates, meaning these districts have a larger gender gap in terms of literacy and that women are being employed in menial unskilled jobs. Due to low literacy rates, the incidence of disease is also much higher in these districts.
16	Dependency ratio	1. Moderate Negative correlation with Households with any usual member covered by a health scheme or health insurance ($r^2=-0.498$) This indicator was selected as correlation with the above indicators is Low, $r^2 < 0.5$
17	Access to an alternate employment source (MGNREGS)	No Correlation with any other indicators, selected
18	Road connectivity	1. Moderate Negative correlation with Percentage of villages electrified weighted by number of hours of electricity provided ($r^2=-0.536$) 2. Moderate positive correlation with Variability of revenue from mining ($r^2=0.584$) 3. Moderate positive correlation with Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.589$) Excluded due to Moderate - High correlation with 9 other indicators ($r^2 > 0.5$) Road connectivity is essential for the overall development of a region. All the above correlations with this indicator point to this simple logical fact. Unfortunately, districts with better road connectivity have low literacy rates, which leads to higher incidence of disease and low skill levels which lead to increased variability in mining revenue.
19	Percentage of villages electrified weighted by number of hours of electricity provided	1. Moderate Negative correlation with Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=-0.512$) 2. Moderate Negative correlation with Variability of revenue from mining ($r^2=-0.459$) Excluded due to Moderate - High correlation with 11 other indicators ($r^2 > 0.5$)
20	Variability of revenue from mining	1. Cases of vector borne diseases/ 1,000 Population (Malaria) ($r^2=0.630$) Excluded due to Moderate - High correlation with 7 other indicators ($r^2 > 0.5$)

21	Number of establishments (OAE, Estt, Micro, small and Medium)	No Correlation with any other indicators - selected
22	Infant Mortality Rate (IMR)	Correlations described above - Selected
23	Number of functional Health Care Facilities/ 10,000 population	1. A low positive correlation with Households with any usual member covered by a health scheme or health insurance ($r^2=0.464$) - A logical correlation, as districts with functional health care infrastructure would also instil knowledge and awareness about medical insurance products available to aid households in meeting medical expenses. <i>This indicator was selected as correlation with the above indicators is Low, $r^2 < 0.5$</i>
24	Cases of vector borne diseases/ 1,000 Population (Malaria)	1. Moderate positive correlation with Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population ($r^2=0.612$) - Logical as both are water-related diseases. Indicates unsanitary disposal or drainage of waste waters. <i>Excluded due to Moderate - High correlation with 12 other indicators ($r^2 > 0.5$)</i>
25	Persons suffering from water borne diseases (Diarrhoea/Dysentery)/ 1,000 Population)	Correlations described above - Selected
26	Households with any usual member covered by a health scheme or health insurance	Correlations described above - Selected

1.4: Actual and Normalised Values of the 12 Finalised Indicators

The actual and normalised values of the final 12 selected indicators are presented in Table A4 and Table A5 below. For the sake of representing the all the indicators on a single page, the names of the indicators have been modified, the actual labels are provided here as a reference: 1. Crop, livestock, and fish yield variability (**Yield Variability**); 2. Percentage net area cultivated under **Horticulture**; 3. Percentage of available water resources under **fish** culture; 4. **Forest dependence of rural tribal communities**; 5. Number of approved Minor Forest Produce (**MFP**) Microenterprises; 6. Percentage of rural households below the poverty line - adjusted for inequalities (**BPL**); 7. Dependency ratio (**DR**); 8. Access to an alternate employment sources (**MGNREGS**); 9. Number of establishments (OAE, Estt., Micro, small and Medium) (**Industry**); 10. Infant Mortality Rate (**IMR**); 11. Number of **functional Health Care Facilities**/ 10,000 population; 12. Households with any usual member covered by a health scheme or **health insurance**

Table A4: Actual values of the 12 indicators used for constructing vulnerability assessment

Districts	Yield variability	Horticulture	Fish	Forest dependence of rural tribal communities	MFP	BPL	DR	MGNREGS	Industry	IMR	Functional Health Care Facilities	Health Insurance
Balod	13.13	0.04	95.57	0.17	0.00	88.49	80.60	45.88	2324.50	32.84	2.90	68.30
Baloda Bazar	12.34	0.22	92.19	0.16	0.00	92.71	88.67	42.45	2658.80	38.00	1.04	58.50
Balrampur	16.35	0.17	91.61	0.62	0.00	93.05	85.14	55.17	1009.60	41.00	1.62	71.80
Bastar	19.46	0.69	86.72	0.42	20.89	92.56	75.30	43.03	1737.80	33.68	5.32	71.20
Bemetara	23.53	0.41	88.63	0.00	0.00	88.49	80.60	43.27	1279.40	38.00	2.17	68.30
Bijapur	21.36	0.31	86.79	2.46	0.00	90.66	78.79	53.05	253.50	36.00	2.52	86.00
Bilaspur	17.11	0.18	91.93	0.20	17.82	93.02	89.27	57.45	4343.50	34.21	1.01	69.00
Dantewara	23.46	0.31	98.11	0.92	10.00	90.74	71.61	52.37	997.70	36.00	2.00	65.00
Dhamtari	20.33	0.15	97.96	0.48	11.42	89.34	71.33	47.91	2256.30	37.71	2.52	83.20
Durg	26.26	0.30	95.94	0.00	0.00	88.49	80.60	41.16	5266.90	32.84	2.36	68.30
Gariaband	18.80	0.13	94.63	0.73	12.12	92.71	88.67	54.09	925.40	35.65	2.37	58.50
Gaurela-Pendra-Marwahi	17.11	0.18	91.93	0.20	17.82	93.02	89.27	57.45	4343.50	34.21	1.01	69.00
Janjgir-Champa	18.51	0.11	99.35	0.03	0.00	92.73	75.81	40.50	3159.40	37.29	0.89	70.10
Jashpur	14.55	0.35	89.70	0.46	17.50	91.97	67.62	50.89	1384.10	41.26	3.85	78.10
Kanker	17.67	0.08	90.58	0.79	37.33	90.96	70.22	59.90	4853.70	36.12	5.31	78.90
Kawardha	18.28	0.22	97.51	0.36	0.00	90.95	86.87	58.71	6983.00	41.69	0.97	66.40

Kondagaon	11.47	0.22	96.97	0.63	29.67	92.56	75.30	43.19	1067.20	36.00	2.10	71.20
Korba	20.66	0.10	98.11	0.73	30.12	91.84	85.74	41.91	11836.2	38.08	2.20	62.30
Koriya	22.28	0.14	92.80	1.03	27.51	90.55	80.85	65.56	1446.50	41.04	3.38	63.40
Mahasamund	18.11	0.04	85.48	0.27	0.00	93.59	77.27	44.45	2299.10	45.38	2.35	73.10
Mungeli	5.90	0.32	92.42	0.26	0.00	93.02	89.27	48.82	1177.90	38.00	0.87	69.00
Narayanpur	15.23	0.05	98.33	1.89	25.20	92.83	83.40	46.99	235.40	36.00	5.79	81.40
Raigarh	16.34	0.28	98.72	0.37	20.83	92.20	79.83	37.87	3004.60	43.59	2.04	62.60
Raipur	24.20	0.23	90.07	0.00	30.27	92.71	88.67	44.88	7224.40	36.83	1.18	58.50
Rajnandgaon	20.39	0.12	97.62	0.33	17.50	90.82	72.39	56.64	4298.70	38.66	2.47	76.60
Sukma	11.18	0.24	95.83	1.75	8.88	90.74	71.61	57.93	2938.90	34.87	2.22	65.00
Surajpur	9.02	0.30	90.81	0.47	0.00	93.05	85.14	61.64	1187.00	40.00	3.34	71.80
Surguja	17.79	0.28	99.94	0.51	38.80	93.05	85.14	46.96	1351.40	40.50	2.13	71.80

Table A5: Normalized values of the 12 indicators used for constructing vulnerability assessment

Districts	Yield variability	Horticulture	Fish	Forest dependence of rural tribal communities	MFP	BPL	DR	MGNREGS	Industry	IMR	Functional Health Care Facilities	Health Insurance
Balod	0.24	1.00	0.30	0.83	1.00	0.00	0.60	0.71	0.70	0.00	0.35	0.60
Baloda Bazar	0.19	0.52	0.54	0.84	1.00	0.83	0.97	0.83	0.65	0.41	0.92	1.00
Balrampur	0.43	0.64	0.58	0.39	1.00	0.89	0.81	0.38	0.89	0.65	0.76	0.46
Bastar	0.61	0.00	0.91	0.59	0.46	0.80	0.35	0.81	0.79	0.07	0.00	0.49
Bemetara	0.84	0.00	0.78	1.00	0.00	0.00	0.60	0.80	0.85	0.41	0.60	0.60
Bijapur	0.72	0.26	0.91	0.00	1.00	0.42	0.52	0.45	1.00	0.25	0.55	0.00
Bilaspur	0.47	0.60	0.55	0.80	0.54	0.89	1.00	0.29	0.41	0.11	0.91	0.57
Dantewara	0.84	0.27	0.13	0.10	0.74	0.44	0.18	0.48	0.89	0.25	0.64	0.74
Dhamtari	0.66	0.69	0.14	0.53	0.71	0.17	0.17	0.64	0.71	0.39	0.50	0.00
Durg	1.00	0.28	0.28	1.00	0.00	0.00	0.60	0.88	0.28	0.00	0.51	0.60
Gariaband	0.57	0.74	0.37	0.29	0.69	0.83	0.97	0.41	0.90	0.22	0.60	1.00

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Gaurela-Pendra-Marwahi	0.47	0.60	0.55	0.80	0.54	0.89	1.00	0.29	0.41	0.11	0.91	0.57
Janjgir-Champa	0.55	0.80	0.04	0.98	0.00	0.83	0.38	0.91	0.58	0.35	0.94	0.53
Jashpur	0.32	0.16	0.71	0.55	0.55	0.68	0.00	0.53	0.84	0.67	0.00	0.21
Kanker	0.50	0.87	0.65	0.23	0.04	0.48	0.12	0.20	0.34	0.26	0.00	0.17
Kawardha	0.54	0.50	0.17	0.65	1.00	0.48	0.89	0.25	0.03	0.71	0.96	0.68
Kondagaon	0.14	0.49	0.20	0.39	0.24	0.80	0.35	0.81	0.88	0.25	0.65	0.49
Korba	0.68	0.84	0.13	0.29	0.22	0.66	0.84	0.85	0.00	0.42	0.63	0.85
Koriya	0.77	0.71	0.49	0.00	0.29	0.40	0.61	0.00	0.83	0.65	0.20	0.80
Mahasamund	0.53	0.98	1.00	0.74	1.00	1.00	0.45	0.76	0.70	1.00	0.55	0.41
Mungeli	0.00	0.23	0.52	0.75	1.00	0.89	1.00	0.60	0.87	0.41	1.00	0.57
Narayanpur	0.36	0.95	0.11	0.00	0.35	0.85	0.73	0.67	1.00	0.25	0.00	0.07
Raigarh	0.42	0.33	0.08	0.64	0.46	0.73	0.56	1.00	0.60	0.86	0.63	0.83
Raipur	0.88	0.47	0.68	1.00	0.22	0.83	0.97	0.75	0.00	0.32	0.89	1.00
Rajnandgaon	0.66	0.77	0.16	0.68	0.55	0.46	0.22	0.32	0.42	0.46	0.45	0.27
Sukma	0.13	0.45	0.28	0.00	0.77	0.44	0.18	0.28	0.61	0.16	0.48	0.74
Surajpur	0.00	0.30	0.63	0.54	1.00	0.89	0.81	0.14	0.86	0.57	0.24	0.46
Surguja	0.51	0.33	0.00	0.50	0.00	0.89	0.81	0.67	0.84	0.61	0.57	0.46

1.5: Interquartile Rule for Identifying Outliers with respect to 12 indicators

Six out of the twelve indicators had outliers:

- Mungeli district was estimated to have exceptionally low yield variability of crop, livestock and fish production (5.9 per cent)
- Bastar had relatively high area under horticulture (0.69 per cent)
- Bijapur, Narayanpur and Sukma was estimated to have extremely high forest dependence of rural tribal communities (2.46, 1.89 and 1.75 ha per capita availability of forest resources, respectively)
- Korba reported to have remarkably high number of establishments (particularly Own Account establishments and establishments having at least one hired worker – 11836 industries)
- Bastar, Kanker and Narayanpur were estimated to have very high number of functional health care facilities per 10,000 population (5.32, 5.31 and 5.79, health care facilities with doctors and para medical staff in position per 10,000 population)
- Bijapur district reported having health care coverage for almost 86 per cent of households in the district, which is very high.

All these outliers were excluded during the normalisation process, as outliers largely undermine the variability of the remaining observations.

Table A6: Outliers identified among data for 12 indicators, using the Interquartile Rule

	Yield variability	Horticulture	Fish	Forest dependence of rural tribal communities	MFP	BPL	DR	MGNREGS	Industry	IMR	Functional Health Care Facilities	Health Insurance
Minimum	5.90	0.04	85.48	0.00	0.00	88.49	67.62	37.87	235.40	32.84	0.87	58.50
Q1	14.89	0.13	90.69	0.23	0.00	90.74	75.30	43.23	1182.45	36.00	1.81	65.00
Q2 (Median)	18.11	0.22	94.63	0.46	11.42	92.20	80.60	47.91	2256.30	37.71	2.22	69.00
Q3	20.53	0.30	97.79	0.73	23.04	92.78	85.44	55.91	3729.05	40.25	2.71	72.45
Maximum	26.26	0.69	99.94	2.46	38.80	93.59	89.27	65.56	11836.20	45.38	5.79	86.00
IQR	5.64	0.17	7.10	0.50	23.04	2.04	10.14	12.68	2546.60	4.25	0.90	7.45
Very low (outlier)	6.44	-0.13	80.05	-0.52	-34.56	87.69	60.08	24.22	-2637.45	29.63	0.45	53.83
Very high (outlier)	28.98	0.56	108.44	1.48	57.61	95.83	100.66	74.92	7548.95	46.62	4.07	83.63

For the outlier values that were excluded from the normalisation process, depending on whether they were very-low or very high outliers and their functional relationship, either 0 or 1 was assigned:

- For Mungeli district, very-low outlier value of 5.9 per cent for yield variability of crop, livestock and fish production which has a positive functional relationship, zero was assigned.
- Bastar – very-high outlier value of 0.69 per cent for area under horticulture, which has a negative functional relationship, zero was assigned.
- Bijapur, Narayanpur and Sukma: one was assigned to very-high outlier values of 2.46, 1.89 and 1.75 for forest dependence of rural tribal communities, respectively, as this has a positive functional relationship.
- For Korba district, zero was assigned to very-high outlier value of 11836 for number of establishments (particularly Own Account establishments and establishments having at least one hired worker) as this indicator has a negative functional relationship.
- Bastar, Kanker and Narayanpur: zero was assigned to very-high outlier values of 5.32, 5.31 and 5.79 health care facilities with doctors and para medical staff in position per 10,000 population, respectively, as this indicator also has a negative functional relationship with vulnerability.
- For Bijapur district, zero was assigned for the very-high outlier value of 86 per cent of households covered under health insurance.

1.6: Drivers of Vulnerability

Table A7: Major drivers of vulnerability for districts under different vulnerability classes

Vulnerability Class	Yield variability	Horticulture	Fish	Forest dependence of rural tribal communities	MFP	BPL	DR	MGNREGS	Industry	IMR	Functional Health Care Facilities	Health Insurance	Percentage of vulnerability
Very High	2.81	6.74	8.01	9.06	11.69	10.58	9.42	8.58	8.66	7.10	9.63	7.73	71.30
High	7.98	8.74	5.49	8.75	6.28	11.13	10.32	8.04	7.81	5.10	10.49	9.86	63.24
Moderate	7.72	6.40	6.88	9.00	8.75	8.87	10.74	9.22	9.37	6.16	8.36	8.54	54.15
Low	9.75	10.52	5.05	5.85	8.91	9.88	5.91	8.97	14.49	7.64	6.34	6.69	45.72
Very Low	7.47	15.79	11.09	2.77	9.64	11.01	3.62	5.72	11.34	5.04	5.67	10.85	34.98

Annexure II: Detailed Forest Sector Vulnerability Assessment

The State Action Plan on Climate Change (SAPCC, 2014) of Chhattisgarh concluded that any short-term or long-term fluctuations of climate can have dramatic effects on the forest productivity and impact forest dependent communities and their livelihoods. Increased climatic variability and prolonged droughts and higher temperatures can result in increased fire incidence and lead to forest degradation.

In this assessment, the impact of climate change on forests is assessed using latest CORDEX regional climate model outputs, under two RCP scenarios – RCP 4.5 and RCP 8.5. The key objectives of this assessment are:

- Assess the impact of projected climate change on the forests in Chhattisgarh, in particular the forested grids that will undergo vegetation change, using a dynamic vegetation model, and by using multi-model ensemble of high resolution downscaled (CORDEX/IITM) climate projections under two scenarios and for two periods.
- RCP 4.5 – Low emission scenario for short term (2030s) and long term (2080s) periods.
- RCP 8.5 – High emission scenario for short term (2030s) and long term (2080s) periods.
- Project the impact of climate change on Net Primary Productivity (NPP) of the forests in Chhattisgarh
- Suggest adaptation strategies in the context of climate change.

Methodology

Description of the Dynamic Global Vegetation model

The dynamic global vegetation model used is the LPJ model (Lund-Postdam-Jena Model), developed by Department of Plant Ecology, Lund University, Sweden; Potsdam Institute for Climate Impact Research, Germany and Max Planck Institute for Biogeochemistry, Jena, Germany. The version of the model used is LPJ v-3.1. LPJ uses a modular framework to combine process-based, large-scale representations of terrestrial vegetation dynamics and land-atmosphere carbon and water exchanges (Sitch *et al.*, 2003, Smith *et al.*, 2001). LPJ is one of the extensively used vegetation models globally and has been validated for India by Sharma *et al.* (2016). The model is implemented at 0.5° latitude and longitude resolution with specified atmospheric CO₂ concentration, soil type, monthly fields of temperature (degree Celsius), precipitation (mm/month), and cloudiness (per cent) (Table 1).

Table 1: Input data requirement for the LPJ model

Climate Parameters	Non-climatic parameters
Monthly mean cloudiness (per cent)	Soil type
Monthly mean precipitation (mm/month)	CO ₂ concentration
Monthly mean temperature (Degree Celsius)	Grid or domain

The LPJ model is able to simulate transient structural changes in Earth's major vegetation types in response to variations in, among other factors, climate, water availability, and atmospheric CO₂ content. The model also simulates the Net Primary Productivity under projected climate change scenarios.

Input data for LPJ model

Climate data (temperature, precipitation and cloud cover) from CORDEX (Coordinated Regional Climate Downscaling Experiment) is used as the input for the LPJ model. Temperature and precipitation data from

six CORDEX models from the IITM RCM ensemble are used for the two future scenarios. These models are listed in Table 2. The cloud cover data is obtained from the SMHI RCM ensemble.

