Madhya Pradesh
State Action Plan on Climate Change

May 2022

State Knowledge Management Centre on Climate Change (SKMCCC)

Environmental Planning & Coordination Organisation (EPCO)

Department of Environment, Government of Madhya Pradesh

Message from Hon'ble Chief Minister, Madhya Pradesh

Message from Hon'ble Minister of Environment, Madhya Pradesh

Message from Chief Secretary, GoMP

(Iqbal Singh Bains)
Chief Secretary, Govt. of MP

Message from Principal Secretary, GoMP, Department of Environment

Preface from Executive Director, EPCO

Acknowledgement

Section- I

State Profile

1. SAPCC Context

1.1 Overview

Climate change poses one of the most serious threats to mankind. It has far-reaching implications for environment, agriculture, water availability, natural resources, ecosystem, biodiversity, economy and social well-being. As per the latest assessment report (AR6) released by Intergovernmental Panel on Climate Change (IPCC), the human influence on the climate system is significant and it concludes that the recent anthropogenic emissions of greenhouse gases (GHG) are the highest in history. It also specifically highlights that human induced global warming to 1.5°C can be limited; however, it would require transformative change.

Recognizing the severity of climate change challenge, the Prime Minister's Council on Climate Change launched India's voluntary National Action Plan on Climate Change (NAPCC) in June 2008 to address climate-related issues through eight national missions.

In order to ensure that Climate actions at the States are also aligned to India's NAPCC, the Ministry of Environment, Forests and Climate Change advised all states to prepare State Climate Change Action Plans. The State Action Plans on Climate Change (SAPCC) were expected to ensure that national objectives are aligned with regional development priorities and the local environmental context. The Government of Madhya Pradesh recognized the need for SAPCC and developed the first SAPCC in as early as 2013-14. Government of Madhya Pradesh was among the first four states in the country to get the approval from National Steering Committee on Climate Change in 2012-13. However, since then, there has been considerable change has occurred in legal policy and technology sphere. In view of this, the Govt. of India, MoEFCC has advised the states to revise their SAPCC and align with NDC and Paris Agreement.

The United Nations Framework acknowledged the requirement for action on climate change and adopted the Paris Agreement on 12 Dec 2015. The agreement came into force on 04 Nov 2016. India ratified the Paris Agreement on 02 Oct 2016. India's NDC can be summarised as below:-

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
4. To achieve about 40 percent 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 including from Green Climate Fund (GCF).
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.
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.

[1]Available at https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf

7. To mobilize domestic and 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.
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.

1.2 Madhya Pradesh SAPCC

The State Action Plan on Climate Change (SAPCC) for Madhya Pradesh was first formulated in the year 2012-13. The revision of the SAPCC has been carried out in line with the Nationally Determined Contributions (NDCs). Post India's submission of its NDC, the Government of India recognized that State Action Plans also need to be revised and to be aligned to its NDC submitted to the UNFCCC. MoEFCC, therefore, requested all states to revise their respective State Climate Action Plans on Climate Change accordingly. The strategies outlined in the sectors of the plan are aligned with the National Missions, Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs).

1.3 Process

In view of the advisory of MoEFCC to all the states to revisit state climate strategies and actions contributing to the NDCs which are aligned with SDGs, systematic process has been initiated. The version 2.0 of Madhya Pradesh SAPCC is aligned with the targets of NDCs. MoEFCC has suggested a common framework and has advised the states to follow the process and sequencing of contents.

A bottom-up approach followed to develop the SAPCC wherein consultation workshops were organized. A thorough review of sectoral programmes/policies was done, in order to keep the recommendations of SAPCC in line with the national objectives as well as statepriorities.

The process of revision of MP SAPCC kick started with inception meeting with representatives of technical knowledge provider organisations such as UNDP, WRI and GHG Platform India. In Feb 2019, an inception workshop with key stakeholders and line departments was organised for receiving suggestions from representatives of concerning departments on respective sectors. They were also requested to provide necessary information and data for SAPCC revision. On the basis of the inputs received from inception workshop, the sectoral chapters of the revised MP SAPCC have been drafted. Simultaneous to this process, a broad based technical core group of subject experts was constituted as advised in the guidelines of MoEFCC. The core member represents academia, practitioners, policy makers and civil society. Copy of the order is enclosed at the annexure-1.

The draft chapters were presented in the 1st meeting of Core Group constituted for reviewing the content as well as the process of the revised version of MP SAPCC in June 2019. The inputs and suggestions received from the core group members were then incorporated in the draft chapters and again presented in the 2nd meeting of core group in Nov 2019.

These drafts were further refined by the insights received in the core group. These chapters were then shared with the concerned departments for corrections & endorsement. Departmental consultations and peer to peer consultations with departments were also organised to receive the comments & suggestions on the respective sectoral chapters.

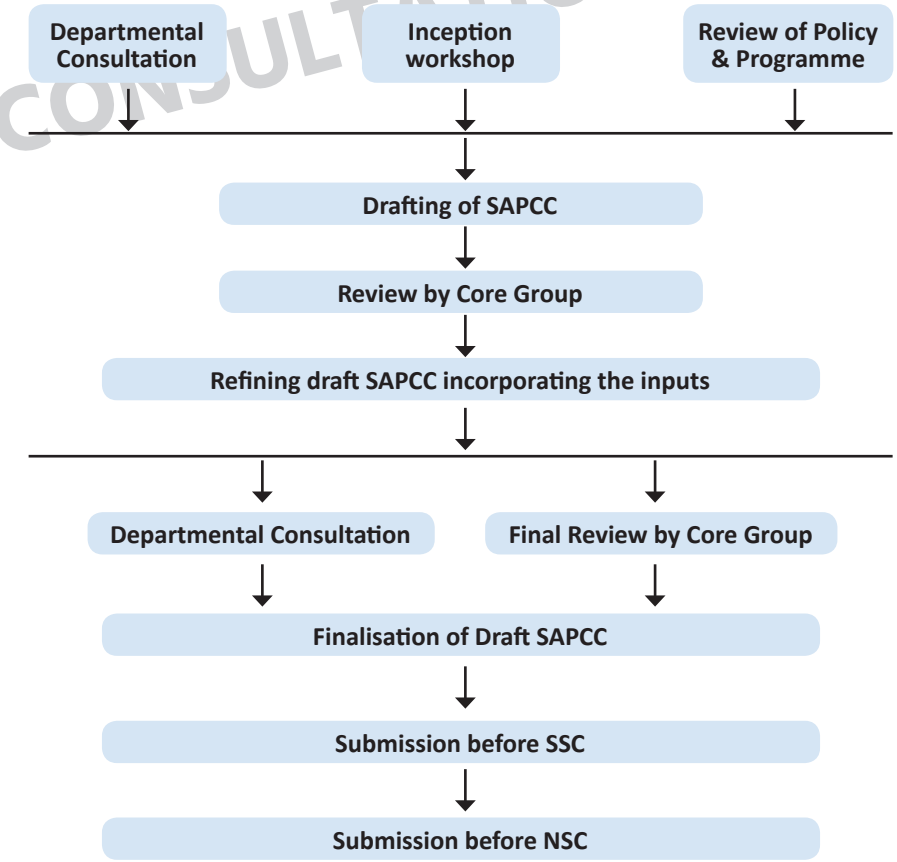
A detail and through study & analysis of prime policy instruments of the state was also carried out. These include state vision of SDG 2030, the State Biodiversity Strategy and Action Plan, the draft Environment Policy, the State Action Plan on Climate Change & Human Health, the MP Green India Mission plan, the State Water Action plan. It is important to mention that State Knowledge Management Centre on Climate Change has been proactively involved in the formative process of all these important policy documents and has successfully integrated the climate change concerns in all these policy instruments.

The process and content of the draft version of the revised MP SAPCC has been constantly reviewed at the highest level at the meetings of State Steering Committee headed by Chief Secretary (SSC). The SSC has reviewed the progress of the revision of MP SAPCC twice in the FY 2020-21. Project Monitoring Committee chaired by Additional Chief Secretary, GoMP, Environment Department and Project Management Committee chaired by Executive Director EPCO keeps reviewing the progress of activities related to climate change and revision of MP SAPCC.

Having received the instructions from the higher authorities and inputs/comments from concerned departments, the revised version of draft MP SAPCC has been refined accordingly and the first draft has since been submitted to MoEFCC in July 2020.

The final draft would be placed before the SSC for approval and then submitted to NSC for approval and endorsement. Following graphic depicts the process flow of SAPCC revision:-

Figure 1 Process of MPSAPCC II Preparation

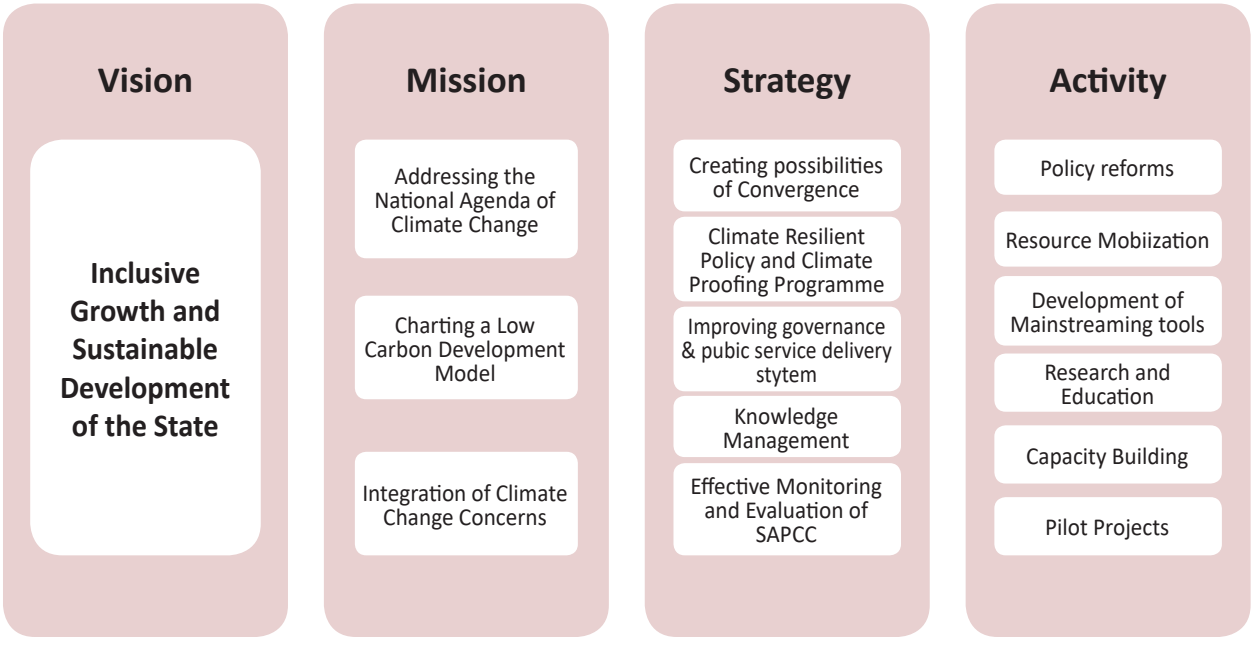


1.4 The Guiding Principle of MP SAPCC

The State Action Plan on Climate Change (SAPCC), developed by the Government of Madhya Pradesh (GoMP), aims to address the regional concerns and to outline strategies required to develop a climate resilient state. The strategies and recommendations of the SAPCC will, in due course, strengthen the developmental planning process of the state with policy level interventions favouring low carbon growth. Since Vulnerability and Adaptation (V&A) have been underlined as the key concerns for Madhya Pradesh, the focus of SAPCC is on devising appropriate adaptation strategies based on vulnerability assessment and subsequently integrating and mainstreaming into respective policies and programmes. The guiding principles for preparing the revised SAPCC are as follows:-

1 Framework of MoEFCC
2 Aligning with NDC, SDGs, SBSAP
3 Climate Compatible Development
4 Adaptation continues to be the key concern
5 Ecosystem based Climate Actions
6 Tapping the Mitigation Opportunities
7 Mainstreaming Climate Change
8 Gender and Climate Change issues prominent
9 Climate Knowledge would lead to Climate Actions
10 Accessing Climate Finance
11 Participative and Consultative Process
12 Strategic Research, Education, Training and Public Awareness

The vision, mission, strategy and activity are summarised in the diagram below.



2. State Profile

2.1 Overview

Madhya Pradesh is India's second largest state by area and sixth largest state by population. The state has a complex social structure, a predominantly agrarian economy, undulating terrain, scattered settlements over a vast area, and a large population below poverty line. The state has fifty districts grouped into ten administrative divisions.

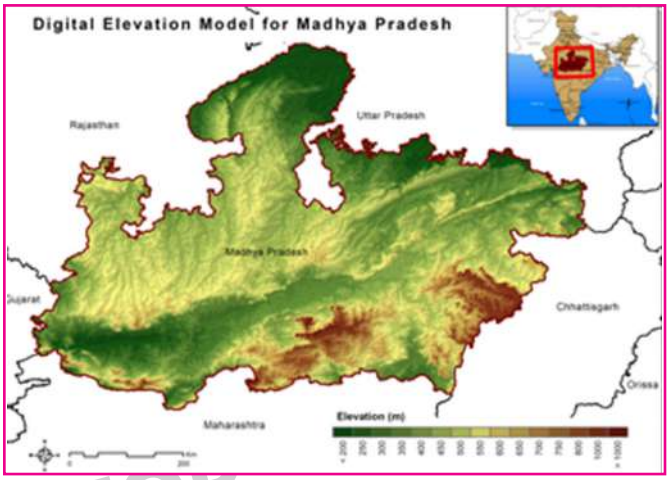


Fig. Physiographic Map of MP

Madhya Pradesh has an area of 3,08,252 sq.kms constituting 9.38% of the land area of the country. It lies between lat. 21°04'N and long. 74°02' and 82°49' E. Being centrally located, it is often referred to as the "Heart of India". The state is bordered on the west by Gujarat, northwest by Rajasthan, north - east by Uttar Pradesh, east by Chhattisgarh, and south by Maharashtra. It has diverse physiography with large plateaus, numerous mountain ranges, meandering rivers and miles of forests supporting rich biodiversity.

2.2 Physiography

The country has been divided into three major physiographic regions viz., the Mountain Region of the Himalayas, the Great Indo-Gangetic and Brahmaputra Plains and the Traingular Plateau of the Peninsula. Madhya Pradesh falls in the last region i.e. the Traingular Plateau of the Peninsula which is subdivided into following land form units.

- **Northern Plains:** Parts of central highlands covering Gird region fall in this land form unit
- **Central Highlands:** Malwa plateau, parts of Bundelkhand upland, Vindhyan scraplands, Madhya Bharat plateau, and parts of Aravalli range are included in this land form unit.
- **Eastern Plateau:** This unit includes parts of Baghelkhand plateau (MP & Chhattisgarh), parts of Chhota Nagpur Plateau, Mahanadi Basin and Dandakaranya plateau (Chhattisgarh)
- **Deccan Plateau:** Major parts of Nimar Valley, Satpura plateau and adjoining areas fall in this land form unit.

2.3 Climate

Madhya Pradesh falls under sub-tropical Climatic Region with three distinct seasons viz., winter season (Dec-Feb), summer season (Mar – May) and rainy season (June – Oct).

Minimum temperature may go up to 1°C in winters and maximum can go up to 48°C in summers. Average annual rainfall for the state is 1160 mm with the heaviest rains in the south-eastern parts which decreases towards north-west.

Balaghat receives the maximum rains with an average of 1600 mm. Most of the rainfall is received from the south-west monsoon during June to September [MP Resource Atlas 2007, MPCST]

2.4 Land use

The total geographical area of Madhya Pradesh is 30, 825,000 hectares. The land use pattern for the same is given below:-

Table 1 Land Use Pattern Madhya Pradesh

Sr.	Details	Area (Lakh Ha)
1	Forest	86.94
2	Gross cropped area	261.15
3	Area under Misc. Tree Crops	0.21
4	Permanent Pastures	13.16
5	Current fallow	4.93
6	Other fallow	4.66
7	Cultivable Waste	9.33
8	Land put to non-agricultural use	22.69
9	Barren and uncultivable land	13.49

Source: Land record Madhya Pradesh 2018-19 http://www.landrecords.mp.gov.in/

Madhya Pradesh has a semi-arid upstream topography and rainfall is the major source of water. The state receives maximum rainfall during monsoon period. The ground storage capacity is low because of its physiographic characteristics.

2.5 Forest

Madhya Pradesh has a vast expanse under forest cover which is spread across an area of 94.69 lakh Ha (31 % of total geographical area of the State). This is equal to 12.44% of the forest area of India. The state's forest area has been classified into Reserved Forest (RF), Protected Forest (PF) and Unclassified Forest *[MP Resource Atlas 2007, MPCST].* These forests are house to a rich floral and faunal biodiversity and host 22,600 forest villages whose livelihoods depend substantially on the forest produce. Madhya Pradesh has been a pioneer both in in-situ and ex-situ biodiversity conservation. The state holds 10 National Parks and 25 Sanctuaries. These parks and sanctuaries are spread over an area of 10,862 sq.km constituting 11.40% of the total forest area *[MP Resource Atlas 2007, MPCST].* Two Biospheres namely, Pachmarhi and Achanakamar – Amarkantak are also located in MP.

2.6 Biodiversity

Madhya Pradesh has a wide variety of wild animals inhabiting the vast expanse of its forest areas. It has 10 national parks and 25 sanctuaries. It has nearly 20% of the tiger population of the country. Herbivors like

the chital, sambar, black buck, chinkara, nilgai, wild boars etc., roam about freely in the forests of the state. Important recognized breeds of cattle considered as native breeds of Madhya Pradesh are 'Malwi' and 'Nimari'. 'Gaolao' breed is found all over 'Vidarbh' region of Maharashtra and adjoining areas of Madhya Pradesh (Chhindwara district) and 'Kankattha' breed of cattle in Panna district. Similarly, 'Bhadawari' breed of Buffalo is found in abundance at Bhind and Gwalior districts. 'Jaloni' breed of sheep is found in Tikamgarh and Shivpuri which forms the border with Jhansi and Jalaun districts of Uttar Pradesh. 'Jamnapari' breed of goat is found in various villages of Bhind district situated near Chambal River. 'Malwi camel' is also found in Mandsaur district of Madhya Pradesh. In the poultry sector 'Kadaknath' is the native breed of Madhya Pradesh found at Jhabua and Dhar districts of Madhya Pradesh.

2.7 Agriculture

Agriculture, the prime livelihood source of majority of the State's rural population, is highly influenced by soils and climatic conditions. Net sown area of Madhya Pradesh is 152.05 lakh Ha which is about 49% (above than country's net sown area percentage) of the total geographical area of the State *[MP Resource Atlas 2007, MPCST].*

In order to delineating potential areas for agriculture, India is divided into fifteen agroclimatic zones and twenty agroecological regions whereas Madhya Pradesh is further divided into eleven agroclimatic zones and five agroecological regions *[Soil Resources and Agroclimatic Zones of Madhya Pradesh by V.S.Tomar, G.P.Gupta and G.S.Kaushal].*

Per capita gross cropped area in the state is 0.33 Ha which is double than all India average of 0.18 Ha and the cropping intensity is 156% which is slightly higher than all India average of 126%. The state ranks 1st in pulse, soybean and gram production and 2nd in oilseed production. For cotton and sugarcane the state is positioned at 7th and 11th rank respectively *[Economic Survey, 2020-21].*

2.8 Soils

The state is characterised by a great diversity of parent rocks which have weathered under different climatic conditions, vegetative covers and topographic situations to form soils with different characteristics in different zones. The principal underlying rocks are Deccan Traps, Vindhyan Sandstones, Archaean Gneisses, Gondwanas and Lametas.

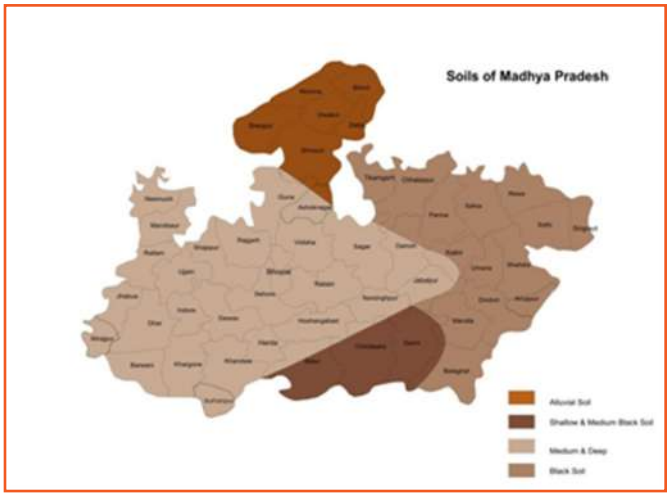


Fig.0.2Soil Map of Madhya Pradesh

According to *Raychaudhuri et al (1961) and Sinha and Gupta (1985),* the state comprises of a variety of soils ranging from rich clayey to gravelly. Major groups of soils are Alluvial, Medium & deep black, Shallow & medium black, Mixed red & black, Red & lateritic and Red & yellow *[Soil Resources and Agroclimatic Zones of Madhya Pradesh by V.S.Tomar, G.P.Gupta and G.S.Kaushal].*

2.9 Water Resources

Narmda River is the life line of Madhya Pradesh. Nearly 60% of the surface water can be retained for different uses. Thus there is a scope for almost more than double the irrigation capacity by building small dams in different streams. It is also seen that, the eastern and south-eastern part of Madhya Pradesh has more runoff because of relatively higher rainfall, high gradient and occurrence of crystalline rocks in the major portion of the area. The central part receives lesser rains and therefore proportionate decrease in runoff water and cropping patterns.

Western part of Madhya Pradesh receives much less rain and hence the relative runoff is less. Most of the streams are almost dry for 4 to 6 months in the year (Jan to June). It is essential that this runoff water should be harnessed by putting a series of small and medium dams on small and big streams. This will not only provide sufficient water on the surface for different uses but also the percolation into the ground. It will increase the level of the ground water to a great extent.

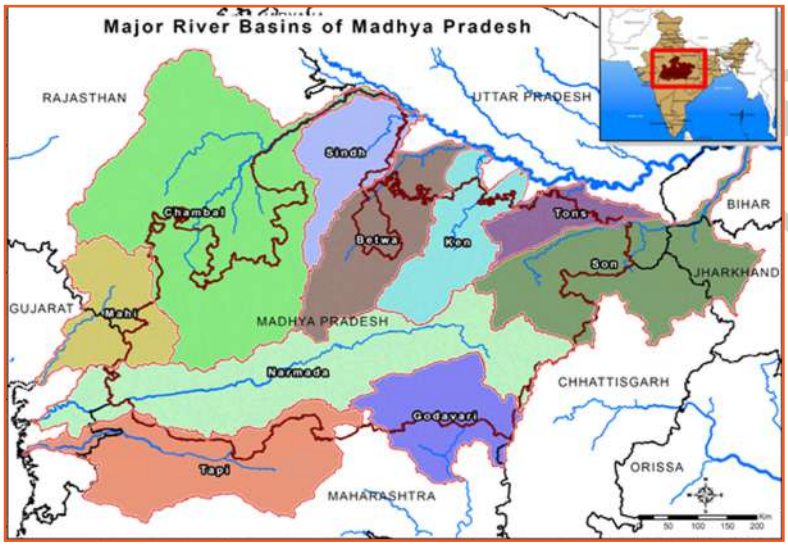


Fig.0.3Major Basins of Madhya Pradesh

The total quantity of surface and ground water is distributed in different catchment areas of Madhya Pradesh. Madhya Pradesh is endowed with seven river basins draining a watershed area of about 308 lakh Ha [MP Resource Atlas 2007, MPCST].

Major rivers of the state include Narmada, Chambal, Betwa, Son, Ken, Tons, Sind, Wainganga, Mahi and Tapi. Total annual replenishable groundwater resource and the total annual groundwater availability of the state is 37.19 and 35.53 BCM respectively. Annual recharge from monsoon in the state is 30.64 BCM where as recharge from other sources are estimated at 6.55 BCM.

2.10 Mineral Resources

The state ranks first in production of Diamond, Diaspore, Pyrophyllite and Copper. Except Malwa plateau and some of the central districts, entire state is rich in mineral resources. Coal, bauxite, Limestone, Asbestos, Calcite, Manganese, Dolomite etc are some of the mineral resources of the state.

2.11 Socio-Economic Profile

Some of the indicators that determine the adaptive capacity of population include its economic strength, access to infrastructure, access to health facilities, land use pattern, literacy rates, income generating sectors and their strengths, policies and governance structures. A brief description of all these indicators, as they exist now, is summarised below:

Demography: Total population of Madhya Pradesh is 7,25,97,565 *[Census 2011].* With respect to 2001 there has been an increase of 24.34% with a population density of 196 people per square kilometer. About 72% of state's population resides in villages whose main occupation is agriculture. Sex ratio of the state stands at 930 whereas the literacy rate is 70.6%.

Madhya Pradesh has a substantial tribal population. The lifestyle, culture and customs of this community are more akin to nature. Gond is the best known tribe and forms the largest group in Madhya Pradesh. Agaria, Pradan, Ojhan, Solahas are the descendent tribal groups originating from Gonds, with two sub castes - Rajgond and Datoliya. Bhil, the second largest tribe is largely concentrated in the area around Jhabua, Dhar and Ratlam.

Economic Profile : The State is one of the fastest growing states in the country. The gross state domestic rate of Madhya Pradesh for 2018-19 (at current prices) is estimated to be in Rs 8,26,106 crore, 19.7% higher than the estimate for 2017-18. In 2016-17, the Gross State Domestic Product (GSDP) of the State was Rs 6,48,849 crore which increased to Rs 7,28,242 crores during the FY 2017-18. The GSDP of the State at constant price during the base year 2011-12 was Rs 3,15,562 crores which rose to Rs 5,35,362 during 2018-19. The GSDP of the State increased at a compound annual growth rate (CAGR) of 14.39% from financial year 2012 to financial year 2018. According to economic survey of the State, the per capita income rose to Rs 90,998 in 2018-19 from Rs 82,941 in 2017-18 marking an increase of 9.71% in 2018-19 compared to the previous year.

During 2018-19, the share of primary sector in state's GSVA at current prices is 44.26%, followed by tertiary sector with a share of 35.94% and secondary sector forming 19.80%. Agriculture contributes maximum to the state's GDP followed by Industries and service sector. Agriculture sector provides maximum employment followed by Services sector followed by industries.