Table 2: Input data to the LPJ model from six CORDEX models from IITM

Domain	Driving Model	Experiment	Ensemble	RCM Model	Frequency	Variable
WAS-44	CNRM-CERFACS-CNRM-CM5	Historical	R1i1p1	RegCM4-4	Monthly	hurs
	CSIRO-QCCCE-CSIRO-Mk3-6-0	RCP 4.5				tas
	MPI-M-MPI-ESM-LR	RCP 8.5				pr
	NOAA-GFDL-GFDL-ESM2M					sfc Wind
	IPSL-IPSL-CM5A-MR					cld
	CCCma-CanESM2					

Climate Projections and Representative Concentration Pathways

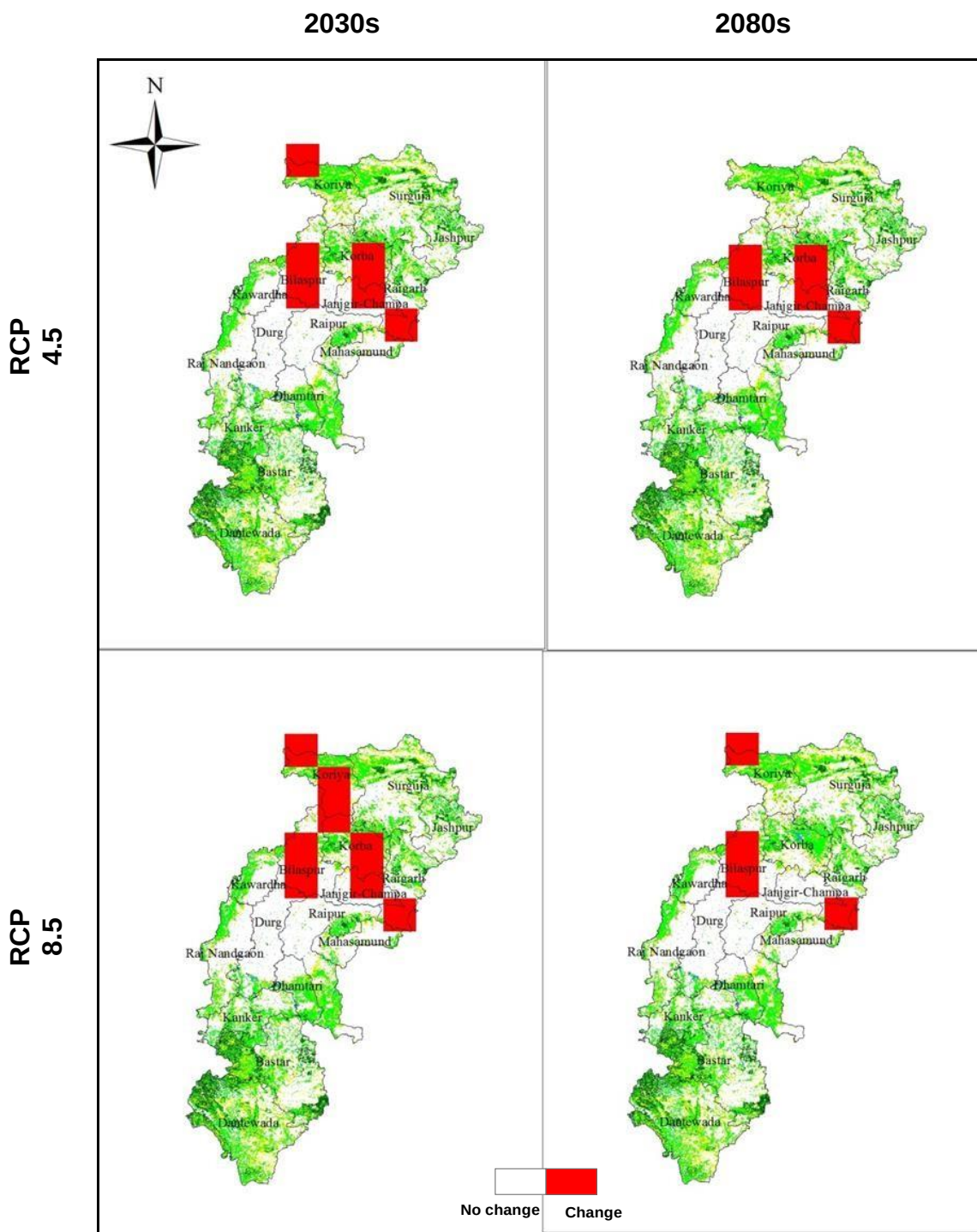
Climate outputs from CORDEX models are used in this study for impact modelling. Further, there are four climate futures described and considered possible, depending on how much greenhouse gases are emitted in the years to come. The four RCPs; RCP2.6, RCP4.5, RCP6, and RCP8.5, are named after a possible range of radiative forcing values in the year 2100, relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 W/m², respectively) (Weyant *et al.*, 2009). In our study, we focus on two of the four RCP scenarios - one moderate emission scenario (RCP 4.5) and the other high emission scenario (RCP 8.5). The two future scenarios are mainly assessed for the mid-term (2030s - average from 2021 to 2050) and the long term (2080s - average from 2071 to 2100). The climate change projections are bias corrected.

Impact of Climate Change on Forests in Chhattisgarh

Impact of climate change on forest types

LPJ model is run at national level for India and the grids falling in Chhattisgarh state have been extracted to assess the impact of climate change on forest types. Figure 55 shows the forested grids that will be impacted by the changing climate in the 2030s (short term) and the 2080s (long term) for the two future scenarios: the RCP 4.5 and the RCP 8.5, compared to the historical baseline from 1975-2005 for Chhattisgarh. Figure 54 also shows the distribution of various forest density categories across Chhattisgarh: they are divided into four categories of Very Dense Forest, Moderately Dense Forest, Open Forests and Scrub. The red colour grids indicate that, those grids are subjected to vegetation change. As it can be seen from Figure 54, vegetation change is projected for grids falling in the districts of Koriya, Bilaspur, Korba, Janjgir-Champa and Raigarh districts under both RCP 4.5 and RCP 8.5 scenarios, in 2030s and 2080s. This means that the future climate at such locations would not be suitable for the existing vegetation or forest type and biodiversity. The forest type change may be accompanied by forest dieback and mortality.

Figure 54: Grids (red colour) undergoing change in forest type overlaid on forest density categories of FSI for the 2030s (2021-2050) and the 2080s (2071-2100) with respect to the historical baseline from 1975-2005 for RCP 4.5 and RCP 8.5 scenarios.



Impact of climate change under RCP 4.5 scenario

Short Term (2030s): It can be observed that among the forested regions of Chhattisgarh, forested grids in the districts of Koriya, Bilaspur, Korba, Janjgir-Champa and Raigarh are projected to undergo change in the short term.

Long Term (2080s): Forested grids in the districts of Bilaspur, Korba, Janjgir-Champa and Raigarh are projected to undergo change in the long term.

Impact of climate change under RCP 8.5 scenario

Short Term (2030s): In the short term, the trends in vegetation change under RCP 8.5 scenario in the short term are similar to that projected for RCP 4.5 scenario in the short term with changes projected for the same districts of Chhattisgarh.

Long Term (2080s): Even under RCP 8.5 scenario forested grids in the districts of Koriya, Bilaspur, Janjgir-Champa and Raigarh are projected to be impacted by climate change in the long term.

Change in vegetation is projected largely in the Moderately Dense Forest and open forest areas of the state both in the short- and long-term periods under both RCP 4.5 and 8.5 scenarios, mainly in the northern parts of the state. Under the CORDEX models considered and using LPJ model, the forests of the densely forested districts of southern part of Chhattisgarh are not likely to be impacted by climate change. However, this could change with improved knowledge and modelling in the coming years.

Impact of climate change on Net Primary Productivity

LPJ model simulations for RCP 4.5 scenario suggests that the mean forest NPP is projected to show a marginal increase of up to 50 per cent by 2030s (short term) and a larger increase of up to 150 per cent in the 2080s (long term) in Chhattisgarh. Under RCP 8.5 scenario, an increase of up to 100 per cent in NPP is projected for the 2030s and in the long term, the increase in NPP is projected to be up to 150 per cent. Figure 56 presents the impact of climate change on Net Primary Productivity (NPP) of forests in Chhattisgarh.

RCP 4.5 scenario

Short Term (2030s): Under RCP 4.5 scenario, an increase in NPP of up to 50 per cent is projected for all the districts of Chhattisgarh.

Long Term (2080s): Under this scenario, the projected increase in NPP is by up to 100 per cent for the districts of Chhattisgarh.

- The increase is up to 50 per cent for the districts of Durg, Raipur, Rajnandgaon, Dantewada, Mahasamund, Kanker, parts of Dhamtari, Bilaspur.
- The increase is projected to be in the range of 50 per cent to 100 per cent for the districts of Koriya, Surguja, Jashpur, Raigarh, Bastar and parts of Korba.

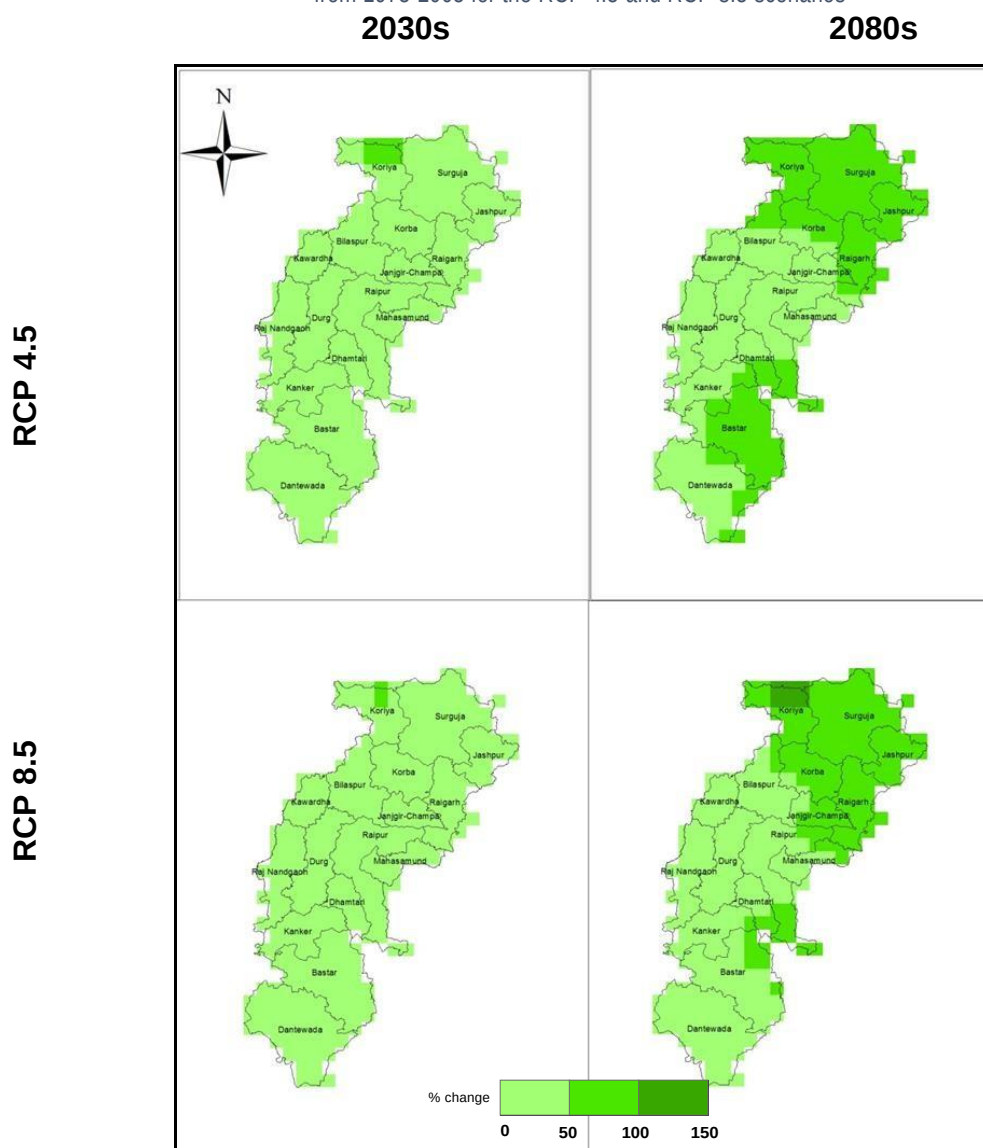
RCP 8.5 scenario

Short Term (2030s): The trends in NPP are similar to that projected for RCP 4.5 scenario in the short term. The increase is projected to be up to 50 per cent for all the districts of Chhattisgarh.

Long Term (2080s): Under this scenario, the projected increase in NPP is by up to 150 per cent for the districts of Chhattisgarh and the projected increase is in the range of 100 per cent to 150 per cent only for the part of district of Koriya.

- The increase is by up to 50 per cent for the districts of Dantewada, Kanker, Rajnandgaon, Durg, Mahasamund, Kawardha, Bilaspur, Raipur and others.
- The increase is in the range of 50 per cent to 100 per cent for the districts of Surguja, Jashpur, Korba, Raigarh, Janjgir-Champa, parts of Bastar, Kanker and Dhamtari.

Figure 55: Mean NPP change in the 2030s (2021-2050) and the 2080s (2071-2100) with respect to the historical baseline from 1975-2005 for the RCP 4.5 and RCP 8.5 scenarios



It can be observed from Figure 55 that NPP is projected to increase under both RCP 4.5 and RCP 8.5 scenarios and the percentage increase in the long term (2080s) is more than that projected for the short term (2030s). The projected increase is largely due to elevated CO₂ concentration in the atmosphere and CO₂ fertilization. However, the model has many limitations and does not consider soil nitrogen limitations and potential impacts of forest pests and fire under a changing climate.

Adaptation Strategies for Forests and Plantations of Chhattisgarh

Fortunately, large parts of forests, in the southern and central parts of Chhattisgarh are not likely to be impacted by climate change, under the climate change scenarios and the vegetation model used. In a few northern districts of the state, climate change may impact various aspects of forest ecosystems, including shifts in vegetation types, loss of biodiversity and forest dieback. The impacts of projected climate will be visible over decades. However, there is a need for evolving and initiating the adaptation strategies now to minimize the potential adverse impacts of climate change, as adaptation measures take time to establish and become effective.

Forest adaptation strategies can be considered under three broad categories as a precautionary measure in all regions:

- Silviculture practices
- Conservation oriented measures
- Policy and institutions

The precautionary adaptation strategies under the three categories are elaborated in the following sections.

i) Silvicultural Practices for adaptation

- Promote natural regeneration and mixed species planting in the afforestation programmes to enable risk spreading, and also to increase genetic diversity.
- Anticipatory planting of tree species across latitudinal and altitudinal gradients, in particular identification of species from warmer districts and their promotion in districts projected to become warmer.
- Develop and adopt climate resilient silvicultural practices.
- Climate resilient afforestation and reforestation programmes and practices that seek to establish natural potential vegetation with native species and complex structure.

ii) Conservation oriented policies and measures for adaptation

- Assisted migration to maintain or improve migration corridors, including active management to improve survival along the shifting vegetation especially in the transitional zones and by translocation of species.
- Linking of Protected Areas, Corridors and Fragmented Forests; Maintain large-scale landscape connectivity through a network of strict conservation areas
 - Identify critical forest corridors and fragmented forests and promote ecosystem restoration through climate-resilient afforestation and by managing non-climate disturbances.

iii) Policies and Institutions

- Promote social forestry, farm forestry and urban forestry to reduce dependence on remnant natural forest areas and thereby maintain and strengthen their long-term resilience.
- Build resilience in communities through agroforestry and plantation forestry, incorporating climate resilient practices such as promotion of mixed species and native species.
- Conserve forest biodiversity, promote agroforestry and plantation forestry on farmlands, and community lands incorporating multiple tree species providing:
 - Diverse livelihood opportunities: economic products (fruits, seeds, etc.), apart from timber and fuelwood to build resilience among the farmers by supplementing their income and to reduce their dependence on natural forests.
- Adopt the strategy recommended in Greening India Mission to promote synergy between climate change mitigation and adaptation.
- Undertake long term monitoring of changes in forest vegetation to changing climate, particularly focusing on biodiversity.

Adaptation Projects; Examples

Adaptation projects will have to be selected by the state Forest Department, through a consultative process. However, a few titles of projects for promoting adaptation are listed below for Chhattisgarh, since only a small part of the forest in the state is at risk of being impacted by climate change.

Table 3: Project Examples

Project title	Location	Activities
1. Climate resilient afforestation and reforestation in Northern districts of Chhattisgarh	Koriya, Bilaspur, Janjgir-Champa and Raigarh; pockets or grids identified to be impacted by climate change by modeling.	1. Develop afforestation and reforestation modules or models for the identified districts 2. Develop silvicultural practices for different afforestation and reforestation modules or models; especially tree species choice and mix. 3. Implement and monitor the afforestation and reforestation projects
2. Monitoring of impact of climate change on forests and biodiversity in Chhattisgarh through long term forest plots;	Sample Districts or Forest Divisions or forest types (to be selected by the Forest Dept.)	1. Define the objectives of long-term monitoring of impact of climate change on forests and biodiversity. 2. Develop ecological, soil and vegetation monitoring protocols and methods 3. Select locations for laying the long-term monitoring plots. 4. Identify institutions for monitoring the identified parameters.
3. Linking Forest corridors to bridge forest fragments and promote migration of plant and animal species.	Based on FSI maps identify or select districts and forest divisions with maximum potential for linking forest fragments by Forest Dept.	1. Identify and map corridors and locations for forest regeneration to bridge or link the forest fragments. 2. Develop Forest regeneration models or modules for different districts. 3. Develop silvicultural and vegetation management practices to link corridors. 4. Implement Forest regeneration measures. 5. Develop community participation strategies in the corridors.

Mapping of SDGs and NDCs relevant to forest sector with state targets, initiatives and gaps

The SDGs and NDCs include various components related to sustainable development and mitigation actions. The tables below map the SDG and NDC action and targets relevant to Forest sector with existing state initiatives and targets to assess the gaps in the policy landscape

Table 4: SDGs Relevant to Forests and Biodiversity

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the SDG targets /Goal
1	Goal 15 Life on Land	Conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands; maintaining the biodiversity, mobilizing resources for forest management; sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation.	1. Implement Green India Mission activities 2. Review of forest working plans as per government of India's New Work Plan Code 2014, and incorporation of measures of forest sustainability, Climate Change	Green India Mission, RDF, RDBF etc.	1. There are variations in cover by forest type but there is evidently no change in the net forest cover matrix which is due to forest degradation leading to an increase in the open forest and scrub area. 2. In Chhattisgarh, during the period 1st January 2015 to 5th February 2019, a total of 3,793.05 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019)
2	Goal 6 Clean Water and Sanitation	Restoring water-related ecosystem including forests, wetlands, rivers, aquifers and lakes	Soil and moisture conservation through watershed management	Riverbank plantation, Soil and moisture conservation works under CAMPA.	The depletion of groundwater level especially during summer in the state has become a challenge due to

					overexploitation of groundwater in few areas during last few years.
3	Goal 12 Responsible Consumption and production	Sustainable management and efficient use of natural resources;	Distribution of LPGs under UJJWALA Yojana and other energy efficient devices in forest areas.	CAMPA fund for Ujjawala Yojana implementation. Joint Forest management committee, Narwa Garua Ghurwa Bari Scheme.	Destructive collection practices of NTFPs & medicinal plants and removal and collection of tubers, roots, bark fruits and seeds beyond the regenerative capacity causing forest degradation.
4	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities; mainstreaming climate measure in national policies; improving education and awareness about CC; building capacities of individuals and institutions	1. Promote research studies on forest related activities. 2. Access international support and benefits in sustainable management of forests through Reducing Emissions from Deforestation and Forest Degradation (REDD+), Clean Development Mechanism (CDM) projects on Forestry.	Establishment of Chhattisgarh State Centre for climate change, Chhattisgarh state action plan for climate change prepared in 2014, capacity building and awareness program organised and revision of SAPCC till 2030 is done.	Climate finance and budget availability for carrying out climate actions in the State.

Table 5: NDCs Relevant to Forests and Biodiversity

S. N.	Description	Relevant Focus	State Target	Initiatives in terms of existing programme /scheme	Gaps in achieving the NDC targets /goal
1	NDC 5	Creating additional carbon sink through additional forest and tree cover.		Green India Mission, RDF, RDBF, Riverbank plantation activity	
2	NDC 6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change.		CAMPA, JFM	
3	NDC 1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.	-	Suraji Gaon Scheme (<i>Narwa, Garua, Ghurwa aur Bari Scheme</i>).	
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Annexure III: Detailed Water Resources Sector Vulnerability Assessment

Introduction

The link between climate change and water security is evident from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report, which brings out that the patterns of rainfall are changing thus altering freshwater systems, affecting the quantity and quality of water available in many regions. In terms of climate projections, droughts and floods are likely to increase and coastal systems will be affected by submersion, coastal flooding and sea-level rise. Both population growth and economic development, especially in poor and middle-income groups in developing countries, will exacerbate the negative effects of climate change.

Across the Indian sub-continent, climate change is recognised as a key threat to sustainable development, exacerbating other socio-economic and environmental pressures. Potential impacts of climate change in India extend from the high Himalayan states to the coastal zones, are transboundary in nature, as well as are multi-sectoral. Recognising these challenges, state governments have been proactive in their development of State Action Plans on Climate Change (SAPCC) that identify key vulnerabilities and risks. Due to its importance for sustaining livelihoods and serving as a backbone to economic development, the rural sector in particular is considered highly vulnerable to the adverse effects of climate change. Climate change has been recognised as one of the key challenges for India together with increasing population, poverty and environmental degradation.