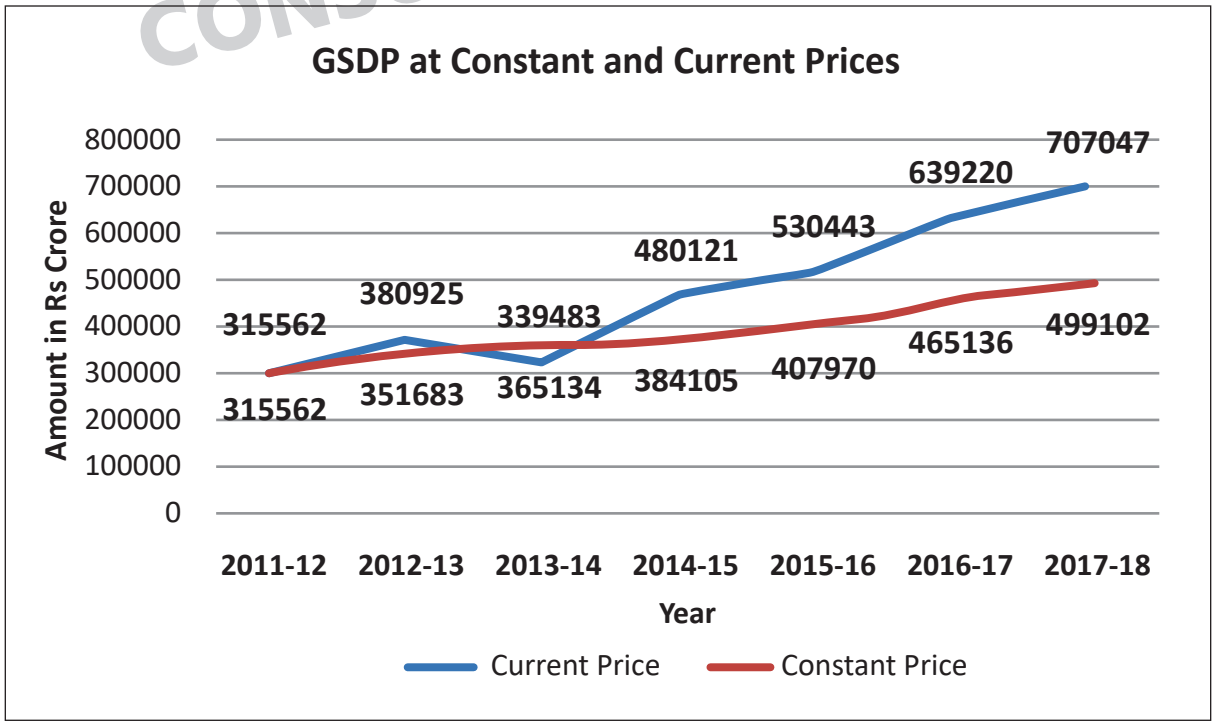


Figure : Madhya Pradesh GSDP at Constant and Current Prices in Rs Crores
Source: Economic Survey of Madhya Pradesh 2017-18

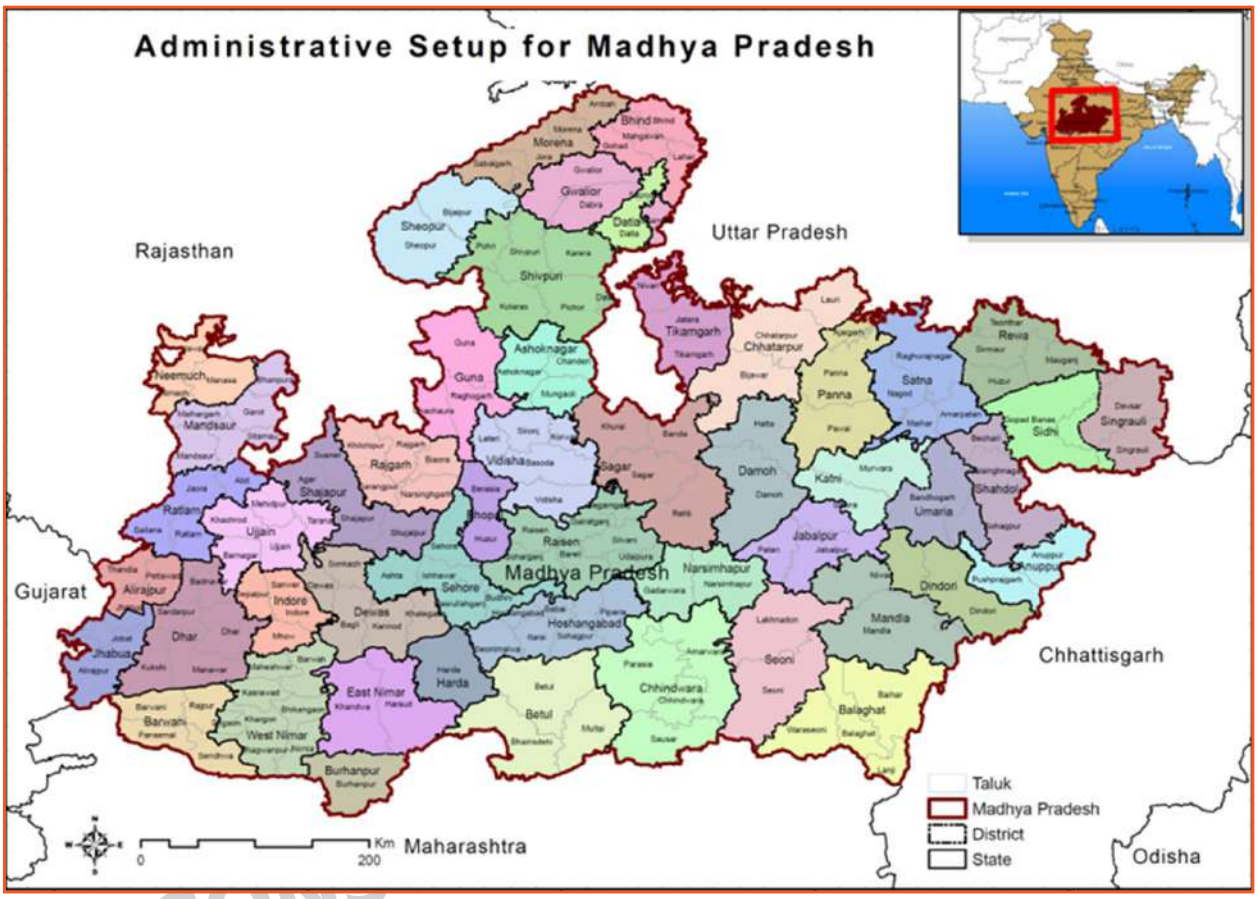


Fig. : Administrative Map of MP

Governance : The state of MP has vibrant three-tier Panchayati Raj system and Urban Local Bodies as the institutions of local self-governance. The state has 10 Commissioner Divisions, 52 Districts, 424 Tehsil and 313 Community Development Blocks including 89 Tribal Development Blocks.

Under three-tier Panchayati Raj, the state has at present 52 Zila Panchayat, 313 Janpad Panchayat, 23,922 Village Panchayat, 16 Municipal Coorporation, 98 Municipalities and 294 Nagar Parishad. This has effectively improved delivery of key services integrating the administrative, academic units and local bodies. Also a provision has been made to encourage innovations in the state, for creative ideas generated at the field level or by a department so that it could be supported under the plan on a pilot basis.

2.12 Physical infrastructure

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

Transport: Madhya Pradesh has 70,900 km of roads, of which 67,200 km are surfaced. It has 4,286 km of national highways, 8,728 km of state highways, 10,817 km of major district roads (MDRs), and 48,590 km of other district roads (ODRs)/village roads. The road network is 45 km/100 sq km in Madhya Pradesh (National average is 75 km per 100 sq km).

Power: Madhya Pradesh has total installed power generation capacity of 8,539 MW, which comprised 4,582.9 MW under state utilities, 3,525 MW under central utilities and 216.1 MW under the private sector. Coal-based thermal power and hydro power contribute around 51.4% and 38.7% to the total installed capacity, respectively. Balance generation capacity is based on nuclear and renewable energy sources. The present average energy consumption per capita in the State is 580.34 kWh.

Telecommunication: The state has a tele-density of 40.4 (telephone connections per 100 populations). The state has about 2560 telephone exchanges with 28.6 million telephone connections.

Urban infrastructure: Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), 22 projects have been sanctioned for urban centres such as Bhopal, Indore, Jabalpur and Ujjain. Projects for water supply, solid-waste management and urban transport have been identified for development under the JNNURM. 50% of the population is connected to sewage network in major cities.

Water supply: The average per capita supply of water in major cities such as Indore is around 80 litres per day. Under the JNNRUM, cities are planned to achieve per capita water supply of 135 litres per day between 2015 and 2021.

2.13 Social infrastructure

Education Sector: Madhya Pradesh had a literacy rate of 70.6 %. The state has about 159 engineering colleges, 139 management institutes and five medical colleges

Health Infrastructure: 52 district hospital (15,450 beds), 321 community health centres, 1,232 primary health centres and 10,223 sub-centres.

3. Climate Profile

3.1 Overview

Madhya Pradesh, which is a Central Indian state, has a sub-tropical climate. Like most of the north India it has a hot dry summer (April to June) followed by monsoon rains (July to September) and a cool and relatively dry winter (November to January). During the summer season, the temperature reaches more than 45°C. The average rainfall decreases from east to west. The south-eastern districts have the heaviest rainfall, some places receiving as much as 2,150 mm (84.6 in), while the western and north-western districts receive 1,000 mm (39.4 in) or less. Winters are very short. Winters start in the mid-November and lasts up to the mid-February. Winter rains also occur due to western disturbances.

3.2 Analysis of Current Climate

The high resolution (0.25^0 x 0.25^0 latitude and longitude) daily gridded rainfall data set for 438 precipitation grids provided by Indian Meteorological Department (IMD) for the Madhya Pradesh region for a period of 63 years (1951–2013) for precipitation, and 1.0^o x 1.0^o latitude and longitude daily gridded temperature datasets for 26 temperature grids, spanning over 63 years (1951-2013) for maximum and minimum temperature *(Joshi and Rajeevan 2006)* has been used to calculate the variability and trend in precipitation and temperature respectively. Annual, seasonal and monthly mean values of precipitation along with 10 precipitation extremes indices for Madhya Pradesh and its districts have been analysed for the time period 1951-2013 (63 years). Similarly annual, seasonal and monthly mean values of maximum temperature, minimum temperature along with 11 climate extremes indices for Madhya Pradesh and its districts have been analysed for the time period 1951-2013 (63 years).

Trends of annual and seasonal maximum and minimum temperature and rainfall variability is studied using the non-parametric Mann-Kendall test, while the increasing or decreasing slope of trends in the time series is determined by using Sen's method *(Sen 1968).*

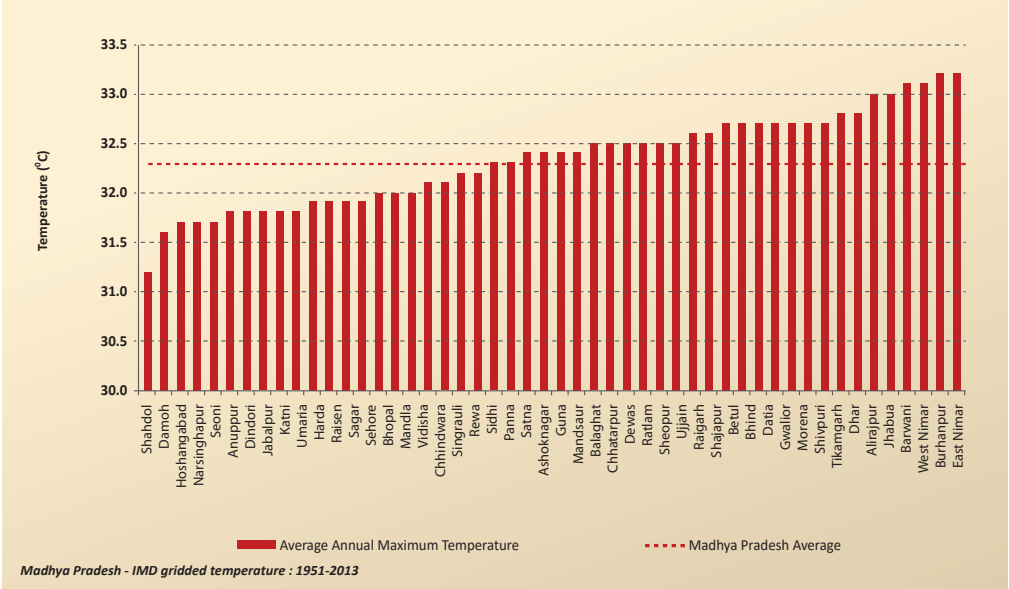
3.2.1 Observed Maximum and Minimum Temperature

Mean annual minimum temperature is 18.7°C with a range varying from 17.7°C-19.8°C Minimum temperature attains its mean highest value (23.9°C) during monsoon season (JJAS), while it attains its mean lowest value (10.7°C) in winter season. The spatial variation in seasonal temperature can be seen from Figure. It is also seen that for annual minimum temperature the highest value is attained for district Balaghat while the lowest value is attained for district Shahdol for the period 1951-2013.

In JF season Northern districts show relatively lower temperature while during JJAS season they show relatively higher temperature than the other districts of the State. The OND season temperature in South Western districts of the State namely, Alirajpur, Balaghat, Barwani, Betul, Burhanpur, Chhindwara, East Nimar, Jhabua and West Nimar is relatively higher than that of the other districts (Figure). Across the MAM season not much variability is observed amongst the districts. There is not much temporal variation observed across the districts of Madhya Pradesh in maximum temperature as is evident from the mean maximum temperature and very low CV values (1% to 2%). However, temporal variability in Northern districts of the State is little higher as compared to the Southern 8 districts (Figure).

Temporal variability in minimum temperature across the districts is marginally higher than the maximum temperature. However, temporal variation in minimum temperature across the districts of Madhya Pradesh is also low as is evident from the CV values and varies from 2% in the Southern districts to 3% in the Northern part of the State (Figure).Temporal variability in minimum temperature across the districts is marginally higher than the maximum temperature. However, temporal variation in minimum temperature across the districts of Madhya Pradesh is also low as is evident from the CV values and varies from 2% in the Southern districts to 3% in the Northern part of the State (Figure).

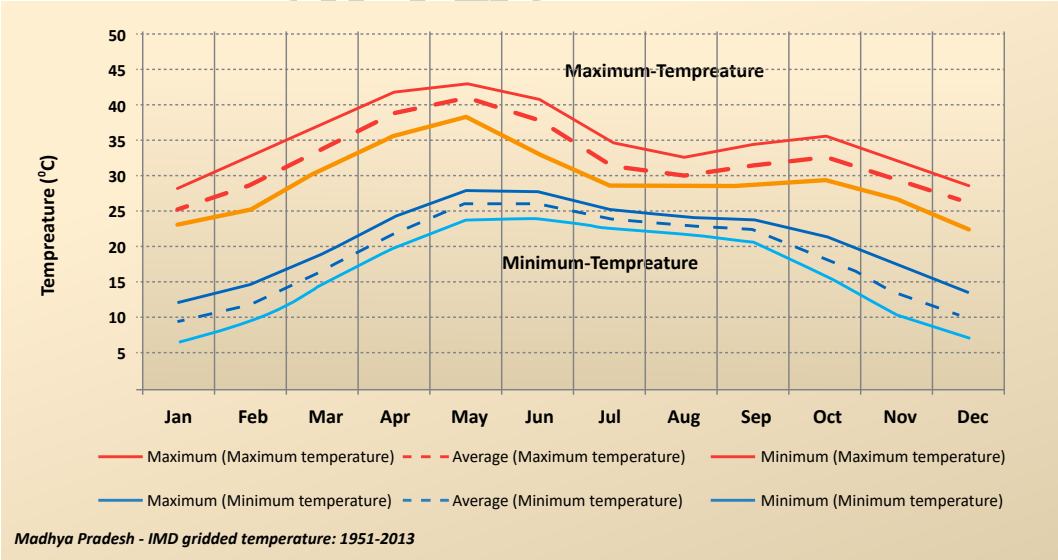
Figure : Long term annual average, max and mintemperature for districts of Madhya Pradesh (1951-2013)



1. For annual maximum temperature the highest value is attained for district East Nimar while the lowest value is attained for district Shahdol for the period 1951-2013 (63 years).
2. For annual minimum temperature the highest value is attained for district Balaghat while the lowest value is attained for district Shahdol for the period 1951-2013 (63 years).

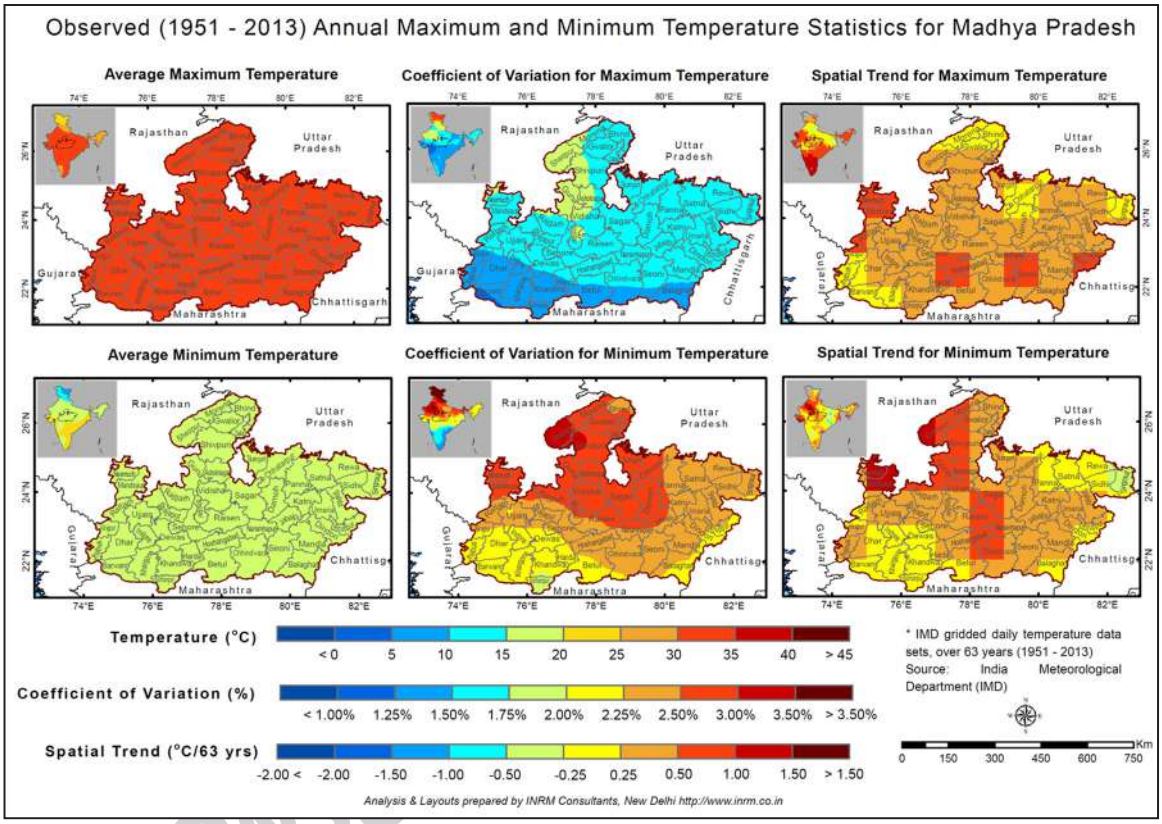
3. Annual maximum temperature shows statistically significant positive trend for 9 districts namely, Anuppur, Balaghat, Dindori, Harda, Mandsaur, Narsimhapur, Neemuch, Sehore, Seoni while annual minimum temperature shows statistically significant positive trend for 18 districts.
4. For the period 1951-2013 both annual rainfall and rainy days shows negative trend for Madhya Pradesh State. The negative trend for annual rainfall is statistically not significant while the negative trend for rainy days is statistically significant.
5. Districts namely, Ashoknagar, Bhind, Datia, Dindori, East Nimar, Gwalior, Hoshangabad and Morena show significant negative trend in annual rainfall.
6. Out of 63 years rainfall analysis, Madhya Pradesh received normal rainfall in 48 years, 8 years had excess rainfall and 7 years received deficit rainfall. Alirajpur district receives the maximum number of 20 years of excess rainfall while Jhabua district has maximum of 22 deficient years of rainfall as compared to the other districts of Madhya Pradesh. Umaria and Seoni districts have maximum of 45 years of normal rainfall.
7. The maximum (316.3mm) and minimum (93.9mm) annual one day maximum rainfall for Madhya Pradesh State has been recorded on 2007, 7th August and 1966, 30th July respectively.
8. August received the highest amount of one day maximum rainfall (41%) followed by July (32%), September (17%) and June and October 5%. Thus about 95% of 1 day maximum rainfall is received in JJAS (monsoon) months in the period of analysis (1951-2013).
9. Over the 63 years period districts namely, Mandla and Anuppur have the maximum number of total rainy days while Neemuch and Mandsaur has the least number of total rainy days.

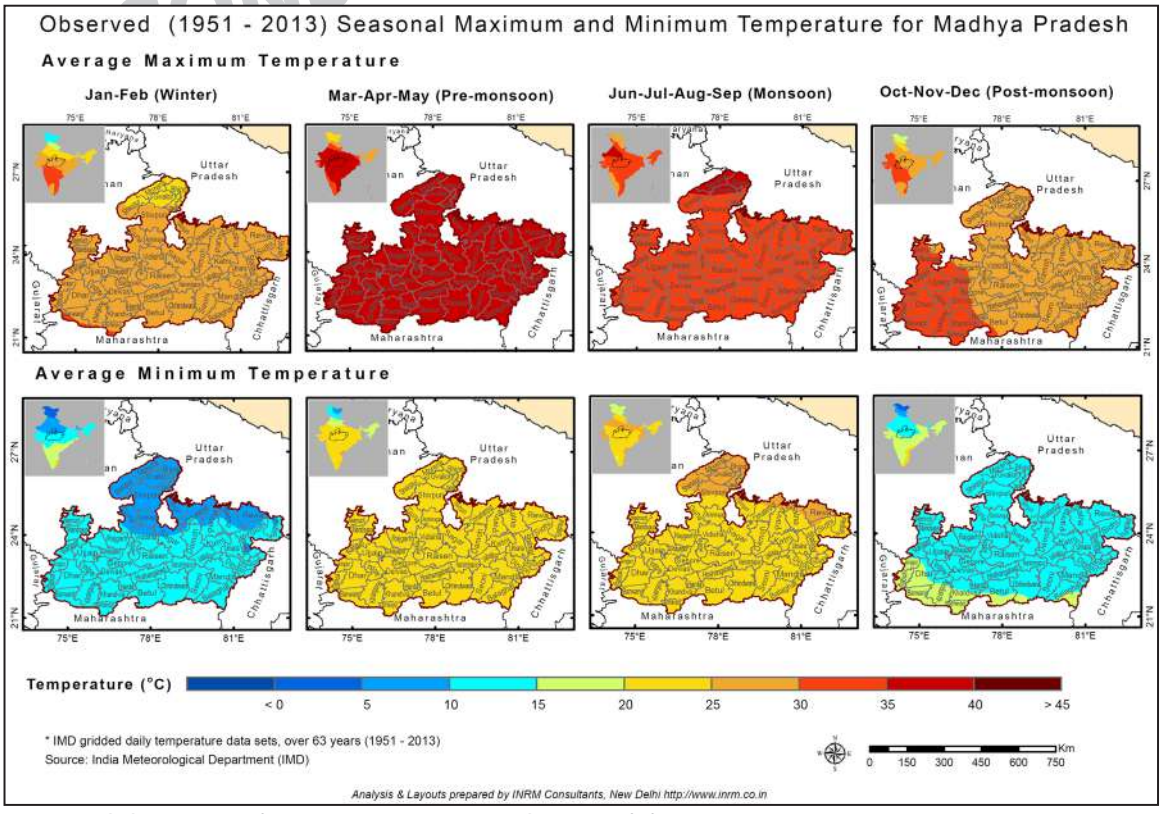
Figure : Long term monthly average, maximum and minimum temperature for Madhya Pradesh(1951-2013)



Madhya Pradesh - IMD gridded temperature: 1951-2013

Figure : Spatial variation in observed average annual and seasonal maximum and minimum temperature for Madhya Pradesh (1951-2013)





3.2.2 Observed Rainfall

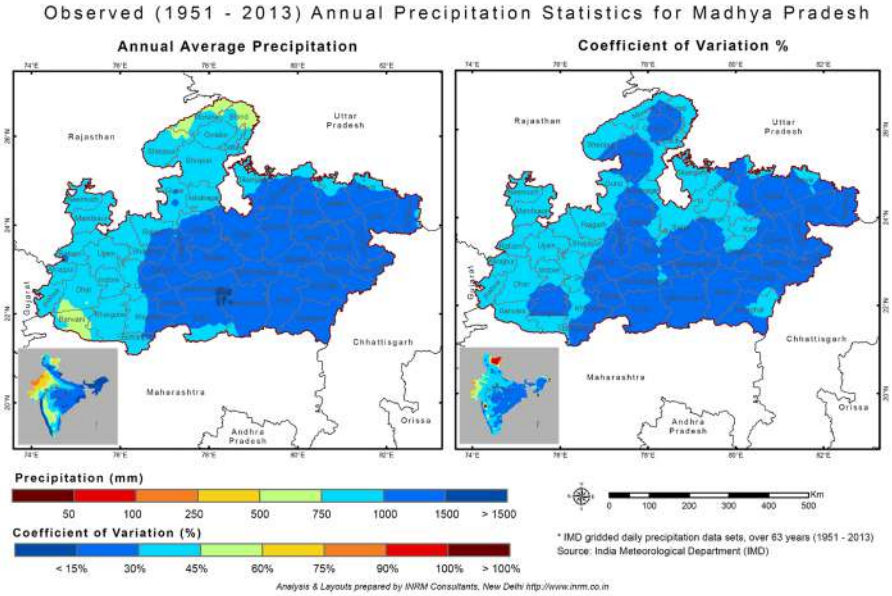
Information on spatial and temporal variations of rainfall is essential in understanding the hydrological balance on a global or regional scale. The distribution of precipitation is also important for water management in agriculture, power generation and drought monitoring. In India, rainfall received during the SW monsoon season (June-September) is crucial for its economy. Real-time monitoring of rainfall distribution on a daily basis is required to evaluate the progress and status of monsoon and to initiate necessary action to control drought/flood situations.

Average annual rainfall of Madhya Pradesh State is 1027.3 mm with a range varying from 531.9-1681.1 mm over the 63 years period (1951-2013). Amongst all districts, Hoshangabad receives the maximum average annual rainfall while Barwani receives the least. It is observed that the average rainfall decreasesfrom east to west. The south-eastern districts namely Dindori, Anuppur, Jabalpur, Balaghat, Mandla and Hoshangabad have the heaviest rainfall, while the western and northern districts receive 1,000 mm or less (Figure 7). The coefficient of variation in annual rainfall lies in the range of 0.18 to 0.34 (18% to 34%) across the districts of Madhya Pradesh thus marginal variability is observed across the districts.

From Figure 32 it can be seen that the mean south west monsoon (June, July, August and September months) rainfall contributes the maximum to annual rainfall amounting to approximately 91% for the State. Contribution of pre-monsoon (March, April and May) rainfall on average is 1.8%, contribution of post-monsoon (October, November and December) rainfall in annual rainfall is about 5% and winter rainfall (January, February) contribution is 2%. The spatial variation in seasonal rainfall can be seen from Figure 32. In JF, MAM and OND season not much variability is observed across the districts of Madhya Pradesh. In JJAS season South Eastern parts of Madhya Pradesh receive higher rainfall as compared to the other parts.

The coefficient of variation (inter annual variation in rainfall) is relatively low during JJAS season as rainfall variability is least during these months very high during the other three seasons due to higher variability in rainfall during these months. However, Composite Vulnerability of monsoon rainfall is estimated to increase from east to west (Figure 32).

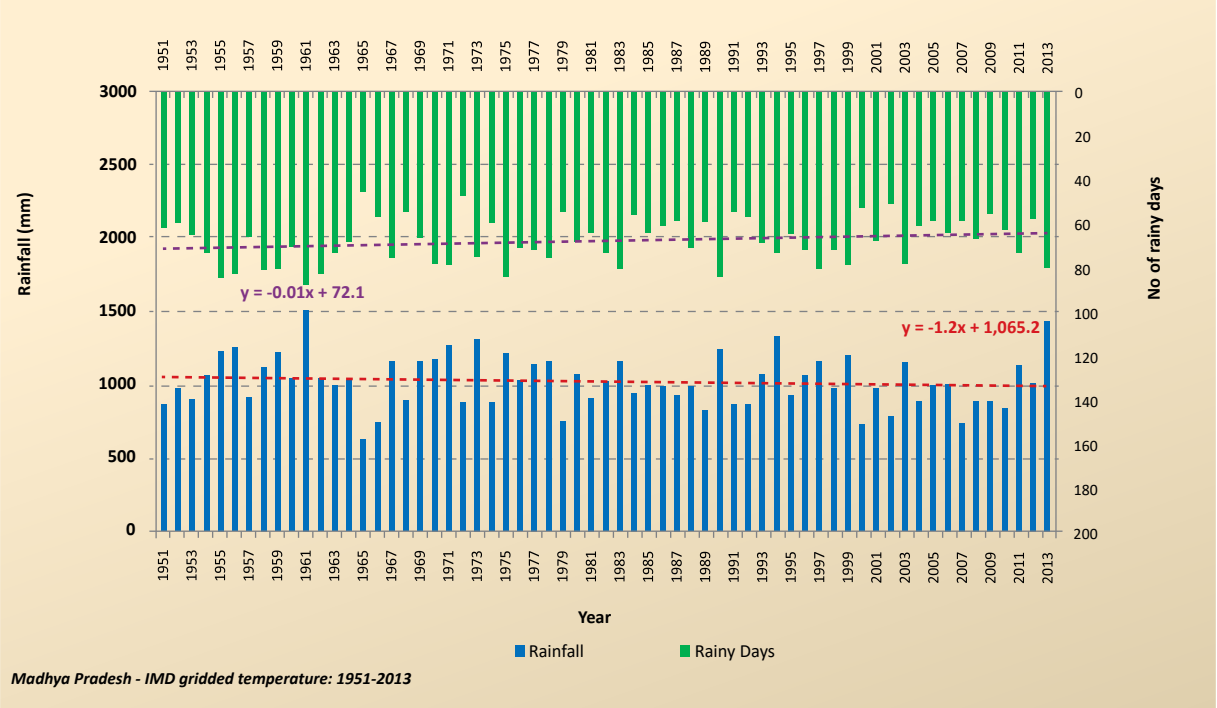
Figure 6 : Spatial variation in observed average annual and seasonal rainfall for Madhya Pradesh (1951-2013)



The rainfall received in an area is an important factor in determining the amount of water available to meet various demands, such as agricultural, industrial, domestic water supply and for hydroelectric power generation. Global climate change may influence long-term rainfall patterns impacting the availability of water, along with the danger of increasing occurrences of droughts and floods. The southwest (SW) monsoon, which brings about 91% of the total rainfall over the state, is critical for the availability of fresh water for drinking and irrigation. Changes in climate over Madhya Pradesh, particularly the SW monsoon, would have a significant impact on agricultural production, water resources management and overall economy of the State.

In the view of the above, a number of studies have attempted to investigate the trend of climatic variables at the country scale, regional scale and at the individual stations. Recently, (Rathore, Attri and Jaswal 2013) examined the trends for monthly, seasonal and annual rainfall series over the States of India and observed significant long term trends over some of the States during southwest monsoon season. This clearly indicated regional variation in the rainfall trends over India. However, there is no study that has examined trends in the rainfall or related indices at district level in Madhya Pradesh. Figure 10 gives the summary of observed annual rainfall (mm) and number of rainy days for Madhya Pradesh for the period 1951-2013 (63 years). The spatial variation in trend in annual and seasonal rainfall for the districts is shown in Figure 11. Trend tests are run at 10% level of significance to indicate the presence of statistical significant trends over the period of years. Since rainfall does not follow a linear pattern, non-parametric trend using Man-Kendall rank statistics has been determined. Trend analysis results for annual rainfall and rainy days for Madhya Pradesh and its districts (1951-2013) from Figure 33 and Figure 34 are summarized as follows:-

Figure 7 : Characteristics of observed annual rainfall and number of rainy days for Madhya Pradesh



- From Figure 33, it can be inferred that for the period 1951-2013 both annual rainfall and rainy days shows negative trend for Madhya Pradesh State. The negative trend for annual rainfall is statistically not significant while the negative trend for rainy days is statistically significant. Thus, assuming that rainfall has not declined but rainy days have declined it implies that the intensity of rainfall has increased over the period for the State.

- 10 districts of Madhya Pradesh show positive non-significant trend in rainfall while 40 districts show negative trend in rainfall. The statistical significance varies for the districts as can be seen. However, all the Districts except Sheopur show negative trend in rainy days. Districts namely, Ashoknagar, Bhind, Datia,Dindori, East Nimar, Gwalior, Hoshangabad and Morena show significant negative trend in annual rainfall as seen from.
- In pre monsoon (MAM) and monsoon (JJAS) season positive non-significant trend in rainfall is observed in certain parts of Madhya Pradesh while in winter (JF) and post monsoon (OND) season negative non-significant trend in rainfall is observed in majority of the districts.
- The IMD gridded temperature and rainfall data of Madhya Pradesh districts has been analysed for 21 climate extremes indices (11 temperature and 10 precipitation extremes indices) for periods 1951-2013 (63 years). The annual value of the climate extremes indices have been used for the trend analysis. Trend tests are run at 10% level of significance to indicate the presence of statistical significant trends over the period of years, i.e. only those districts trend will be considered as statistically significant whose confidence level is greater than or equal to 90%.

3.3 Climate Change Scenarios

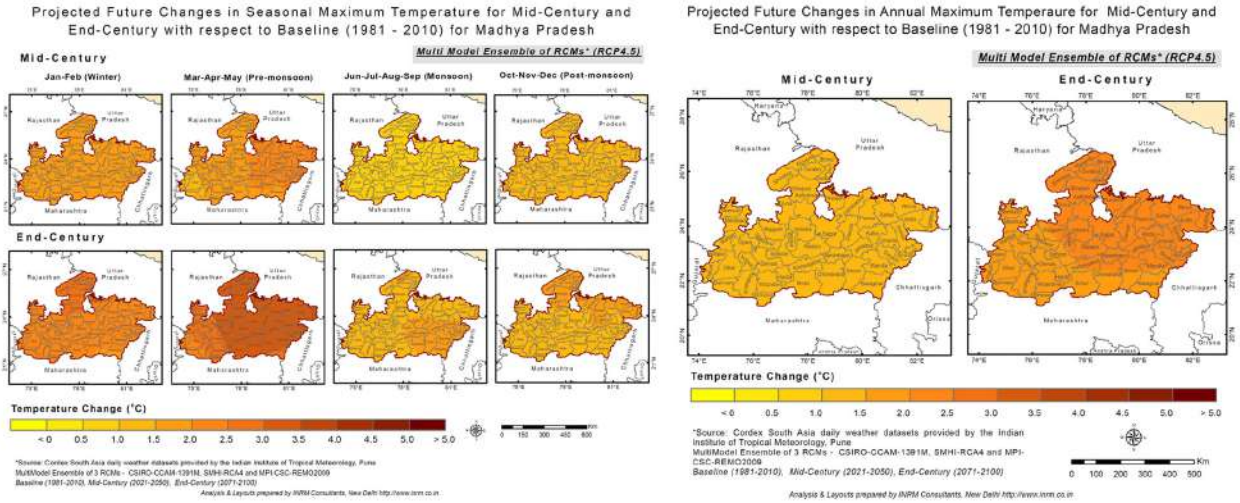
3.3.1 Projected Climate Data Analysis

The CORDEX South Asia modelled climate data on precipitation, maximum temperature, minimum temperature and 21 climate extremes indices have been analysed for Madhya Pradesh State and its 52 districts for baseline (BL, 1981-2010), mid-century (MC, 2021-2050) and end-century (EC, 2071-2100). Ensemble mean of 10 RCMs at a spatial resolution of 50 km x 50 km has been used. The CORDEX South Asia simulations with the models indicate an all-round warming over the study area. Projected increase in temperature and precipitation towards end-century is higher than that towards mid-century. The summary for three time periods-BL, MC and EC is as follows:-

3.3.1.1 Projected Maximum Temperature

- Average annual maximum temperature for IPCC AR5 RCP4.5 scenario is projected to increase by about 1.3°C towards mid-century and by 2.0°C towards end-century while for IPCC AR5 RCP8.5 scenario it is projected to increase by about 1.6°C towards mid-century and 4.3°C towards end-century for Madhya Pradesh State. Thus projected temperature increase in end-century is higher than that of mid-century.
- The projected increase in maximum temperature towards MC does not show significant variation across the districts of Madhya Pradesh for both IPCCAR 5 RCP 4.5 and RCP 8.5 scenarios.
- The projected increase in maximum temperature towards EC varies from 1.8°C in Alirajpur to 2.2°C in Shivpuri district for IPCC AR5 RCP4.5 scenario and 3.9°C in Barwani and West Nimar to 4.6°C in Singrauli and Ashoknagar districts of Madhya Pradesh for IPCC AR 5 RCP 8.5 scenario.
- Highest maximum temperature increase is project edin pre monsoon season (MAM) for IPCC AR5 RCP4.5 and RCP8.5 scenarios towards MC and EC for Madhya Pradesh State as compared to the other seasons.
- For both IPCC AR5 RCP4.5 and RCP8.5 scenarios, increase in annual and seasonal maximum temperature is projected for Madhya Pradesh and its districts towards MC and EC. However, IPCC AR5 RCP8.5 scenario shows higher increase than that of IPCC AR5 RCP4.5 scenario.

Figure : Spatial representation of projected changes in annual and seasonal maximum temperature for IPCC AR5 RCP4.5 scenario



3.3.1.2 Projected Minimum Temperature

- Average annual minimum temperature for IPCC AR5 RCP4.5 scenario is projected to increase by about 1.4°C towards mid-century and by 2.6°C towards end-century while for IPCC AR5 RCP 8.5 scenario it is projected to increase by about 1.8°C towards mid-century and 5.3°C towards end-century for Madhya Pradesh State. Thus, projected temperature increase towards EC is higher than that of MC.
- The projected increase in minimum temperature towards EC varies from 2.4°C in Ashoknagar to 2.8°C in East Nimar district for IPCC AR5 RCP4.5 scenario and 5.0°C in Ashoknagar and Damoh districts to 5.7°C in East Nimar district of Madhya Pradesh for IPCC AR5 RCP8.5 scenario.
- Highest minimum temperature increase is projected in monsoon season (JJAS) for IPCC AR5 RCP4.5 scenario and pre monsoon season (MAM) and monsoon season (JJAS) for RCP8.5 scenario for both MC and EC for Madhya Pradesh State as compared to the other seasons.
- For IPCC AR5 RCP4.5 and RCP8.5 scenario, minimum temperature show higher projected increase than the maximum temperature towards MC and EC for Madhya Pradesh.

3.3.1.3 Projected Precipitation

- Average annual rainfall for IPCC AR5 RCP4.5 scenario is projected to decrease marginally by about 0.1% towards mid-century and increase by about 4.4% towards end-century while for IPCC AR5 RCP8.5 scenario it is projected to increase marginally by about 0.2% towards mid-century and 5.8% towards end-century for the State. Thus the percentage of the projected rainfall increase is very low towards MC and EC for both the climate scenarios.
- Districts in the South West belonging to Narmadapuram and Indore divisions namely, Barwani, Burhanpur, Jhabua, West Nimar, Dhar, Indore, East Nimar, Alirajpur, Betul, Dewas and Harda show highest projected increase in rainfall as compared to the other districts of Madhya Pradesh towards MC and EC with respect to BL. While some of the districts in the East belonging to Jabalpur and Shahdol divisions namely, Jabalpur, Umaria, Katni, Damoh, Shahdol, Narsinghpur, Mandla, Dindori and Sagar show the projected decrease in annual rainfall towards MC and EC with respect to BL for IPCC AR5 RCP4.5 scenario.

- Districts in the Indore division namely, Barwani, West Nimar, Burhanpur and Indore show the highest projected increase (20%-25%) in annual rainfall towards EC while the Eastern districts of Madhya Pradesh namely, Shahdol, Umaria, Jabalpur and Katni show the projected decrease in annual rainfall towards MC and EC with respect to BL for IPCC AR5 RCP8.5 scenario.
- In pre monsoon season (MAM) and post monsoon season (OND) rainfall decrease is projected towards MC while in winter season (JF) highest rainfall increase is projected towards MC and EC for Madhya Pradesh State for IPCC AR5 RCP4.5 scenario.
- In winter season (JF) and post monsoon season (OND) rainfall decrease is projected towards MC while in winter season (JF) highest rainfall increase is projected towards EC as compared to BL for Madhya Pradesh State for IPCC AR5 RCP 8.5 scenario.

4 State GHG Emission Profile

4.1 Overview

Government of India acknowledges the need for rapid and transformative changes in order to mitigate the impacts of climate change. Formulation of SAPCCs has been a significant milestone in evolving national policies around climate change in India. Considering the evolving framework of climate policy and climate science, both nationally and internationally, therefore, SAPCCs need to be revised and strengthened further. The SAPCC needs to be updated in the context of present and future vulnerabilities linking with NDCs and effectively integrate and mainstream Climate Change into the development planning. In the absence of clarity on the issues of GHG inventorisation. No systematic effort was made by GoMP to assess the emission level however, there were many credible independent groups like GHG Platform India, who have carried out state specific sectoral GHG estimation for baseline and projections upto 2030. No state action plan on climate change can be complete and justified until and unless the state sectoral GHG emission projections are not only factored into but also internalised. With this view, the information and analysis on GHG done by independent groups has been referred to devise appropriate strategies. The inferences on GHG estimations have immensely helped to inform the process of devising appropriate mitigation strategies.

4.2 State GHG Inventory – Sources and Sinks

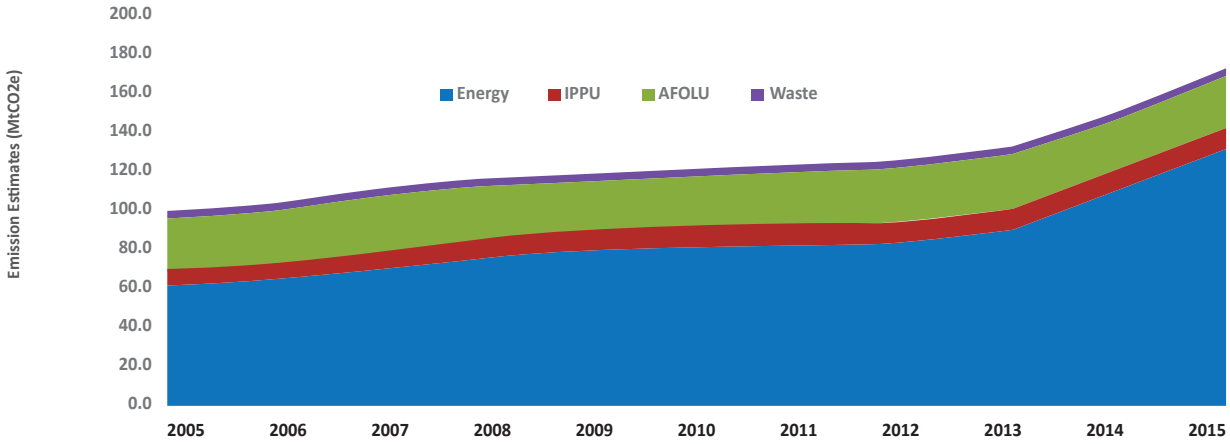
The emissions from Madhya Pradesh have been estimated from the GHGs namely CO_2, CH_4 and N_2O. As seen from Table, maximum emission change has been observed in CO_2 from 2005 to 2015. The emissions from CO_2 have changed by 106.7%. If CO_2e values are considered, maximum emissions are observed from CO_2 gas. The total CO_2e values have increased by 74.5%.

The total emissions in Madhya Pradesh have increased at a CAGR of 5.7% from 99.3 $MtCO_2e$ in 2005 to 173.3$MtCO_2e$ in 2015. Maximum of the emissions from Madhya Pradesh arise from the Energy sector followed by the AFOLU sector.

Table : Total GHG emissions and removals by year and gas

Year	2005	2015 (or the latest available year)	Percentage change b/w 2005 and 2015
Unit	Million tonnes		
CO_2	68.15	140.84	106.7%
CH_4	1.30	1.26	-3.1%
N_2O	0.01	0.02	54.4%
CO_2e	99.3	173.3	74.5%

Figure : Executive Summary: GHG emissions by sources (2005-2015)



Source: GHG Platform India

Table : Sector-wise GHG emissions and removals for 2005 and 2015

Sector	2005	2015	% change b/w 2005 and 2015
Unit	**in $MtCO_2e$**		
AFOLU	27.0	26.0	-3.6%
Energy	62.0	130.7	111.0%
IPPU	7.5	12.5	66.4%
Waste	2.8	4.0	42.3%
Total	**99.3**	**173.3**	**74.5%**

GHG emissions from the AFOLU sector declined by 3.6% from 27.0 $MtCO_2e$ in 2005 to 26.0 $MtCO_2e$ in 2015. Maximum emissions under this sector were registered from Livestock with a contribution of nearly 68% in 2015. While Aggregate Sources and non-CO_2 emissions sources on land accounted for 24% in the same year and the remaining 8% from Land sub-sector.

While Energy sector emissions increased by 111.0% from 62.0 $MtCO_2e$ in 2005 to 130.7 $MtCO_2e$ in 2015. Maximum emissions arise from the public electricity generation under the energy sector. Emissions from IPPU increased from 7.5 $MtCO_2e$ in 2005 to 12.5 $MtCO_2e$ in 2015 by 66.4%. Around 91% of the total IPPU emissions arise from cement production.

GHG emissions from the Waste sector increased by 42.3% from 2.8 $MtCO_2e$ in 2005 to 4.0 $MtCO_2e$ in 2015. Domestic waste water related emissions from rural and urban areas contributed to 83.5% of the total emissions from the sector in 2015. Solid waste disposal and industrial waste water accounted for 11.6% of the Waste sector emissions in 2015.

4.3 GHG Emissions

The energy sector is the highest GHG-emitting sector in the state. Emissions from the energy sector grew at a cumulative annual growth rate (CAGR) of 7.8% per annum. Public electricity generation (PEG) was

responsible for contributing around 72% of energy-based emissions in 2015. This was followed by industries (13%), transport (8%) and other sectors, and fugitive emissions. Coal-based thermal plants in the state grew from 4 GW to 8 GW between 2005 and 2015, which increased the emissions from public electricity generation (PEG) from 40.52 $MtCO_2e$ in 2005 to 85.43 $MtCO_2e$ in 2015. Population growth, urbanization, and industrialization are the major drivers for the increase in electricity demand and concurrently, the increase in installed capacity of thermal power plants. In case of the transport, residential/commercial and agriculture sectors, the increase in disposable income, farm mechanization, and higher penetration of LPG at the household level are the major drivers for increase in GHG emissions.

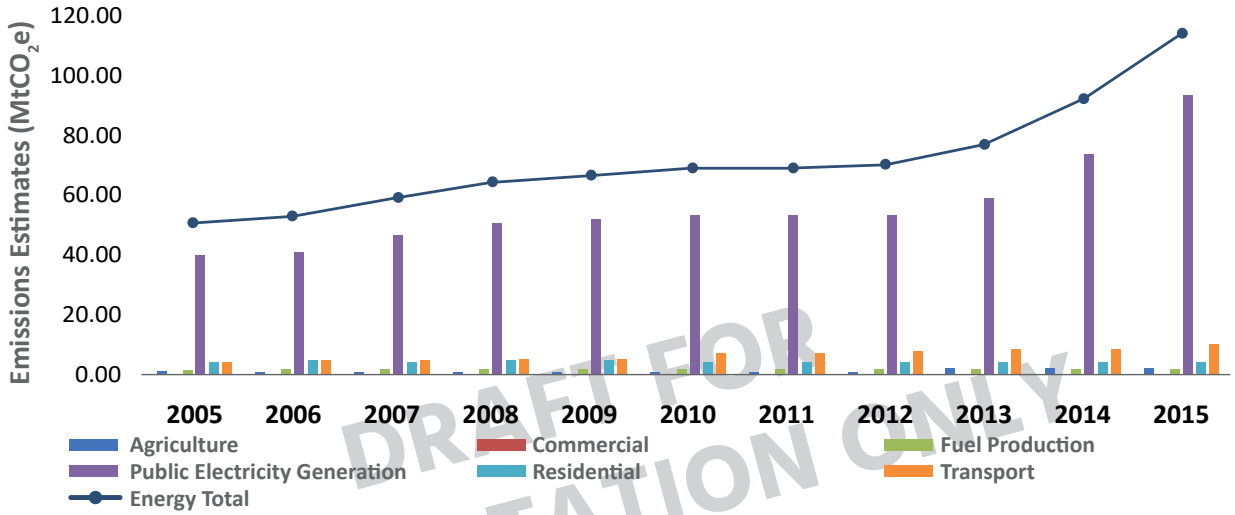


Figure : GHG Emissions from the Energy Sector in Madhya Pradesh (2005 to 2015)

Energy-sector emissions are broadly classified into two categories: 1A Fuel-Combustion Activities and 1B Fugitive Emissions from Fuel Production. Moreover, 1A examines emissions from energy industries (1A1), transport (1A3) and other sectors (1A4). The other sectors include emissions from residential, commercial, and the agriculture/fisheries sectors. 1B includes fugitive emissions that arise from various activities in fossil fuel-production at mines and wells, where coal, oil, and natural gas. The total emissions from the energy sector in Madhya Pradesh were estimated to be 51.7 $MtCO_2e$ and 105.4 $MtCO_2e$ in 2005 and 2015, respectively.

Table : Energy: GHG emissions of the state for 2005 and 2015 (in million tonnes)

IPCC ID	Category description	2005 (Base year)				2015				% change (only in CO_2e)
		CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e	
1A1	Electricity Generation	40.3	0.0	0.0	40.5	84.9	0.0	0.0	85.3	110.6%
1A3	Transport	4.1	0.0	0.0	4.3	9.8	0.0	0.0	10.1	136.3%
1A4	Other Sectors	3.8	0.1	0.0	5.3	6.4	0.0	0.0	7.5	40.9%
1B	Fugitive Emissions	0.0	0.1	0.0	1.6	0.0	0.1	0.0	2.5	51.6%

Energy based GHG emissions in the state have doubled from 2005 to 2015. Within the sector, the electricity generation sector contributed 81%, followed by transport (10%), other sectors (7%), and fugitive emissions (2%) in 2015. The energy based emissions per capita increased from 0.8 tCO_2e in 2005 to 1.37 tCO_2e in 2015

due to the increase in number of thermal power plants and higher consumption of fuel for transportation sector within the state.

4.3.1 Electricity generation based emissions

The thermal power plants in MP are all coal-based with an installed capacity of 4080 MW, as on 31st March 2016[3]. Of which, four of them are owned by state power generating company-MPPGCL and one by NTPC. Private sector accounts for the largest share of coal TPP ownership.

To estimate GHG emissions in PEG sector, fossil-fuel consumption and fuel emission factor are required. The fuel-consumption data for power plants owned by the state and private sector is obtained from the reports published by Central Electricity Authority (CEA) (MoP, yearly report 2006-2017). In case of power plants owned by the center, the fuel-consumption data is provided region-wise instead of state. Hence, the ratio of the net electricity generated by the central power plant in Madhya Pradesh with the net electricity generated by all the central power plants in the region was used to apportion the fuel consumed in the state.

MPPGCL has installed the updated equipment's & pollution control technologies in its thermal power units & always strive for their optimum O&M in order to minimise GHG emissions. On 07/12/2015, GoI, MoEFCC have issued Gazette Notification for reduction in the maximum permissible limits of particulate matter (PM), Hg, GHG gases like SO_2, NO_x, Hg in the stack emissions from thermal power plants. in compliance, MPPGCL is in the process of & installation / renovation of the equipment's related to the above mentioned parameters so that the revised emission norms may be ensured timely.

4.3.2 Transport emissions

In case of transport emissions, it has been further divided into road, railways, and aviation based emissions. Motor spirit, diesel, and Compressed Natural Gas (CNG) are the main fuels consumed in the road sector whereas diesel in railways and Aviation Turbine Fuel (ATF) in aviation sector were considered for emission estimation. Data on consumption of these fuels was sourced from MoPNG reports (MoPNG, yearly report 2006-2017). The retail-based-diesel consumption at the state level was apportioned to transport sector using the survey data published by Petroleum Planning and Analysis Cell (PPAC) in 2013 (Nielsen, 2013).

4.3.3 Other Sectors

As per the IPCC methodology, other sectors are categorized into energy used in residential, commercial, and agriculture sector. The activity data for this sector represents the fuel consumption for specific applications such as cooking, lighting, heating, use of small (< 1 MW) Diesel Generator (DG) sets, operation of tractors and diesel pump-sets. The thermal energy for cooking, lighting, and heating in MP were majorly met by biomass and kerosene. About 72% of the population is with the rural sector based on 2011 census data. The biomass dependence in the rural sector is quite high that about 93.8% of the sector population was dependent on biomass based cooking/heating. The data for fuel consumption in other sectors were mainly sourced from NSSO reports and from PPAC[4]. The per capita monthly consumption (PCMC) data for fuel wood (biomass), coke, coal and charcoal were the data sourced from NSSO. In cases where data is not available for intermediate years, a linear interpolation method was applied.

[3]CEA, 2019

[4]Based on expert consultation

Natural gas has witnessed very low penetration in the state. Increasing consumption of the fuel has been witnessed after the establishment of an oil refinery in Bina. The petroleum refining sector consumes more than 70% of the natural gas available to the sector for end use. Apart from that, chemicals and fertilizer is the only other sector reporting consumption of natural gas in the state.

Non-metallic minerals, other energy industries, and petroleum refining together represented 80% of the emissions arising from the combustion of petroleum fuels in the manufacturing sector. The cement sector uses a large amount of petroleum coke in its production process; other energy industries report diesel consumption towards mining of coal and lignite; petroleum refining in the state primarily relies on crude fractions for their energy requirements. In the energy sector, about 96.3% of the cumulative emissions in 2015 were from CO_2 as most of the activities involved complete fuel combustion. CH_4 emissions contributed about 3% of the energy based emissions and are mainly due to the activities related to mining and fuel production. The remaining emissions contributed by N_2O were quite negligible in energy sector (< 1%).

4.4 GHG Projections

Energy based emissions are expected to only grow in the future due to the rise in population and increase in disposable income. The emissions are projected to continue the same trend as that from 2005 to 2015 with a CAGR of 8.3%[5]. With the current trend, the energy based emissions are expected to increase by 3.5 times in 2030 from 2015 level.

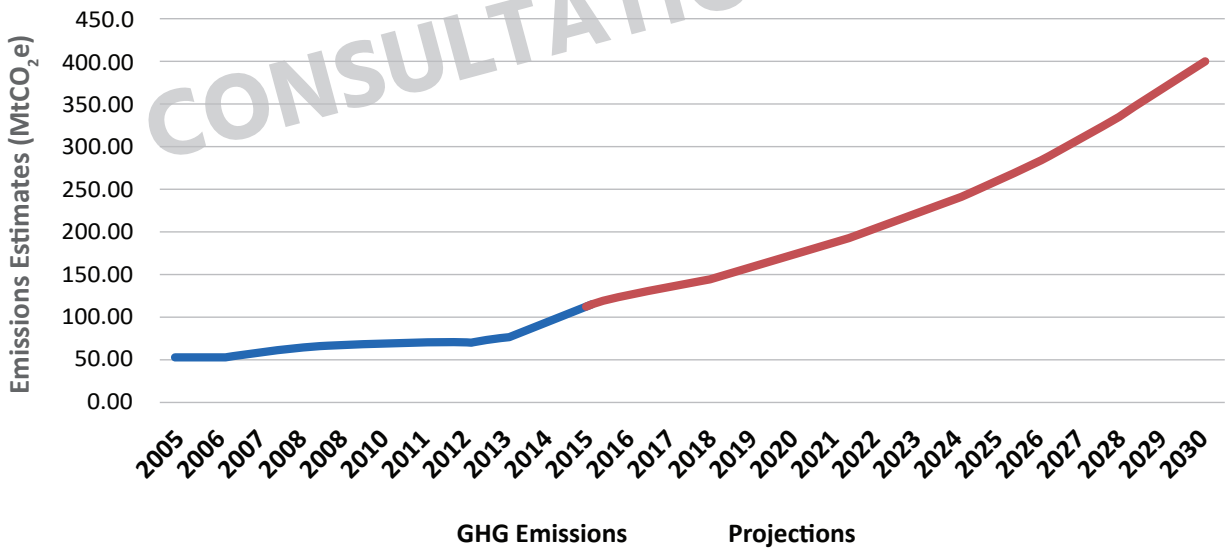


Figure : Projected GHG Emissions from the Energy Sector in Madhya Pradesh (2005 to 2030)

[5]Assuming that there is no change in the structure of the state economy till 2030

Section- II

Vulnerability Assessment

5 Vulnerability Assessment

5.1 Overview

Vulnerability Assessment is the process of recognizing, measuring and prioritizing the vulnerabilities in a system. Various studies have suggested that Madhya Pradesh which is a land-locked state is highly vulnerable to climate change. This is mainly due to the fact that large number of people of state are dependent on climate sensitive natural resources for their livelihood.

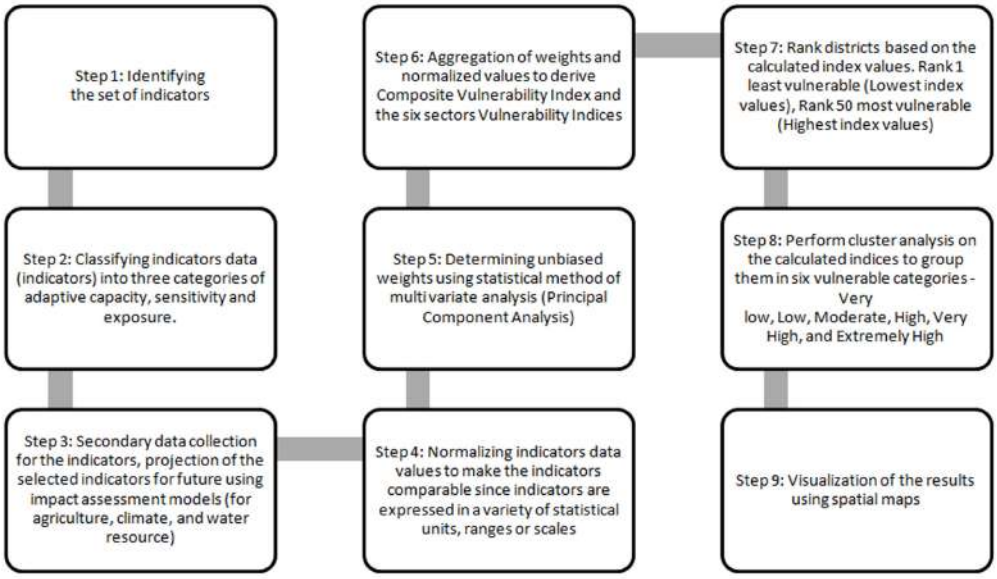
Madhya Pradesh is also a pioneer state in the country to make a genuine effort to understand the dynamics of climate change vulnerability and its subsequent impact on communities and natural ecosystem. The first attempt was made in early 2012 as part of the CCA-RAI project of MoEFCC, GoI supported by GIZ India. Those were early days. The data availability and reliability was an issue so was the standard acceptable methodology to carry out this assessment. However, the findings of the study were quite useful and relevant. The SKMCCC has since revised the vulnerability assessment using latest scenarios and model outputs as part of the GoMP-UNDP-SDC project. Climate Change Vulnerability Assessment studies of MP has helped in:-

- Understanding present vulnerability;
- Recognizing the factors that make some areas more vulnerable than others;
- Inform and encourage the decision-making process;
- Selection of adaptation strategies and practices.

5.2 Methodology

The MP vulnerability study has been carried out at the state level over the periods 2021-2050 (mid-century, MC) and 2071-2100 (end-century, EC) by using a multi model ensemble from the CORDEX experiment for RCP 4.5 and RCP 8.5 scenarios. The assessment is done by taking Composite Vulnerability Index (CVI) obtained using multivariate analysis for current and projected climate scenarios (under IPCC AR5 RCP4.5 and RCP8.5 climate scenario towards mid and end-century). As a result, six sectoral vulnerability indices for social, economic, climate, water resources, forest and agriculture have also been created that helped in identification of districts which are vulnerable to climate change and need special attention. Steps in Vulnerability Assessment of Madhya Pradesh[6].

[6]Climate Change Vulnerability Assessment for Madhya Pradesh, 2018



A set of 72 indicators have been taken which have been assembled under six sectoral categories- social (31 indicators), economic (5 indicators), climate (8 indicators), water resources (8 indicators), forest (5 indicators) and agriculture (15 indicators). These indicators are further classified into exposure indicators (8 indicators), sensitivity indicators (29 indicators) and adaptive capacity indicators (35 indicators).