Severe floods, storms, droughts and heat-waves as well as land and forest degradation and salinisation of groundwater resources that we already see today are often viewed as a foretaste of climate change interacting with other anthropogenic impacts on the environment. Mitigating climate change by reducing greenhouse gas emissions is one way of lessening the adverse effects of a more variable and changing climate. However, even if a radical reduction of global greenhouse gas emissions were possible today it would not completely prevent significant changes in the world's climate. Therefore, societies and economies at all levels and on every continent have to prepare for and adapt to the potential impact of climate change. Climate change is one of the biggest environmental and developmental challenges that the natural ecosystems and socio-economic systems face.

Further, climate change in the coming decades is likely to intensify, thereby adversely impacting food production, water resources, biodiversity and health. The impact or risk of climate change is the result of interaction of climatic hazards, exposure and vulnerability of the communities and systems. According to multiple global climate risk assessments, India is one of the most vulnerable countries in the world. Assessment of vulnerability of a system is one of the critical steps in adaptation planning.

Chhattisgarh - Brief Profile

Chhattisgarh is a state in Central India and was formed on November 1, 2000, by partitioning 16 Chhattisgarhi-speaking south-eastern districts of Madhya Pradesh. The state of Chhattisgarh, which looks like a 'sea horse', is surrounded by six different states. While Maharashtra and MP form its western neighbours, UP and Jharkhand lie in its north and Odisha on its east. The newly created state of Telangana lies on its south. Raipur is the capital of Chhattisgarh, which is the ninth largest state in India. The northern and southern parts of the state are hilly, while the central part is a fertile plain. The total area of the state is about 1,37,898 Sq. km and nearly 45 per cent of it is covered with forests. The total human population of the state is about 3.22 crores as of 2020. Raipur and Bilaspur is the most populous districts with about 2 million, followed by Durg, Janjgir-Champa, Rajnandgaon and Raigarh.

Chhattisgarh is a source of electricity and steel for the country, accounting for 15 per cent of the total steel produced as well as a large contributor of coal. The languages spoken are Chhattisgarhi and its local dialects, along with Hindi and English. Raipur, Bhilai, Durg, Bilaspur, Korba and Rajnandgaon are some of the major cities of the state. Chhattisgarh is presently one of the few states with surplus power. It is among the few profitable states in terms of utility-based electricity.

In the north lies the edge of the great Indo-Gangetic plain. The Rihand River, a tributary of the Ganges, drains this area. The eastern end of the Satpura Range and the western edge of the Chota Nagpur Plateau form an east-west belt of hills that divide the Mahanadi River basin from the Indo-Gangetic plain. The central part of the state lies in the fertile upper basin of the Mahanadi River and its tributaries. This area has extensive rice cultivation. The upper Mahanadi basin is separated from the upper Narmada basin to the west by the Maikal Hills (part of the Satpuras) and from the plains of Orissa to the east by ranges of hills. The southern part of the state lies on the Deccan plateau, in the watershed of the Godavari River and its tributary, the Indravati River.

Chhattisgarh has 28 administrative districts. At the time of separation from Madhya Pradesh, Chhattisgarh originally had 16 districts. Two new districts: Bijapur and Narayanpur were carved out on May 11, 2007, and nine new districts on Jan 1, 2012. The new districts have been created by carving out the existing districts to facilitate more targeted, focused and closer administration. These districts have been named Sukma, Kondagaon, Balod, Bemetara, Baloda Bazar, Gariaband, Mungeli, Surajpur and Balrampur. The newest district, Gaurela-Pendra-Marwahi, was inaugurated on 10 February 2020.

On the basis of regional topography Chhattisgarh region is divided into three agro-ecological regions,

- the Northern Hills,
- the Central Plains and
- the Bastar Plateau¹⁰⁶.

Water Resources and River Basins

The State covers parts of five river basins. The Mahanadi Basin has 77,302 Sq km, Godavari Basin has 38,361 Sq km, Ganga Basin has 18,865 Sq km, Brahmani Basin has 1,316 Sq km and Narmada Basin has 2113 Sq km of catchment area respectively in the state. A map depicting the catchment area of respective river basins in the State is given in figure 56. River Mahanadi, draining the vast central region of Chhattisgarh state, forms the most important and biggest drainage system of the state. The Mahanadi Basin extends over an area of 1,43,441 Sq Km and major part of the Mahanadi Basin falls in Chhattisgarh. This river system collects the rainwater of the basin in Chhattisgarh as well as part of the basin in Odisha and carries it to the Bay of Bengal. However, in case of Godavari basin, out of the total basin area of 312,813 Sq km, major part of the basin falls in Maharashtra and only about 38,361 Sq Km (12.26 per cent of the basin area) falls in the State of Chhattisgarh. The major rivers that drain the state are Mahanadi, Indravati, Son and Narmada. Mahanadi and Godavari cover 85 per cent of the total basin area. Mahanadi is the main river of the state. The other main rivers are Hasdo (a tributary of Mahanadi), Rihand, Indravati, Jonk, Arpa, and Shivrath. Chhattisgarh has fairly good rainfall, yet frequent droughts in recent times plague the State. One reason for this is the neglect of traditional water harvesting practices. The details of river basins are given in the table given below.

¹⁰⁶ <http://cgclimatechange.com/about-chhattisgarh/>

Table 6: Major River Basins in Chhattisgarh State

No.	Major Rivers	Catchment Area (sq. km)	Proportion of state covered (per cent)	Tributaries /Sub-basins	Districts
1	Ganga	18789	13.6	Son	Surguja, Koriya, Jashpur and Bilaspur
2	Mahanadi	77432	56.2	Seonath. Ib, Mand, Hasdeo, Pairi, Jonk, Tel, Kelo	Raipur, Mahasamund, Dhamtari and parts of Durg, Rajnandgaon, Kawardha, Korba, Kanker, Bastar, Surguja, Raigarhand Bilaspur.
3	Godavari	39497	28.6	Indravati, Sabari, Wain ganga	Parts of Durg,Bastar, Rajnandgaon, Kanker and Dantewada
4	Narmada	759	0.6	Narmada	Parts of Rajnandgaon, Bilaspur, and Kawardha
5	Bramhani	1423	1	Sankh	Part of Jashpur

Source: Chhattisgarh at a Glance, 2018, Water Resources Department-Chhattisgarh & INRM

Surface water

The State is divided in to five river basins. The area contributing to the Mahanadi Basin is the largest; Godavari Basin comes next, followed by Ganga Basin, Brahmani Basin and then the Narmada Basin.

Most of the rivers in the state have a torrential regime characterized by high flow of water for three to four months during monsoon (June to September) during which around 80 per cent of the annual runoff flows. Floods and droughts are the main characteristics of the annual flow of the rivers in Chhattisgarh requiring storage reservoirs for efficient use of the available surface water resources.

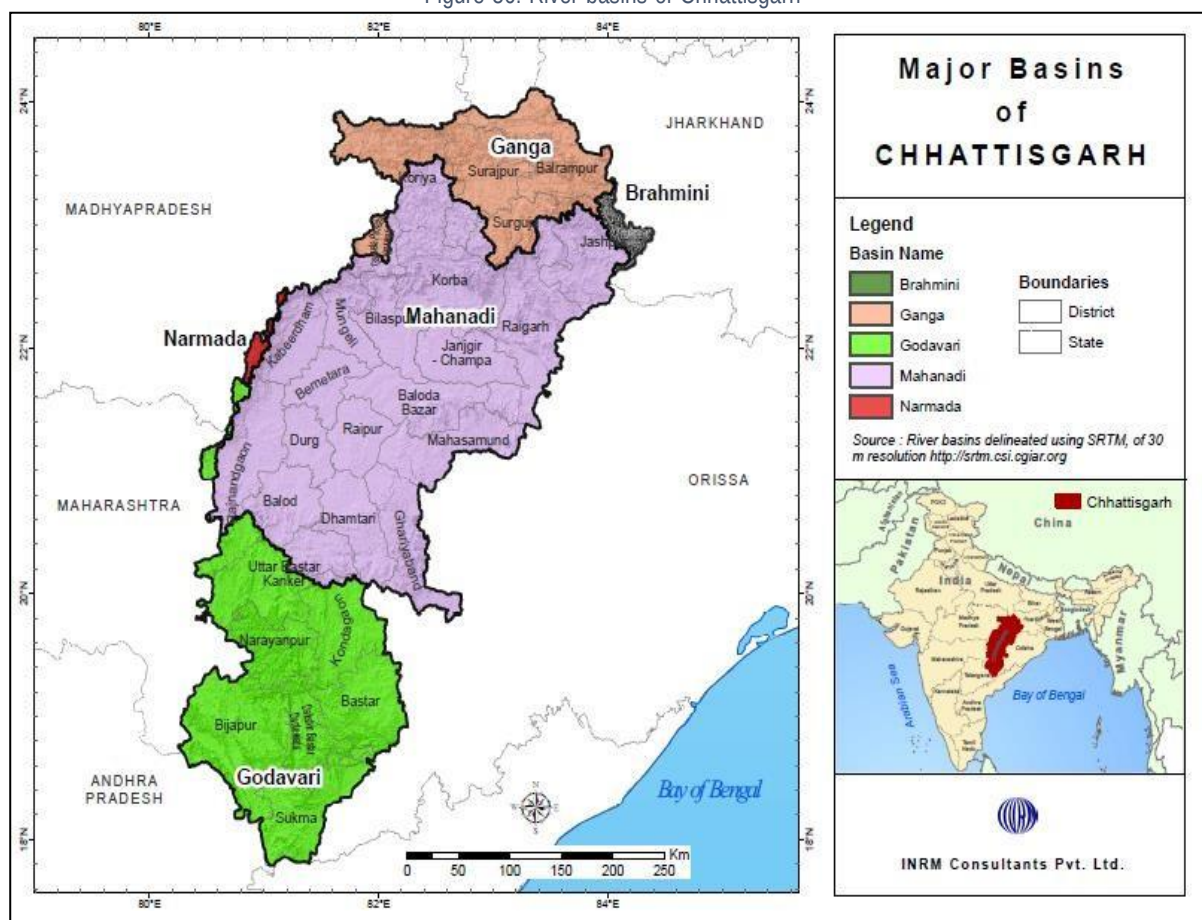
Table 7: Water level

	India	Chhattisgarh	per cent
Surface Water	18,69,000 MCM	48,296 MCM	3.2
Ground Water	4,35,420 MCM	14,548 MCM	3.17

Estimated surface water flowing through rivers is 48,296 Million Cum. and due to various geographical and interstate constraints the usable surface water in the state is 41,720 Million Cum. Surface water being used at present is only about 18,249 Million Cum.

86.3 per cent of the households have access to safe drinking water in the state. About 26 per cent of the households have access to drinking water availability away from the premises in the state (Census 2011).

Figure 56: River basins of Chhattisgarh



Groundwater

Groundwater is an essential and vital component of our life support system. The groundwater resources are being utilized for drinking, irrigation and industrial purposes. The important attribute of groundwater regime monitoring is through monitoring of groundwater level. The natural conditions affecting the regime involve various hydro meteorological parameters like rainfall, evapotranspiration, runoff, etc., whereas anthropogenic influences include pumpage from the aquifer, recharge due to irrigation systems and other practices like water conservation structures etc. Estimated ground-water in the state is 14,548 Million Cubic meters and present exploration is about 18.31 per cent¹⁰⁷. Out of 146 blocks, 22 have been categorized as 'Semi-critical', 2 as 'Critical', and 122 as 'Safe' and there is no over-exploited block. There are 1397 groundwater monitoring stations in Chhattisgarh as of 2018¹⁰⁸. In Chhattisgarh the depth to water level generally varies from 2-5 meter below ground level. The contribution in Annual Replenishable Groundwater Resource from rainfall during monsoon season is more than 70 per cent in the state.

There is growing concern on deterioration of groundwater quality due to geogenic and anthropogenic activities. The quality of groundwater has undergone a change to an extent that the use of such water could be hazardous. Increase in overall salinity of the groundwater and presence of high concentrations of fluoride, nitrate, iron, arsenic, total hardness and few toxic metal ions have been noticed in large areas in several states of India.

¹⁰⁷ Water Resources Department, Government of Chhattisgarh

¹⁰⁸ Groundwater Year Book, 2017-18

Fluoride: 85 per cent of rural population of the country uses groundwater for drinking and domestic purposes. High concentration of fluoride in groundwater beyond the permissible limit of 1.5 mg/l poses the health problem. The occurrences of fluoride beyond permissible limit (> 1.5 mg /litre) in groundwater have been observed in many districts of Chhattisgarh state¹⁰⁹.

Nitrate: Nitrate is a very common constituent in the ground water, especially in shallow aquifers. The source is mainly from anthropogenic activities. High concentration of nitrate in water beyond the permissible limit of 45 mg/l causes health problems.

Iron: High concentration of Iron (>1.0 mg/l) in groundwater has been observed in Bastar, Dantewada, Kanker and Koriya districts of Chhattisgarh.

Arsenic: Arsenic as a contaminant is significant in terms of its toxic nature with exceedingly diverse manifestations of poisoning. Drinking water is the major pathway for ingestion of arsenic in human system. It is observed in Rajnandgaon district of Chhattisgarh.

Table 8: Groundwater Quality in Chhattisgarh

Groundwater Contaminants	Districts affected (in part)
Fluoride (>1.5 mg/l)	Bastar, Bilaspur, Dantewada, Janjgir-Champa, Jashpur, Kanker, Korba, Koriya, Mahasamund, Raipur, Rajnandgaon, Surguja, Raigarh, Durg, Baloda Bazaar
Iron (>1.0 mg/l)	Bastar, Dantewada, Kanker, Koriya
Nitrate (>45 mg/l)	Bastar, Bilaspur, Dantewada, Dhamtari, Jashpur, Kanker, Kawardha, Korba, Mahasamund, Raigarh, Raipur, Rajnandgaon
Arsenic (>0.05 mg/l)	Rajnandgaon

A comprehensive master plan for the state, for optimum use of water resources is under preparation. The state is moving ahead towards a more integrated and sustainable approach to water resources management.

Irrigation

Irrigation is the prime need of the state for its overall development and therefore the state government has given top priority to development of irrigation potential. Net sown area of the Chhattisgarh state is 4.683 million hectares and the gross sown area is 5.561 million hectares. It is estimated that about 75 per cent of the gross sown area of the state can be irrigated with proper use and management of available water resources. Irrigation potential was 1.328 million hectares at the time of formation of the state (i.e., on 1st November 2000) which was 23 per cent of the gross sown area. The irrigation potential has now been raised to 1.844 million hectares at the end of March 2012 which is 33.15 per cent of gross sown area.

Apart from the state budget, irrigation projects are also being financially assisted by Central Government (AIBP), ADB, and NABARD etc.

¹⁰⁹ <http://cgwb.gov.in/wqoverview.html>

Climate Change Vulnerability Assessment for districts of Chhattisgarh

Climate change vulnerability assessment for water resources sector has been taken up for the state of Chhattisgarh. The main purpose of vulnerability assessment is to identify and prioritise the regions and sectors which are likely to be adversely impacted by climate change so as to enable development of adaptation practices and strategies to help mainstream the climate change into the broader developmental programs and projects.

Definition of Vulnerability to Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading scientific international body for the assessment of climate change. According to the IPCC (2007) definition, vulnerability in the context of climate change is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

IPCC Fifth Assessment Report defines vulnerability to climate change broadly as follows: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt".

Climate vulnerability is characterised as a function of both biophysical and socio-economic vulnerabilities, each defined by the three dimensions of exposure, sensitivity and adaptive capacity.

Approach and Methodology

There are several methods for evaluating the level of vulnerability. Selection of a particular method is determined by the context, purpose and scale of analysis as well as by the availability of appropriate data. A common method to quantify vulnerability to climate change is by using a set or composite of proxy indicators. Indicator approach constructs comparative indicators which helps to compare the vulnerability and adaptive capacity of different systems, groups or regions (Adger, W.N. et al., 2004¹¹⁰).

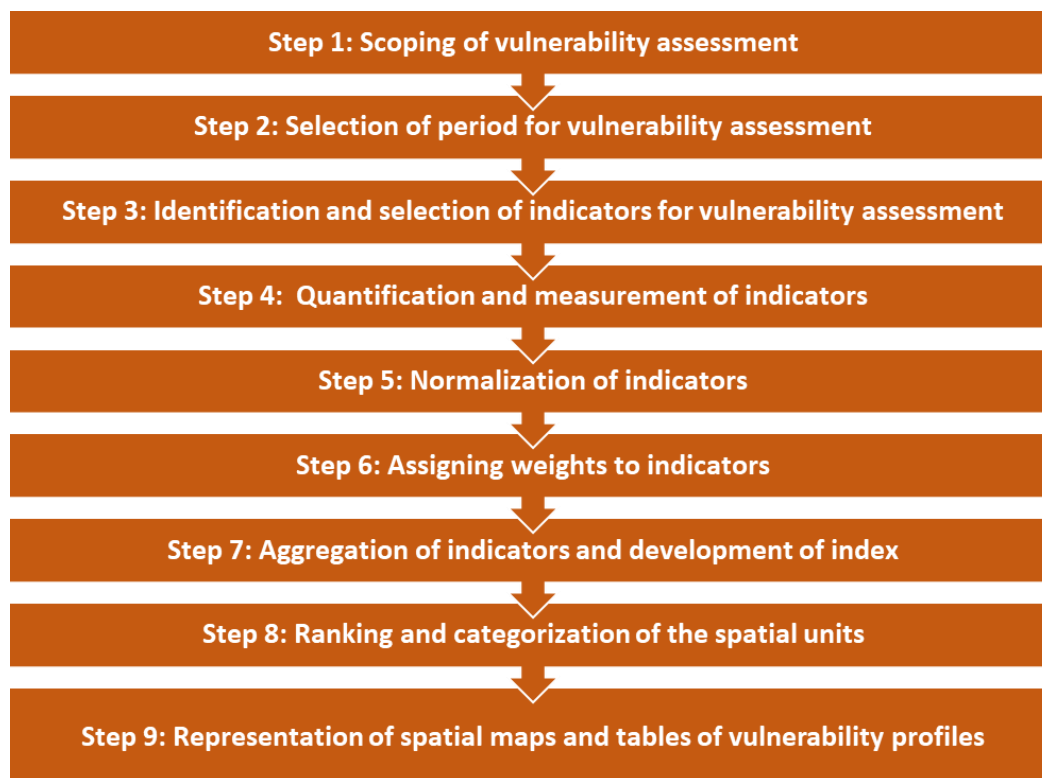
For the present study relative vulnerability approach is followed as it is useful when comparing vulnerability at a regional scale. Here the inter district comparison can be done as to which is more vulnerable compared to the other. If absolute vulnerability is calculated the emphasis is on areas with the greatest number of vulnerable people, not necessarily the most vulnerable. Comparison of vulnerability within the districts is not possible here since the required data/information available is aggregated at these respective levels. Vulnerability has been assessed at the district level.

¹¹⁰ Adger, W.N., Brooks, N., Bentham, G., Agnew, M., Eriksen, S., 2004. New Indicators of Vulnerability and Adaptive Capacity. Technical Report 7, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich.

Methodology

The steps involved in the vulnerability assessment of the districts of Chhattisgarh are shown in figure 57 Each of the steps mentioned in 30 have been discussed in detail below:

Figure 57: The steps of Vulnerability Assessment



Step 1: Scoping of vulnerability assessment

The scope and objective are to identify and rank the districts of Chhattisgarh which are vulnerable. Generate the Chhattisgarh district level Water Resources Vulnerability Index (WRVI) developed using multivariate analysis of individual indicators of water resources that are vulnerable to climate change. The purpose is to develop both current and projected vulnerability profile at district level due to the current and projected climatic conditions. The indices would facilitate the identification of districts, which have high vulnerability and needs to be identified for prioritisation at the time of policy making for formulating adaptation planning and creating awareness.

Step 2: Selection of Period for vulnerability assessment

Vulnerability assessment can also be carried out for different time periods. The present assessment is done for current, mid-century (2021-2050) and end-century (2071-2100) scenario. The projected vulnerability profile is developed using IPCC AR5 RCP4.5 (moderate emission scenario) and RCP8.5 (high emission scenario) scenarios, based on CMIP5 and CORDEX regional climate model outputs. There have been a large number of RCM models that have generated RCP4.5 and RCP8.5 climate scenarios for the future. Some of these models perform reasonably well to simulate the BL whereas some other may not be performing well for the same region. In the present case ensemble mean with three regional climate models (RCM) from CORDEX South Asia (with total of 10 experiments) having grid resolution of 50 kmx50 km has been used. Ensemble mean reduces model related uncertainties and in the present case is found to be closer to observed climate than any individual model.