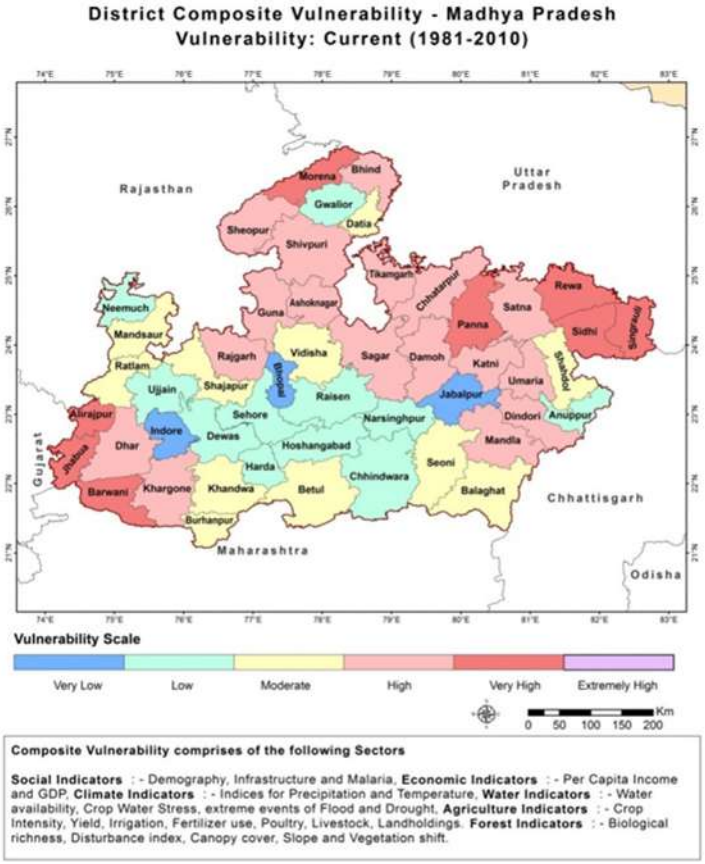


Figure 12: District Composite Vulnerability Madhya Pradesh Baseline

(Source: http://www.climatechange.mp.gov.in/en/vulnerability-dashboard)

5.3 Key Findings

5.3.1 Current Composite Vulnerability

Eight districts namely Singrauli, Jhabua, Barwani, Panna, Morena, Sidhi, Rewa and Alirajpur with ranks 50, 49, 48, 47, 46, 45, 44 and 43 respectively are identified as most vulnerable districts under current climate.

- Singrauli with rank 50 is the most vulnerable district under current conditions.
- Singrauli and Sidhi have high social, economic and agriculture vulnerability.
- Jhabua and Rewa have high social, economic, climate, water resource and agriculture sector vulnerability.
- Barwani has high social, economic, climate, water resources and forest sector vulnerability.
- Panna has high social, economic, climate and agriculture sector vulnerability.
- Morena has high social, economic, climate, water resources; forest and agriculture sector vulnerability. All six sectors contribute to its High vulnerability.
- Alirajpur has high economic, climate and water resource sector vulnerability.

Seventeen districts namely Dindori, Ashoknagar, Shivpuri, Umaria, Sheopur, Chhatarpur, Tikamgarh, Khargone (West Nimar), Bhind, Damoh, Guna, Satna, Dhar, Katni, Sagar, Mandla and Rajgarh with ranks 42 to 26 in the given order fall under high vulnerable category.

Eleven districts namely Shahdol, Burhanpur, Ratlam, Khandwa (East Nimar), Shajapur, Balaghat, Betul, Seoni, Vidisha, Mandsaur and Datia fall under moderate vulnerability. The main contributing factors to their vulnerability include lack of proper access to drinking water, permanent houses, livestock population and schools while relatively higher sex ratio, below poverty line population, death rate and drought frequency.

Eleven districts namely Hoshangabad, Harda, Narsinghpur, Gwalior, Dewas, Neemuch, Ujjain, Sehore, Chhindwara, Anuppur and Raisen with ranks 4 to 14 in the same order fall under low vulnerability. Mainly social, economic and agriculture sectors contribute to the low vulnerability of these districts.

Three districts namely Bhopal, Jabalpur and Indore districts with ranks 1, 2 and 3 respectively are the least vulnerable districts. The main contributing factors come from higher adaptive capacity due to higher social and economic capital.

5.3.2 Projected Composite Vulnerability

It is observed that the overall Composite Vulnerability (CV) of the districts is projected to increase towards the mid-century when compared to the baseline and decrease towards the end-century when compared to the baseline for both moderate and high emission scenarios of RCP4.5 and RCP8.5 respectively. District vulnerability under RCP4.5 scenario is projected to be higher as compared to RCP8.5 scenario towards both mid and end-century.

- The overall climate and forest vulnerability of the districts is projected to increase towards mid and end-century as compared to the baseline for both emission scenarios of RCP4.5 and RCP8.5.
- The overall water resources vulnerability of districts is projected to increase towards mid-century while decrease towards the end-century under RCP4.5 and RCP8.5 climate scenarios as compared to current conditions.

- The overall agriculture vulnerability of the Madhya Pradesh districts is projected to decrease towards mid-and end-century as compared to the current conditions for both emission scenarios. Districts vulnerability under RCP8.5 scenario is projected to be lower as compared to RCP4.5 scenario.

- Exposure to rainfall variability, drought weeks and sensitivity to heat stress and seasonal crop water stress are projected to increase towards the mid-century as compared to current conditions, thus, contributing to increase in overall Composite Vulnerability (CV).

- Composite Vulnerability (CV) improves towards end-century as compared to current conditions as exposure to drought weeks and sensitivity to seasonal crop water stress is projected to decrease while yield for rice and soya bean crops are projected to increase. Dry Teak Forests are the most vulnerable to impact of climate change.

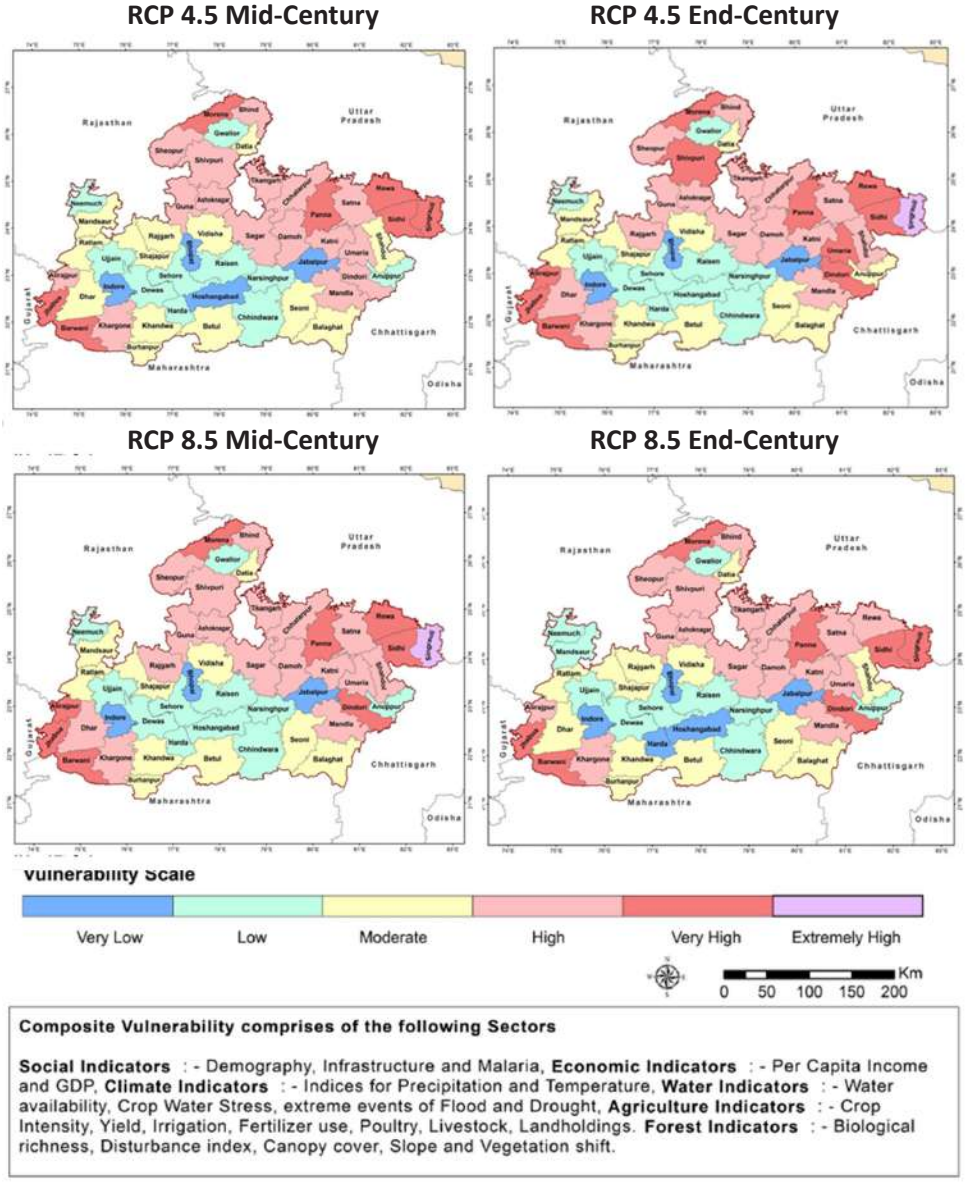


Figure 13: District Composite Vulnerability Madhya Pradesh Projected

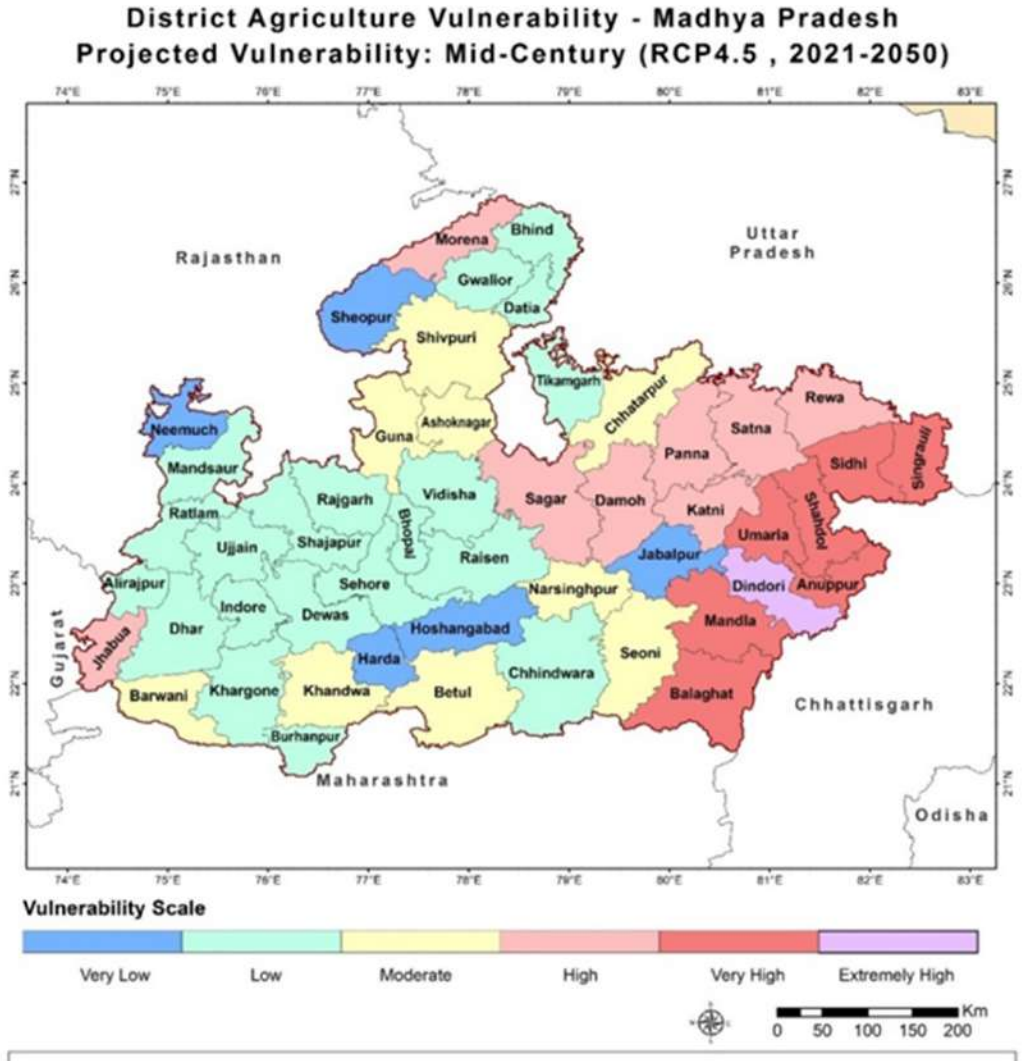
(Source: http://www.climatechange.mp.gov.in/en/vulnerability-dashboard)

6 Sectoral Climate Change Vulnerability

6.1 Agriculture sector

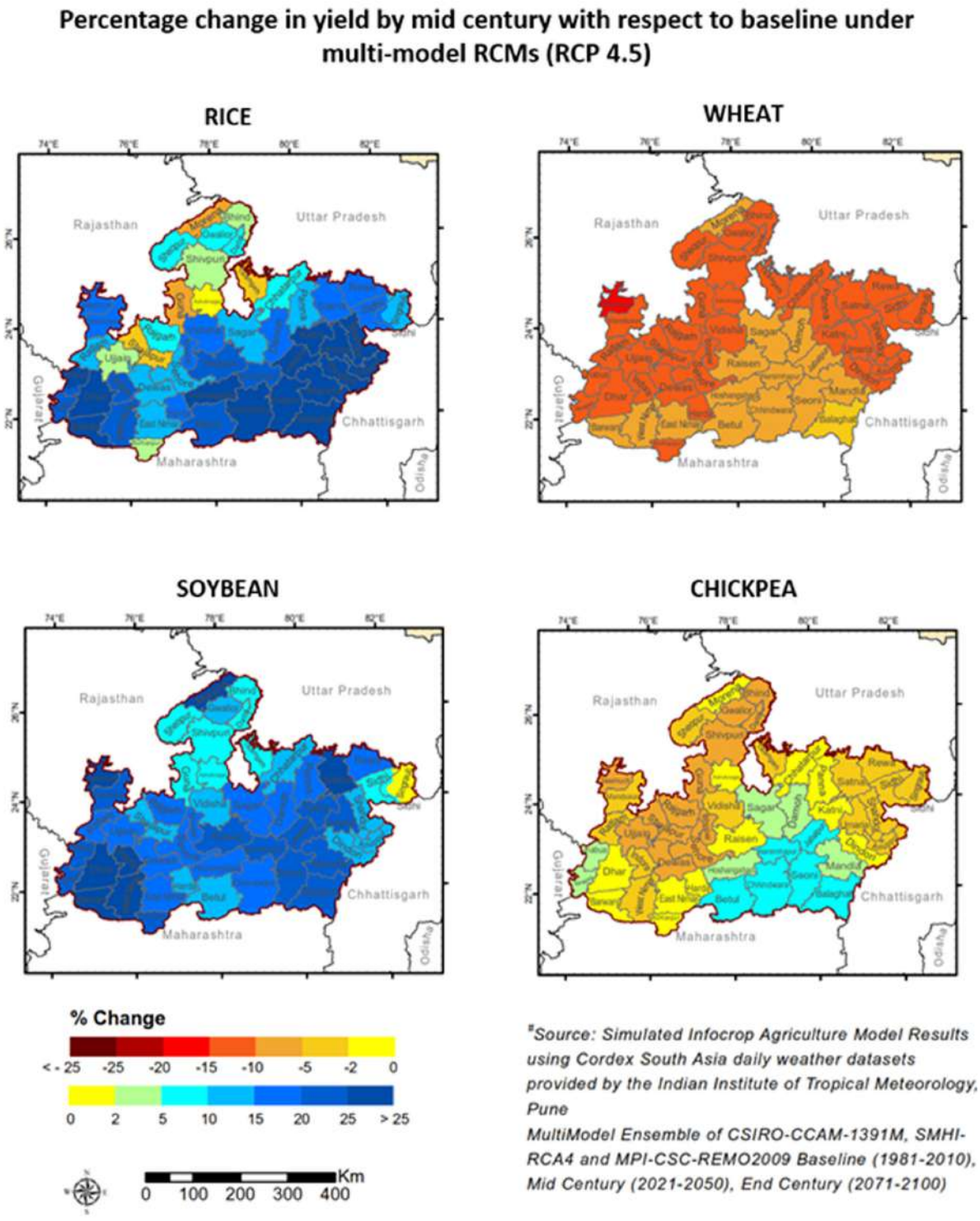
The overall agriculture vulnerability of the Madhya Pradesh districts is projected to decrease towards mid- and end-century as compared to the current conditions for two emission scenarios, RCP8.5 and RCP4.5. Of the two scenarios, districts will face lower vulnerability under RCP8.5 scenario as compared to the RCP4.5 scenario. The main reasons for reduced agricultural vulnerability are projected increases in rice and soybean crop yield.

Different districts will have different vulnerability profiles. Figure shown below indicates that how the different districts are, with only the agricultural indicators of vulnerability under RCP4.5 by mid-century. Even though the overall agricultural vulnerability is reducing due to rice and soybean yield, there will be variable impacts on districts with respect to various other crops than the state farms.



Agriculture : Indicators - Cropping Intensity, Net Sown/Irrigated area, Wasteland (DACNET), Livestock, Poultry (Livestock Census), Per capita milk and egg production, Change in Rice, Wheat, Soyabean and Chickpea Yield Simulated by InfoCrop Model (IARI) using : Cordex South Asia daily weather datasets from

Figure : Madhya Pradesh: District wise agricultural vulnerability for mid-century under RCP4.5
Figure : Change in yields of major crops



The InfoCrop model was used to assess the impact of climate change on the four major crops of Madhya Pradesh: rice, wheat, soybean and chickpea. The model was used to create a baseline (1981-2010), a mid-century projection (2021-2050), and an end-century projection (2071-2100) using RCP4.5 and RCP8.5 scenarios.

- **Rice: A significant increase in rice yield is projected for all the rice growing districts:** a 24% to 55% increase under the RCP4.5 scenario and a 30% to 70% increase under the RCP8.5 scenario in rice-growing districts of the state.
- **Wheat:** The models show a projected decline in the production of wheat. Wheat yield is projected to decline by 5% to 15% under the RCP4.5 scenario and 4% to 39% under the RCP8.5 scenario.
- **Chickpea:** Chickpea yield is projected to decrease marginally towards mid-century (6% to 8% under both scenarios) and but gain between 10% (RCP4.5 scenario) to 20% (RCP8.5 scenario) towards the end of the century.
- **Soybean:** Soybean yield is projected to increase, by between 3% and 37% under the RCP4.5 scenario and by between 6% and 27% in the RCP8.5 scenario. This means that by the end of the century, the yield is projected to double compared to the baseline.

6.2 Livestock sector

The livestock response to climate change can be assessed using the Temperature Humidity Index (THI) which measures heat stress (a combination of environmental temperature and relative humidity) among animals. Table 22 below shows how different THI affect animals differently.

Table : THI Stress-Level Scales

THI* (°C)	Stress Level	Comments
<18	None	
19-21	Mild	Dairy cows will adjust by seeking shade, increasing respiration rate and dilation of the blood vessels. The effect on milk production will be minimal
22-24	Moderate	Both saliva production and respiration rate will increase. Feed intake may be depressed, and water consumption will increase. There will be an increase in body temperature. Milk production and reproduction will be decreased.
25-27	Severe	Cows will become very uncomfortable due to high body temperature, rapid respiration (panting) and excessive saliva production. Milk production and reproduction will be markedly decreased.
Danger	**>2**8	Potential cow deaths can occur
*** THI: Feels like Temperature (°C)**		

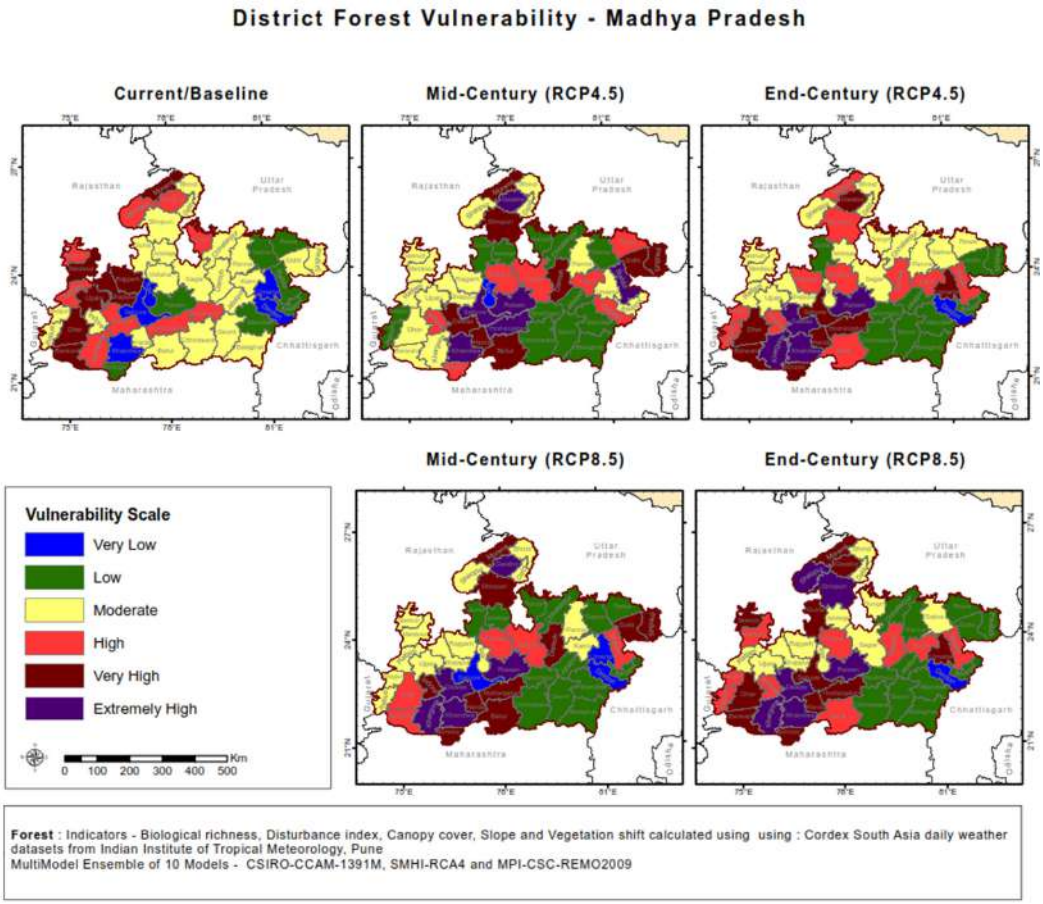
THI has been calculated for Madhya Pradesh for both RCP4.5 and RCP8.5 climate change scenarios, for mid-century and end-century timescales, for the months between April and September which are significant for either high temperature or high humidity. Under the RCP4.5 scenario, districts are projected to have the maximum number of days in the 'moderate' stress level.

This situation is likely to deteriorate, especially under the RCP8.5 scenarios for mid- and end-century, when the number of days with 'severe' stress level is expected to increase during the months of April, May, and June. Notably, none of the projections show any days in the 'danger' stress level, when cow deaths can occur, for any of the months. However, the projected increase in numbers of days for 'moderate' and 'severe' will impact livestock health and productivity.

6.3 Forest sector

The vulnerability assessment findings indicate a mixed picture for forests: it suggests that climate change will cause substantial changes in forests (in the figure below) and will present both opportunities and threats to the forests of Madhya Pradesh. The opportunities come in the form of an increase in Net Primary Productivity towards mid-century which, in conjunction with increased biomass, can increase the supply of both timber and non-timber forest produce as well as enrich the soil carbon and productivity due to increase litter-fall.

Figure : District Forest Vulnerability for Madhya Pradesh



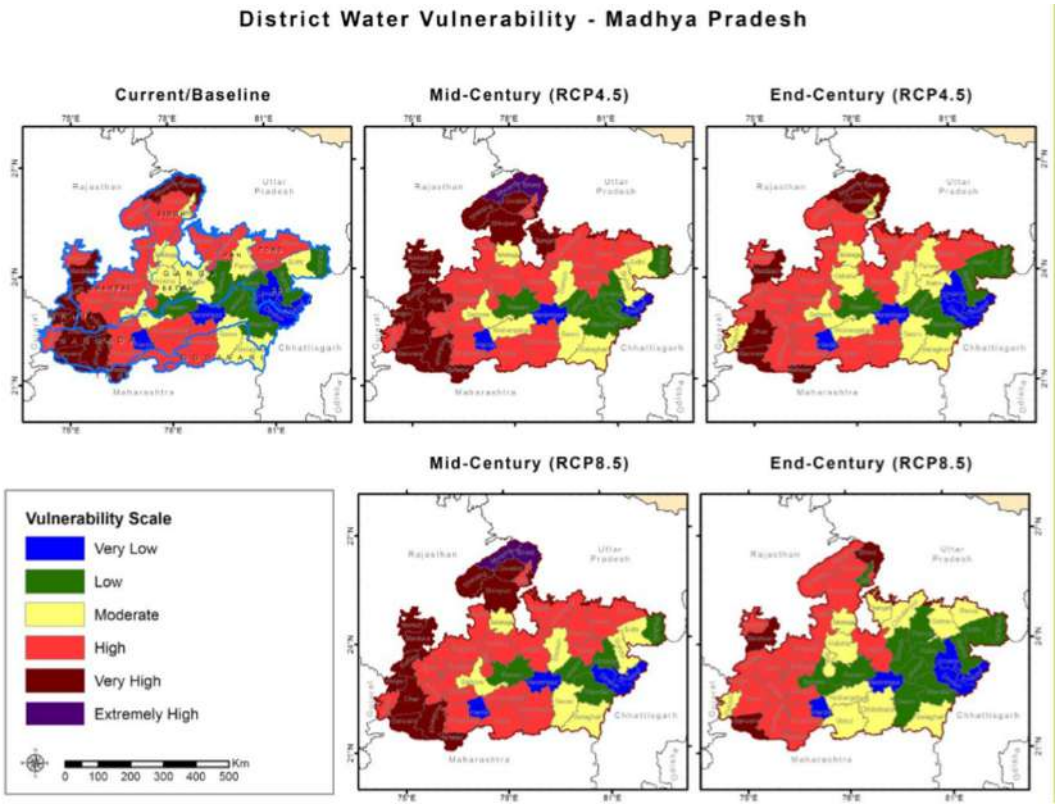
However, the projections also show that the vegetation and forest type of Madhya Pradesh will change due to climate change. Dry Teak forests will be the most vulnerable, followed by southern dry mixed deciduous and northern dry mixed deciduous forests, under both scenarios (RCP4.5 and 8.5). The forests in the district of Dindori are projected to be least vulnerable to climate change under both RCP4.5 and 8.5 scenarios towards end-century, but forests in 17 out of 52 districts will be impacted by climate change under RCP4.5 and 22 districts out of 52 are likely to be impacted by climate change under RCP8.5 towards end-century.

Under the RCP4.5 scenario, about 22.4% of forests will undergo a forest type shift or no longer be suitable for existing vegetation types by mid-century, and this increases to 35.6% by end-century. Under the RCP 8.5 scenario, these figures are 27.2% by mid-century and 45.9% by end-century. Much of this change could be attributed to changes in temperature, precipitation, and increased CO_2 in the atmosphere. However, there is a fair amount of uncertainty in these projections, especially with regards to precipitation.

6.4 Water sector

The study indicates that the overall water resource vulnerability of Madhya Pradesh is projected to increase towards mid-century as compared to current conditions. This projected increase in water resource vulnerability is attributed to increased exposure to drought, higher seasonal crop water stress, low recharge rates, and increased pressure on the groundwater resources. Figure below shows the district-wise mid-century vulnerability projections and end-century vulnerability projections for RCP4.5 and RCP8.5.

Figure : District Agricultural Vulnerability for Madhya Pradesh



As shown by the figures above, the projections differ for various districts of the state: in some districts a marginal to 17% increase in precipitation are projected, while in others and marginal to 7% decrease in precipitation are projected for the mid-century threshold. Towards the end-century, a marginal to 22% increase in precipitation have been projected for some districts and marginal to 10% decrease in precipitation have been projected for others.

These changes in precipitation will have an effect on evapotranspiration rates, stream flow, and groundwater and aquifer recharge. These, in turn, will have an effect on water availability for irrigation and other purposes, as well as water storage and management. For instance, many reservoirs are likely to experience an increase in peak flow by 10-30% towards the end-century for both scenarios. This will likely require additional risk management strategies for the surrounding areas.

Lack of rainfall will also result in some districts facing higher incidences of drought. For instance, there is a possibility of increased drought conditions in several districts of Madhya Pradesh towards mid-and end-century. At the same time, the incidences of drought will likely insert to West Nimar, Indore, Dewas and Dhar towards the mid-and-end century, as compared to the baseline.

National Water Mission Awards

Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti has announced National Water Mission Awards 2019 under 10 categories for doing exemplary work in the field of conservation of water, minimising its wastage and water management. EPCO established under Department of Environment, Government of Madhya Pradesh has been awarded as winner under the category "Assessment of the impact of Climate Change on Water Resources" for preparing Climate Change Vulnerability Assessment report. In the award ceremony convened on 25 Sept 2019 at Vigyan Bhawan, New Delhi, Hon'ble Union Minister of Ministry of Jal Shakti distributed the prize to the awardees.