Step 3: Identification and selection of indicators for vulnerability assessment

This is one of the most crucial steps in vulnerability assessment as the outcome will highly depend on the choice of indicators. While choosing the indicators, several things were considered, viz., type of indicator (i.e., whether it captures 'hazard', 'exposure' 'sensitivity' or 'adaptive capacity'), impact of indicator.

The indicators for this study have been selected based on the availability of data across time and space (districts), literature research, and experiences drawn from previously carried out climate change vulnerability assessment for the Indian states of Madhya Pradesh, Jharkhand, Chhattisgarh, Uttarakhand, Gujarat, West Bengal, Karnataka, Tamil Nadu, Telangana, Punjab and Himachal Pradesh.

A set of 26 indicators for districts of Chhattisgarh have been identified for the water resources vulnerability assessment. Details of the list of identified indicators, their sources, functional relationship with vulnerability and time period for vulnerability assessment are given figures of Appendix I. The rationale for the indicator selection is also given in Appendix I.

Step 4: Quantification and measurement of indicators

We need data in quantifiable units to apply mathematical operations over it. Secondary data collection and cleaning of the indicators and projection of the climate indicators for future using impact assessment models carried out.

Step 5: Normalisation of indicators

Normalise indicators data values to make the indicators comparable since indicators are expressed in a variety of statistical units, ranges or scales. E.g: density of population in terms of persons per sq km, forest area in percentage, Consecutive Dry Days in number of days, etc. As the vulnerability assessment is about ranking, the indicators have to be brought in common units. In order to make the indicators unit- free, each indicator is normalised. This is also done to avoid one variable having an undue influence on the analysis. Normalised values always lie between 0 and 1. The normalization process varies, depending on the nature of relationship of that particular indicator with the risk (positive or negative relationship).

Whenever an indicator has positive relationship with vulnerability normalised value for each of the indicator for each district is computed as:

$$NV = \frac{[X - \text{minimum}(X)]}{[\text{maximum}(X) - \text{minimum}(X)]}$$

Whenever an indicator has negative relationship with vulnerability then the normalized value is calculated as:

$$NV = \frac{[\text{maximum}(X) - X]}{[\text{maximum}(X) - \text{minimum}(X)]}$$

This is possible when, for example, higher water availability leads to lower vulnerability.

Were,

NV = Normalised value of X, X is an observed value for the districts for a given variable, Max X is the highest value of the variable across the district, Min X is the lowest value of the variable across the district.

Step 6: Assigning weights to indicators

Weights were assigned to each indicator according to their importance in determining vulnerability of a system. To get reliable result, weights have been assigned to each indicator based on Iyengar and Sudarshan (1982) methodology. The choice of the weights in this manner ensures that large variation in any one of the indicators does not unduly dominate the contribution of the rest of the indicators and distort the overall ranking of the districts. This methodology is statistically sound and well suited for the development of vulnerability index to climate change also. The detail of the methodology is given in Appendix.

Step 7: Aggregation of indicators and development of index

Aggregation of different indicators with weight is necessary to obtain a composite aggregated index or value for each district. Index is constructed by simply taking a summation of all the normalised scores of the sub-indicators multiplied by their respective weights.

$$Vulnerability\ Index = \sum_{i=1}^n (w_i * NV_i)$$

Where, $i = 1$ to n is the number of indicators, w = weights, NV = Normalized value

Higher index value represents high vulnerability while lower index value represents low vulnerability. Weighted arithmetic mean has been used to combine the indicators to get the Water Resources Vulnerability Index.

Step 8: Ranking and categorisation of the spatial units

Arrangement of the assessed Index values in decreasing or increasing order allows for ranking of units of study. Vulnerability Index values lies between 0 and 1, where 0 indicates least vulnerability and 1 indicates most vulnerability. Rank 1: least vulnerable (Lowest index values), Rank 28 most vulnerable (Highest index values)

With respect to their respective degree of vulnerability, all spatial units are categorised. Cluster analysis is done on the calculated indices to group them in six categories -very low (VL), low (L), moderate (M), high (H), very high (VH) and extremely high (EH).

Cluster analysis or clustering is the task of assigning a set of objects into groups (called clusters) Cluster analysis is a class of statistical techniques that can be applied to data that exhibit "natural" groupings. Cluster analysis sorts through the raw data and groups them into clusters. A cluster is a group of relatively homogeneous cases or observations. Objects in the same cluster are more similar (in some sense or another) to each other than to those in other clusters.

Step 9: Representation of spatial maps and tables of vulnerability profiles

The obtained water resources vulnerability index is represented with the help of tables and maps.

Limitations of Indicator Base Method

Indicator based assessment for ranking and comparing vulnerability across spatial units (districts) have following challenges and limitations mainly because of subjectivity involved in:

- Selection and creation of appropriate indicators.
- Underlying assumptions in weighting variables.
- Dynamic nature of vulnerability which requires a constant updating of vulnerability scores.

Limitations on Data

- Selection of indicators used in this analysis is based on the availability of the data.
- Same time period data was not available for every indicator chosen for this study.
- Most of the data used have been compiled from secondary sources available in public domain.

Vulnerability Profiles of districts of Chhattisgarh

In the present study, an assessment of the overall implications of climate change and vulnerability to the district of Chhattisgarh for water resources sector has been carried out to identify the vulnerable regions (districts) to climate change.

Using indicator-based methodology; districts of Chhattisgarh have been classified into various vulnerability categories. It is seen that indicators vary widely within the districts of Chhattisgarh. Water Resources Vulnerability Index (WRVI) has been constructed across the 28 districts for Chhattisgarh using identified indicators (Appendix I). Districts are ranked based on the calculated index values. Higher index value represents high vulnerability while lower index value represents low vulnerability for the districts. A rank value 1 indicates that the district is least vulnerable to climate change and rank value 28 indicates that it is the most vulnerable. The WRV analysis has been presented in the following paragraphs. Tables showing the district wise index values, ranks and vulnerability category for current and projected vulnerability for WRV are given in Appendix I.

District Water Resource Vulnerability Analysis

The Water Resource Vulnerability Index (WRVI) represents an overall view on the entire set of indicators considered. WRVI across the 28 districts of Chhattisgarh has been constructed using 26 indicators from water resources sector.

Current Vulnerability

This section represents the summary of districts which are grouped together at various levels of similarity on the basis of water resource vulnerability. The ranks of the respective districts are given in bracket.

Spatial representation of current Water Resource Vulnerability category for districts of Chhattisgarh is depicted in Figure 58. The index values for baseline are plotted in figure 59.

Table 9: Summary of the results of WRVI

Very High vulnerability	High vulnerability	Moderate vulnerability	Low vulnerability	Very Low vulnerability
7 districts	7 districts	5 districts	7 districts	2 districts
(Mean index = 0.49)	(Mean index=0.46)	(Mean index=0.44)	(Mean index =0.4)	(Mean index=0.36)
Janjgir-Champa (28)	Baloda Bazar (20)	Raigarh (13)	Gariyaband (3)	Mungeli (1)
Bijapur (27)	Rajnandgaon (20)	Surajpur (13)	Narayanpur (4)	Dhamtari (2)
Koriya (26)	Raipur (18)	Kanker (12)	Surguja (5)	
Durg (25)	Sukma (18)	Mahasamund (11)	Balod (6)	
Balrampur (24)	Dantewada (17)	Gaurela Pendra (10)	Jashpur (7)	
Bilaspur (23)	Bemetara (15)		Kabeerdham (8)	
Bastar (22)	Korba (15)		Kondagaon (9)	

Seven districts namely, Janjgir-Champa, Bijapur, Koriya, Durg, Balrampur, Bilaspur and Bastar of Chhattisgarh state with ranks 28, 27, 26, 25, 24, 23 and 22 are the most vulnerable under current climate

as can be seen in brown colour in the map below. Baloda Bazar, Rajnandgaon, Raipur, Sukma, Dantewada, Bemetara and Korba districts fall under high vulnerability category but they are relatively less vulnerable than the very high vulnerable districts. Districts namely, Raigarh, Surajpur, Uttar Bastar Kanker, Mahasamund and Gaurela Pendra Marwahi fall under moderate vulnerability category. The location of these districts can be seen in figure 58 represented in yellow colour. Ghariyaband, Narayanpur, Surguja, Balod, Jashpur, Kabeerdham and Kondagaon districts with ranks 3, 4, 5, 6, 7, 8 and 9 respectively fall under low vulnerability category. The districts of Mungeli and Dhamtari with ranks 1 and 2 respectively have least water resource vulnerability.

The major contributing factors to very high vulnerability category districts are presented below:

Table 10: Drivers of Water Resource Vulnerability

District	Drivers of Vulnerability
Janjgir-Champa	Major contributing factors include high population density, higher drought frequency, crop water stress in North-East Monsoon season, flood discharge, larger number of wells with depth to water level (>10m) and consecutive dry days. Lack of adaptive capacity mainly in terms of relatively lower rainfall, forest area, low surface water and groundwater availability in South-West Monsoon season makes it fall under higher vulnerability.
Bijapur	High vulnerability is attributed to exposure to extreme events like flood discharge, drought frequency, number of extremely wet days, consecutive dry days, high rainfall variability and higher sensitivity to heat stress. Percentage of households with access to drinking water sources away from premises is also high. Bijapur has also low per groundwater availability in North East Monsoon season, lower net irrigated area and a smaller number of installed hand pumps per sq km relative to other districts.
Koriya	Koriya district has higher crop water stress in South West and North-East Monsoon season, larger number of wells with depth to water level (>10m), high concentration of iron in groundwater beyond the permissible limit and consecutive wet days. Percentage of households with access to improved source of drinking water is low and also net irrigated area which makes it fall under higher vulnerability.
Durg	Major contributing factors include high population density, drought frequency, larger number of wells with depth to water level (>10m), larger number of blocks where the stage of groundwater extraction is critical and semi critical and high heat stress. Lack of adaptive capacity mainly in terms of relatively lower rainfall, forest area, low surface water and groundwater availability in both seasons makes it fall under higher vulnerability.
Balrampur	High vulnerability is attributed to higher number of consecutive wet days, consecutive dry days, and higher sensitivity to crop water stress. Percentage of households with access to drinking water sources away from premises is also high. Balrampur has also low per capita surface water availability in SWM and NEM seasons, lower number of households with access to safe drinking water and a

	smaller number of installed handpumps relative to other districts which makes it vulnerable.
Bilaspur	Bilaspur district has higher population density, flood discharge, larger number of wells with depth to water level (>10m), and larger number of blocks where the stage of groundwater extraction is critical and semi critical. Lack of adaptive capacity mainly in terms of relatively lower rainfall, forest area, low surface water and groundwater availability in both seasons makes it fall under higher vulnerability.
Bastar	The main contributing factors include higher drought frequency, variability in rainfall, high iron content in groundwater beyond permissible limit, flood discharge, larger number of wells with depth to water level (>10m), extremely wet days and heat stress. Percentage of households with access to drinking water sources away from premises is also high. Relatively low groundwater availability in NEM season and net irrigated area are also the factors which make it fall under high vulnerability.

Figure 58: Current Water Resources Vulnerability map for Chhattisgarh districts

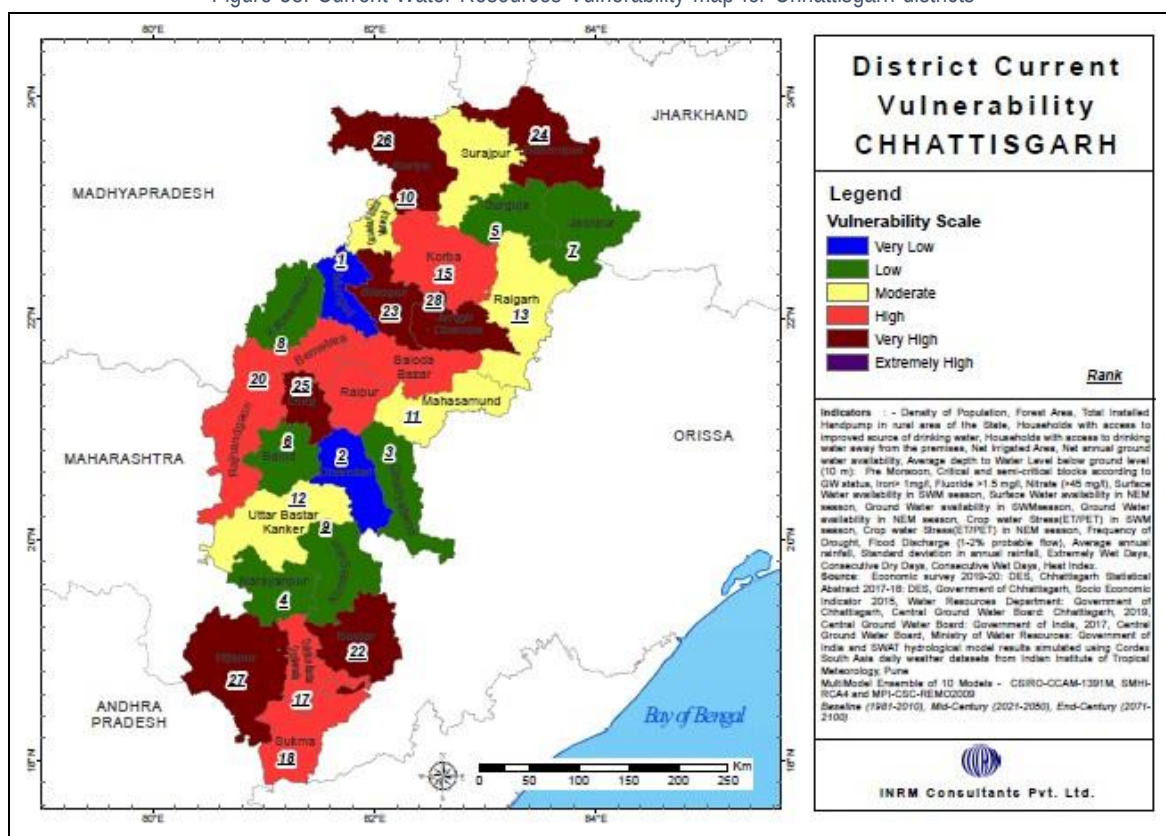
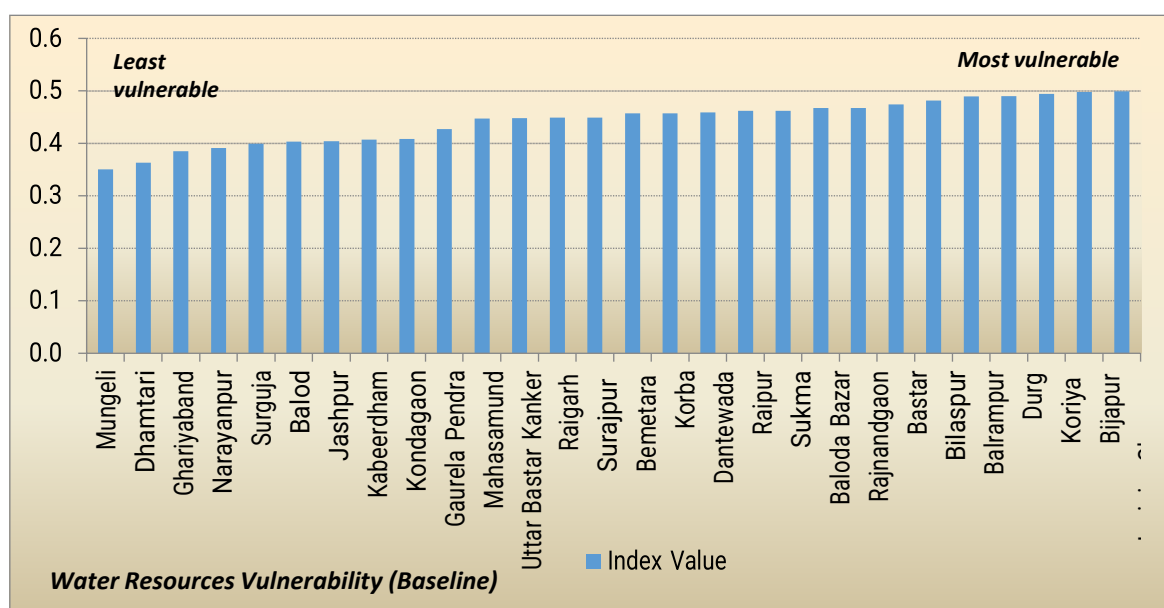


Figure 59: Water Resources Vulnerability Index values for current vulnerability for Chhattisgarh districts



Projected Vulnerability

The overall water resources vulnerability of the districts is projected to increase towards mid-and end-century as compared to the current conditions for both emission scenarios. Districts vulnerability towards end-century under RCP8.5 scenario is projected to be higher as compared to RCP4.5 scenario. Spatial representation of current and projected Water Resource Vulnerability category for districts of Chhattisgarh is depicted in Figure 590.

Projected increase in water resources vulnerability towards mid-century and end century is attributed to likely increase in sensitivity to crop water stress in northeast monsoon season, increase in flood probability, and projected increase in rainfall variability, exposure to extremely wet days, consecutive wet days and higher sensitivity to heat stress. However, exposure to drought weeks is projected to increase towards MC and EC RCP4.5 scenario but decline towards MC and EC RCP8.5 scenario as compared to BL.

RCP4.5, Mid-century: Vulnerability of almost all the districts is projected to increase under RCP4.5 mid-century scenario. Eighteen districts are projected to shift towards higher levels of vulnerability under RCP4.5 mid-century scenario as compared to current vulnerability. Districts Mahasamund, Raigarh and Uttar Bastar Kanker are projected two folds increase from current moderate vulnerability to fall under very high vulnerability category. 15 districts namely, Balod, Baloda Bazar, Bemetara, Bijapur, Dantewada, Dhamtari, Jashpur, Kabeerdham, Kondagaon, Korba, Raipur, Rajnandgaon, Sukma, Surajpur and Surguja are projected to fall under extremely high, very high, high, moderate, and low vulnerability from current very high, high, moderate, low and very low vulnerability category. The remaining 10 districts are projected to remain in the same vulnerability category as current vulnerability. Surface water availability in NEM season and annual rainfall is projected to decline in addition to increase in rainfall variability, exposure to drought weeks, consecutive dry days and higher sensitivity to heat stress towards MC as compared to baseline for Chhattisgarh districts thus contributing to increase in their vulnerability.

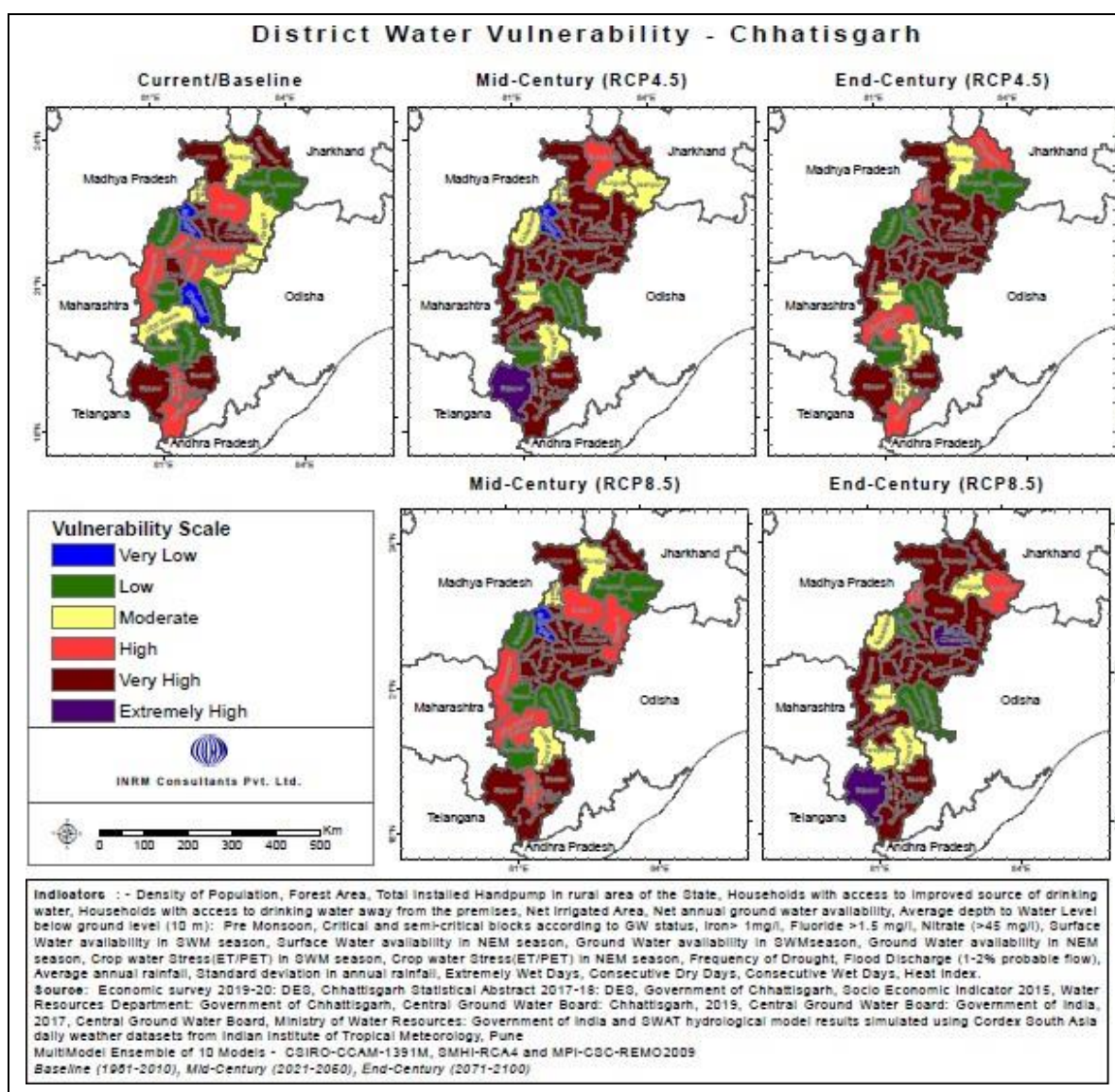
RCP 4.5, End-century: The overall WRV of the districts is projected to decline towards end-century as compared to mid-century though increase as compared to the BL. Rainfall, Surface water, groundwater

availability is projected to increase while exposure to drought frequency and consecutive dry days are projected to fall towards EC as compared to MC. These factors lead to decline in WRV towards EC as compared to MC.

RCP 8.5, Mid-century: Thirteen districts are projected to shift towards higher levels of vulnerability under RCP8.5 mid-century scenario as compared to current vulnerability. Districts namely, Balod, Baloda Bazar, Bemetara, Dhamtari, Gaurela Pendra Marwahi, Kondagaon, Korba, Mahasamund, Mungeli, Raigarh, Raipur, Rajnandgaon, Uttar Bastar Kanker are projected to shift (Fig. 60 below).

RCP 8.5, End-century: The districts vulnerability is projected to be the highest towards RCP8.5 end- century scenario as compared to current and mid-century vulnerability. Vulnerability of almost all the districts is projected to increase under RCP8.5 end-century scenario. Twenty-two districts are projected to shift towards higher levels of vulnerability under RCP8.5 end-century scenario as compared to current vulnerability.

Figure 60: Water Resources Vulnerability map for Chhattisgarh districts under RCP 4.5 and RCP 8.5 scenarios



District Water Resource Vulnerability Index

The study is focused on generating district level Water Resource Vulnerability Index (WRVI) for Chhattisgarh. The vulnerability index would facilitate the identification of districts, which are vulnerable to climate change and need special attention towards adaptation. Water resources vulnerability to climate change in Chhattisgarh has been derived using integrated vulnerability assessment approach. Accordingly, water resource indicators of vulnerability are employed and classified into adaptive capacity, sensitivity, and exposure. 26 indicators have been identified from the three sectors for vulnerability analysis and have been categorised as positive or negative with respect to their relationship with vulnerability. To analyse the data, statistical method of lyengar and Sudarshan is performed to obtain the scores. These are used as weight for the indicators before arriving at the indices. The selected indicators explained the differences in Water Resource vulnerability between districts with good agreement. Districts are ranked based on the composite Water Resource vulnerability indices. Further, this index is developed for the baseline climatic conditions (1961-1990) and for future projected climatic conditions mid-century (2021-2050) and end century (2071-2100), for IPCC AR5 RCP scenarios, namely, RCP4.5 (corresponding to moderate global emission scenario) and RCP8.5 (a scenario corresponding to comparatively high global greenhouse gas emissions)

Furthermore, cluster analysis is performed on the indices to group the districts according to their degree of vulnerability using Ward Method of Agglomeration. The districts are grouped into very low (1), low (2), moderate (3), high (4), very high (5) and extremely high (6) categories of vulnerability. The outputs are shown spatially using colour coded maps; blue colour for very low (1), green for low (2), yellow for moderate (3), red for high (4), dark brown for very high (5) and purple for extremely high (6) vulnerability category.

WRVI has been created by standardising indicators across the range of data for districts of Chhattisgarh. Districts which are at the top of the range with "high" scores nearing 1 have the highest relative vulnerability. The districts at the bottom end of the range with "low" scores nearer to 0 do not necessarily have low absolute vulnerabilities; rather they are better off compared to other districts of Chhattisgarh.

Analysis based on the WRVI of the districts for baseline, mid-century and end century scenarios show that:

- Seven districts namely, Janjgir-Champa, Bijapur, Koriya, Durg, Balrampur, Bilaspur and Bastar of Chhattisgarh state with ranks 28, 27, 26, 25, 24, 23 and 22 are the most vulnerable under current climate. The major contributing factors for very high vulnerability of these districts have been pointed in the report.
- The districts of Mungeli and Dhamtari with ranks 1 and 2 respectively have least water resource vulnerability.
- The overall water resources vulnerability of the districts is projected to increase towards mid-and end-century as compared to the current conditions for both emission scenarios. Districts vulnerability towards end-century under RCP8.5 scenario is projected to be higher as compared to RCP4.5 scenario.
- Projected increase in water resources vulnerability towards mid-century and end century is attributed to likely increase in sensitivity to crop water stress in north east monsoon season, increase in flood probability, and projected increase in rainfall variability, exposure to extremely wet days, consecutive wet days and higher sensitivity to heat stress. However, exposure to drought weeks is projected to increase towards MC and EC RCP4.5 scenario but decline towards MC and EC RCP8.5 scenario as compared to BL.

Recommendations

The Water Resource Vulnerability Index (WRVI) would be useful for the policy makers of the state government to formulate action plan at district level. By looking at the WRVI ranks they can make out which district is more vulnerable. Thus, they would be able to bring suitable policies and actions for combating climate change impacts in the target district.

For water experts of the State and water managers of Water Resources Department, WRI (Water resources Index) would be useful as they can prioritize the districts which need more attention than the others with respect to the investment in the state.

Adaptation to global warming and climate change is a response that seeks to reduce the vulnerability of natural and human systems to climate change effects. Addressing the impacts and combating climate change assumes top priority in our country in the context of its influence on the poorest in the society. Large reductions in greenhouse gas emissions are achievable if the right policies are put in place. However, besides reducing the emissions it shall also be required to formulate strategies for adaptation to climate change. Policies suggested to combat the effects of climate change in Chhattisgarh may include:

- Support integrated water resources planning and management in river basins of the state level. Emphasis should be laid on evaluating the water resource availability verses demand imposed so as to identify if there is deficit in water availability because such situation is not sustainable.
- Improve water use efficiency and make changes to water allocation in line with the justifiable demands in the state.
- Improve education and information by establishment of training programs for extension officers through Universities Training programs for farmers in water efficiency. Establish training hubs for dissemination of information on climate change.
- Improve early warning systems and flood hazard mapping for storms.
- Create new or strengthen existing institutions (e.g., establishing committees, identifying mechanisms for sharing information across institutional boundaries, training staff responsible or policy development).

This exercise can be regarded as a modest attempt to assess the preparedness of the districts of Chhattisgarh to cope up with the vulnerability issues and board the development pathway in a sustainable manner.

Mapping of SDGs and NDCs Relevant to Water Resource with State Targets, Initiatives and Gaps

The Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) include various components related to sustainable development and mitigation actions. Table below map the SDG and NDC action and targets relevant to Water Resources sector with existing state initiatives and targets to assess the gaps in the policy landscape respectively.

The SDGs and NDCs offer an unprecedented opportunity to address some of the development and environmental challenges. Both SDG and NDC agendas are clear, both gives the intrinsic relation between development and climate change.

Table 11: SDGs Relevant to Water Resources

S. N.	Description of SDGs	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving the SDG Targets /Goal
1	Goal 6 Clean Water and Sanitation	Universal & equitable access to safe and affordable potable water; water quality; water use efficiency, IWRM; restoring water related ecosystem.	By 2030, 100 per cent Rural and urban Households having main source of drinking water as "treated tap water".	Drinking water and sanitation program implementation ongoing under National Rural Drinking Water Programme and AMRUT	Difficulty in identifying safe and sustainable water sources for pipe water schemes for small and scattered habitations
2	Goal 12 Responsible Consumption and Production	Sustainable management and efficient use of natural resources including water; waste and chemical management to protect against pollution of water resources.	By 2030, 1. community-based management of aquifers, and providing a regulatory role for PRIs at the appropriate level. 2. Recycling of the used water in industrial sector and urban areas will be	Projects undertaken by the state government for better utilisation and effective use of water resources include, a) Rural Infrastructure Development Fund (RFID) Programmes with	Poor state of the water distribution infrastructure due to poor maintenance, which in turn results in very low water use efficiency because of inadequate control on operations.

			incentivised and regulated.	an irrigation potential of 221166 ha, b) Accelerated Irrigation Benefit Programme (AIBP) major and minor projects that created an irrigation potential of 143030 ha and c) World Bank Associated "National Hydrology Project Phase-II	
3	Goal 13 Climate Action	Combating climate change and its impacts; strengthening resilience and adaptive capacities	By 2030, Planning and management of water resource structures, such as dams, flood embankments in view of Climate Change. Non-structural measures such as early Warning systems for flood and drought are also being planned	State is promoting micro-irrigation techniques (drip irrigation, sprinklers) to increase water use efficiency and apply water soluble fertilisers (fertigation) efficiently through assistance from Central Government	Rain-fed agriculture is prevalent in the State and it faces the challenge of frequent droughts caused by low and erratic rainfall leading to wide variation in production and productivity

4	Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems and halt biodiversity loss	Protect and restore land degraded from floods and droughts; restore environmental flow in the rivers and streams; restore and rejuvenate wetlands and water bodies; increase capacity of local communities to pursue sustainable water-based livelihood opportunities	By 2030, Local bodies should install collection, treatment and disposal system of wastewater generated from their area to reduce fresh water consumption. • Rain water harvesting should be done on large scale to recharge groundwater but keeping in view the externalities of such action	Narwa Garuwa Ghurwa Baari scheme being implemented in the State to rejuvenate local water bodies.	Pollution in the inland water bodies and poor market linkages

Table 12: NDCs Relevant to Water Resources

S. N.	NDCs	Relevant Focus	State Target	Initiatives in Terms of Existing Programme /Scheme	Gaps in Achieving the NDC Targets/Goal
1	NDC 6	Enhancing investments in water sector to adapt to Climate change		• Real-time weather-based agro-advisory information dissemination through the Gramin Krishi Mausam Sewa by IMD • Soil Health card • Pradhan Mantri Crop Insurance scheme • Fasal Bima Yojana • 'Narwa, Garuwa, Ghurwa, Baadi' scheme that is aimed at developing micro-watershed structures for groundwater recharge and increasing surface water irrigation, livestock development, promoting vermicomposting and developing kitchen gardens to help develop	Implementation of cross sectoral initiatives is a challenge without proper coordination National targets and commitments on climate change differ from state target and convergence is an issue.

				climate resilience and encourage sustainable agriculture. • Pradhan Mantri Krishi Sinchai Yojana (PMKSY) • Micro Irrigation Scheme (Per Drop More Crop) • Small Scale Irrigation Scheme (Construction of ponds to irrigate a minimum of 40 acres of land) • Jan Jagran Abhiyan (promotes agriculture among people who are staying in relief camps (scheme applicable in Bijapur, Dantewada and Sukma districts)) • Kisan Samridhi Yojana (to increase the area under irrigation by using groundwater sources) • Dalhan, Tilhan and Corn Promotion Scheme • Promotion of riverside vegetable production • Promotion of Drip Irrigation • State Micro Irrigation Scheme • National Rural Drinking Water Programme (NRDWP)	
2	NDC 1	Propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation	Practices to farm alternate crop, based on traditional knowledge systems in agriculture by 2040	• Loan waivers for drought-hit farmers • Crop insurance schemes (Pradhan Mantri Crop Insurance scheme) • Investments to improve irrigation efficiency • Alternative livelihood options • Solar pump irrigation scheme • Integrated watershed management schemes • Forest Rights Act	• Poor market prices • Overexploitation of natural resources • Awareness and understanding
3	NDC 2	Adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of		• Increasing minimum support price (MSP) • Awareness, incentivising and promotion of efficient farming techniques • Solar pump irrigation scheme • National Green Corps Programme (NGC) in all Districts	• Inter departmental coordination • Effective governance & Ensuring accountability in relation to actions

		economic development		• MGNREGA (water augmentation – 1. 879 ponds cleaned and deepened in the entire district. 2. 4986 works approved in entire district under MNREGA. 2a. 28 works of canal repairing 2b. 576 works of well construction 2c. 2229 works of small pond construction 2d. 245 works of pond construction 2e. 109 works of pond deepening 2f. 1797 works of land repairing • Krishak Samagra Vikas Yojana (increase production of Ramtil (scheme applicable in Bastar, Dantewada, Kanker, Jashpur and Surguja districts) • Compensatory Afforestation Fund Management and Planning Authority (CAMPA) - Eco - tourism development • Scheme for riverside tree plantation with the objective of preventing soil erosion • Scheme for Reforestation - encourage tree plantation and reforestation in the areas which are affected by habitations. Development of groundwater management with afforestation	• Institutional capacity and political will • Awareness & understanding • Policy coherence and integration

Key Concerns of the Sector

Poor Water Quality: Besides the concern about losing sustainability of sources, widespread pollution of surface and groundwater is affecting the quality of these resources. Industrial waste and mining are biggest contributor of the poor water quality in the state. The state is facing challenges to tackle chemical contaminations such as iron, sulphate and fluoride mostly in Northern part of the state. Sulphate contamination is mostly observed in Bemetara, Mungali and Bilaspur districts. A few districts having salinity and arsenic issue are Bemetara and Rajnandgaon districts. Districts with high level of Fluoride are Rajnandgaon, Raigarh, Jashpur, Korba, Baloda Bazar and Mahasamund. District with high concentration of Iron include all northern and central districts of state.

Low Water Use Efficiency: Poor management of water resources is leading to wastage and under- utilization of available resources. Siltation of reservoirs has reduced their capacity and ability to supply the required volumes of water; many of the medium and low storage volume reservoirs have a large surface area relative to their depth, resulting in high seepage and evaporation losses. This has resulted in a wide gap between the irrigation potential created and utilized. Implementation of participatory irrigation management is often limited or non-existent due to uncertainty of water availability. Further, the farmers who have their holdings at the head end of the canal tend to appropriate more water than required, whereas the farmers at the tail end often fail to get their apportioned share of water. With the introduction of new schemes by government promoting drip irrigation, water use efficiency is expected to improve.

Lack of Capacity for Operation and Maintenance of Water Supply Infrastructure: The water supply sector has suffered from lack of capacity building programme of local bodies and other institutions for operation and maintenance. Due to lack of ownership, technical skills and the financial management of schemes is a challenge. In many cases there are problems with cross drainage – either due to the inadequate provision of cross-drainage infrastructure, or damaged or broken infrastructure. Performance evaluation of the water distribution system is very rarely taken up. Water supply infrastructure is being augmented under government scheme “Ghar Ghar Jal Yojna”. Still 100 per cent coverage would not be achieved by the end of the scheme.

Lack of Capacity on Sanitation Programs: Sanitation programme requires renewed emphasis on capacity building, both of the programme managers as well as the implementers in the field. The state and district officials, especially the District Collectors/CEOs of Zila Panchayats (district level local government body) need to be trained in the various approaches, especially community approaches and triggers for collective behaviour change. Although under Nirmal Bharat Abhiyan (NBA) in rural India, this issue is being addressed to a larger extent after 2014, but a lot needs to be done.

Small and Scattered Habitations: There are regions in the state that are covered with forest and have small habitations covering 15 to 50 households in forest regions. Providing water with pipe water supply schemes is neither feasible nor optimal for such regions. For such small habitation coverage by drilling of tube well is essential. High yield tube wells are used for Mini-Piped Water Supply Scheme. In addition, solar or electric power Mini Piped Water Supply systems are being planned for these areas by PHED and CREDA.

Inter-State Dispute: Recently disputes over sharing of the Mahanadi waters have arisen. The issues are related to agriculture and industrial water allocation and use, environmental flows, water pollution and groundwater use in the Mahanadi River basin.

Perceived Climate Impacts

Some of the major impacts are as follows:

- Climate change can affect the hydrological regime on account of changes in the distribution pattern and intensity of precipitation and resulting in changes in water flows and evapo-transpiration. These

changes would in turn impact the communities and natural ecosystem adversely; through variability in water availability in the rivers and surface water bodies; changes in the groundwater recharge; impacting crop yields and jeopardizing food security;

- Increased incidences of drought are certain to exacerbate existing land degradation and widespread water stress.
- Health concerns due to occurrence of extreme events such as floods and droughts, heat waves etc.
- Extreme precipitation events could have geomorphological significance to the State. The response of hydrological systems, erosion processes and sedimentation in this region could alter significantly due to climate change.
- Increase in rainfall is likely to cause flash floods, landslides and damages to the landmass. This has a very severe implication for the existing infrastructures such as dams, bridges, roads, etc.

Climate Change Adaptation and Mitigation Strategies

Some of the key climate adaptive strategies that will be relevant for the state are listed and explained below.

1. **Groundwater Conservation Measures** – Given the hydrogeology of Chhattisgarh, any plan for groundwater conservation and recharge must be long term and well-conceived. Aquifer mapping would be required and should be a part of the integrated river basin management. In areas identified as over-exploited, intensive programmes for groundwater recharge will be undertaken by introducing rainwater harvesting, recycling and re-using of water. Rejuvenation and restoration of water bodies and groundwater shall be taken on priority. Efforts should also be made to change the cropping patterns by introducing less water intensive crops so that pressure on groundwater can be eased.
2. **Watershed Management Interventions** – Considering the hilly and undulating topography of certain regions and the high rate of surface runoff, implementation of projects following 'Ridge to Valley Concept' for integrated water management will be given priority and watershed management interventions such as contour bunds, check dams and gully plugs would serve to arrest the soil erosion as well as improve the yield of rain-fed crops grown during the Kharif season.
3. **Special Plan for Augmenting Drinking Water Facilities** – For long term security of drinking water supplies, it is important to move away from bore well based individual village and hamlet schemes to large surface water systems that can provide reliable supplies of high-quality water, as the former cannot guarantee source dependability and chemical quality for portability. The demand for safe and clean drinking water is increasing with the increasing population, both in rural as well as in urban areas. In order to meet the increasing demand of safe and clean drinking water for the people of Chhattisgarh, a serious effort with time bound action plan shall be worked out to augment the live capacity of existing reservoirs dedicated for supplying drinking water through debilitation or by adopting other effective technical interventions including saving water by checking leakages in drinking water supply pipeline are short-term measures. In view of growing urban demand for drinking water, the Government will take initiative for the construction of large reservoirs near thickly populated cities for the supply of drinking water.
4. **Research, Development and Promotion of State-of-Art Technologies in Water Sector for Improved Irrigation Techniques** – Introduction and promotion of new technology for more efficient and productive water-use namely drip and sprinkler shall be undertaken. The reuse of water for non-irrigation and non-drinking purposes by recycling and effluent treatment should be promoted. The State shall undertake to promote the development, adaptation and dissemination of affordable and

appropriate water and agricultural technology and expand the knowledge base through its various institutions.