Climate Change Vulnerability Assessment report gives a comprehensive & scientific projections in the sectors like water resources, forest, agriculture & human health with regard to climate change. Taking the inferences from the report, new projects related to climate change adaptation are being formulated by EPCO. The inferences are also being used by young professionals & researchers. Currently, EPCO is implementing three projects based on the results of the report. The report has been prepared as part of the EPCO-UNDP-SDC project "Strengthening State Strategies for Climate Actions".

6.5 Human Health sector

The impact of heat on human health is described by humidex, which describes the combined effect of temperature and humidity on human body. The humidex, also known as the apparent temperature, is an index number to describe how hot the weather feels to the average person by combining the effect of heat and humidity. The range of heat value and the comfort or discomfort level with each range is shown in table below:-

Table : Humidex Range and Comfort Levels

Humidex (°C)	Degree of comfort or discomfort
Less than 32	Caution - Fatigue is possible with prolonged exposure and/or physical activity
32 to 39	Extreme Caution - Sunstroke, heat cramps and heat exhaustion are possible with prolonged exposure and/or physical activity
39 to 50	Danger - Sunstroke, heat cramps and heat exhaustion are likely. Heat stroke is possible with prolonged exposure and/or physical activity
Above 50	Extreme Danger - Heatstroke/sunstroke is highly likely with continued exposure

Figure number shows the human heat stress levels in the summer months of April, May and June. As seen in the maps for the month of May under RCP4.5 by mid-century, northern and central Madhya Pradesh are projected to have conditions close to 50°C which is extremely dangerous for human health. Below figure shows the number of extreme heat days in each district in the month of May.

Figure : Projected heat stress in Madhya Pradesh in the month of May with green bars showing mid-century increase in extreme heat days

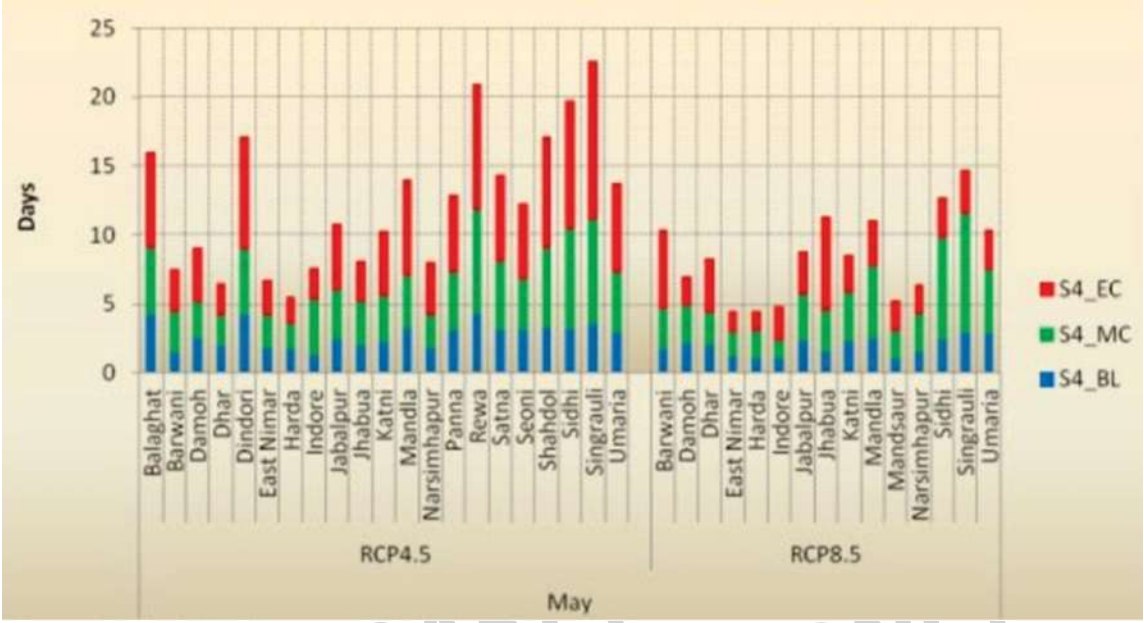
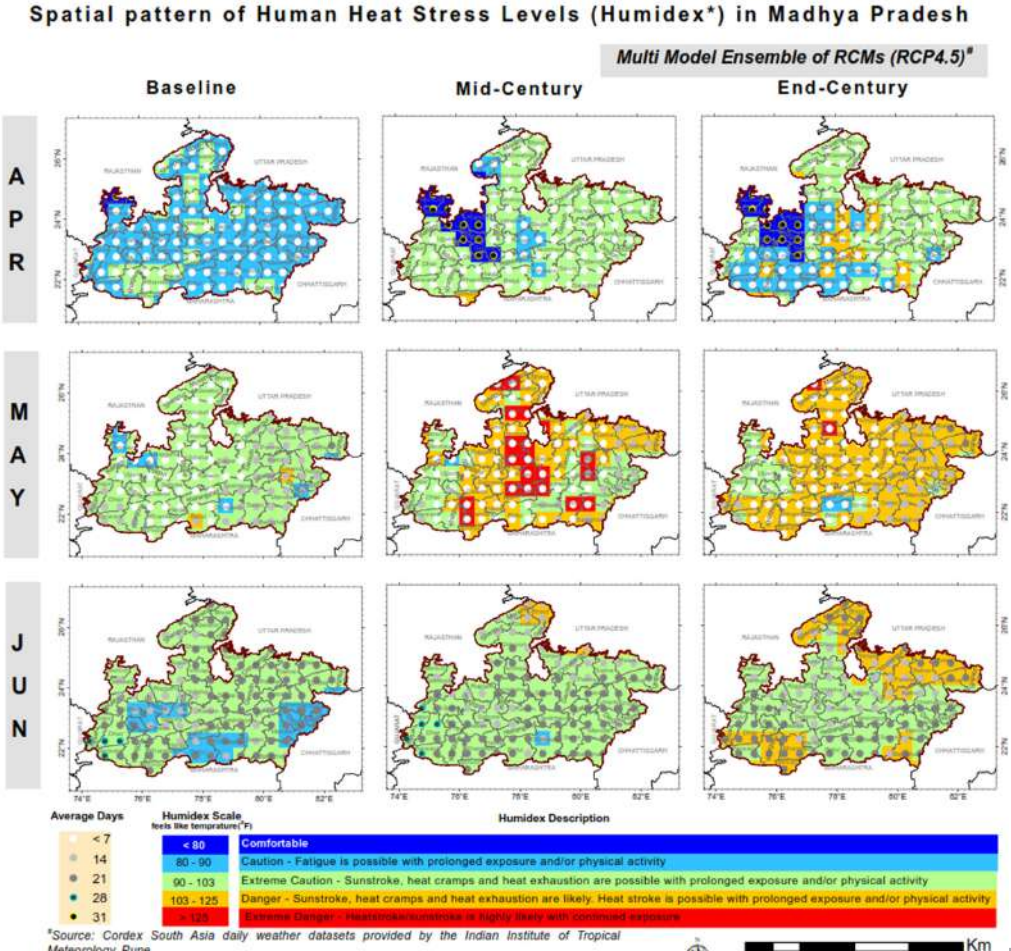


Figure : Humidex projections for Madhya Pradesh



Section- III

Sectoral Strategies and Actions Adaptation & Mitigation

7 Forest & Biodiversity

7.1 Sector Overview

Forests constitute some of the most intricate natural ecosystems and are essential to the health of our environment. Today there is a welcome paradigm shift in appreciating at forests from being only provider of timber and non-timber forest produce to providing essential and invaluable ecosystems services.

Forests regulate water cycles, maintain soil quality, and reduce the risks of natural disasters such as floods. The psycho physiological influence of trees in the form of purified air, clean water, sink for GHGs, shield for noise level reduction, recreation, scenic enjoyment and spiritual replenishment are now being fully appreciated much more than ever before.

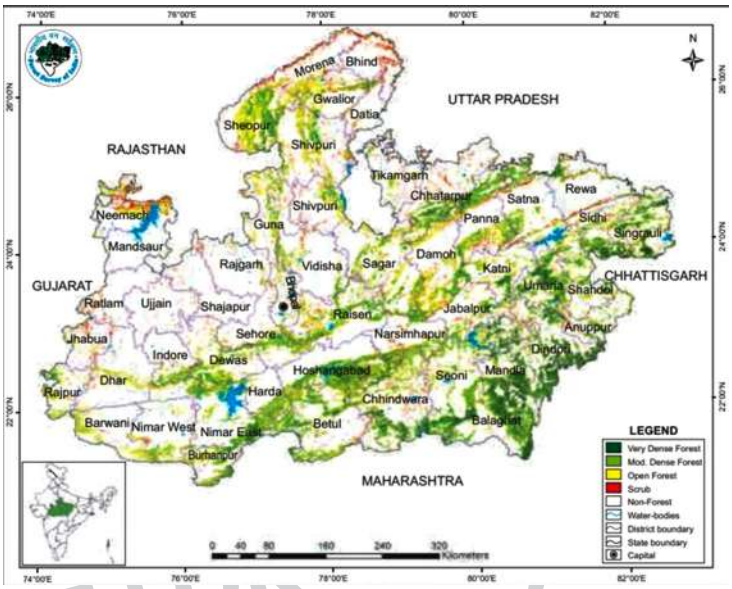
Many of these services are undervalued although they are key to the resilience and green growth of local and state economies. Forest conservation and protection would continue to be a priority particularly at a time when natural systems are coming under severe demographic, economic and climatic pressure. Although the pace of deforestation has slowed in some regions, however there is greater need for protecting our forest wealth and prevent massive loss of green cover.

The state has largest forest cover of 77482.49 sq km in the country (FSI 2019). The recorded forest area of the State is 30.72% of its total geographical area, as against 23.34% for the country. However, the forest cover of the state has increased from 25.11 in 2017 to 25.14 in 2019. FSI report of year 2019 attributes expansion of agriculture, developmental activities, submergence, mining and rotational felling as reasons for change in forest cover.

Forest sector at a glance	
Total Forest Area	94689 sq. km
Percentage of State area under forest	30.72%
Area under VDF (Very Dense Forest)	6676 sq. Km
Area under MDF (Moderately Dense Forest)	34,341 sq. Km
Area under OF (Open Forest)	36,465 sq. Km
Scrub	6001.91 sq. km
Protected forests in the state	32.84% of the recorded forest area
Total tree cover (outside recorded forest area)	8339 sq. km
Total forest and tree cover (outside recorded forest area)	21,069 sq. km
Forest types	Teak forest, Sal forest, Mixed forest, Bamboo forest, Blank
Bamboo bearing area within forest area of state	20,867 sq. Km
Total carbon stock of forest	588.73 million tonnes (2158.68 million tonnes of CO_2 equivalent); 8.26% of total forest carbon of country
Wetlands inside the Recorded Forest Area (RFA)	1,62,573 sq. Km
Total Grand Growing Stock of State (RFA + TOF)	449.01 m. Cum
Protected areas	10 national parks, 6 tiger reserves, 25 wildlife sanctuaries , 3 biosphere reserves
Biodiversity Status	**Floral-** Sal, Tendu, Harra, Baheda, Teak, Mahua, Salai, Achar, Anola, Beeja, Haldu, Khair, Tinsa, Kardhai **Fauna-** Tiger, Barasingha, Leopard, Hyena, Bison, Wild Boar

7.2 Initiatives in vogue

The Forest Department has adopted various policies, acts, and management practices which support conservation and forest regeneration activities. Following are the major policies and missions being operated by MP Forest Department:-



National Forest Policy, 1988

This policy provided guidance on sustainable forest management practices with a focus on soil and water conservation. The policy aims to increase tree cover and productivity of the forest. Notably, the policy emphasized the role of forest communities in management and use of forest services. The policy supported scaling up of Joint Forest Management (JFM) initiative and led to creation of a programme with legal backing for the JFM communities. The JFM programme has been instrumental in supporting forest and wildlife conservation along with livelihood development.

Draft National Forest Policy, 2018

This draft policy aims to bring one third of India's land under forest cover to reduce land degradation and conserve water resources to ensure flow of ecosystem services to future generations. The policy focuses more on the economic benefits of forest resources and notes that increased forest cover will help the country achieve its Nationally Determined Contributions (NDCs).

Madhya Pradesh State Forest Policy, 2005

The state policy completely mirrors the national policy in focusing on sustainable management practices. The policy emphasizes the importance of public participation, especially for economically weaker sections of society and women. Additionally, the policy intends to support conservation outside the protected areas by promoting eco-tourism and private investments to increase tree cover.

Madhya Pradesh State Bamboo Mission (MPSBM)

MPSBM promotes bamboo-based development and entrepreneurship to create sustainable bamboo economy. MPSBM functions as the coordinating organization for bamboo-related activities in the state including development of Fast Growing High Yielding (FGHY) bamboo varieties.

7.3 Sectoral Concerns

The climate change is significantly affecting forest health, productivity, and distribution. Fluctuations in temperature and precipitation alter ecological relationships, forest migration patterns, and the regular pattern of disturbance regimes (Dale, et al., 2001). These disturbances, which are both human-induced and natural, include fire, drought, insect and pathogen outbreaks, hurricanes, and landslides. In turn, these disturbances have widespread social and economic effects.

In addition to an increase in vulnerability due to climatic factors, there are several challenges that are having either direct or indirect impacts on the forest and biodiversity in Madhya Pradesh. The health of forest is a direct reflection of its sustainable use. Biotic pressure coupled with development pressure is continuously affecting the quality of forest in the state. Key issues faced by the state forests:-

1. Biotic Pressure – Gaps in supply and demand

Increased dependence on forest for fuelwood, NTFPs and grazing results in forest degradation. In Madhya Pradesh, about 72% of the population is residing in rural areas and they are depended on forest for fuelwood, fodder and livelihood. This is leading to unsustainable use & over-exploitation of forest resources.

2. Habitat Loss & Fragmentation

This is one of the major threats to the forest and the biodiversity in the state. The pressure for food, fibre, shelter, fuel and fodder combined with compelling needs for economic development exerts enormous pressure on natural resources. The unsustainably planned development activities like construction of highways, railway lines and expansion of agricultural lands is responsible for fragmentation of natural ecosystem and habitats of the local species. This also results in conflict between human & wildlife. Fragmentation divides the population into small units and imposes barriers to their migration, which could lead to extinction of local species.

3. Lack of species diversity

All the afforestation programs running in the state focus on limited species plantation, species that are preferred in forest plantations is mostly Teak, Aonla and Bamboo. There is a need to shift the focus towards multi species forest plantation activities henceforth.

4. Land Diversion and Unplanned development projects

Consumption and diversion of forestland for development activities is a major concern for forest sector. Infrastructure projects like expansion of highways, railway lines, electricity projects, dams etc. often do not take into account the possible implications on environmental parameters. There has been significant diversion of forest land in Madhya Pradesh: between 1980 and 2017, 2.74 lakh hectare of forest area was diverted for development activities (FSI, 2019).

5. Forest Fires

The forests of the state are mostly dry and deciduous and prone to forest fires in the summer season from February to June. Frequent forest fires in the state are one of leading cause for biodiversity destruction. Frequent forest fires eliminate fire sensitive species, and affects forest regeneration, microclimate, soil and wildlife. The forest area affected by fire outbreak has been increasing in MP. In 2017 the forest area affected by forest fire increased to 13809 ha from 9439 ha in 2016.

6. Ignorance of climate change concerns in Forest Working Plans

The forest working plans are mostly tree centric. This approach needs a change towards holistic biodiversity conservation that includes ecosystem services into planning and integration of climate change concerns.

7. Invasive alien species

One of the major issues faced by the native floral and faunal species is the increasing expansion of invasive species. In Madhya Pradesh, the major invasive species are Lantana camara, Hyptissuaveolens, Parthenium hysterophorus, (livelihood put pressure) etc. Also, there is lack of institutions and expertise in the field of alien species.

8. Un-sustained efforts in grasslands

Restoration of the productivity of grasslands in wildlife protected areas requires sustained efforts.

9. Increasing encroachment cases and illicit felling

Encroachment of forest lands for the purpose of agriculture & livelihood put pressure on the forests. Also, the illicit felling of trees results into depleting forest cover.

10. Deterioration of soil affecting biodiversity and reducing forest growth & produce

With the increase in temperature & erratic rainfall pattern, it is likely that higher rates of degradation of forests and soils would occur thereby affecting biodiversity and eventually, reduce forest produce. Hilly and sloppy lands are more prone to soil erosion and loss of leafy biomass.

7.4 Proposed Strategies and Actions

Strategy		Actions	Department/ Organisation	Priority level	Proposed Cost (in Crore) for 2021-30
Scientific management of forest for enhancement of ecosystem services and climate change mitigation	1.	Biodiversity conservation by enhancement in the area under PA network - National Parks, Sanctuaries, Buffer and Corridors.			67183.90
	2.	Reduction in fragmentation of habitat by the voluntary relocation of villages			1558.20
	3.	Improvement of major biodiversity area through "Landscape Approach" and mainstreaming of Biodiversity conservation concerns into all the departments of the Government and sectors of production			6212.71
	4.	Specific conservation plans for RET species, rare vegetation communities and specialized habitats.			0.00
	5.	Information, Education and Communication (IEC) campaign to engage citizens for conservation and reduction in man-animal conflict.			
Improve Forest cover to achieve nationally determined contribution (NDC) goals on climate change mitigation and adaptation and ecosystem services - water and soil conservation	6.	Improvement in 7.5 Lakh ha forest area through assisted natural regeneration.			1500.00
	7.	Restoration of 7.0 Lakh ha degraded forest area, with special focus on river catchment areas, through active participation of local communities by planting 20 crore saplings.			8015.00
	8.	Capacity Development of joint forest Management Committees through better policy, institutional arrangement and training.			0.00

Strategy		Actions	Department/ Organisation	Priority level	Proposed Cost (in Crore) for 2021-30
	9.	Increase in green cover outside forest by planting 1.00 crore saplings of useful trees on community lands and farmlands.			50.00
	10.	Greening of urban areas through recreational forests and roadside plantations			22.90
	11.	Use of IT for improving forestry governance and resolution of disputes between forest and revenue department by using remote sensing, GPS and GIS technologies.			
To increase forest-based livelihood incomes of forest-dueeling families through provisioning services like fodder, timber and fuel non-timber forest products	12.	Strengthening livelihoods of forest-dueeling communities through conservation of Non-Timber Forest Products, non-destructive harvesting and post-harvest processing.			837.44
	13.	Entrepreneurship development among local communities by handing over operation of Non-Timber Forest produce processing centres.			
	14.	Enhancement of bamboo productivity in the state and development of bamboo-based entrepreneurship.			324.00
	15.	Increased opportunities in the ecotourism sector in collaboration with forest dwelling communities and entrepreneurs.			60.00
	16.	Sharing timber and fuelwood in lieu of conservation efforts of the local communities as per the provisions of the Government Resolution of the year 2001 on joint Forest Management.			7.15
	17.	Integrating forest-dwelling communities into mainstream economic activities through skill development of youths.			
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	18.	Create Climate Change Working Group in the department			7.00
	19.	Integrate climate change concerns with the departmental activities			
	20.	Coordinate / liaison with National missions and programme for convergence			
	21.	Coordinate / liaison with MP SAPCC M&E agency			
				Total	**85778.00**

8 WATER RESOURCES

8.1 Sector Overview

Water resources of state are primarily dependent on the amount of precipitation it receives and traditional practices of storage and usage patterns. Precipitation, temperature, runoff and groundwater recharge are key variables controlling water availability. With an increasing population, high climate variability, and the pressure of anthropogenic activity, water resource management poses unique set of difficult challenges for the state.

Catchments of many rivers of India lie in Madhya Pradesh. The northern part of the state drains largely into the Ganga basin and the southern part into the Godavari system. The Narmada and Tapi rivers flow from east to west.

Various studies and reports suggest that currently many rivers do not comply with the set water quality criteria in Madhya Pradesh and the rivers with polluted river stretches have increased in the state (CPCB, 2018). The river systems are threatened by ecological stress, depleting forest cover, illegal and indiscriminate sand mining, and pollution by industrial waste and untreated sewage.

Groundwater is a major source of irrigation and drinking water in our state. There have been several incidences of indiscriminate use of groundwater in many parts of the state leading to conditions of over-exploitation and crisis of groundwater.

Water sector at a glance		
Items	**Unit**	**Quantity/ Description**
Normal Rainfall[9]	mm.	1073
Net Irrigated Area	Lakh Ha.	95.84
Water User Association (WUA)	Nos.	2064
Major River basin[10]	Nos.	5 Ganga (Yamuna Basin), Wainganga (part of Godavari Basin), Tapti, Narmada and Mahi
River sub-basin	Nos.	10 Chambal, Sindh, Betwa, Ken, Tons (Upper Ganga), Sone (Lower Ganga), Narmada, Wainganga, Tapti and Mahi
Total Annual Replenishable Ground Water[11]	BCM	36.04
Total Annual Ground Water recharge	BCM	36.16
Ground Water Draft	BCM	**Total -** 19.52 **Irrigation-** 93.14% **Domestic & Industrial-** 6.86%
Ground water status (Block)	Nos.	**Safe-** 233 **Semi Critical-** 50 **Critical-** 08 **Over Exploited-** 26 **Saline-** 0
Annual Surface Water Availability (75% dependability)[12]	BCM	81.5
Allocated to MP	BCM	56.8
Allocated to neighboring states	BCM	24.7
Annual extractable ground water resource	BCM	33.38
Annual groundwater extraction	BCM	18.97
Stage of ground water extraction	%	56.82

[9]http://www.mpwrd.gov.in/documents/18/568216f2-aab3-4aae-aea0-40a23f9ea585
[10]http://www.mpwrd.gov.in/aboutus
[11]Dynamic Ground Water Assessment, Madhya Pradesh, 2015 <http://www.mpwrd.gov.in/dynamic-gw-assessment-2015>
[12]Source: Meeting of "Inter Ministerial Committee on Water Conservation" held on 1st May, 2019

Dynamic Ground Water Resources Assessment is carried out at periodical intervals jointly by Central Ground Water Board, North Central Region, Bhopal and Ground Water Survey, Water Resource Department, Govt. of Madhya Pradesh under the guidance of State Level Committee and under the overall supervision of the Central Level Expert Group. Such joint exercises have been taken up earlier in 1980, 1995, 2004, 2009. 2011, 2013 and 2017.

The assessment involves computation of Dynamic Ground Water Resources or Annual Extractable Ground Water Resource, total Current Annual Ground Water Extraction (utilization) and the percentage of utilization with respect to annual extractable resources (Stage of Ground Water Extraction). The assessment units (Blocks/ Urban areas) are categorized based on Stage of Ground Water Extraction, which are then validated with long-term water level trends. The assessment prior to that of year 2017 were carried out following Ground Water Estimation Committee (GEC) 97 Methodology, whereas 2017 as well as the present assessment are based on norms and guidelines of the GEC 2015 Methodology.

The main source of replenishable ground water resources is recharge from rainfall, which contributes to nearly 77 % of the total annual ground water recharge. A major part of the state receives rainfall mainly during SW Monsoon season spread over the months of June to September. Over 99 % of the annual rainfall is received in the four rainy months for June to September only thereby leading to large variations on temporal scale.

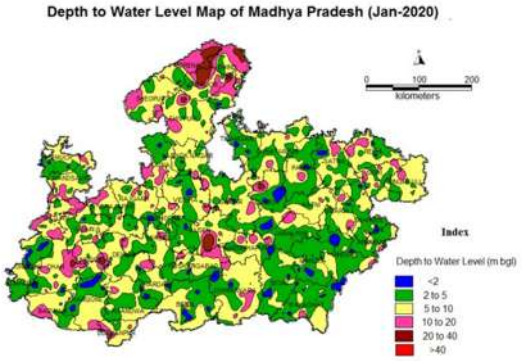
Type of rock formations and their storage and transmission characteristics have a significant influence on ground water recharge. Ground water occurrence in the Hard rock formations which are occupying nearly 80% of the total geographical area of the state, are forming poor aquifers. Porous formations such as the alluvial formations in the Bhind (Chambal basin), Hoshangabad and Narsimhapur districts (Narmada basin) and also in Sheopur, Morena, Datia, Chhatarpur, Jabalpur, Katni, Khandwa, Burhanpur, Raisen, Sidhi and Balaghat districts and along rivers in some other districts on the other hand generally have high specific yields and are good repositories of ground water.

In the present assessment, the total annual ground water recharge has been assessed as 36.16 bem. Keeping an allocation for natural discharge, the annual extractable ground water resource works out as 33.38 bem. The total annual ground water extraction (as in 2020) has been assessed as 18.97 bem. The average stage of ground water extraction for the state as a whole works out to be about 56.82%. The extraction of ground water for various uses in different parts of the state is not uniform. Out of the total 317 assessment units (Blocks/ Urban areas) in the state, 26 units (8.20 %) have been categorized as Over-Exploited indicating Ground Water extraction exceeding the total Annual Extractable Resources. A total of 8 (2.52 %) assessment units have been categorized as 'Critical', where stage ground water extraction between 90-100 % of annual extractable resources available. There are 'Semi-Critical' units (15.77%), where the ground extraction between % and % and 233 (73.51%) assessment units have categorized 'Safe' where the stage of Ground water extraction less than %. 33383.40 mem of total Annual Extractable Resources the state, 3349.83 (10.04 %) are under 'Over-Exploited', 754.83 mcm (2.26 %) are under 'Critical", 5021.66 mem (15.04 %) are under 'Semi-Critical', 24254.07 mem (72.66%) are under 'Safe' category assessment units.

In assessment, the total numbers of assessment units in the state have increased from 313 four urban areas of the namely Bhopal, Indore, and Jabalpur are added this assessment. The total annual ground water recharge decreased from 36.42 36.16 bem. The changes are attributed mainly to changes in recharge from 'Other Sources'. Accordingly, the annual extractable resource of Ground Water Assessment, comparison Ground Water Resource Assessment, shows from 34.47 33.38 bem. The ground water extraction has marginally increased from 18.88 to 18.97 bem and the changes are attributed mainly due increase in the abstraction structures and increase in population. The overall stage of groundwater extraction has increased from 54.76 % to 56.82

units western part of Madhya Pradesh, which is known “MALWA where ground water extraction has increased many folds during District wise of data of annual extractable resource annual ground extraction indicate namely Indore, Mandsaur, Ratlam Shajapur are districts where stage of ground water extraction is more 100% a whole.

As per the Central Ground Water Board report, there are 26 blocks which are classified as severely over-exploited. The CGWB report further reveals that the ground water availability status is semi-critical in 50 blocks, critical in 8 blocks and overexploited in 26 blocks. The deteriorating quality of ground water is also a rising concern of our state.



The wetlands are the lifeline of state's aquatic ecosystem. Unfortunately, these unique wetlands are facing tremendous ecological stress because they are seen only as source of water and not as, traditional holistic biotic system. This has diminishing effect on wetlands numbers, size and ecological integrity of wetlands across the state. The growing demand for land in urban areas has also led to the loss of wetlands.

Our ability to cope, adapt and responding to these challenges depends on how we incorporate the understanding into water resource planning and management decisions.

The quality of fresh water system in state is fast deteriorating owing to depleting forests cover, siltation, ove rexploitation of surface and groundwater and growing pollution levels caused by many sources. In case of wetlands, sewage inflow and subsequent weed infestation and encroachment are major concerns. These concerns call for a review of current water use and management practices and monitoring mechanisms.

8.2 Initiative in vogue

The Water Resources Department (WRD) oversees all the irrigation projects via minor, medium, and major irrigation projects, flood control, and drainage works. Since water is a multi-sectoral resource, and climate impacts on water have cascading effects on society and environment, there are multiple departments that influence the water sector in Madhya Pradesh. Water Resources Department has adopted various policies and schemes with a focus on water availability.

Enhancing Adaptive Capacity to Climate Change throughConservation of Traditional Water Supply Sourc of Indore City

The project is sanctioned by Ministry of Environment, Forest and Climate Change under Climate Change Action Program (CCAP) and is being jointly executed by EPCO and Municipal Corporation, Indore to enhance the adaptive capacity to address climate change through the conservation of traditional water supply sources. The objective of the project is to conserve and rejuvenate 330 wells and bawdies of Indore city with community participation addressing twin challenges of rising water demand and impact of climate change.

The project has positively impacted environmental, social and economic systems in Indore as water is conserved through traditional, low-carbon intensive techniques, increase in water availability and improved quality with increased savings of IMC. IMC would save an amount of Rs. 5.61 crores per annum through the project activities.

National Water Policy 2012

This policy seeks to address issues such as the scarcity of water, inequities in its distribution, and the lack of a unified perspective in planning, management and use of water resources. It stresses the importance of climate change in water management by supporting micro-level watershed management, revival of traditional water harvesting structures, coordination among various departments for demand management, and stakeholder engagement for land-soil-water management. It also highlights that climate change projections need to be considered before planning and designing new irrigation and storage projects.

Earth Care Awards 2019

EPCO has received prestigious Earth Care Award 2019, set up by Times of India-JSW foundation in the year 2019 under "Leadership in Urban Climate Actions" category for the project "Enhancing Adaptive Capacity to Climate Change through Conservation of Traditional Water Supply Sources (Wells & Bawdies) of Indore city" being implemented by EPCO in association with Indore Municipal Corporation as part of the Climate Change Action Programme of Ministry of Environment, Forest and Climate Change (MoEFCC).