5. **Capacity Building and Awareness Generation on the Sectoral Impact of Climate Change** – There will be a need to enhance the capacity of the State water resource department on identifying, addressing and resolving conflicts that could arise out of water availability and associated allocation issues due to climate-induced events such as droughts. Such capacity will be particularly required in the line departments that are involved with the water related issues in the river basin. This includes the departments responsible for water resources management, agriculture, rural development, urban development and industries.
6. **Increase Water use Efficiency in the Irrigation Sector** – The National Water Mission on Climate Change proposes enhancement of water use efficiency in the irrigation command areas by 20 percent. The state government has proposed lining of canals and undertaking canal rehabilitation work under the rehabilitation of canal networks, including lining/ construction of the field channel. Upgrading / rehabilitating will be given higher importance, many water storage infrastructures suffer from excessive sediment / silt accumulation that result in reduced storage capacity. Rehabilitation of the embankments and other repairs should necessarily be accompanied with removal of sediment/ silt.
7. **Research on Basin Wise Impact of Climate Change** – It is important to undertake basin wise analysis to identify impacts of climate change on precipitation and other hydrological components in the basin especially in terms of extreme events of floods and droughts so that appropriate adaptation options can be devised. Efforts shall be made to undertake these studies.
8. **Institutional Reforms to Address Water Distribution and Use Issues from the Point of View of Climate Change** – Establishment of Chhattisgarh State Water Management Institute will be completed for surveying, research, consultation and evaluation of water management schemes in the state, reviving 'Water User Associations' to effectively manage irrigation systems and transfer of management functions to the Water User Associations will be systematically done to improve system-wide efficiency within each basin.
9. **State Water Policy Reforms** – Inclusion of sectoral climate change resilient policy in the State Water Policy, 2012 and preparation of the 'Action Plan for Water on Climate Change'. This action plan will serve as the roadmap for climate resilient planning of water resources activities in the state.

Early Warning System (EWS) – Drought is a usual occurrence in virtually all regions of the Chhattisgarh. Floods and droughts are natural hazards that cause damage and extensive human suffering. The situation shall be even worst under future climate scenarios. Managing flood and drought risks in an informed and effective way is of utmost importance to reduce damages. The flood and drought risk management, including the development of monitoring and early warning systems is need of the hour. EWS shall help the farmers as well as policy makers in taking timely action.

Appendix I

List of Indicators for District Vulnerability Assessment

Table 13: Sectors of vulnerability and the associated indicators for Chhattisgarh districts

No	Indicators	Abb	Unit	Functional Relationship with vulnerability	Data Source
Socio-Economic					
1	Density of Population	DP	Persons/Sq. Km	Increase	Economic survey 2019-20: DES
2	Forest Area	FA	Percentage	Decrease	Chhattisgarh Statistical Abstract 2017-18: DES
3	Total Installed Hand pump in rural area of the State	HP	Number/sq km	Decrease	
4	Households with access to improved source of drinking water (tap water, covered well, hand pump, tube well)	DWS	Percentage	Decrease	Government of Chhattisgarh, Socio Economic Indicator 2015
5	Households with access to drinking water away from the premises	DWA	Percentage	Increase	
6	Net Irrigated Area	IA	Percentage to Net Sown Area	Decrease	Chhattisgarh Statistical Abstract 2017-18: DES
7	Net annual groundwater availability	GW	ha m	Decrease	Water Resources Department:Government of Chhattisgarh
8	Average depth to Water Level below ground level (10 m): Pre Monsoon	DWL	per cent of wells	Increase	Central Groundwater Board: Chhattisgarh, 2019
9	Critical and semi-critical blocks according to GW status	CRGW	Number	Increase	Central Groundwater Board: Government of India, 2017
10	Iron> 1mg/l in ground water	IR	Binary	Increase	Central Groundwater Board, Ministry of Water Resources: Government of India
11	Fluoride >1.5 mg/l in ground water	FLU	Binary	Increase	
12	Nitrate (>45 mg/l) in ground water	NIT	Binary	Increase	
13	Surface Water availability in South West Monsoon season	SWSWM	mm/lakh population	Decrease	SWAT Hydrological model outputs, CORDEX climate data-RCP4.5, RCP8.5 (IITM, Pune)
14	Surface Water availability in North East Monsoon season	SWNEM	mm/lakh population	Decrease	
15	Groundwater availability in South West Monsoon season	GWSWM	mm/lakh population	Decrease	

16	Groundwater availability in North East Monsoon season	GWNEM	mm/lakh population	Decrease	
17	Crop water Stress (ET/PET) in South West Monsoon season	CWSSWM	Ratio	Increase	
18	Crop water Stress (ET/PET) in North East Monsoon season	CWSNEM	Ratio	Increase	
19	Frequency of Drought	DR	Number of weeks	Increase	
20	Flood Discharge (1-2 per cent probable flow)	FL	cumecs-day	Increase	
21	Average annual rainfall	RF	mm	Decrease	
22	Variability in annual rainfall	STDRF		Increase	
23	Extremely Wet Days-Annual total rainfall when rainfall>99th percentile	EWD	mm	Increase	
24	Consecutive Dry Days-maximum number of Consecutive Days With Rainfall Less Than 1 mm	CDD	Number of Days	Increase	
25	Consecutive Wet Days-maximum number of Consecutive Days	CWD	Number of Days	Increase	
26	Heat Index	HI	Severity of days	Increase	

Tables for Water Resource Vulnerability

Table 14: District wise Water Resources Vulnerability Index values, ranks and vulnerability category under current and projected scenario - RCP4.5 and RCP8.5

Districts	BL Rank	Index value					Category				
		BL	MC RCP4.5	EC RCP4.5	MC RCP8.5	EC RCP8.5	BL	MC RCP4.5	EC RCP4.5	MC RCP8.5	EC RCP8.5
Mungeli	1	0.350	0.368	0.359	0.380	0.395	VL	VL	VL	L	L
Dhamtari	2	0.363	0.382	0.381	0.379	0.397	VL	L	L	L	L
Ghariyaband	3	0.385	0.406	0.399	0.400	0.414	L	L	L	L	L
Narayanpur	4	0.391	0.418	0.401	0.400	0.432	L	L	L	L	M
Surguja	5	0.399	0.428	0.402	0.400	0.439	L	M	L	L	M
Balod	6	0.403	0.431	0.414	0.432	0.443	L	M	L	M	M
Jashpur	7	0.404	0.425	0.412	0.414	0.461	L	M	L	L	H
Kabeerdham	8	0.407	0.425	0.413	0.415	0.424	L	M	L	L	M
Kondagaon	9	0.408	0.425	0.421	0.426	0.446	L	M	M	M	M
Gaurela Pendra Marwahi	10	0.427	0.450	0.425	0.454	0.455	M	M	M	H	H
Mahasamund	11	0.447	0.489	0.484	0.493	0.476	M	VH	VH	VH	VH
Uttar Bastar Kanker	12	0.448	0.480	0.461	0.465	0.493	M	VH	H	H	VH
Raigarh	13	0.449	0.487	0.468	0.479	0.491	M	VH	H	VH	VH
Surajpur	13	0.449	0.454	0.443	0.434	0.480	M	H	M	M	VH
Bemetara	15	0.457	0.477	0.480	0.473	0.487	H	VH	VH	VH	VH
Korba	15	0.457	0.481	0.457	0.490	0.495	H	VH	H	VH	VH
Dantewada	17	0.459	0.479	0.467	0.452	0.501	H	VH	H	M	VH
Raipur	18	0.462	0.491	0.483	0.488	0.489	H	VH	VH	VH	VH
Sukma	18	0.462	0.474	0.472	0.460	0.505	H	VH	VH	H	VH
Baloda Bazar	20	0.467	0.489	0.487	0.482	0.501	H	VH	VH	VH	VH
Rajnandgaon	20	0.467	0.486	0.468	0.488	0.504	H	VH	H	VH	VH
Bastar	22	0.474	0.492	0.494	0.474	0.517	VH	VH	VH	VH	VH
Bilaspur	23	0.481	0.499	0.489	0.510	0.523	VH	VH	VH	VH	VH
Balrampur	24	0.489	0.493	0.485	0.469	0.522	VH	VH	VH	H	VH

Durg	25	0.490	0.516	0.518	0.516	0.520	VH	VH	VH	VH	VH
Koriya	26	0.494	0.516	0.492	0.495	0.522	VH	VH	VH	VH	VH
Bijapur	27	0.498	0.528	0.516	0.507	0.546	VH	EH	VH	VH	EH
Janjgir - Champa	28	0.499	0.499	0.489	0.497	0.524	VH	VH	VH	VH	EH

VL: Very Low, L: Low, M: Moderate, H: High, VH: Very High, EH: Extremely High

Rank 1: Least Vulnerable; Rank 28: Most Vulnerable

High values of index imply Higher Vulnerability as seen in the table above

Table 15: Rationale for selecting indicators of vulnerability

No	Indicators	Rationale
1	Density of Population	A region with high population density is more sensitive to climate because more people are exposed and therefore the region will need greater humanitarian assistance. High density leads to more problems related with security, water, pressure on available natural resource, etc.
2	Forest Area	Forests provide safeguard ecological processes; provide biophysical stability and alternate livelihood options through extraction of fodder, fuel wood, and NTFPs. One of the most important strategies for controlling runoff and erosion risks, thus limiting the probability of flood events.
3	Total Installed Hand pump in rural area of the State	The hand pump is also the ubiquitous source of drinking water. Hand pumps are manually operated pumps and are widely used to supply water to communities or individual households
4	Households with access to improved source of drinking water (tap water, covered well, hand pump, tube well)	Accessibility to improved water sources is of fundamental significance to lowering the faecal risk and frequency of associated diseases. Without clean water, children are at risk of diseases such as diarrhea
5	Households with access to drinking water away from the premises	Social costs of collecting water from outside the premises are substantially higher. Lack of access to water also makes the community prone to several diseases and health care problems. Hence, increases vulnerability.
6	Net Irrigated Area	Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, trees, pastures and vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Hence higher the net area irrigated better is the adaptive capacity of a region.

7	Average depth to Water Level below ground level (10 m): Pre Monsoon	It shows that groundwater of the region is getting depleted due to overexploitation which is hence treated as vulnerable.
8	Critical and semi-critical blocks according to GW status	It determines the stage of groundwater extraction demanding immediate change in extraction pattern and surface water interventions to save the households of the block. 'Semi-critical' areas are where cautious groundwater development is recommended; 'Critical' areas; are where there should be intensive monitoring and evaluation and future ground development being linked with water conservation measures.
9	Iron > 1mg/l in ground water	The high concentration of iron into the body can form free radical which can lead to tissue damage and other neurodegenerative disease. Apart from this illness, accident and death of many people's are commonly observed. Hence, increases vulnerability.
10	Fluoride >1.5 mg/l in ground water	High concentration of fluoride in groundwater poses health problem. Water does not remain suited for domestic consumption and make people more vulnerable.
11	Nitrate (>45 mg/l) in ground water	High concentration of nitrate in groundwater makes it unsuitable for agriculture purposes. Though nitrate is considered relatively non-toxic, a high nitrate concentration in drinking water is an environmental health concern arising from increased risks of methemoglobinemia particularly to infants. Adults can tolerate little higher concentration
12	Surface Water availability	The impacts of climate change on freshwater systems and their management are mainly due to the observed and projected increases in temperature, sea level and precipitation variability. Areas with more productive soil and more groundwater available for agriculture will be more adaptable to adverse climatic conditions and better able to compete and utilize the opportunities of trade. If districts have larger availability of these water sources implies it is less vulnerable to climate change impact.
13	Groundwater availability	
14	Crop water Stress	Increasing crop water stress in a region impacts the productivity of the crops.
15	Frequency of Drought	The increase in natural disasters, primarily droughts, further exacerbates issues over water availability and water quality directly affecting the life and livelihoods of humans. Incidence of more frequent droughts implies more risky agriculture and hence more sensitivity.
16	Flood Discharge (1-2 per cent probable flow)	Increase in floods would add to stress on water resources, food security, human health, and infrastructure, constraining development. Larger area susceptible to flood incidence implies high sensitivity.
17	Average annual rainfall	The amount of rainfall received over an area is an important factor in assessing the amount of water available to meet the various demands of agriculture, industry, irrigation, hydroelectric power generation, and other human activities. A region with high rainfall is better off as compared to that with low rainfall.

18	Variability in annual rainfall	The increased variability in rainfall in various areas affects the annual and seasonal runoff and hence, water quality, water supply, and flood hazards.
19	Extremely Rainfall Indices	An increase in extreme rainfall indicates the possibility of crop productivity getting affected. Increase in the intensity of such extreme rainfall event also means higher probability of floods with all the attendant problems.
20	Heat Index	Higher HI impacts human health and can cause heat strokes, heat cramps and heat exhaustion. Exposure to extreme heat can result in occupational illnesses and injuries. Thus, air coolers and ACs need rise to cool the temperature.

Appendix II

Software Used

- Statistical software STATA
- GIS software ArcGIS
- Microsoft Excel
- R software
- SWAT modelling

Iyengar and Sudarshan method

Iyengar and Sudarshan (1982) developed a method to work-out a composite index from multivariate data and linked the weight to variance across the indicators. This methodology is statistically sound and well suited for the development of risk index to climate change also.

Method: It is assumed that there are M districts, K indicators of vulnerability and x_{ij} , $i = 1, 2 \dots M$; $j = 1, 2 \dots K$ are the normalized scores. Let x_{ij} be the normalized value of the indicator j corresponding to region i. The level or stage of development of i^{th} district, y_i , is assumed to be a linear sum of x_{ij} as,

$$y_i = \sum_{j=1}^K w_j x_{ij} \quad (0 < w < 1 \text{ and } \sum_{j=1}^K w_j = 1)$$

Where w 's are the weights. In Iyengar and Sudarshan's method the weights are assumed to vary inversely as the variance over the regions in the respective indicators of vulnerability. That is, the weight w_j is determined by,

$$w_j = \frac{c}{\sqrt{\text{var}_i(x_{ij})}}$$

Where, c is a normalizing constant such that

$$c = \left[\sum_{j=1}^{j=K} \frac{1}{\sqrt{\text{var}_i(x_{ij})}} \right]^{-1}$$

The choice of the weights in this manner would ensure that large variation in any one of the indicators would not unduly dominate the contribution of the rest of the indicators and distort the overall ranking of the districts. The vulnerability index so computed lies between 0 and 1, with 1 indicating maximum vulnerability and 0 indicating no vulnerability at all.

Annexure IV: Summary of Sectoral Action Plans

Summary of Sectoral Action plan for Climate Change: Agriculture and Allied Sector

S.N	Proposed Strategies	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing department
1	Development Climate Resilient Agriculture action strategies. (Having targeted budget allocation for women in agriculture and allied sector)	Climate Change Resilience Strategy	NDC 1 NDC 6 NDC 8	SDG 2 SDG 12 SDG 13	National Mission for Sustainable Agriculture PMKSY	NICRA	Agriculture Department
2	Assessing and Broadcasting knowledge on appropriate seed rate, soil moisture conservation activities, water efficient technologies including drip irrigation and village operations Massive and repetitive Climate Awareness programs	Climate Change Adaptation Strategy	NDC 8	SDG 13	Gramin Krishi Mausam Seva	NABARD	Agriculture Department
3	Research on exploring potential of Carbon Sequestration in agriculture sector	Research and Development	NDC 8	SDG 13	Grant in Aid to different Agriculture corporations, agencies and Missions	Any international agency such as GIZ, SDC etc.	Agriculture University
4	Strengthening the farmers by establishing Farmer Producer Organisations (FPOs) and finding market linkage	Climate Change Adaptation Strategy	NDC 1 NDC 6 NDC 8	SDG 2 SDG 12 SDG 13	National Food Security Mission	- NABARD	NABARD
5	Cold Chain Development using Renewables	Climate Change Mitigation Strategy	NDC 1 NDC 6 NDC 8	SDG 2 SDG 12 SDG 13	National Food Security Mission	- CREDA - Horticulture Department	NABARD

6	Develop Water-Efficient Micro-Irrigation methods: individual and community farm ponds	Climate Change Adaptation Strategy	NDC 6	SDG 6 SDG 12 SDG 13	MGNREGA	- Agriculture Department - NABARD	Rural Development
7	Establishment of Seed Bank at village level (involve women SHG Group)	Climate Change Adaptation Strategy	NDC 1 NDC 6 NDC 8	SDG 2 SDG 12 SDG 13	National Mission on Seeds / Rastriya Krishi Vikas Yojana	- NABARD - International Funding agencies	Agriculture Department & Horticulture Department
8	Management of Soil Health and Fertility	Climate Change Mitigation Strategy	NDC 1 NDC 6 NDC 8	SDG 2 SDG 12 SDG 13	National Project on Management of Soil Health and Fertility / Soil Reclamation and Management scheme / Soil Health Card scheme	NABARD	Agriculture Department & Horticulture Department
9	Install 10 HP solar pumps sets in irrigation scheme to offset emission from fuel combustion in motors	Climate Change Mitigation Strategy	NDC 1 NDC 6 NDC 8	SDG 7 SDG 12 SDG 13	Solar Pumping Programme for Irrigation and Drinking Water/ Solar Water Pump Scheme (CREDA)	Agriculture Department, NABARD & CREDA	Irrigation Department
10	Establish scientifically designed community-based shelters in all blocks to accommodate at least 300 cattle of small and marginal farmers-with plantations	Climate Change	NDC 1 NDC 6 NDC 8	SDG 13	Rashtriya Gokul Mission	NABARD	Animal Husbandry &

	around for reducing temperature of the surrounding microclimate, and water harvesting structure	Adaptation Strategy					Agriculture Department
11	Organic farming	Climate Change Adaptation Strategy	NDC 1 NDC 6 NDC 8	SDG 13	State Organic Farming Mission	Agriculture Department	Agriculture Department

Summary of Sectoral Action plan for Climate Change: Forest and Biodiversity Sector

S.N	Proposed Activities	Action Type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing Department
1	Continuing assisted natural regeneration and thereby fostering growth of native species that are adapted to the prevailing ecological and climatic conditions	Climate Change Mitigation interventions	NDC 5	Goal 15 Goal 13	RDF, RDBF, CAMPA, National Afforestation Programme (NAP) and Green India Mission	State Forest Department, CAMPA, National Adaptation Fund for Climate Change, Green Climate Fund, Adaptation Fund and other available national and international climate finance	Chhattisgarh State Forest Department
2	Continuing "Sustainable Forest Management" practices	Climate Change Mitigation / Adaptation interventions	NDC 1 NDC 5	Goal 15 Goal 6 Goal 13	Soil and water Conservation, Suraji Gaon Scheme, CAMPA, Jak Shakti Abhiyaan, MGNREGA Scheme		Chhattisgarh State Forest Department, Department of Rural Development (MGNREGA)

3	Better offset of fire incidences due to increased temperature	Climate Change Mitigation interventions	NDC 1 NDC 5	Goal 15 Goal 13	Joint Forest management committee Forest Fire Prevention & Management Scheme		Chhattisgarh State Forest Department
4	Enhancing Tree outside Forests (TOF)	Climate Change Mitigation / Adaptation interventions		Goal 12 Goal 13 Goal 15	Hariyali Prasar Yojana Sub-Mission on Agroforestry (SMAF) (60:40), National Bamboo Mission (60:40) Namami Gange Programme, Green Highways Policy		Chhattisgarh State Forest Department, Department of Rural Development (MGNREGA)
5	Climate change related sensitization, awareness generation and capacity building of forest department staff and allied sectors	Capacity Building	NDC 1 NDC 5 NDC 6	Goal 13	Training, Publicity, Research & Evaluation; Chhattisgarh State Climate Change Action Plan Green India Mission		Chhattisgarh State Forest Department; State Institute for Rural Development.
6	Review of working plans for incorporation of climate concerns	Policy level interventions for Climate change adaptation	NDC 5 NDC 6	Goal 13	Training, Publicity, Research & Evaluation; Chhattisgarh State Climate Change Action Plan		Chhattisgarh State Forest Department, IMD, FSI Dehradun
7	Implementation of the REDD+ strategy in Chhattisgarh	Climate Change Mitigation /	NDC 5 NDC 6	Goal 13	Green India Mission		Chhattisgarh State Forest Department

		Adaptation interventions			Chhattisgarh State Climate Change Action, CAMPA		
8	Conserve wildlife and its habitat, assessing the threats to biodiversity and wildlife	Climate Change Adaptation interventions	NDC 1 NDC 5 NDC 6	Goal 15	-		Chhattisgarh State Forest Department
9	Increasing and realising livelihood opportunities near forest area	Climate Change Adaptation interventions	NDC 1 NDC 5 NDC 6	Goal 8	-		Chhattisgarh State Forest Department