State Water Policy 2003

This policy is driven by the principles and objectives of National Water Policy of 2002 and suggests multi-purpose planning of water resources at basin level with provisions for drinking water and irrigation. The policy has not been revised to include climate change impacts in the planning process. However, programs under the guidance of this policy need to focus on elements such as basin-level planning and watershed management in accordance with climatic conditions and ground water development can support integration of climate impacts in implementation plans. Activities under the policy now need to consider climate projections in addition to demand projections in order to manage water resources better in increasingly uncertain conditions.

Atal Bhoojal Yojana

Atal Bhujal Yojana (ATAL JAL) is a Central Sector Scheme for facilitating sustainable ground water management. The scheme lays emphasis on community participation and demand side interventions for sustainable ground water management in identified water stressed areas in seven States of the country, including Madhya Pradesh. The scheme will benefit 678 gram panchayats of 9 blocks of 5 districts (Sagar, Damoh, Panna, Chhatarpur & Tikamgarh) of MP.

PM Krishi Sinchayi Yojana

This scheme has been formulated with the vision of extending the coverage of irrigation with the mission of "Har Khet Ko Paani" and improving water use efficiency undertaking, "More crop per drop" in a focussed manner with end to end solution on source creation, distribution, field application and extension activities.

8.3 Sectoral Concerns

1. Rainfall variability

The south-eastern districts receive more rainfall than thenorth-western districts. The southwest (SW) monsoon, which brings about 91% of the total rainfall over the state, is critical for the availability of fresh water for drinking and irrigation. Changes in climate over Madhya Pradesh, particularly the SW monsoon, would have a significant impact on agricultural production, water resources management and overall economy of the State.

2. Groundwater Dependence & Exploitation

70% of the rural water supply is dependent on groundwater versus 30% of the urban water supply (World Bank 2012). Given that groundwater is a critical resource for climate adaptation, largely acting as a buffer with precipitation changes, there is a need to combat groundwater exploitation and dependence.

3. Groundwater Exploitation

Over-exploitation of groundwater has been causing shortages of water for irrigation and drinking water. With an estimated 18 billion cubic meters (bcm) groundwater extraction, the state is fast hurtling towards a serious crisis of groundwater overuse and groundwater contamination. The report[13] of the MPWRD and Central Water Ground Board (CWGB) stated that majority of Madhya Pradesh's districts were showing alarmingly levels of groundwater over exploitation and half of the districts come under semi-critical, critical and over exploited category.

4. Degrading wetland ecosystems

In Madhya Pradesh, there are 17,666 wetlands with an estimated area of 8,18,166 hectares (MoEF 2013). The Bhoj wetland of Bhopal is one of the most important wetlands in the country and the only recognized Ramsar Site of the state (Ramsar 2002). However, wetland ecosystems are at risk of degrading due to changes in temperature and precipitation. As carbon sinks, wetlands play a key role in buffering climate change effects.

Building Climate Resilience of communities through participatory Groundwater Management in Burhanpur and Ratlam districts

A pilot project on "Participatory Groundwater Management" was implemented as part of the EPCO-UNDP-SDC project "Strengthening State Strategies for Climate Actions" in Sangrampur block of Burhanpur district and Gudarkheda block of Ratlam district. As part of the project, following interventions have been made:-

- **Supply Side Interventions:**

a) **Sub-surface recharge structures:** Artificial groundwater recharge measures such as Vertical Recharge Shafts, Defunct Borewell recharge, Soil Aquifer Recharge etc. have been demonstrated.

b) **Surface recharge structures:** Gabion structures (20) and Loose Boulder structures (6) were constructed to control silt load and increase water accumulation at the artificial recharge structures.

- **Demand Side Management:**

a) **Measures for Optimum Groundwater:** Water use efficiency, Crop Water Budgeting etc. have been demonstrated to strengthen the concept of shared aquifer management, reduce evapotranspiration losses and to improve irrigation water scheduling.

b) **Sustainable Agriculture Practices:** Sustainable agriculture practices were demonstrated to improve soil health, minimize water use, better soil moisture management and reduce risks from climate variability.

c) **Institution Building on PGWM:** Enabling environment for Climate Action Plan implementation has been created through strengthening scientific groundwatermanagement and capacity building activities offering a package of practices on PGWM.

5. Dams and Infrastructure

Out of the 5,701 large dams in India, 906 are in Madhya Pradesh (CWC 2015). Dams and other infrastructure development can act as adaptation measure, but they can also threaten freshwater diversity via (i) upstream effects caused by impounded water (ii) downstream effects caused by disrupted flow and quality of water. Dam design, planning, and management should incorporate the uncertainties linked to a changing climate while considering biodiversity conservation and natural flow of the river.

6. Drying up of major rivers

Rivers are critical resources, yet they are at risk due to human interference (pollution, flow modification, and large-scale storage reservoirs). These risks are exacerbated by climate change, which affects water quantity and quality. For example, extreme rainfall events dump excessive water on headwater regions which causes floods. At the same time, because soils can't absorb all the rain, contaminated runoff enters the river.

7. Improper Waste Management Practices

Industrial and agricultural waste, trash, sewage sludge, and other toxic materials are often dumped into water bodies. These waste management practices pollute the water and disrupt its ecology. Waste reduction & proper treatment strategies can help ensure clean water provision.

Restoration & Conservation of Traditional Water Supply Sources in Burhanpur city

A project has been sanctioned by the Ministry of Environment, Forest and Climate Change, GoI under Climate Change Action Program (CCAP). This is being jointly executed by EPCO in association with Burhanpur Municipal Corporation and Burhanpur Forest Department to build climate resilience of Burhanpur city through restoration and use of traditional water structures and treatment of the kundi bhandara catchment area.

As part of the project restoration of 71 open & step wells of the city along with restoration of Kundi Bhandara Network (110 kundis) are being done. Besides these 250 rain water harvesting structures in the govt. buildings are being. One of the most significant interventions is plantation & grassland development and protection activities in the upper catchment of Kundi Bhandara.

The project is expected to help in augmentation of water availability in Burhanpur. The additional water supply through Kundi Bhandara network would directly reach to more than 3500 families. It is expected that the project will result in cost saving of INR 17.23 lakh per annum for the Municipal Corporation by reducing the pumping costs.

[13]Dynamic Ground Water Resources of Madhya Pradesh, 2015

8.4 Proposed Strategies and Actions

Strategy	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
Adoption of Integrated Basin Management approach for conservation & security of water resources	1.	Developing Sub basin level integrated management programs by involving various stakeholders to maximize economic and social welfare	WRD	High	407.00
	2.	Develop Integrated Aquifer Management Plans and implement Aquifer recharge structures (like construction of recharge shafts) in the no ground water stress areas to address the supply & demand issues.	WRD	High	
	3.	Release of water from dams to ensure environmental flows especially during lean periods, also support ground water recharge	WRD	High	
	4.	Command Area Treatment (CAT) Plans for Forest Catchment Areas: Surveying, identification and protection of head waters, especially forested catchments of all rivers of the state to ensure water security of the state and region	WRD, DoRD, MoWD	High	
	5.	Research & pilot projects in water stressed areas to enable improved efficiency in water use	WRD, DoRD, MoWD	High	
	6.	Biological stabilization & treatment of river banks for preventing bank erosion and filtering pollutants reaching the river by increasing the vegetative cover on the banks	WRD, DoRD, MPFD, Research Institutes	High	
	7.	Preparation & implementation of natural infrastructure driven soil and water conservation plan	WRD, DoFW&AD, Research Institutes	High	
	8.	Promote conjunctive use of surface and ground water a. by establishing tracking system for handling canal supplied water for irrigation	WRD, CGWB	High	
Advancement of technological inputs for informed decision making with regard to water conservation, augmentation and preservation	9.	Development of a comprehensive water data base and use of Information systems a. To create a district level ground water data bank of the entire state for successful implementation / execution of various development and management programmes / schemes. b. Development of Decision Support System (DSS) for basin level water management including command & catchment area of dams	WRD, CWC, CGWB, DoE	Medium	454.65
	10.	Expansion of Hydrometry (monitoring of components of hydrological cycle) Network to support planning and asset management decisions at sub basin level	WRD	High	

Strategy	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
	11.	Promotion of traditional system of water conservation by implementation of programme for repair, renovation and restoration of water storing bodies viz. wetlands, lakes, open wells, step wells in the affected areas	WRD, DoRD, UADD, PHE, DoE	High	
	12.	Expeditious implementation of programme for conservation of water through recharge of ground water including rainwater harvesting and artificial recharge in areas / situations sensitive to CC	WRD, DoRD, UADD, PHE, DoE	High	
	13.	For effective management of water involve the communities through PRI's in rural areas and WUA's in urban areas.	WRD, DoRD, PHED, UADD, DoE	High	
	14.	Legislation for use of GW regulation & management.	WRD	High	
	15.	Develop a convergence basesd viable Panchayat/ District level model using NREGA funds towards GW conservation especially in over exploited areas	WRD, DoRD, MoWR	High	
Strengthening of Planning and Extension Services	16.	Formulation of a State Ground Water Policy which is responsive to the agro climatic zones, water demand, equitable distribution and climate change projections	WRD, DoE	High	4.00
	17.	Supply/demand coordination & water audit to reduce water losses	WRD, PHED	High	
	18.	Constitution of MP State River Conservation Authority to achieve inter-sectoral approach for management and conservation of ground and surface water	WRD	Medium	
	19.	Strengthening of guidelines for optimum utilization of ground water resources for agriculture purposes and restriction on exploitation of sensitive belowground aquifers	WRD, CGWB, DoFW&AD	Low	
	20.	Awareness among users for avoiding misuse of water	WRD, CGWB, DoE	Medium	
Increase water use efficiency in domestic, commercial, agricultural and industrial purposes	21.	Improvement of water drainage systems to reduce flood risk during heavy rainfall days	WRD, PHED, UADD	Medium	146.00
	22.	Reduce water use and promote reuse of wastewater by promoting water use efficiency measures like promoting Public Recharge systems, Nozzle Taps technologies, etc.	WRD, UADD, DoE	High	
	23.	Development of rain-water harvesting and retention structures in urban and rural areas	UADD, DoRD, DoFW&AD	Low	
	24.	Promote wise water practices and harvesting techniques	UADD, PHED	High	
	25.	Establish mechanism for conjunctive use of surface and ground water	UADD, PHED	High	

Strategy	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
	26.	Development and enforcement of appropriate pricing policy for water usage in industrial, agricultural, domestic aspects	WRD, UADD, DoF, DoA, DoIP&IP, DoE	Medium	
	27.	Incentivising adoption of water efficient technologies.	WRD, UADD, DoF, DoA, DoIP&IP, DoE	High	
	28.	Mandatory water use audit for industries and allied sectors	DoF, DoIP&IP, DoE	Medium	
	29.	Development of PPP model for recycling & treatment of waste water (industrial as well as urban)	UADD, DoIP&IP	Medium	
Comprehensive water database in public domain and assessment of the impact of climate change on water resources of MP	30.	Comprehensive reassessment of the groundwater resources upto block level at regular interval	WRD, CGWB	High	61.00
	31.	Promote scientific planning of groundwater development and conservation methods	WRD	Medium	
	32.	Expansion of groundwater monitoring stations	WRD	High	
	33.	Collection of necessary additional hydro-meteorological, hydrogeological and hydrological data and ensure availability on public domain.	WRD, MoWR, CWC, CGWB	High	
	34.	Development of Water Resources Information System (except the data of sensitive and classified nature, all information to be in public domain), adding Climate Change scenarios to Water Data Analysis Centre and Hydrology Info Systems	WRD, MoWR, CWC, CGWB	High	
	35.	Assessment of basin wise surface water availability in present and future climate scenario including water quality	WRD, MoWR	High	
	36.	Review of State Water Policy in view of National Policy and National Water Mission	WRD, DoE / SKMCCC	High	
	37.	Assess scope and implications of further inter basin connections and thus adopt integrated water resource management and encourage basin development	WRD, DoE / SKMCCC	Medium	
	38.	Giving due attention to water scarce areas and under developed basins develop management plans for the river basins of MP	WRD, DoRD, DoA	High	
	39.	Mapping of areas likely to experience floods, establish hydraulic and hydrological models and developing comprehensive schemes for flood management & reservoir sedimentation	WRD, MoWR, Research Institutes, SDMA	High	
	40.	Develop, revise and update inventory of wetlands, lakes on GIS platform	SWA, DoE	High	

Strategy	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
Promote accelerated pace of surface water development in the state	41.	Effective implementation of Participatory Irrigation Management (PIM) Act 2006	WRD, ID, DoRD	High	140.00
	42.	Climate proofing of irrigation projects in areas that are sensitive to Climate Change- identification of areas and undertaking pilot projects	WRD	High	
Capacity building	43.	Training of professionals from various departments / organizations / PRIs / ULBs associated with water resources development and management	WRD / DoRD / WALMI	High	5.00
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	44.	Create Climate Change Working Group in the department	WRD, DoE	High	7.00
	45.	Integrate climate change concerns with the departmental activities	WRD, DoE	High	
	46.	Coordinate / liaison with National missions and programme for convergence	WRD, DoE	High	
	47.	Coordinate / liaison with MP SAPCC M&E agency	WRD, DoE	High	
				Total	**1234.00**

9 Human Health

9.1 Sector Overview

Human resource is envisioned as demographic dividend however environmental degradation can have a significant impact on human health. Estimates of the share of environment related human health impacts are very high. Air pollution and exposure to hazardous chemicals are important causes of the environment-related burden of disease. State has shown considerable improvement in most of the health indicator, however state has some of the worst maternal and child health indicator with highest number of malnourished children.

Health sector at a glance					
Birth Rate (%)	24.6 (2018, Vol 53 No 1)	27.3 (2010-11)			
Death Rate (%)	6.7 (2018, Vol 53 No 1)	8.3 (2010-11)			
IMR (per 1000 live births)	48 (2018, Vol 53 No 1)	62 (2010-11)			
Project Level of Life Expectancy at Birth	Male 66.5; Female 67.3 (National Health Profile, 2019)				
Total Neonatal Death	35 (2018, July)				
Total Fertility Rate (Birth/Woman)	2.7 (2018, SRS)	3.1 (2010-11)			
Health Infrastructures (31ST March 2020)	10189 Sub-Centres	1199 PHCs	330 CHCs	84 CH	52 DH

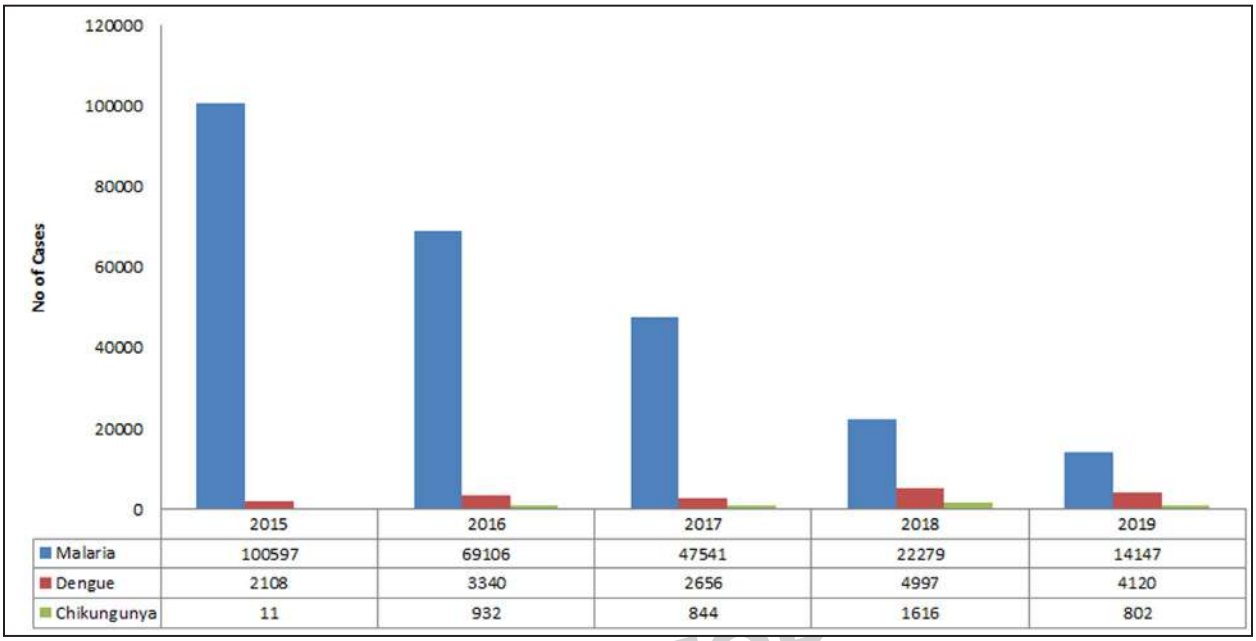
Zoonotic Diseases are major public health issue and India is among the top geographical hotspots for such diseases. According to World Health Organization (WHO), "there is a coexistence of humans in a complex, interdependent relationship with the companion, production, and wild animals we depend on for our food, livelihoods, and well-being, as well as with the environments we live and work in together". In India, incidence and prevalence of zoonotic diseases have affected human health throughout times. In recent past, India has seen emergence and re-emergence of high priority and neglected Zoonoses. Emergence of new zoonotic pathogens like Novel Corona virus has recently caused heavy toll on human life and economy.

The increasing temperature in northern India or excessive rainfall in north-eastern part of India due to climate change leads to higher growth of vectors. Increase in crop and food production after rainfall increases the population of rodents and birds and thus increases the chances of water and food borne Zoonoses. Poor personal hygienic practices, improper farming practices, lack of awareness, poor diagnostic facilities, under-reporting system, poverty and lack of medical facilities, all this causes' high burden of morbidity and mortality. However studies suggest that cases for Zoonoses in central states (like Madhya Pradesh and Chhattisgarh) were either under-reported or less prevalent.

Opportunities for reducing environment-related health risks are considerable. The benefits of environmental policies in terms of reduced health care costs and increased productivity significantly exceed the costs of implementing these policies.

The State is taking initiatives in building a healthy society by making quality medical facilities available and reachable to the people and also by focusing on preventive health care. According to SRS data 2014-16, during 2010-12 the Maternal Mortality Ratio (MMR) in the state was 230 that reduced to 173 and as per 2014-16 State Health Management Information System Data against the National MMR of 130. The present Total Fertility Rate (TFR) in the state is 2.8 against India's status of 2.3.

There has also been an increase in vector-borne diseases like dengue and chikungunya from 2010 to 2018 (Figure below). Transmitted by infected arthropods (mosquitoes, ticks, flies, etc.), these vector-borne are highly climate sensitive.



	2015	2016	2017	2018	2019
Malaria	100597	69106	47541	22279	14147
Dengue	2108	3340	2656	4997	4120
Chikungunya	11	932	844	1616	802

Non-communicable diseases such as hypertension, bronchitis, and severe mental disorder (as in table below) have increased from 2016 to 2017. While the reason for this increase is not solely attributable to climate change, there is evidence that climate change can influence and exacerbate these diseases. Non-communicable diseases are also strongly linked to environmental exposures like air pollution and extreme weather events. (DoPH&FW 2018)

Table : Non-Communicable Diseases in Madhya Pradesh

Diseases	2016	2017
Cardiovascular Diseases		
Hypertension	217490	219590
Ischemic Heart Diseases	37541	31032
Lung Diseases		
Bronchitis	181812	188966
Emphysema	13378	11817
Asthma	119796	96768
Psychiatric Disorder		
Common Mental Disorder	16175	13359
Severe Mental Disorder	1646	2862

9.2 Initiatives in vogue

Department of Public Health & Family Welfare is making efforts towards integrating climate change concerns into its departmental plans and activities to build the adaptive capacity of the Health sector. Currently, following plans and schemes are being coordinated by Department of Public Health & Family Welfare.

National Health Policy

This policy aims to make the health care system people-centric and achieve well-being with preventive methods and promotion of good health practices. Apart from increasing government expenditure on health care, the policy aims to reduce the fertility rate from 2.3 to 2.1 by 2025 to improve development indicators such as maternal mortality and infant mortality rate. The policy especially focuses on women and children's health by monitoring and addressing malnutrition levels. The policy discusses convergence with various departments to reduce vector propagation and air and water pollution but does not directly discuss impacts of climate change on the sector and their convergence with the department's regular activities.

National Rural Health Mission

The mission seeks to provide equitable, affordable, and quality health care to the rural population, especially marginalised communities, women, and children. The mission aims to provide health services in relation to air, water, sanitation, gender equality, nutrition, and education with the help of communities' own decentralised services and with support from other departments such as Ministry of Rural Development and Panchayati Raj.

National Urban Health Mission

The mission aims to increase service centres along with growing population with a special focus on urban poor, slum dwellers, homeless, street vendors, rickshaw pullers, and construction workers. The mission converges on health determinants such as drinking water, sanitation, and education implemented by the Ministries of Urban Development, Housing & Urban Poverty Alleviation, Human Resource Development and Women & Child Development.

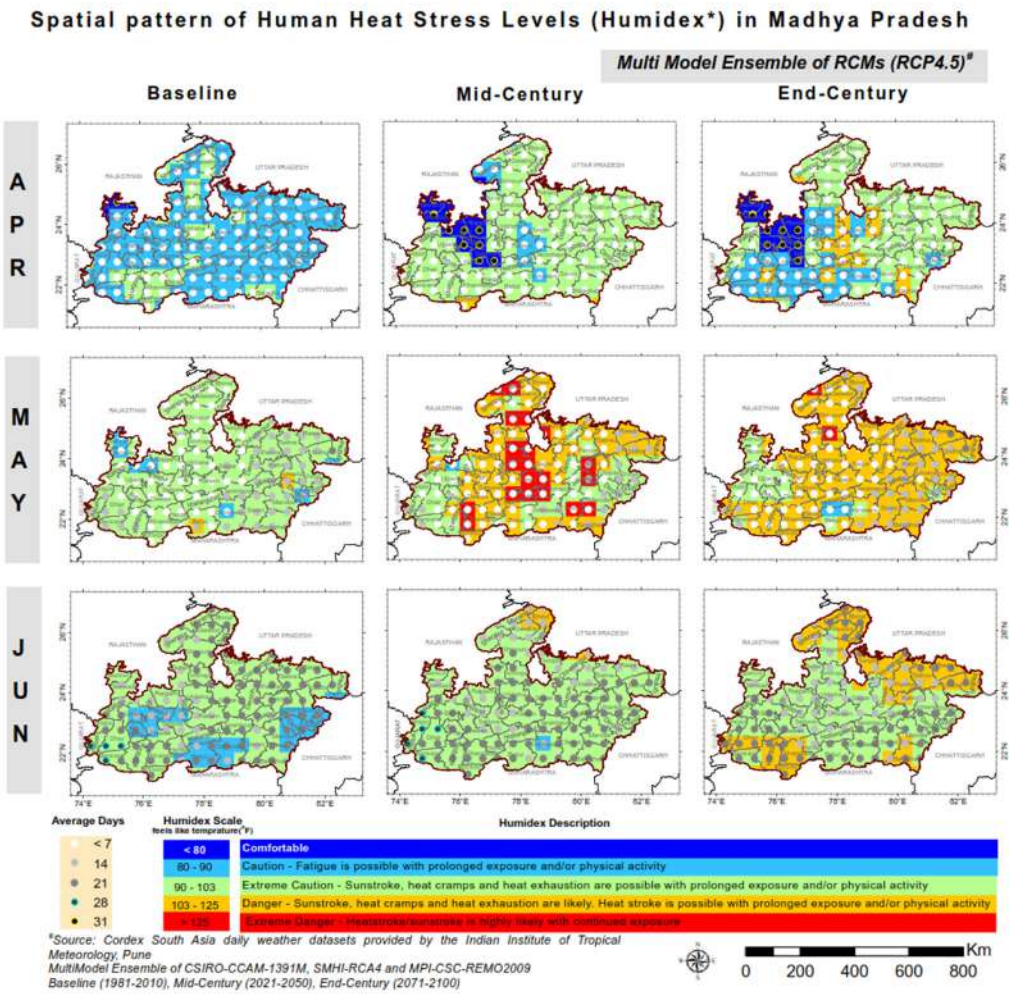
Strengthening Health Quality under Quality Assurance Program

This unit is committed to work towards the continuous up-liftment of the healthcare services through implementing National Quality Assurance Standards and Swacchata Guidelines under Kayakalp Abhiyan.

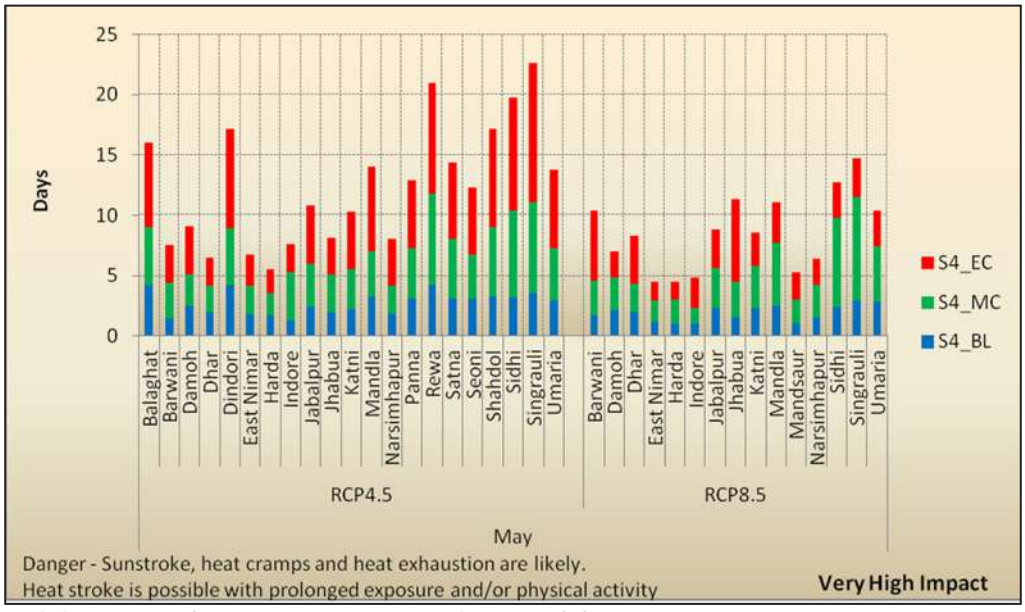
Draft State Health Policy

The state policy mirrors the national policy on increasing coverage of health care services to the poor and marginalised. The policy aims to support the disaster management authorities at various stages of disasters to reduce diseases and injuries, and provide quick response when necessary. The policy aims to increase surveillance of diseases under public as well as private health centres to control spread of vectors and communicable diseases.

Humidex projections for Madhya Pradesh



Projected heat stress in Madhya Pradesh in the month of May with green bars showing mid-century increase in extreme heat days



9.3 Sectoral Concerns

1. **Low Disease Surveillance**

   Coverage area for disease surveillance in the state is low specially in the tribal areas and remote location areas.

2. **Re-emergence of vectors and emergence of new vectors/viruses**

   Mutation in strains of viruses has been observed in studies. Hence, vectors and viruses become more resilience towards climatic conditions and re-emerge which cause different kinds of diseases. Due to change in climatic conditions, many new vectors & viruses are emerging having potential of creating health hazards.

3. **Food and Nutrition**

   Climate change can affect crop and milk production adversely, resulting in nutrition deficits especially in women and children. There is high prevalence of Severe Acute Malnutrition and Severe Anaemia in children ageing below 5 years, due to lack of iron and micronutrients. Nutrition deficits can reduce the human body's natural resilience and immunity to diseases.

4. **Illness from contaminated air, water and soil**

   Contamination of air, water and soil due to discharge of chemicals and greenhouse gases increases the risk of health issues.

5. **Extreme Heat Effect**

   Extreme high air temperatures contribute directly to deaths from cardiovascular and respiratory disease, particularly among elderly people. High temperatures also raise the levels of ozone and other pollutants in the air that exacerbate cardiovascular and respiratory disease. Pollen and other aeroallergen levels are also higher in extreme heat. These can trigger asthma, which affects around 300 million people.

6. **Extreme climate events and variability**

   The number of reported weather-related natural disasters has more than tripled since the 1960s. Increasingly variable rainfall patterns are likely to affect the supply of fresh water. A lack of safe water can compromise hygiene and increase the risk of diarrhoeal disease. In extreme cases, water scarcity leads to drought and famine. Floods contaminate freshwater supplies, heighten the risk of water-borne diseases, and create breeding grounds for disease-carrying insects such as mosquitoes. They also cause drowning and physical injuries, damage homes and disrupt the supply of medical and health services.

7. **Change in Transmission Windows**

   Climatic conditions strongly affect water-borne diseases and diseases transmitted through insects. Changes in climate are likely to lengthen the transmission seasons of vector-borne diseases and to alter their geographic range. Malaria is strongly influenced by climate. Mosquito vector of dengue is also highly sensitive to climate conditions, and studies suggest that climate change is likely to continue to increase exposure to dengue.

9.4 Proposed Strategies and Actions

Strategies		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Understanding the health-climate inter-linkage and planning of healthcare services	1.	Developing a climate induced diseases profile	DoPH&FW, Medical University, Research Institutes	High	333.50
	2.	Strengthening/ development and coordination of early warning and surveillance systems to reduce spread of diseases	DoPH&FW, IMD	High	
	3.	Establishment of online system to help identify availability of care provider, register patients in Government hospitals	DoPH&FW, MAP_IT	Medium	
	4.	Monitoring and reporting mechanism with IT and GIS inputs to assess the preparedness and service delivery mechanisms	DoPH&FW, MAP_IT	Medium	
	5.	Involving medical colleges / institutions to prioritize research of climate change impacts on human health	DoPH&FW, Medical University, Research Institutes	High	
	6.	Development of risk maps for climate sensitive diseases such as Respiratory illness, Cardiovascular, Circulatory illnesses, Mental illness, Dengue, Chikungunya and Malaria	DoPH&FW, MAP_IT, Medical University, Research Institutes	High	
	7.	Strengthening Integrated Disease Surveillance Programme to improve planning for epidemic prone areas	DoPH&FW, MAP_IT	High	
	8.	Establishing network of Tele-medicine services to provide timely healthcare advice using consultants and medical specialists from various institutions	DoPH&FW, MAP_IT	Medium	
	9.	Establishment of disease-wise health infrastructure at divisional level	DoPH&FW	Medium	
Strengthening planning for mitigating climate associated risks on health	10.	Strengthening health disaster management framework to mitigate risks associated with climate extremes	DoPH&FW, DoE	High	358.50
	11.	Ensuring involvement of private sector (PPP) in health care financing, management, and service provision like mobile health vans, establishment of laboratories, etc.	DoPH&FW	Medium	
	12.	Establish Nutritional Support Programme for under-nourished in all districts of MP	DoPH&FW, DoWCD	Medium	
	13.	Research & studies on climate change and health impacts	DoPH&FW, DoE, Medical University, Research Institutes	Medium	
	14.	Train & build the capacities of NGOs / CSOs for detecting disease source and reducing source	DoPH&FW, NGOs	High	

Strategies		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Controlling the expansion of transmission windows and containing vector-borne diseases	15.	Source reduction for all vector and water borne diseases through inter-sectoral convergence with other agencies responsible for several ecological determinants of health particularly - air, water, food, etc	DoPH&FW, DoE, UADD, DoRD	High	11.00
	16.	Awareness among communities to ensure community participation in prevention & control of climate sensitive illness	DoPH&FW, DoE, UADD, DoRD	High	
Early case detection and quick control with a focus on areas where coverage is low or absent	17.	Setup disease diagnosis centres in remote and tribal areas (pathological labs)	DoPH&FW, Medical University, Research Institutes, NRHM	High	150.00
	18.	Sensitising communities for early detection of disease and diagnosis	DoPH&FW, Medical University, Research Institutes, NRHM	High	
	19.	Establishment of drug distribution centres with provision of availability of alternative medicines	DoPH&FW, Medical University, Research Institutes, NRHM	High	
Public Awareness and Health	20.	Health education about various vector-borne, water-borne and other climate related diseases to general public	DoPH&FW, PRIs, NRHM, Research Insitutues	Medium	10.00
	21.	Preparation of district, block and village level human health & climate change action plans	DoPH&FW, DoE	High	
Capacity Building	22.	Training & Education of Health professionals on climate change issues	DoPH&FW, DoE	High	5.00
	23.	Capacity building of PRIs to implement block & village level health action plans	DoPH&FW	High	
	24.	Training of rural health activities on vector borne diseases as well as techniques to purify drinking water	DoPH&FW,	High	
Build institutional mechanism for SAPCC plementation and Monitoring & Evaluation	25.	Create Climate Change Working Group in the department	DoPH&FW, DoE	High	7.00
	26.	Integrate climate change concerns with the departmental activities	DoPH&FW, DoE	High	
	27.	Coordinate / liaison with National missions and programme for convergence	DoPH&FW, DoE	High	
	28.	Coordinate / liaison with MP SAPCC M&E agency	DoPH&FW, DoE	High	
				Total	**875.00**

10 Rural Development

10.1 Sector Overview

Rural development ideally seeks social change, sustainable, economic & social development. The ultimate goal therefore is to improve the quality of life of rural people and preserve the natural, landscape and cultural resources environment. Madhya Pradesh is administratively divided into 10 divisions, 52 districts and 54,903 villages. More than 72% of state population resides in villages whose main occupation is agriculture.

Rural Development Sector at a glance	
Total Rural Population	52.5 millions
Decadal population growth	18.4%
Literacy rate	65.3%
Total no. of villages	54,903
No. of total development blocks in M.P.	313
No. of Tribal Development Blocks in M.P.	89 (28.43%)
No. of Gram Panchayats	22,812
No. of Zila Panchayats	50
Livelihoods	Predominantly agriculture
Land Holdings	Total - 163.72 La Hectares Small and Marginal Farmers – 41 La Hectares
Source: Census 2011, Compendium of Agricultural Statistics, Govt. of MP, 2006-07, Statistics of Govt of MP 2020-21	

Maintenance of the natural resource base is crucial to the livelihood of the villagers of the state. Therefore halting and reversing the process of degradation of the natural resources will contribute substantially towards alleviation of poverty in the state. Ecosystem goods and services play a critical role in the provision of livelihoods, good health, habitable environs and resiliency for poor people. Conversely, if ecosystem goods and services are degraded or access is denied, poverty is exacerbated and the natural resource capital for economic development is compromised.

There are many challenges in the sustainable rural development process, namely: ensuring a sustainable food production for present and future generations; offering steady and sustainable rural livelihoods; reducing the vulnerability of the farm sector and maintaining the productive and regenerative capacity of natural resources.

Table 8: Scenario in India and Madhya Pradesh from 2011 Census

Category (As per Census 2011)	India	Madhya Pradesh
Rural Population	833, 087, 662	52,557,404
Share of rural population to total	68.84%	72.37%
Decadal Rural Population Growth (2001-2011)	12.2%	18.42%
Rural Sex Ratio	947	936
Rural Literacy Rate	68.9%	63.94%

Source: Census Madhya Pradesh

The total rural population, as per 2011 Census, in the State is 5.26 crore increasing from 4.44 crore in 2001 Census, achieving a decadal growth of 18.42%. From the table, it can be inferred that Madhya Pradesh has 6.31% of India's total rural population. As per Census 2011, nearly 72.37% population lives in rural areas where they rely on agriculture, forestry, livestock and fisheries for their livelihoods. The total scheduled tribes population in the state is 21.10% of the total population whereas scheduled caste population is around 15.60%.

Table 9: Number of Villages in India and Madhya Pradesh

Census Year	India	Madhya Pradesh
2001	6,38,588	55,393
2011	6,40,867	54,903

From the table above, it can be inferred that number of villages in India increased by 2279 from 2001 to 2011 whereas the number of villages in Madhya Pradesh declined by 490 from 2001 to 2011. The Human Development Index of Madhya Pradesh during 2017 was 0.594 which is not very good. As per Census 2011, about 13% of rural population has access to drinking water within the premises, 51% has access near the premises and 36% has access far away from the premises. About 10.7% of the rural population has access to in-house sanitation facilities. Rural areas especially areas in its south-west, south-east, and north-west are more backward. These are also the regions which are forested and have a large tribal population.

As per the Economic Survey report 2019-20 and Ministry of Jal Shakti , state has been declared as ODF in all the gram panchayats and villages. Phase-wise strategies are being devised for Solid Waste Management in the rural areas of the state.

The major and naturally occurring variations in climate conditions including climate extreme events affect not only urban regions but also rural regions. Thus it becomes imperative to make rural regions more resilient to the impacts of climate change by combining adaptation and mitigation aspects into the planning process.

The chart shows the share of rural population to total population year wise. The share of rural population to total population in the State steadily decreased from 83.36% in 1961 to 72.37% in 2011

The chart shows the trend of decadal rural population growth in Madhya Pradesh. It is observed that growth rate peaked to 26.3% during the year 1961-71 and then gradually decreased to 18.4% during 2001-11.

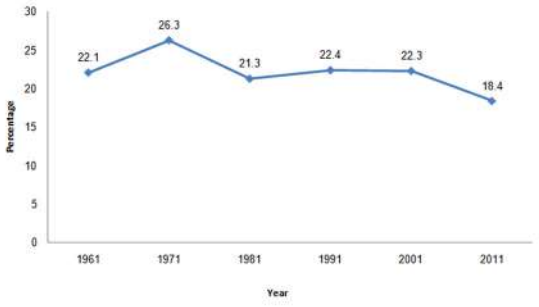


Figure : Decadal Growth of Rural Population

(Source: Census Madhya Pradesh)

The chart shows the trend of decadal rural population growth in Madhya Pradesh. It is observed that growth rate peaked to 26.3% during the year 1961-71 and then gradually decreased to 18.4% during 2001-11.

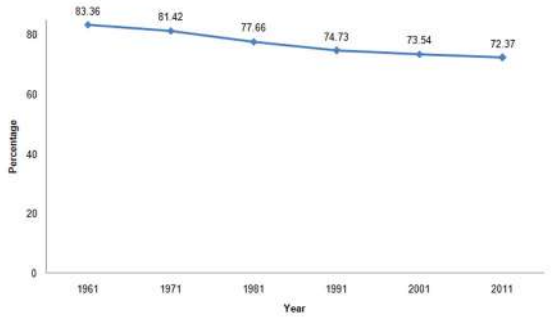


Figure : Share of rural population to total population Madhya Pradesh

(Source: Census Madhya Pradesh)

[14]Human Development Index 2017

[15]http://sbm.gov.in/sbmreport/Report/Physical/SBM_VillageODFMarkStatus.aspx

10.2 Initiatives in vogue

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)

It aims at enhancing the livelihood security of people in rural areas by guaranteeing hundred days of wage-employment in a financial year to a rural household whose volunteer to do unskilled manual work. Launched in the partnership with the states, Government of India through MGNREGA helps reduce rural poverty gap (intensity of rural poverty) and also create employment opportunities.

National Rural Livelihood Mission (NRLM)

NRLM is a national level program to reduce poverty through building strong grassroot institutions of the poor. These institutions enable the poor households to access gainful self-employment and skilled wage employment opportunities, resulting in appreciable increase in their incomes, on a sustainable basis.

State Rural Livelihood Mission (SRLM)

It is an autonomous organisation at the state level for poverty alleviation by creating opportunities for sustainable livelihood through an enabling environment for empowerment and employability support and community based service provider.

10.3 Sectoral Concerns

- Insecure livelihoods due to crop failure, deforestation, deteriorating soil and water quality because of adverse climatic conditions.
- Climate variability affects crop productivity leading to loss of income and migration.
- Low level of income and high dependence on natural resources for sustenance.
- Reduction in the availability of water due to high extraction of groundwater and less availability of surface water.
- Inadequate marketing and processing infrastructure in agriculture and livestock sector due to which primary producers do not get remunerative prices at times. Marketing of products still needs more attention.
- Income disparity needs to be addressed by enabling dignity of labour and gender sensitive ecosystems.
- Unemployable education causing economic deprivation among the youths and families.
- Lack of adequate skill development of the skilled, semi-skilled and unskilled labour force. There is a need to stress on development of skills for specific trade in local context.
- High rate of illiteracy is a major state problem causing vicious circle of poverty in the present and in subsequent generations.
- Education, trainings and skill sets acquired to get employment for rural youth.
- Attention is required towards treatment of 82% unprocessed solid waste.
- Lack of proper drainage system for the sewerage and absence of safe technology options for disposal of faeces.
- Lack of proper maintenance of the infrastructure (IHHL) developed for sanitation.

- Frequent climate extreme events affect the rural development programmes and their implementation.
- Rise in temperature increases the rural demand of energy, and high dependency on conventional sources of energy.

10.4 Proposed Strategies and Actions

Strategies	Action Points		Department/ Organisation	Priority	Activity budget (INR Crore)
Enhancement of livelihood security and employment generation of rural communities	1.	Integration of climate change related actions in poverty alleviation programs like MGNREGA, employment generation schemes, NRLM for BPL and other economically poorer sections of the society.	DoRD, DoE	High	194.00
	2.	Sector wise skill enhancement of the semi-skilled and unskilled workforce to enhance output, productivity for sustaining livelihoods.	DoRD, DoTESD&E	High	
	3.	Handholding in establishing small enterprises to supplement livelihoods	DoRD, DoTESD&E	High	
	4.	Training & Capacity Building of rural communities / PRIs on various aspects of climate change and Ecosystem based climate actions	DoRD, SKMCCC	High	
	5.	Support the workforce in getting jobs as per the obtained skills at local level	DoRD, DoTESD&E	High	
Review of existing rural development programmes with Climate Change focus	6.	Impact assessment of the programme and climate resilience check of the works in progress	DoRD, DoE	High	0.50
Planning of climate change related activities in rural sector and Panchayats	7.	Integration of climate change related activities in annual panchayat plans	DoRD	High	290.00
	8.	Micro-level vulnerability assessment at district and block level, using GIS, to take up informed policy decisions	DoRD, DoE, MPCST	High	
	9.	Rejuvenation of water supply sources and placing recharge shafts for groundwater recharge	DoRD, DoPHE	High	
	10.	Development of open scrub lands through plantations and its maintenance	DoRD, MPFD	Medium	
	11.	Water conservation techniques like Gabion structures, trenches, check dams, etc to restrict soil erosions	DoRD, MPFD	High	

Strategies	Action Points		Department/ Organisation	Priority	Activity budget (INR Crore)
	12.	Replication of best practices from NICRA and other missions in all parts of state in the domain of climate change adaptation and mitigation measures.	DoRD, MPFD, DoFW&AD	Medium	
	13.	Village wise water budgeting for sustainable usage of available water	DoRD	High	
	14.	Development of Farmer Field and Water Schools	DoRD, DoFW&AD	Medium	
	15.	Promotion of consumption of captive energy generation through renewable sources of energy	NRED	High	
	16.	Promote energy plantation in forest areas for biomass generation and Training to villagers about pellet formation to enhance their incomes	NRED, FD	Medium	
	17.	Promotion of water efficiency in agriculture and other uses	DoRD, DoE	High	
	18.	Promotion of Energy efficiency measures, bio-gas and Solar energy applications	DoRD, NRED	High	
	19.	Take up ecosystem and community based climate adaptation projects in rural areas	DoRD, DoE	High	
Development of the food processing units to enable better market for the produce.	20.	Establishment of incubation centre for development of climate resilient value chain of local produce to establish brand and earning higher income.	DoRD	High	12.50
	21.	Market accessibility & linkages to be enhanced	DoRD, DoFW&AD, DoH&FP	Medium	
Rural Infrastructure development	22.	Development of fodder banks at village level	DoAH	Low	185.00
	23.	Ensuring & maintenance of basic infrastructure like RWS, roads, internet, toilets, solar based street lights, etc.	DoRD, MPUVN, MPRRDA	High	
	24.	Ensuring regular piped supply of potable drinking water in the rural areas with necessary maintenance arrangements.	DoPHE	Medium	
Strengthening the efforts being made for solid waste management and sanitation	25.	Change in behavioural aspects through awareness campaigns.	DoRD, DoE/ SKMCCC	High	7.00
	26.	R&D for devising new technologies for treatment and disposal of Solid Waste Management.	DoRD/SBM	Medium	
Convergence & integration with the CC action plans departments like Forest, Agri, Water, Health, RD, Energy etc	27.	Following integrated planning approach for effective convergance	DoRD, DoE	Low	7.00

Strategies	Action Points		Department/ Organisation	Priority	Activity budget (INR Crore)
Training & Capacity building of rural communities	28.	Documentation of traditional / indigenous knowledge to be done as it can provide insights for adaptation and assess possibilities of value addition to enhance adaptive capacities	DoRD, DoE	High	30.00
	29.	Development of skills for alternative income generation activities to reduce climate induced vulnerabilities	DoRD	High	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	30.	Create Climate Change Working Group in the department	DoRD, DoE	High	7.00
	31.	Integrate climate change concerns with the departmental activities	DoRD, DoE	High	
	32.	Coordinate / liaison with National missions and programme for convergence	DoRD, DoE	High	
	33.	Coordinate / liaison with MP SAPCC M&E agency	DoRD, DoE	High	
				Total	**733.00**

11 Agriculture

11.1 Sector Overview

Agriculture is the backbone of state's economy as 55% population of MP depends on agriculture for their livelihood. Investments have been made on developing agriculture infrastructure and agriculture technology promotion through different government schemes. Of all the sectors, agriculture responded the best, resulting in quantum jump in overall food grain, oilseed, milk and livestock production leading to growth of this sector.

The agriculture sector contributes one-fourth of GSDP in the State. Last decade witnessed significant growth in agriculture sector in the state. This growth was highest in India.

Agro-Climatic Zones: Based on rainfall pattern, topography, and type of soils, Madhya Pradesh is divided into 11 agro-climatic zones as shown in Figure of ACZ. Agro-climatic zoning is a longstanding method to plan for sustainable, climate & resource appropriate cropping patterns. Therefore, this zoning helps the department suggest appropriate crops and inputs, such as fertilizers and pesticide, to farmers.

Agriculture sector at a glance	
Agro Climatic Zones	11
Soil Profile	**Type:** Alluvial soil, deep black soil, medium black soil, shallow black soil, red and black soil, red & yellow, gravelly soil
Gross Cropped Area	261.15 Lakh ha (2018-19)
Net Sown Area	152.05 Lakh ha(2018-19)
Cropping Intensity	172 % (2018-19)
Net irrigated area	115.35 Lakh Ha (2020-21)
Area under Cereal crops	123.21 Lakh ha(2018-19
Area under Paddy Cultivation (lakh ha)	16.86 (2004-05) 31.10 (2020-21)
Area under Pulses crop	65.95 Lakh ha(2018-19
Area under Oilseed crops	66.54 Lakh ha(2018-19
Fertilizers distribution (Lakh MT)	19.81 (2016-17) 24.17 (2019-20)
Total Agriculture Production	65,603 Lakh MT (2019-20)
Source: http://www.landrecords.mp.gov.in/ and Madhya Pradesh Economic Survey 2020-21	

Presently, more than half of the state's geographical area is under cultivation having net sown area of 152.05 lakh ha. With prospering agriculture in the state, around 109.10 lakh ha area has been used as double cropping. This has resulted in increase in gross cropped area of the state at 261.15 lakh ha in 2018-19 that comprises 84.91% of the reporting land use of 307.56 lakh ha. The State Government is continuously pursuing the expansion of irrigation coverage and it has started showing results in terms of increase in the agriculture productivity.

Figure: Agro-Climatic zones of Madhya Pradesh

Madhya Pradesh is the major producer of wheat, soybean, gram, sugarcane, rice, maize, cotton, rapeseed, mustard and arhar. Almost 47 percent of the gross cropped area is under Cereals, 26.7 percent is under pulses, 27.7 percent is under Oilseeds and 2.7 percent area is under commercial crops like cotton and sugarcane in the state with 172% cropping intensity.

Madhya Pradesh plays a significant role in the nation's agriculture productions share through remarkable increased production of individual or group of the major crops. This increased production has bagged the state, prestigious Krishi Karman Award for the seven consecutive years from 2011-12. Going by highest order of production levels, wheat, paddy, maize, gram and other pulses are turned out to be the major crops produced in Madhya Pradesh.

The state produced 442.86 lakh metric tonnes of food grains, 94.69 lakh metric tonnes of pulses and 74.65 lakh metric tonnes of oilseeds during 2018-19. Among different crop groups, foodgrain, pulses and oilseeds production shows impressive growth by reporting 131 %, 156% and 132% respectively over 2015-16.

The number of operational land holders in the state is 88.73 Lakh and area of land holding is 158.36 lakh hectares. In Madhya Pradesh only 34% land is being operated by small and marginal farmers which have 72% numbers; 66% of farms are cultivated by medium and large farmers which has only 28.5% numbers. The average size of the land holding in the State is 1.56 hectare which is more than the average size of land holding of the country (1.15 hectare).

Madhya Pradesh has created immense irrigation potential of around 115.35 lakh ha which is 75.9 percent of net sown area. There is still tremendous potential for increasing the irrigation coverage of the state where agriculture is still mainly dependent on the vagaries of the monsoon.

Madhya Pradesh boasts of immense for organic farming, with 2.32 lakh ha area already under organic certification. In addition a large part of Madhya Pradesh is rainfed with tribal dominated farmers with comparatively less fertilizers uses.

Due to the priority accorded to the agriculture sector, Madhya Pradesh is the first state to achieve an average growth of agriculture sector per annum of 18% between 2013-14 to 2016-17, with 2013-14 recording the highest ever growth rate of 22.41%. Over the last 12 years, the total growth of agricultural production has increased by 154% by the year 2018-19. Since 2011-12, the state has received the Krishi Karman Award every year. One of the primary factors for this achievement is the increase in the total irrigated area from 46.31 lakh hectares in the year 2004-05 to 115.35 lakh hectares in the year 2020-21. This increase in irrigation access has doubled the cropping intensity bringing it to 55% of cultivated land. One of the major contributors of success in irrigation is the feeder separation programme, which ensures assured electricity for irrigation. This has led to optimum utilization of irrigation potential being created in the state. *(Source: Madhya Pradesh Agriculture Economic Survey 2016 & 2020-21 and Gulati el al. 2017)*

Below the success of Agriculture sector in the state comes at the backdrop of frequent natural calamities and non-favourable climatic conditions affecting the potential of crop production. Almost every alternate year, one part or the other of the state is hit by natural climate induced calamities with varying intensity. *(Source: Madhya Pradesh Agriculture Economic Survey 2016)* These natural calamities have adversely affected the economy of the state. Climate change will not only affect agricultural productivity, but also the people dependent on it for their livelihoods. The cascading physical and biological impacts of climate change on various inter-cultural operations, agricultural production systems, post-harvest storage, and in turn on livelihoods and food security of farmers.

Extreme daytime heat and increased night time temperatures can affect yields and grain size and reduce overall production levels *(Mall et. al. 2006)* . There are added uncertainties about yields due to the interaction between CO_2, nitrogen stress, and high temperature stress. Climate change may also increase the impact of pests by making them appear early due to increased temperatures. Crops that are already weakened by other stresses may be more susceptible to damage by pests *(FAO 2016)*. In addition, crops or plants dependent

on pollinators are at risk due to sensitivity of the pollinators to already high temperatures in the tropics.

As well as directly influencing crops, climate change is projected to reduce surface and ground water significantly. Increased precipitation events will increase flood and drought risk due to high run off and less ground water recharge. Uncertain rainfall, especially a delay in the monsoon and increased dry spells, can result in seed loss and increase input costs. Untimely rainfall can also affect post-harvest produce in the fields and in open storage spaces. All these climate change impacts will result in low yield and, in certain case like flooding, result in complete crop loss.

The Economic Survey in 2017-18 (it has an exclusive chapter that covers climate change and its impact on agriculture in India) has warned that "Climate change could reduce annual agricultural incomes in the range of 15% to 18% on an average, and up to 20% to 25% for unirrigated areas". It has further pointed out the stagnation of growth in agriculture gross domestic product (GDP) and farm revenues in the preceding four years due to repeated monsoon failures.

The quality of food grains is also significantly affected by temperature in many crops, which could in turn have great impact on the nutritional security aspects in a developing country like India. Research has indeed shown that the decline in grain protein content in cereals could partly be related to increased carbon di-oxide concentrations and temperature. There are also reports of quality of Basmati rice being adversely impacted due to temperature increase beyond the optimum level. Pest and disease incidences in any crop are functions of ambient temperature and humidity. Crop-pest/ disease interactions will therefore change significantly in an era of climate change.

Biochar: A New Environmental Paradigm in Management of Agricultural Soils and Mitigation of GHG Emission

Soils host the largest terrestrial carbon pool and play a crucial role in the global carbon balance by regulating dynamic bio-geochemical processes and the exchange of greenhouse gases (GHG) with the atmosphere. (Lal, 2013) It is crucial to maintain a threshold level of organic matter in the soil for maintaining physical, chemical and biological integrity of the soil and for sustained agricultural productivity. Efficient use of biomass by converting it as a useful source of soil amendment/nutrients is one way to manage soil health and fertility. *(Ch. Srinivasarao, 2013)*

Madhya Pradesh produced 40.31 million tonnes crop residue was in the year 2015, of which 84% is made up of three crops which are Paddy, Maize and Wheat. These residues are either partially utilized or un-utilized due to various constraints. In the state about 17.66 million tonnes of crop residues are being burned, emits 0.18 $MtCO_2e$ every year. Residue burning traditionally provides a fast way to clear the agricultural field of residual biomass, facilitating further land preparation and planting. Besides loss of valuable biomass and nutrients, crop residue burning leads to emission of GHGs and PMs in the environment. *Source: www.ghgplatform.india.org*

There are three key policy - related and/or functionality issues related crop residue management that need to be taken into consideration for any future interventions. *They are:* (1) The need to think of a self-running mechanism, rather than isolated ones; (2) Empowering stakeholders; and (3) Avoiding sectoral thinking, and if possible, lean towards nexus thinking. Individual small-scale farmers do not have the capacity to establish a long-lasting solution. Hence, a pilot scale project should be implemented in association with multi- stakeholders for conversion of crop residue to biochar.

Addressing food security and climate challenges in a "business-as-usual" approach will make the tasks more difficult. Therefore, it's high time that rationale of climate-smart agriculture (CSA) is understood and appreciated by decision makers at all levels. There should be structured trainings to build the capacity of officials of relevant departments to sensitize them to understand the diverse impacts of global climate change events at local levels. Similarly, defined institutional architecture has to be built into the Government system to sustain focus and integrate activities into ongoing schemes and programs aligned to sustainable agriculture practices. *source: Padhee et. al. 2020, ICRISAT*

11.2 Initiatives in vogue

- **National Food Security Mission**

  To increase production of rice, wheat, pulses and coarse cereals through area expansion and productivity enhancement in a sustainable manner in the identified districts of the country, restoring soil fertility and productivity at the individual farm level, and to enhance farm level economy to restore confidence amongst the farmers.

- **National Mission for Sustainable Agriculture (NMSA)**

  To ensure sustainable agricultural productivity depends on quality and availability of natural resources like soil and water. To make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific integrated / composite farming systems, etc.

- **National Mission on Agricultural Extension and Technology (NMAET)**

  This scheme was introduced in 2010 with the objective of strengthening the extension machinery and utilising it for synergising the interventions under these schemes. Under the umbrella of Agriculture Technology Management Agency (ATMA).

- **Rashtriya Krishi Vikas Yojna (RKVY)**

  To incentive the state so as to increase public investment in agriculture and allied sector to provide flexibility and autonomy to states in the process of planning and executing agriculture and allied sector schemes and to finally to bring about quantifiable changes in the production and productivity of various components of agriculture and allied sectors by addressing them in a holistic manner.

- **Soil Health Card Scheme**

  Through this scheme, farmers are informed about the nutrition status of their soils, which further help them decide on the kind of cultivation in the season. In the current scenario, the farmers are not acquainted with judicious usage of balanced fertiliser, which continuously deteriorates the soil health and depletes the micro-nutrients in soil.

- **Paramparagat Krishi Vikas Yojna**

  To promote organic farming in the country, according to the scheme, farmers

Increasing Adaptive Capacity to Climate Change through Development of Climate Smart Village in Three Vulnerable Districts of MP

"Developing Climate Smart Village" project was sanctioned by Ministry of Environment, Forest and Climate Change under National Adaptation Fund for Climate Change (NAFCC). The project is being jointly executed by EPCO in association with Farmer Welfare and Agriculture Development Department.

The project aims to develop 360 climate-smart villages, 120 in each of the three vulnerable districts Sehore, Rajgarh & Satna. Introduction of Climate Friendly agricultural practices through piloting climate smart technologies, demonstrating best practices and creating general awareness among the farming community and villagers are the key objective of the project. To enhance the farmer's ability to adapt to the climate risk, distribution of drought tolerant seeds, construction of lined farm ponds for irrigation, promotion of broad bed furrow planting, providing ICT based weather advisories, distribution of macro - micro nutrients & leaf colour charts, mulching, zero tillage practices, Direct seeding of Rice cultivation, crop residue management, promotion of Solar irrigation pumps are the major training and capacity building.

are being encouraged to form groups or clusters and take to organic farming methods over large areas in the country.

- **Pradhan Mantri Krishi Sinchai Yojna**

  To achieve convergence of investments in irrigation at the field level, expand the cultivable area under assured irrigation, improve on farm water use efficiency to reduce wastage of water, enhance the adoption of precision irrigation in other water saving technologies.

- **Pradhan Mantri Crop Insurance Scheme**

  To provide insurance coverage and financial support to the farmers in the event of failure of any of the notified crop as a result of natural calamities, pest and diseases, to encourage the farmers to adopt progressive farming practices, high value inputs and higher technology in agriculture and to stabilise farm income, particularly in disaster years.

- **Mukhya Mantri Khet Teerth Yojna**

  This is scheme is for promoting rapid technological dissemination to the farmers, state government has declared the identified well-known and progressive agriculture institution as Krishi Teerth.

11.3 Sectoral Concerns

1. **Input intensive farming**

   With expanding agriculture areas and assured markets for commercial crops like wheat, maize, and rice, the practice of mono-cropping has increased. Mono-cropping results in excessive use of fertilizers and pesticides which pollute water sources and reduce soil fertility. Mono-cropping also leads to loss of biodiversity, which in turn, can affect flowering patterns and productivity in some crops. Farmers are heavily dependent on markets for procurement of seeds and specialized mechanization for seeding and harvest leading to high input costs. Use of fertilizers in the state has gone up from 77.2 kg/hectare to 133 kg/hectare between 2010 to 2015.