Summary of Sectoral Action plan for Climate Change: Water Resources Sector

SI No	Proposed Activities ¹¹¹	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing dept.
1.	Increase water use efficiency in the irrigation sector	Climate Change Adaptation strategies	NDC 6	SDG 12 SDG 13	Major, Medium and Minor Irrigation Schemes / Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Jal Shakti Abhiyan	- Agriculture Department - Rural Department	Water Resources Department
2.	Groundwater Conservation measures		NDC 1 NDC 6	SDG 6 SDG 13	Groundwater conservation and artificial recharge scheme / AMRUT/ PMKSY	-Urban Development and Housing -Rural Development	Water Resources Department
3.	Watershed management interventions		NDC 1 NDC 2	SDG 12 SDG 13 SDG 15	Minor Irrigation Scheme / MGNREGA / Watershed	-NABARD -Water Resources Department	- Department of Rural Development

¹¹¹ Department of Water Resource Annual Plans

					Development Component-PMKSY /Neeranchal Watershed program	-Agriculture Department	- Department of Agriculture
4.	Special Plan for augmenting Drinking Water facilities		NDC 1 NDC 6	SDG 6 SDG 13	Minor Irrigation Scheme / NRDWP / AMRUT		- Department of Urban Development and Housing - Drinking water and sanitation
5.	Research, Development and Promotion of State-of-Art Technology in Water Sector for improved irrigation techniques		NDC 2 NDC 6	SDG 12 SDG 13 SDG 15	Minor irrigation scheme / Pradhan Mantri Krishi Sinchai Yojana	Rural Development Department	- Department of Water resources - Department of Agriculture
6.	Capacity Building and Awareness generation on the sectoral impact of climate change	Capacity Building	NDC 1 NDC 2	SDG 13	National Water Mission, National Hydrology Project		- Department of Water resources - State Institute for Rural Development - Academy of Administration
7.	Research on Basin wise impact of climate change	Research and Development	NDC 1 NDC 2 NDC 6	SDG 13			Department of Water resources
8.	Institutional reforms to address water distribution, and use issues in a climate change context	Policy level interventions for CCA	NDC 2	SDG 13			Department of Water resources
9.	State Water Policy Reforms		NDC 2 NDC 6	SDG 13			Department of Water resources

10.	Early Warning System (EWS)	Climate Change Adaptation strategies	NDC 2 NDC 6	SDG 12 SDG 13 SDG 15	Major, Medium and Minor Irrigation Jal Shakti Abhiyan Schemes	-NABARD -Water Resources Department -Agriculture Department	Department of Water resources

Summary of Sectoral Action plan for Climate Change: Urban Development Sector

SI	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Imp. Dept
1.	Augmenting water availability in urban area by focusing on expediting the laying of pipelines for providing drinking water supply within all premises	Climate Change Adaptation strategies	NDC 1 NDC 2 NDC 6	SDG 6 SDG 12 SDG 13	AMRUT / National Water Mission	- AMRUT - World Bank	Department of Urban Development and Housing
	Provide uninterrupted availability of safe water to meet the per capita norms of water supply	Climate Change Adaptation strategies			AMRUT	AMRUT	Department of Urban Development and Housing
	Maximise use of surface water for drinking purposes through strategies aimed at promoting wider adoption of rainwater harvesting system	Climate Change Adaptation strategies			AMRUT	AMRUT	Department of Urban Development and Housing

2.	Increase plantation on non-forest land. Urban and Peri Urban Plantation Programs	Climate Change Adaptation strategies	NDC 2 NDC 5 NDC 6	SDG 13 SDG 15	AMRUT JNNURM / Green Highway Policy / Namami Ganga Program	-Department of Environment, Forest & Climate Change -Corporate Social Responsibility of Industries	Department of Urban Development and Housing
3.	Update building byelaws and development control regulations to incorporate Climate Change and DRR considerations	Climate Change Mitigation strategies	NDC 2 NDC 6 NDC 8	SDG 11 SDG 13	GRIHA / Smart City Mission	- CREDA - Disaster Management Department	Department of Urban Development and Housing
4.	Incorporate policy framework to encourage non-polluting or "green" economic activities in cities Master Plan	Climate Change Mitigation strategies	NDC 2 NDC 6 NDC 8	SDG 11 SDG 13	AMRUT / JNNURM / Smart City Mission	- State Pollution Control Board	Department of Urban Development and Housing
5.	Development of integrated MSW Management (such as waste to compost, waste to energy etc.)	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 11 SDG 12 SDG 13	Swachh Bharat Mission AMRUT / Swachh Bharat Abhiyan	- State Pollution Control Board - NGO's -International Organizations	Department of Urban Development and Housing
6.	Rejuvenate the water bodies	Climate Change Adaptation strategies	NDC 2 NDC 11	SDG 6 SDG 11 SDG 14	AMRUT Groundwater conservation and artificial recharge scheme Namami Gange	- State Municipal Corporation	Water Resource Department
7.	Urban Transport and Transit Oriented Development	Policy Action	NDC 2 NDC 4 NDC 5 NDC 6	SDG 11 SDG 12 SDG 13	AMRUT JNNURM / National Electric Mobility Mission	ADB	Department of Urban Development and Housing

8.	Promoting use of electric vehicle	Climate Change Adaptation strategies	NDC 2 NDC 3 NDC 8	SDG 9 SDG 11 SDG 13	National Electric Mobility Mission	EESL	Department of Urban Development
9.	Promotion of Solar rooftop system on Government building	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	JNNSM SECI UDAY Power for all	CREDA	Energy Department Department of Urban Development

Summary of Sectoral Action plan for Climate Change: Transport Sector

S. N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing dept
1.	Institute of Driving, Training and Research	Research	NDC 2 NDC 3 NDC 8	SDG 11 SDG 12 SDG 13			Department of Transport
2.	EV Policy and Provision of Subsidy	Policy Action	NDC 2 NDC 3 NDC 8	SDG 9 SDG 11 SDG 13	National Electric Mobility Mission	EESL	Department of Transport
3.	Inspection and Certification Centre	Climate Change Mitigation Strategies	NDC 2 NDC 3 NDC 8	SDG 9 SDG 11 SDG 13		Central Government	Department of Transport
4.	Provision of Weigh Bridge to control overloading of goods vehicle	Climate Change Adaptation Strategies	NDC 2 NDC 3 NDC 8	SDG 9 SDG 11 SDG 13	AMRUT	EESL	Department of Transport
5.	Initiative for Emission Control	Policy Action	NDC 2 NDC 3 NDC 8	SDG 9 SDG 11 SDG 13	AMRUT/ National Electric Mobility Mission		Department of Transport

Summary of Sectoral Action plan for Climate Change: Energy Sector

S.N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing dept.
1.	Generation of power through clean coal Approaches (super critical technologies)	Climate Change Mitigation strategies	NDC 2 NDC 3	SDG 9 SDG 12 SDG 13	-	Industries Department	Energy Department
2.	Develop a state-level energy efficiency standard through effective implementation of ECBC, PAT, etc. and through SDA.	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	PAT ECBC UJALA	-CREDA -Industries Department -SDA -BEE -EESL	Energy Department
3.	Maximise solar energy generation potential to 1.2 GW	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	JNNSM SECI UDAY Power for all	-Private organizations (such as Adani, TATA etc.) -CREDA	Energy Department
4.	Installation of Waste to Energy Plant of 10 MW	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	SBM	-Private organisations -Municipal Corporation -CREDA	Energy Department
5.	Installation of Small Hydro Power Project of 25 MW	Climate Change Mitigation strategies	NDC 3 NDC 4	SDG 7 SDG 11 SDG 12	Small Hydro Power Scheme	-Water Resources -CREDA	Energy Department
6.	Design and Implement Utility Level DSM and EE Programs	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	UDAY	-DISCOM -CREDA -EESL	Energy Department

7.	Build capacity of energy auditors, strengthen the energy conservation cell	Climate Change Mitigation & Adaptation strategies	NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	Training Programs developed by BEE	-BEE -CREDA	Energy Department
8.	Increase energy efficiency in drinking water pumping systems and lift irrigation systems	Climate Change Mitigation strategies	NDC 1 NDC 2 NDC 8	SDG 6 SDG 11 SDG 12	PMKSY	-World Bank -CSR Initiatives -CREDA - Water Resource Department	Energy Department

Summary of Sectoral Action plan for Climate Change: Industry Sector

S.N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Possible Agencies for Convergence of funds	Implementing dept.
1.	Review of Chhattisgarh State Industrial Policy 2019-24 to address CC Concerns	Climate Change Adaptation strategies	NDC 2	SDG 9		Industries Department
2.	Devise an integrated water management plan for industrial clusters	Climate Change Adaptation strategies	NDC 2	SDG 12 SDG 13	-	Water resources department, Chhattisgarh Groundwater Board, Industries Department
3.	Devise a mechanism for green belt development and maintenance for industrial clusters ¹¹²	Climate Change Mitigation strategies	NDC 8	SDG 12 SDG 13	CSR of major industries	Industries Department, Forest department

¹¹² Additional Funds Required

4.	Capacity Building and Awareness programmes	Climate Change Adaptation strategies	NDC 8	SDG 13	International funding agencies such as GIZ, World Bank, DFID could fund such programs in the state	-Industries Department - Chhattisgarh State Centre for Climate Change.
5.	Research and Development	Research and Development for preparation of effective mitigation and adaptation plans	NDC 2 NDC 3 NDC 8	SDG 9 SDG 12 SDG 13	-International funding agencies such as GIZ, World Bank could fund such studies in the state -National Adaptation Fund	-Industries Department Chhattisgarh –Chhattisgarh Environment Conservation Board
6	Energy Profiling, Performance benchmarking and GHG Profiling of State's Industrial sector	Climate Change Mitigation strategies	NDC 2 NDC 8	SDG 12 SDG 13	International funding agencies such as GIZ, World Bank could fund such studies in the state -National Adaptation Fund	-IndustriesDepartment -Chhattisgarh State Centre for Climate Change
7	Scaling up clean energy transition across industrial sector with specific emphasis on MSME Sector	Climate Change Mitigation strategies	NDC 2 NDC 8	SDG 12 SDG 13	CREDA, BEE	Industries Department, CREDA

Summary of Sectoral Action plan for Climate Change: Mining Sector

S. N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing dept
1.	Prepare mineral centric (example-coal) sustainable mining plan ¹¹³	Climate Change Adaptation strategies	NDC 2 NDC 5	SDG 12 SDG 13	PM KKKY	Central Mine Planning & Design Institute Limited (CMPDI), Ranchi	Mining Department /IBM
2.	Study on the impact of mining on climate change ¹¹⁴	Climate Change Mitigation strategies	NDC 2 NDC 5	SDG 12 SDG 13	PM KKKY	Chhattisgarh State Centre for climate change. International funding agencies such as GIZ, World Bank could fund such studies in the state	Environment Department
3.	Prepare an action plan for reclamation and rehabilitation of old abandoned mines.	Climate Change Adaptation strategies	NDC 2 NDC 5	SDG 12 SDG 13	PM KKKY/ National Mineral Exploration Trust	Central Mine Planning & Design Institute Limited (CMPDI), Ranchi	Mining Department/DGMS/IBM/ - Geological Survey of India - IIT, Bhilai
4.	Explore cleaner technologies and best practices in coal mining	Research and Development	NDC 2 NDC 5	SDG 12 SDG 13	PM KKKY	International funding agencies such as GIZ, World Bank could fund such studies in the state	Mining Department/DGMS/IBM/ -Geological Survey of India - IIT, Bhilai

¹¹³ Additional Funds Required¹¹⁴ Additional Funds Required

5.	Conduct heat Island study in mining areas	Climate Change Adaptation strategies	NDC 2 NDC 5	SDG 12 SDG 13	PM KK KY	Respective mining industries	IBM
6.	Capacity building and awareness generation	Climate Change Mitigation strategies	NDC 2 NDC 5	SDG 12 SDG 13			

Summary of Sectoral Action plan for Climate Change – Health Sector

S.No.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing dept.
1.	Institutionalize studies to understand the possible impact of Climate change on health in context of Chhattisgarh (Focus on Women and Child)	Research and Development for Building the Resilience	NDC 1	SDG 3 SDG 5	PMJAY / National Health Mission	Department of Environment Forest and Climate Change National Centre for Disease Control	Department of Health and Family Welfare
2.	Integrate Climate Change considerations into the state Health Policy	Policy Action to build the Resilience of communities	NDC 1	SDG 3 SDG 13	PMJAY / National Health Mission	UNICEF National Centre for Disease Control	Department of Health and Family Welfare
3.	Develop mobile based application on disease outbreak forecast and prevention measures – a to do list	Climate Change Adaptation strategies	NDC 1	SDG 3 SDG 13	PMJAY / National Health Mission	International funding agencies such as World Bank, GIZ, UNICEF etc for technical support to develop the mobile based application	Department of Health and Family Welfare

4.	Strengthen the approaches to managing water & vector-borne diseases that have worsened because of the impacts of climate change	Climate Change Adaptation strategies	NDC 1	SDG 3 SDG 13	PMJAY / National Health Mission	-Municipal Corporation -IMD -UNICEF	Department of Health and Family Welfare
5.	Strengthen the approaches to dealing with the heat wave conditions exacerbated by the impacts of climate change	Climate Change Adaptation strategies	NDC 1	SDG 3 SDG 13	PMJAY / National Health Mission	-Municipal Corporation -IMD -UNICEF	Department of Health and Family Welfare
6.	Sensitization and capacity building for state health department officials	Capacity Building for making the Communities more Resilient	NDC 1	SDG 3 SDG 13	PMJAY / National Health Mission	-UNICEF	Department of Health and Family Welfare

Summary of Sectoral Action plan for Climate Change: Rural Development Sector

S. N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with State govt. scheme	Possible Agencies for Convergence of funds	Implementing dept.
1	Developing and institutionalizing mechanisms for regular maintenance and management of the assets created under the MGNREGA	Climate Change Adaptation strategy	NDC 6	SDG-12,13	Minor Irrigation works MGNREGA	DFID, World Bank	Department of Rural Development Department of Water resources department

2	Preparation of community led action plan on climate change and integration of climate resilient planning in the GPDP	Policy level	NDC 6	SDG-12,13	Atal Gramothan Yojna Gram Panchayat Development Plan		Department of Rural Development, Department of Panchayat Raj
3	Increased incomes for target households through alternate livelihood options	Climate Change Adaptation strategy	NDC-2,6	SDG 1,10	State Rural Livelihood Mission NSDC PMKVY DDY-GKY	CSR Fund	Department of Rural Development, SRLM
4	Continue the livelihood-focused, people-centric integrated watershed development programmes in rain fed areas vulnerable to climatic variations	Climate Change Adaptation strategy	NDC -2,6	SDG-1,10,12,13	NABARD-Watershed Projects PM KSY Neeranchal IWMP	World Bank	Department of Agriculture/ Department of Rural Development Chhattisgarh state watershed management agency

5. *Existing Budget

6. **New Items for budget

Summary of Sectoral Action plan for Climate Change: Disaster Management Sector

S. N.	Proposed Activities	Action type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Possible Agencies for Convergence of funds	Implementing department
1	Develop district level management plans to deal with multiple hazards including flash floods, fire, lightning, heat waves etc.	Climate Change Adaptation- Disaster Risk Resilience	NDC 6	SDG 11 SDG 13 SDG 14	National Disaster Relief Fund	NDMA & SDMA	Revenue and Disaster Management dept.

2	Development of Drought Mitigation Action Plan	Climate Change Adaptation- Disaster Risk Resilience	NDC-6	SDG-13, 14		NDMA	Revenue and Disaster Management dept, Water resources department
3	Develop an integrated flood, erosion, and sediment management Action Plan for the major river basins	Climate Change Adaptation- Disaster Risk Resilience	NDC-6	SDG-13, 14		NDMA	Revenue and Disaster Management dept, Water resources department
4	Set up an integrated capacity-building protocol covering shelter and a self-help group under the Community-Based Disaster Risk Reduction Framework (CBDRF), including college and school volunteers and officials at the state and district levels	Climate Change Adaptation- Disaster Risk Resilience	NDC-6	SDG-11,13	Strengthening of State Disaster Management Authorities (SDMAs) and District Disaster Management Authorities (DDMAs)	NDMA, SDMA for Technical Support	Revenue and Disaster Management dept.
5	Mainstream CCA - DRR in flagship schemes.	Policy level intervention	NDC-6	SDG-11	NDMA NIDM	Technical Support from-All India Institute of Disaster Management, Asian Disaster preparedness center	Revenue and Disaster Management dept.
6	Strengthen training Institute (ATI) at state level with sufficient training resources (search & rescue equipment's, First Aid. human resources, literatures etc.	Climate Change Adaptation- Disaster Risk Resilience	NDC-6	SDG-11,13	Strengthening of State Disaster Management Authorities (SDMAs) and District Disaster Management Authorities (DDMAs)	Technical Support from-All India Institute of Disaster Management, Asian Disaster preparedness center	Revenue and Disaster Management dept.

Summary of Sectoral Action plan for Climate Change: Women and Child Development Sector

S.N.	Proposed Activities	Action Type	NDC linkage	SDG Goal Linkage	Linkage with National /State missions /Schemes	Financial allocation from other source	Implementing department
1	Ensuring participation of at least 33 per cent of women in farmer's training and capacity building program. Gender disaggregated data collection in different beneficiaries' schemes for better gender analysis. Training and involvement of women SHGs for climate resilient agriculture (CRA) practices promotion and value chain development of the CRA crops.	Capacity Building	NDC 6 NDC 8	SDG 5	National Mission for Sustainable Agriculture PMKSY	-NICRA -NABARD -UNICEF	-Agriculture Department - Department of Women and Child Development
2	Women representation in Water user associations, water management and off-farm livelihood initiatives should be given priority Training of Women PRI members for various mitigation measures on waste management, water management and land use change under different regulatory framework.	Capacity Building	NDC 6 NDC 8	SDG 5 SDG 6	National Water Mission	-NABARD -UNICEF	Water resource Department
3	Analyse and design gender aspects in REDD+ and other forest-based livelihood development projects	Knowledge Management	NDC 5	SDG 15 SDG 13	National Afforestation Programme (NAP) and	REDD+	Chhattisgarh State Forest Department

					Green India Mission / RDF, RDBF, CAMPA		
4	Encouraging women operated e-rickshaws in cities and peri-urban areas by providing additional subsidies to women. Subsidised public transport fare for women to encourage use of public transport. Involve women SHGs in waste to energy projects (like Ambikapur model in Chhattisgarh)	Climate Change Adaptation strategies	NDC 2 NDC 4 NDC 5 NDC 6	SDG 11 SDG 12 SDG 13	National Electric Mobility Mission / AMRUT JNNURM	ADB	-Department of Urban Development and Housing -Transport Department
5	Awareness creation among women health workers, Anganwadi workers about various climate change mitigation and adaptation measures. Focus on women's need, especially pregnant and lactating women, special enclosures in disaster relief camps for privacy and sanitation	Policy Action to build the Resilience of communities	NDC 1	SDG 3 SDG 13	National Health Mission / PMJAY	International funding agencies such as World Bank, GIZ, UNICEF etc for technical support to develop the mobile based application	-Department of Health and Family Welfare -Disaster Management
6	Promotion of skills and employment of women work force in food processing, textile and other MSME sector industries.	Capacity Building	NDC 2 NDC 5	SDG 12 SDG 13	PM KKLY	Respective industries	Industries Department
7	Capacity building of women and marginalized sections on off-grid solar systems, bio-fuel generation etc.		NDC 1 NDC 2 NDC 8	SDG 7 SDG 11 SDG 12	Training Programs developed by BEE	-BEE -CREDA	Energy Department

Annexure V: Projected Budget Estimate for Department Wise Climate Relevant Activities

The projected estimates given below are based on existing budgetary provisions of the department based on their relevance to climate actions directly or indirectly.

Proposed Activities and Budget (2020-21 to 2029-30)

Name of the Department – Agriculture and Allied Sector			
			Amount in Lakhs
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
Department of Agriculture			
1	Rajiv Gandhi Kisan Naya Yojana	562789.0	6125853.6
2	Karshak Samagra	8100.0	87171.0
3	Janjagran Abhyan Ke Shivirathriyon ko Protsahan Yojana	60.0	645.3
4	Chattisgarh state marketing federation for Fertilizer	500.0	5377.3
5	Godhan Nyay Yojana	8010.0	178716.0
6	Organic Certification Agency	60.0	645.3
7	Organic Farming Mission	2000.0	21474.1
8	Bonus to sugarcane farmers	11200.0	120451.8
9	Dr. Khubchand Bagheal Krishak Ratan Award	3.0	30.0
10	Grant to NGOs	170.0	1828.3
11	Crop Demonstration	500.0	5377.3
12	Pradhan Mantri Phasal Bima Yojana	57025.0	617916.1
13	Khalihan Bima Yojana	4.0	40.0
14	Shakambhari Yojana	2000.0	14681.0
15	Micro Minor Irrigation Scheme	2500.0	20058.3
16	Grant to Universities / Research Centres	50.0	537.7
17	Grant to Universities / Research Centres	15000.0	172049.5
18	Grant to Universities / Research Centres	410.0	9872.0
19	Grant to Universities / Research Centres	3800.0	40867.6
20	National Food Security Mission	12060.0	129700.8
21	National Mission on Oilseeds and Oil Palm	935.0	10055.6
22	NMAET – Submission on seed and planting material	2413.0	25092.5
23	Rashtriya Krishi Vikas Yojana (RKVY)	16220.0	167416.7
24	NMSA – Rainfed Area Development	2198.0	23638.7
25	NMSA – Soil Health Management	2100.0	22584.7
26	Reclamation of Problemetic Soil	400.0	4301.9
27	Pradhan Mantri Krishi Sichai Yojana	6000.0	64527.8
28	Paramparagat Krishi Vikas Yojana	3468.0	37999.4
29	Targeted Rice Fallow Area	10691.8	116870.9
30	Rashtriya Krishi Vikas Yojana (RKVY) – BGREI	16000.0	173927.4
31	NMAET – Submission on Agriculture Extension	4000.0	43018.5
32	National E-Governance Plan – Agriculture	200.0	2638.7
33	Subsidy on Agriculture Engineering Mission	7890.0	84854.0
34	Integrated Watershed Management	20000.0	117546.3
Sub-Total		778756.8	8447766.2

Department of Fisheries			
35	Fish seed production	437.4	4789.3
36	Fish production from water bodies / river	265.0	2901.6
37	Departmental Training	89.4	978.7
38	Grant to cooperative societies	358.6	3926.6
39	Promotion of Fish Production	546.3	5982.3
40	Pradhanmantri Matsya Sampat Yojana	1090.3	11938.3
41	Matsya Mahavidhyalay (Fisheries College)	240.0	2627.9
42	Insurance	17.1	187.7
43	Rashtriya Krishi Vikas Yojana	922.8	10103.9
44	Blue Revolution	2380.2	26063.0
Sub-Total		6347.1	69499.1
Department of Horticulture			
45	Establishment of new gardens and nurseries	2934.3	32129.2
46	Garden development scheme	6336.4	69381.8
47	Training to Women on Fruit Protection and Sheilding	70.8	774.7
48	Grant for Horticulture Plantation	125.0	1368.7
49	Improved and Certified Seed Production Program	240.0	2627.9
50	Conservative Farming and Post Crop Management	50.0	547.5
51	Demonstration and Training on Crop Diversification	38.0	416.1
52	Poshan Badi Vikas Yojana	1000.0	10949.7
53	State Sponsored Micro Irrigation Scheme	297.0	3252.1
54	Dense horticulture development scheme	210.0	2299.4
55	Horticulture training	50.0	547.5
56	Pradhan Mantri Phasal Bima Yojana	2881.0	31546.1
57	Integrated Horticulture Development Scheme	20500.0	224469.3
58	Rashtriya Krishi Vikas Yojana	4000.0	43798.9
59	National Mission on Oilseeds and Oil Palm	1400.0	15329.6
60	Pradhan Mantri Krishi Sichai Yojana	5000.0	54748.6
61	National Mission on Agro Forestry	1200.0	13139.7
62	National Bamboo Mission	633.3	6934.9
Sub-Total		46965.7	396066.1
Department of Animal Husbandry			
63	Intensive Animal Husbandry Project	70570.5	772727.1
64	Poultry Development Scheme	2135.7	23384.8
65	Research on Disease	1149.0	12581.2
66	Strengthen of Piggery Development	480.4	5260.5
67	Milk production and Infrastructure	1709.3	18716.0
68	Availability of Milk ,Egg , Wool and Meat	78.3	856.8
69	Development of Poultry Feed	517.0	5661.0
70	Organising of Cattle Camps	100.0	1095.0
71	Establishment of Goatry Field	451.2	4940.2
72	State Goat Entrepreneurship Development Scheme	55.0	602.2
73	State Sponsored Dairy Entrepreneurship Development Scheme	1639.9	17956.4
74	Rastriya Krishi Vikas Yojana	4247.2	46505.9
75	National Livestock Mission	1750.0	19162.0
76	Animal Disease control program	1964.6	21511.8
77	Cattle insurance scheme	600.0	6569.8

78	NABARD sponsored cattle and poultry Entrepreneurship Development grant	100.0	1095.0
79	Goat Disease control program	230.0	2518.4
80	National Brucellosis control program	25.0	273.7
Sub-Total		87803.0	121135.6
Grand Total		919872.6	9034467.0

**Note projection revised as per the provision of 2021-2022 for Agriculture Department

Name of the Department – Forest and Climate Change			
Amount in Lakhs			
Sl No	Name of the Program/ Activity	Proposed Budget in 2020 -2021	Projected Budget for 2020-21 to 2029-2030
1	Environmental Forestry	1581.8	17320.27
2	Restoration of Degraded Forest	15640	171253.64
3	Forestry Research in State	177.21	1940.40
4	Strengthening and Development of Joint Forest Management	700	7664.80
5	Soil and Water Conservation Work	1500	16424.58
6	Riverbank Plantation	950	10402.23
7	Fast Growing Plantation Including Bamboo	950	10402.23
8	Hariyali Prasar Yojana	1675	18340.78
9	Renovation of Bamboo Forest	4660	51025.70
10	Roadside Plantation	800	8759.78
11	Plantation against encroachment settlement	300	3284.92
12	NTFEP/ Medicinal Plantation through Village Forest Committee	450	4927.37
13	Social Forestry	375	4106.15
14	Establishment of Community Protected Areas	300	3284.92
15	Lakh Vikas Yojana	200	2189.94
16	Bamboo processing unit	77	843.13
17	National Forestry Program	3500	38324.02
18	Ecosystem Services Improvement Project	864	9460.56
19	Mukhyamantri Bans Vikas Yojana	1200	13139.67
20	CAMPA – Compensatory Afforestation	19545	214012.30
21	CAMPA – Conservation of Natural Forest and Afforestation Works	46624	510519.79
22	CAMPA – Forest Protection	11891	130203.13
23	Wild life and biodiversity conservation	22,495.76	246322.30
Total		1,36,455.7	14,94,152.6

Name of the Department – Water Resources			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020 - 2021	Projected Estimate for 2020-21 to 2029-2030
1	Canal and Related works (2884)	6,821	74,688.05
2	Small Irrigation works (5189)	10,000	1,09,497.21
3	Loan Support form NABARD (9469)	15,000	1,64,245.81
4	Micro-Irrigation Schemes	560	6,131.84
5	Climate Sensitive Scheme	600	6,569.83
Total		32,981.0	3,61,132.7

Name of the Department – Urban Development			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Estimate for 2020-21 to 2029-2030
1	Smart City Mission	59,400	6,50,413.43
2	Street Light National Programme	27,000	2,95,642.47
3	Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	22,000	2,40,893.86
4	Deendayal Antyodaya Yojana – National Urban Livelihoods Mission (DAY-NULM)	5,000	54,748.60
5	Pradhan Mandtri Awas Yojana – Housing for All by 2022(PMAY-HFA)	32,500	3,55,865.93
6	Rajya Pravartit Yojna	10,000	1,09,497.21
7	Integrated Municipal Solid Waste Management	11,963	1,30,991.51
Total		1,67,863.00	18,38,053.02

Name of the Department - Transportation			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
1	Enforcement	234213	2564567.00
2	Vehicle tracking platform	84100	920871.54
3	Motor garage	160512	1757561.62
4	Driver training and research institute organization	6100	66793.30
5	Latest vehicle testing and certification machinery	110	1204.47
6	State Transport Apellete Authority	15432	168976.09
7	Road safety fund	25726	281692.52
Total		526193.00	5761666.54

Name of the Department -Energy			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
1	Solar Sujala Yojana Grant from NABARD	50000	547486.0
2	Solar Sujala Yojana Grant from Energy Department	5000	54748.60
3	Solar Energy Schemes: On grid and Off grid	2500	27374.30
4	Existing Machinery Capacity Enhancement, Maintanance and Capacity Development,	3000	32849.16
5	Bio Energy Development Grant	500	5474.86
6	Rural Energy Grant	2500	27374.30
7	CREDA Support grant	2300	25184.36
8	Chattisgarh Biofuel Development Agency Grant	100	1094.97
9	Energy Conservation and Strengthening Program	100	1094.97
10	Energy Education Development Program (06 Demonstration gardens for Energy Education)	500	5474.86
11	Grant for RE sources other than Solar	100	1094.97
12	Deen Dayal Upadhyay Rural Lighting Program	3	32.85
13	Soubagya Yojana - Solar Electrification of Rural Areas	3	32.85
15	Solar driven Tri Cycles for livelihood enhancement of handicapped people	3	32.85
	Solar pumps for filling ponds from rivers	20	218.99
16	PM-KUSUM Scheme (NABARD)	170.4	1865.83
Total		66799.4	731434.7

Name of the Department - Industries			
			Amount in Lakhs
Sl No	Name of the Program/ Activity	Proposed Budget in 2020 -2021	Projected Budget for 2020-21 to 2029-2030
1	Small industries prize scheme	10	109.50
2	Debt Grant for Industries	3000	32849.16
3	Debt Grant for Industries	700	7664.80
4	Debt Grant for Industries	200	2189.94
5	Start up Chhattisgarh	500	5474.86
6	District Industries Centre	2790.75	30557.93
7	Rural Industries Development Scheme	10	109.50
8	Directorate Industries	1572.3	17216.25
9	Establishment of Investment promotion board	25	273.74
10	Chhattisgarh entrepreneurship development Institute	300	3284.92
11	ISO 9000 promotion expenditure	1	10.95
12	Technical Patent Grant	0.1	1.09
13	Establishment of Industry promotion fund	0.1	1.09
14	Group based Industry development fund	0.1	1.09
15	Partial capital development scheme	300	3284.92
16	Partial capital development scheme	60	656.98
17	Partial capital development scheme	130	1423.46
18	Industrial scheme survey program	1	10.95
19	Environment project management grant	0.1	1.09
20	Grant for technology purchase	0.1	1.09
21	Specially abled employment grant	0.1	1.09
22	Chief Minister youth self employment scheme	150	1642.46
23	Chief Minister youth self employment scheme	115	1259.22
24	Chief Minister youth self employment scheme	36	394.19
25	Industrial unit capital grant	6400	70078.21
26	Industrial unit capital grant	2600	28469.27
27	Industrial unit capital grant	1000	10949.72
28	Establishment of New Industrial areas	2100	22994.41
29	Establishment of New Industrial areas	2060	22556.43
30	Establishment of New Industrial areas	1560	17081.56
31	Establishment of New Industrial areas	500	5474.86
32	Private Industrial area establishment	1	10.95
33	Food processing support grant	1400	15329.61
34	India Agro food processing grant	400	4379.89
35	Grant for reimbursement for market (mandi) fee	70	766.48
36	International Trade fair grant	150	1642.46
37	Competitions, workshops and exhibitions	2000	21899.44
38	Export promotion scheme	0.1	1.09
39	Establishment of food park	5000	54748.60
40	Industrial parks grant	500	5474.86
41	Chhattisgarh Trade center establishment	0.1	1.09

42	District Industries Centre office establishment	200	2189.94
43	Renovation of Industries center	500	5474.86
44	Industrial sub structure lifting work	3986	43645.59
45	Vehicle sale and re-purchase	14	153.30
46	Acquired land compensation	910	9964.25
47	Survey and demarcation expense	5	54.75
	Total	41257.85	451761.95

Name of the Department - Mining		
Transfer of royalty of minor mineral to Gram Panchayat and local bodies		
Amount in Lakhs		
Year	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
2019-20	2919.03	31962. 56

Note: There is no budgetary provision available for Eco restoration to mineral resources department. As per mines act and EC mandate it is sole responsibility of lease holders.

Name of the Department - Health			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
1	National Program on Climate Change and Human Health	1262.54	13824.46
2	Biomedical Waste Management	2200	24089.39
3	Community Interventions	31873.58	349006.81
4	Review, Research, Surveillance and Survey	221.33	2423.50
5	IT Initiatives for strengthening service delivery	1345.07	14728.14
6	National Urban health mission	7810.42	85521.92
7	Integrated Disease Surveillance Programme (IDSP)	175.97	1926.82
8	National Vector Born Disease Control Program (NVBDCP)	1597.63	17493.60
9	Revised National TB Control Programme	7497.28	82093.12
10	National Mental Health Programme	569.3	6233.68
11	National Tobacco Control Program (NTCP)	429.25	4700.17
12	National Programme for Prevention and Control of Cancer, Diabetes, Cardio vascular Disease & Stroke	2214.11	24243.89
	Total	57,196.48	89,541.01

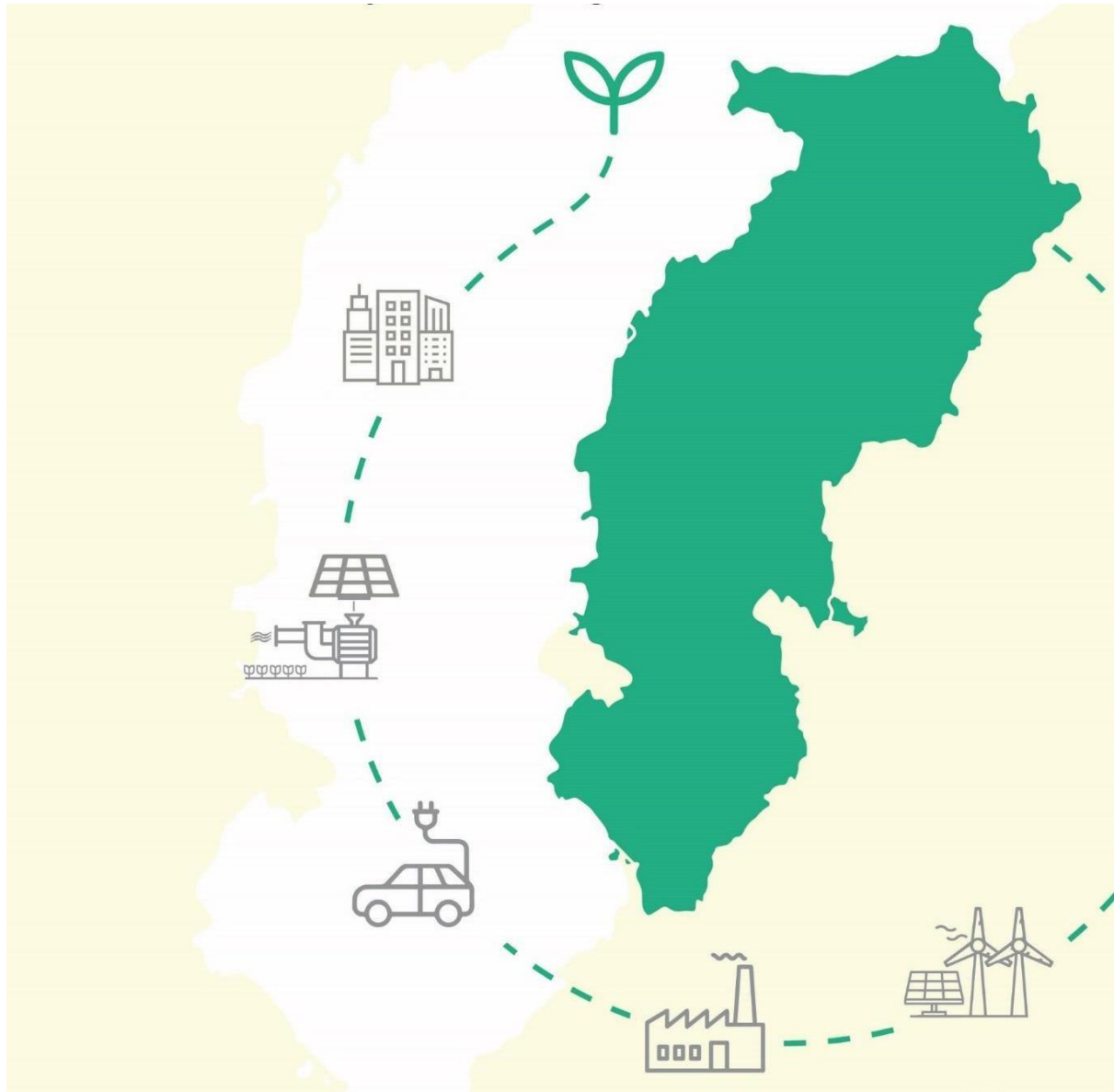
Name of the Department - Rural Development			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020 -2021	Projected Budget for 2020-21 to 2029-2030
1	Swatchh Bharat Abhiyan	45000.00	492737.44
2	Pradhan manthri Awas Yojana Rural	160000.00	1751955.36
3	Abhisarit Aam Admi bima Yojana	100.00	1094.97
4	Abhisarit Aam Admi Jeevan Yojana/ Pradhanmantri Suraksha Yojana	100.00	1094.97
5	National Rural Livelihood Mission	40000.00	437988.84
6	Suraji Gaon Yojana	0.30	3.28
7	MGNREGA	160000.85	1751964.67
8	Pradhan Mantri Gram Sadak Yojana	60000.00	656983.26
9	Gauthano ka Sanchalan	16200.00	177385.48
10	Gauthan Establishment in Rural Area	200.00	2189.94
11	Mukhyamantri Gram Sadak Evam Vikas Yojana	10000.00	109497.21
12	Mukhyamantri Gram Gaurav Path Yojana	5000.00	54748.60
13	District Panchayat Development Funds	2200.00	24089.39
14	Block Panchayat Development Funds	2920.00	31973.19
15	Mukhyamantri Panchayat Sashaktikaran Yojana	1500.00	16424.58
16	Mukhyamantri Samagra Gramin Vikas Yojana	25000.00	273743.02
17	Village Electrification	1000.00	10949.72
Total		529221.1	5794823.9

Name of the Department - Disaster Management			
Amount in Lakhs			
SI No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
1	Drought -101-donation	588.14	6439.97
2	Drought-medicines-health-expenditure	3273.50	35843.91
3	Flood-relief-	1138.34	12464.51
4	2245-02-flood-relief-materials	700.00	7664.80
5	2245-02-flood-roads-bridge-damage-repair	95.89	1049.97
6	02-flood-water drainage system damage repair	10.72	117.38
7	Flood impact relief to suffering families	1601.06	17531.16
8	Flood safety measures support	586.69	6424.09
9	Flood safety measures materials	1000.00	10949.72
10	Flood relief other grants	700.00	7664.80
11	Flood damage home repair grant	2886.66	31608.12

12	Support Farmer grant	695.61	7616.74
13	Capacity building support under state disaster management	0.83	9.09
14	Support to farmers for buying cattle	682.93	7477.89
15	Expenditure allocated for planning for different schemes	1.90	20.80
16	Expenditure allocated for planning for different schemes- additional costs	0.16	1.75
17	Training centre for disaster preparedness	4.40	48.18
18	Office expenditure or disaster management planning	5.73	62.74
19	Relief for disasters including lighting, LPG explosion, mine caving etc.	5969.28	65361.95
20	Fire accident victims support	1790.37	19604.05
21	Relief for hail impact on agriculture etc.	33694.82	368948.88
22	Individual support after disaster	4175.58	45721.44
23	Furniture and office equipment expenditure	533.21	5838.50
24	Capacity Building- Information technology related expenditure	5.27	57.71
25	Capacity Building- Information technology related expenditure	15.96	174.76
26	Payment for commercial services related to capacitybuilding on disaster preparedness	7487	81980.56
27	Materials for disaster relief additional	1500	16424.58
28	Machinery and equipment related to disaster preparedness	2510.29	27486.98
29	Prevention from cold wave and other similar disasters	76.3	835.46
Total		71,730.64	7,85,430.50

Name of the Department - Women and Child Development			
Amount in Lakhs			
Sl No	Name of the Program/ Activity	Proposed Budget in 2020-2021	Projected Budget for 2020-21 to 2029-2030
1	Direction and Administration	576.13	6308.46
2	Children welfare program	52181	571367.39
3	Special Nutrition Program	31282.29	342532.35
4	Women welfare program	2308.05	25272.50
5	Support to Independent organisations (NGOs)	25.76	282.06
Total		86,373.23	9,45,762.77

Chhattisgarh State Action Plan on Climate Change 2022



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