2. **Burning of Crop Residues**

   Farmers burn their crop residue to increase cropping intensity which requires quick removal of residue. Earlier labours were easily and cheaply available to clear the farms for next cropping; however, due to increasing labour costs, farmers are electing to burn the residue to prepare the farms. The issue is prominent in areas with access to surface water irrigation. Due to its scale, the issue leads to increased air pollution, reduced soil fertility and loss of soil microbes.

3. **Over-utilization of Groundwater**

   The dependence on the ground water for irrigation without adequate and timely recharge is leading to ground water depletion. Large number of blocks, specifically in the Malwa Region, has already been declared dark zones. The area of water intensive crops (paddy, onion, garlic, sugarcane etc.) is increasing yearly in the state from the year 2010. Due to high demand for Irrigation creates pressure on ground water.

4. **Weak Market Linkages**

   Traditional and indigenous crops are not linked to consumer behaviour and markets resulting in farmers opting for input intensive crops. The distribution of only wheat and rice under the Public Distribution System and Food Security Mission has negatively impacted traditional crop production and consumption.

5. Fragmented Land Holdings

Due to the growth of population and increase in small nuclear families, sub-division of agricultural land holdings into smaller plots is resulting in smaller land holdings. Small farmers are disproportionately affected to increasing market, climatic and environmental pressures. Asset building is also negatively affected resulting in loss of adaptive capacity.

6. Increasing production risks and Shifting cropping pattern due to climate variability

i. Due to delayed monsoon, dry spells and then erratic rainfall situation affects acreage and shifting of Kharif crops. Difficulties faced by farmers for Pulses and soybean as it get affected by Moisture stressed, Flooding and infestation of yellow mosaic disease. Most affected districts are often Indore, Dewas, Ujjain, Dhar, Sehore, Harda, Shajapur, Mandsaur and Neemuch, some damage happens at other places also in black soils areas. The damage is mostly caused by sudden, very heavy rains and variation in temperature, creating a congenial environment for large-scale attack of dormant rhizoctonia aerial blight (RAB) and anthracnose (pod blight), which infect the soybean crop. Some damage has also been caused by stem fly.

ii. Higher moisture due to winter rains increases occurrence of fusarium wilt disease in chick pea and pigeon pea.

7. Degrading quality of soils

Soil can be a double-edged sword when it comes to carbon fluxes. Anthropogenic impacts on soil can turn it into either a net sink or a net source of GHGs. Soils are a key enabling resource, central to the creation of a host of goods and services integral to ecosystems and human well-being.

Maintaining SOC storage at equilibrium or increasing SOC content towards the optimal level for the local environment can contribute to achieving the SDGs. Climate change has been at the center of various international agreements. Soils are considered in many of these agreements as the biggest carbon reservoirs on earth. Therefore, it is thus crucial to have a good knowledge of the current global SOC stock and its spatial distribution to inform various stakeholders (e.g. farmers, policy makers, land users) to make the best use of available land and provide the best opportunities to mitigate and adapt to climate change.

In Madhya Pradesh, 47 percent area covers black soils, 18.3 percent of mixed red and black soils and rest part covers alluvial soils. The SOC content in the black soils ranges between 2.9 and 3.5 percent in the upper 10 cm, and exceeds 1.2 percent at the lower boundary. Due to their high productivity, most of these soils are intensively used for agriculture. However, they are very sensitive to soil degradation and SOC losses and need to be managed carefully to maintain their productive potential.

8. Soil Erosion:

Soil is eroding quickly than it is being formed, causing land to become unsuitable for agriculture. Reports of NBSS & LUP and CSWCR & TI reports the area of soil erosion and its degree in Madhya Pradesh. Report Indicated that 59 percent total Geographical area is prone to soil erosion in the state. More than 55,000 Sq km area fall under very severe to extremely severe category by which more than 80 tonnes top soil per ha is eroded every year. More over, 39 percent area of state fall under moderately severe category of erosion.

11.4 Proposed Strategies and Actions

Strategies	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
Enhance resilience through improved soil and water conservation	1.	Promote field bunding and soil conservation	FW&ADD, KVK, Research Institutes	High	870.00
	2.	Promotion of special impetus on conservation agriculture in larger scale	DoFW&AD, KVK, Research Institutes	High	
	3.	Promote water conservation through construction of farm ponds	DoFW&AD, DoRD	High	
	4.	Promote use of bio-char in soils	DoFW&AD, KVK, Research Institutes	High	
	5.	Adoption of land levelling and watershed management	DoFW&AD, KVK, Research Institutes	High	
	6.	Promotion of organic mulching	DoFW&AD, KVK, Research Institutes	High	
	7.	Promote broad bed furrow planting.	DoFW&AD, KVK, Research Institutes	High	
	8.	Promotion of techniques for reducing soil erosion viz. contour bunding, strip cropping, terracing, shelter belts and gully reclamation on area basis	DoFW&AD, KVK, Research Institutes	High	
Management of climate risk for sustainable productivity	9.	Promote integrated farming practices	DoA	Medium	52.50
	10.	Promote indigenous varieties of crops by providing access to market	DoA	Medium	
	11.	Promote production and distribution of improved seeds through village seed bank	DoA	Medium	
Enhancing dissemination of new and appropriate technologies developed by researchers and strengthening research further	12.	Soil testing- practice and packages (soil kit to the farmers)	DoA IISSc, ICAR	Medium	107.00
	13.	Provide adequate research facilities to existing agriculture universities and state agriculture research laboratories on Climate Change	DoA	Medium	
	14.	Promotion of energy efficient water pumps	DoA, NRED, BEE, MNRE	High	
	15.	Study on impacts of Climate Change on major crops and livestock in all agro climatic zones based on regional climate modelling & projections	DOA, DoE / SKMCCC	High	
	16.	Development and Promotion of climate resilient crop varieties	DoA, Agri Universities	High	
Agriculture Information Management	17.	Set up a knowledge management network to avail information on Land-use pattern, soil types, weather, genotypes of crops, water availability, pasture, off-season crops and Agro-forestry practices etc.	DoA, DoE / SKMCCC, WRD	Low	10.00

Strategies	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
	18.	Based on the inputs received from this network, set up a single window information dissemination platform / website	DoA, DoE / SKMCCC, WRD	Low	
Planning cropping systems suitable for each agro-climatic conditions	19.	Integrate Climate Change in planning for each agro-climatic zone	DoA, DoH&E / MP CC Cell	High	105.00
	20.	Promote effective implementation of District level contingency crop plans		High	
Increasing water use efficiency and reduce methane emissions from paddy cultivation	21.	Promote drip and sprinkler irrigation	DoFW&AD, WRD	High	115.00
	22.	Encourage sprinkler irrigation in water intensive field crops	DoFW&AD, WRD	High	
	23.	Promote direct seeding of rice cultivation and encourage farmers to adopt alternate wetting & drying irrigation in view of reducing methane emissions	DoFW&AD, DoRD	High	
Reducing weather induced risks through improve farmers access to weather services	24.	Increasing the rate of improvement and distribution of crop varieties tolerant to multiple stresses	DoFW&AD	High	93.00
	25.	Promote dissemination of ICT based weather advisories at micro level using mobile technologies	DoFW&AD, MAP_IT, IMD	High	
	26.	Promote adoption of maximum area under crop insurance	DoFW&AD, General Insurance Companies	High	
	27.	Develop capacity to run agriculture related climate models, decipher their projections, to understand the impact on crops, soils, water etc.	DoFW&AD, MPCST, Research Institutes (IISS)	High	
	28.	Scale up mobile based disease surveillance system for pathogens and pandemics of field crops at ACZ level	DoFW&AD, MAP_IT, Research Institutes (IISS)	High	
Increase adoption of crop residue management	29.	Promote use of crop residue in soil	DoFW&AD, DoE, KVK	High	40.00
	30.	Encourage farmers for wider use of rotavator and happy seeder after crop harvest	DoFW&AD, DoE, KVK	High	
	31.	Promote use of crop residue for industrial purpose	DoFW&AD, DoE, KVK	High	
Increase adoption of organic farming and reducing input costs	32.	Promotion of organic farming practices with special focus on tribal districts which are organic by default	DoFW&AD, KVK	Medium	55.00
	33.	Promote concept of zero budget natural farming clusters in pilot mode	DoFW&AD, KVK	Medium	
	34.	Promote climate resilient, nutritionally superior crops	DoFW&AD, DoE, KVK	Medium	

Strategies	Actions		Department/ Organisation	Priority level	Activity budget (INR Crore)
Provide evidence based research on crop modelling and GHG emissions	35.	Create an evidence-based research for crop modelling at micro level within a specific ACZ	DoFW&AD, Research Institutes	High	12.00
	36.	Research on quantification and options to reduce GHG emissions from Agriculture	DoFW&AD, IISS	High	
Creation of new regional markets for economically viable traditional food crops	37.	Create new regional clusters through FPOs of value-added products of traditional/indigenous crops (millets, sesame, niger, linseeds etc.)	DoFW&AD	High	50.00
Promotion & strengthening of equitable sharing of traditional knowledge and innovation	38.	Compilation of intellectual property aspects of traditional agricultural knowledge	DoFW&AD	High	3.00
	39.	Encourage innovation and best practices in line with climate resilient agriculture	DoFW&AD, DoE	High	
Linking farmers to markets for high-value agricultural commodities	40.	Create growers association at village level for value addition of products	DoFW&AD, KVK	Medium	5.50
	41.	Improving farmers' access to markets through institutional innovations	DoFW&AD, KVK	Medium	
Increase farmers income by reducing input cost	42.	Promote start-ups in agriculture for providing better technological services to farmers	DoFW&AD, KVK, Agri Universities, Research Institutes	Medium	42.00
	43.	Encourage farmers for setting up additional income generating schemes like agro-forestry, bee keeping, silvi-culture etc.	DoFW&AD, MPFD	Medium	
SOC management for sustainable food production and Climate change adaptation and Mitigation	44.	Promote reforestation/ afforestation of arable land	DoFW&AD	Medium	38.00
	45.	Promote principles of organic farming & conservation agriculture for maintaining soil health and carbon flux	DoFW&AD	Medium	
	46.	Promote application of biochar in soil for enhance C sequestration and availability of nutrient	DoFW&AD	Medium	
	47.	Promote crop diversification, zero tillage and crop residue management practices.	DoFW&AD	Medium	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	48.	Create Climate Change Working Group in the department	DoFW&AD, DoE	High	7.00
	49.	Integrate climate change concerns with the departmental activities	DoFW&AD, DoE	High	
	50.	Coordinate / liaison with National missions and programme for convergence	DoFW&AD, DoE	High	
	51.	Coordinate / liaison with MP SAPCC M&E agency	DoFW&AD, DoE	High	
				Total	**1748.00**

12 Horticulture

12.1 Sector Overview

Horticulture sector at a glance	
Total Area under Horticulture	23.43 lakh hectare
Distribution of area under Horticulture	Spices - 8.20 lakh hectare Vegetables – 10.39 lakh hectare Fruits – 4.02 Lakh hectare Flowers – 35.55 thousand hectare Medicinal & Aromatic- 42.96 thousand hectare
Cropping Intensity	139%
Agri processing Mandi Committees	48 notified committees for Fruits and vegetables
Agri export Zones	6 (North western part of Madhya Pradesh)
Sources: Administrative Report of Horticulture Department, GoMP Year 2020-21	

Horticulture is one of the rapidly increasing sectors in Madhya Pradesh. The area under horticulture crops has grown by 2.2 times since 2010, while the production has increased by 3.7 times in the same time period. The area of horticulture crops in MP was 23.43 Lakh Ha in 2020-21 which increased from 15.49 lakh ha in 2014-15. Vegetables area dominate with 44% shares followed by spices at 34%, followed by fruits 17% with medicinal and aromatic plants and flowers bringing up rear end at 1.83% and 1.49% respectively.

Banana, mango, sweet lemon, papaya, guava orange and gooseberry are the main fruits crops; potato, onions, sweet potato, peas, tomato, cauliflower, ladyfinger, brinjal, bottle gourd, spinach and cabbage are the major crops in terms of vegetables; chilies, ginger, garlic and coriander are main spices and; rose, gladiolus, gerbera, tuberose and orchids being grown as commercial flower crops in Madhya Pradesh.

Horticulture sector has become one of the major drivers of growth as it is more remunerative than the agricultural sector (food grains mainly). This sector provides employment possibilities across primary, secondary and tertiary sectors. Horticulture crops are more sensitive to change in weather conditions and the vegetables augment the income of small and marginal farmers. Water utilization is very low; hence ensuring water availability round the year is needed. Risk of crop failure is low and it can be done on smaller farms. Multiple crops are planted simultaneously to get more yield and to use the maximum quantity of the fertilizers. This sector enables the population to eat a diverse and balanced diet for a healthy lifestyle. It became a key driver for economic development in the states.

In the recent years, major agro-climatic zones were identified, based on their potential for certain kinds of horticultural crops. These were as follows:-

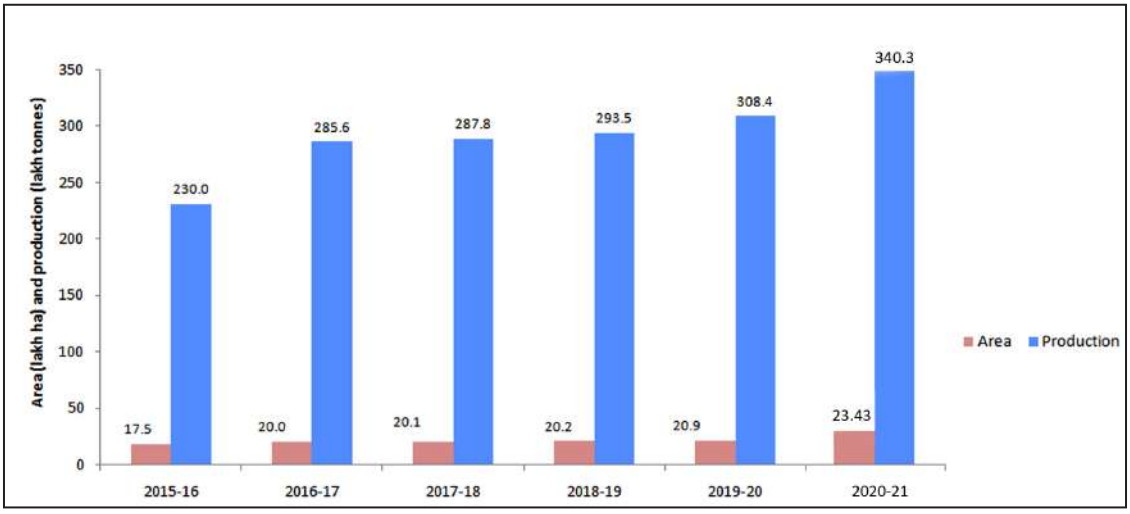
1. Potato, onion and garlic are identified in the districts of Indore, Dhar, Ujjain, Dewas, Mandsaur, Neemuch, Ratlam and Shajapur
2. Seed spices are identified in the districts of Ujjain, Ratlam, Mandsaur, Rajgarh, Guna, Khargone and Shajapur
3. Orange in Chhindwara, Hoshangabad, Betul and Rajgarh

Table No. 1: ACZ wise horticultural crops in MP

ACZ	Major Horticulture Crops
Chhattisgarh Plains	**Fruits:** Mango, Guava, Sapodilla, Lemon, Papaya, Pomegranate, Aonla, Ber, Jack fruit **Vegetables:** Drumsticks, Colocasia, Tomato, Brinjal, Jackfruit, Ginger, Chillies, Bottle gourd **Spices:** Turmeric, Ginger

ACZ	Major Horticulture Crops
Northern Hill region of Chhattisgarh	**Fruits:** Pear, Peach, Litchi, Mango, Guava **Vegetables:** Colocasia, Chillies, Tomato, Brinjal, Jack fruit, Ivy gourd, Cabbage, bitter gourd, Sponge gourd **Spices:** Turmeric, Ginger, Medicinal and Aromatic crops
Kymore Plateau and Satpura Hills	**Fruits:** Mango, Guava, Lemon, Ber, Aonla **Vegetables:** Chillies, Tomato, Brinjal, Jack fruit, Bottle gourd, Colocasia, Cauliflower, Spinach, Amaranthus, Ivy gourd **Spices:** Turmeric, Ginger, Beetle leaves
Central Narmada Valley	**Fruits:** Mango, Orange, Mandarin, Ber, Guava, Aonla, Papaya **Vegetables:** All seasonal **Spices:** Ginger
Vindhya Plateau	**Fruits:** Mandarin, Acid lime, Aonla, Pomegranate, Mango Ber, Chiku, Papaya, Jack fruit **Vegetables:** Colocasia, Chillies, Tomato, Brinjal, coloured crop under spices carom seeds **Spices:** Turmeric, Ginger
Gird Region	**Fruits:** Guava, Mandarin, Sweet orange, Lime, Guava, Ber, Aonla, Custard apple **Vegetables:** Colocasia, Chillies, Tomato, Pumpkin, Lady finger, Potato, Bottle gourd, bitter gourd, Peas etc. **Spices:** Turmeric, Ginger, Coriander
Bundelkhand Region	**Fruits:** Guava, Mandarin, Sweet orange, Lime, Aonla, Mango, Karonda, Ber **Vegetables:** Colocasia, Chillies, Dioscorea, Tomato, Pumpkin, Lady finger, Bottle gourd, bitter gourd, Peas etc. **Spices:** Turmeric, Ginger, Coriander
Satpura Plateau	**Fruits:** Orange, Mango, custard apple, Guava, Sweet lemon, Lime, Pomegranate, Aonla **Vegetables:** Cauliflower, Cabbage, Tomato, Brinjal, Pumpkin, Lady finger, Bottle gourd, bitter gourd, Peas etc **Spices:** Turmeric, Ginger, Coriander
Malwa Plateau	**Fruits:** Orange, Pomegranate, Grapes, Mango, Guava and Custard apple, Strawberry **Vegetables:** Potato, Capsicum, Tomato, Brinjal, Bottle gourd, hyacinth beans **Spices:** Onion, Garlic, Coriander
Nimar Plains	**Fruits:** Papaya, Banana, Mango, Grape, Chiku, Lime, Guava, Custard apple, Pomegranate **Vegetables:** Tomato, Brinjal, Chillies, Colocasia, Fennel and all seasonal vegetables. **Spices:** Turmeric
Jhabua Hills	**Fruits:** Lime, Sweet lemon, Ber, Guava, Aonla, Custard apple, Pomegranate **Vegetables:** Tomato, lady finger, chilies, fenugreek, seasonal vegetables **Spices:** Turmeric, Garlic

Figure : Area and production of horticultural crops in MP



12.2 Initiatives in Vogue

- **Mission For Integrated Development of Horticulture (MIDH)**
  The scheme aims to Promote holistic growth of horticulture sector, covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, cashew cocoa including bamboo and coconut through area based regionally differentiate strategies, which includes research, technology promotion, extension, post harves management, processing and marketing in consonance with comparative advantage o each State/region and its diverse agro-climatic features; It is implemented in 40 district: of MP. The major objective of the scheme is to Enhance horticulture production augment farmers, income and strengthen nutritional security;

- **Pradhan Mantri Krishi Sichai Yojna (Per Drop More Crop)**
  Main objective of the scheme is to increase the quality of production and productivitythrough increased irrigation with minimum water use. Farmers benefitting from this scheme are free to choose drip or sprinkler irrigation system.

- **Horticulture Scheme Under RKVY**
  There are various horticulture related schemes being implemented in the state as major component under RKVY. They are storage of onion, vermi-compost, nursery development, farmer's visit, distribution of plastic carats high-tech betel leaf farming hybrid seed distribution, packaging and infrastructure in seed production areas, etc.

- **National Medicinal Plants Mission**
  In mp 52 districts have been identified under this scheme. In 2008-09 for implementation of various activities like area under medicinal plants, establishing nurseries, organic certification and increasing conservation capacities. 20 focused crop: have been identified under this scheme. The total area under the medicinal plant i: 42956.26 ha. In the year 2020-21.

- **Special Financial Assistance for Food Processing Industries**
  It aims to promote the establishment of food processing industries in the state by providing specific financial assistance to micro, small and medium industries. The Major components of specific financial assistance are investment promotion assistance, power consumption support, Reimbursement on receipt of certification, Reimbursement for promoting research and development, reimbursement on transportation, cost capital grant, Establishment of Mega Food Park etc.

- **Expanding Area Under Cultivation of Horticultural Crops**

  Government of MP is working on scheme for expanding area under horticulture crops as spices, fruits, vegetables, flowers, aromatic and medicinal plants, so as to increase additional area under horticultural crops.

  Some other important schemes such as Spices, potato, floriculture development programe; integrated Food Development Scheme; Integrated medicinal & aromatic development programme; promotion of precision farming for commercial horticulture; Promotion of mechanization in horticulture; and Development of kitchen programme are also being implemented by Horticulture department, Go MP.

- **PM Formalization of Micro Food Processing Enterprises Scheme (PM FME Scheme)**

  The scheme aims to enhance the competitiveness of existing individual micro enterprises in the unorganized segment of the food processing industry and promote formalization of the sector; Support Farmer Producer Organizations (FPOs), Self Help Groups (SHGs) and Producers Cooperatives along their entire value chain. The objectives of scheme are to build capability of microenterprises to enable: i) Increased access to credit by existing micro food processing entrepreneurs, FPOs, Self Help Groups and Co-operatives; ii) Integration with organized supply chain by strengthening branding & marketing; iii) Increased access to common services like common processing facility, laboratories, storage, packaging, marketing and incubation services; iv) Strengthening of institutions, research and training in the food processing sector; and v) Increased access for the enterprises, to professional and technical support.

- **One District One Product**

  The scheme (PMFME) will provide an opportunity to procure inputs under **one district one product** approach, avail common services and reap the benefits of marketing the products. The states will determine the food product for a district keeping in view the existing clusters and raw material. ODOP products can be products based on perishables, grain based products or food products produced widely in the district and their allied areas. Producers under ODOP approach will be given priority.

12.3 Sectoral Concerns

1. **Risks due to climate change**

   Due to extreme temperature and erratic rainfall patterns, there are higher risks of loss of horticultural crops at critical growth stages especially vegetables of Kharif seasons. The risks are higher because of dry spells & floods occurring due to uneven rains and in Rabi season, there are risks due to low temperature, frosts and hailstorms.

2. **Higher input costs than food grains**

   Small and marginal farmers are more reluctant to horticulture crops as it demands higher initial capital.

3. **Lack of irrigation facility during crop cycles**

   Horticulture crop demands irrigation throughout the year. However, the irrigation facilities are inadequately available during period of summers.

4. **Insufficient storage facilities to extend the life of perishable products**

   Currently, the storage facilities to cater to the horticultural produce are insufficient in the state. Only 18 cold storages for horticulture produce are established in the state as on 2016. Being perishable items, the storage facilities need higher attention for extending produce's life.

5. **Low level of adoption of new technologies**

   Majority of the farmers in the state are small and marginal. They refrain from adopting new technologies due to high initial investments costs. Eventually the production level is low, inspite of subsidies being provided on implementation of these technologies.

6. **Mono-culture of vegetables**

   Farmers in many zones of MP produce one or two types (onion, garlic, tomato) of horticulture crops in a single season, due to which there is a higher production of these crops. This results in excessive arrivals of productions in markets hence, low demand & low prices for these input intensive crops.

7. **Lack of post harvest facility and preservation infrastructure**

   Preservation and post harvest facilities needed for value addition in the horticulture produce are lacking in the state. Even if farmers are willing to sell the value added products, the lack of facilities do not allow them to do so.

8. **Horticulture does not have the benefit of a safety net like the Minimum Support Price (MSP) for food grains**

   Unlike agricultural crops, there is no incentivized method for the horticultural crops as they do not have the benefit of MSP with the support of government.

9. **High use of agro chemicals**

   Excessive and indiscriminate use of pesticides not only increases the cost of production but also results in many health problems and environmental pollution. The effect of chemical pesticides-use is more harmful in fruits and vegetables.

12.4 Proposed Strategies and Actions

Strategy		Action	Department/ Organisation	Priority level	Activity budget (INR Crore)
Minimizing the production risks	1.	Promote wider adoption of poly houses, green house technology	DoH&FP, DoFW&AD, Agri. Universities	Medium	980.08
	2.	Promote intercropping of floriculture with vegetable production for minimizing pest and disease induced risks	DoH&FP, DoFW&AD, Agri. Universities	High	
	3.	Promote mulching	DoH&FP, DoFW&AD	Medium	
	4.	Promotion of mulching technique for soil and water conservation	DoH&FP, DoFW&AD	Medium	
	5.	With appropriate Lining and digging of Ponds, the seepage loss of soil and water can be minimized.			
	6.	Promotion of Chain Link Fencing to minimize the crop loss by preventin unwanted livestock.			
	7.	Pollination support through Bee keeping.			

Strategy		Action	Department/ Organisation	Priority level	Activity budget (INR Crore)
Adoption of a mission mode approach for promoting rainfed horticulture	8.	Strengthening the supply of quality planting materials for growth in acreage and production of rainfed horticulture	DoH&FP, DoFW&AD	High	320.00
	9.	Expanding area through drip irrigation	DoH&FP, DoFW&AD	High	
	10.	Promote hybrid seeds production clusters	DoH&FP, DoFW&AD (MP Beej Nigam)	High	
	11.	Expanding irrigation facilities through ponds etc	DoFW&AD	Medium	
	12.	Promote high value horticultural crops suitable for rainfed conditions	DoH&FP	High	
Taking actions for minimizing the input costs	13.	Promote organic vegetable farming to minimize the input cost & increase farmers income	DoH&FP, DoFW&AD	High	80.00
	14.	Promote site specific integrated nutrient management	DoH&FP, DoFW&AD	Medium	
	15.	Promote intercropping of vegetables, spices, fruits and flowers	DoH&FP, DoFW&AD	Medium	
	16.	Promote use of crop residues as source of organic mulching	DoH&FP, DoFW&AD	High	
Minimizing post-harvest losses	17.	Expand storage and cold chain facilities and strengthen marketing linkages	DoH&FP, DoFW&AD, MPWLC	High	180.00
	18.	Promote integrated multi-model logistics unit	DoH&FP, DoFW&AD, MPWLC, KVK	Low	
	19.	Promote the establishment of food processing industries	DoH&FP, KVK	Medium	
	20.	Promote cluster level preservation centers of horticultural products	DoH&FP, DoFW&AD, MPWLC	High	
Devising a policy to provide a safety net to major vegetable crops	21.	Regulate a policy for procuring major vegetable crops like onion and garlic at fixed price (Minimum Selling Price)	DoH&FP, DoFW&AD	High	22.08
	22.	Undertake an assessment of potential of productivity of different horticulture crops in the 11 agro-climatic zones	DoF&WAD, DoH, SAU	High	
	23.	Creation of cluster level storage house for vegetables	DoH&FP, DoFW&AD	High	
	24.	Strengthening and Promote FPO to medicinal farming	DoH&FP, DoFW&AD	High	

Strategy		Action	Department/ Organisation	Priority level	Activity budget (INR Crore)
Enhancing accessibility to mechanization and adoption of new technologies	25.	Capacity building of farmers to adoption of new technologies and enhance their risk bearing ability	DoH&FP, DoFW&AD, KVK, Agri Universities	Medium	12.00
	26.	Provide credits and training to gardeners/youth for establishment of roof top kitchen garden in urban areas	DoH&FP, DoFW&AD, KVK, Agri Universities	Medium	
Enhancing accessibility to mechanisation for value addition and access markets-creating business hubs	27.	Develop institutional support for developing business hubs and access to markets in different agro-climatic zones	DoH&FP, DoFW&AD, KVK, Agri Universities, DoRD, MPMFP	Medium	275.00
Research and Extension support	28.	Encourage research on sustainable horticulture farming techniques	DoH&FP, DoFW&AD, KVK, Agri Universities	Medium	6.50
Capacity building	29.	Promote research on horticulture-biotechnology for better cultivar, seeds etc.	DoFWAD, DoH, Agri Universities	High	6.50
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	30.	Create Climate Change Working Group in the department	DoH&FP, DoE	High	7.00
	31.	Integrate climate change concerns with the departmental activities	DoH&FP, DoE	High	
	32.	Coordinate / liaison with National missions and programme for convergence	DoH&FP, DoE	High	
	33.	Coordinate / liaison with MP SAPCC M&E agency	DoH&FP, DoE	High	
				Total	**1889.16**

13 Animal Husbandry

13.1 Sector Overview

Livestock rearing is inter-woven with agricultural practices and farming communities. Madhya Pradesh has 4.06 crores livestock (cattle, buffaloes, horses, ponies, donkeys, sheep, goat, camel, pigs and mules) population which is 7.57% of the country's livestock population (53.6 crores). A continuous decline in the grazing and pasture land is happening due to diversion for agriculture, industries, townships, roads and railways. Thus sustaining the current animal population with the limitations of resources becomes challenging for the state. The livestock sector is also responsible for high GHG emissions. Thus growing livestock population poses an environmental challenge as to how best we can increase productivity and utilize the unproductive livestock.

Livestock sector at a glance	
State Livestock Population	40.6 million
	Cattle – 18.7 million
	Buffaloes –10.3 million
	Goat & Sheep – 11.38 million
Poultry Population	7.3 million
Contribution to State GDP (at current prices)	16.6%
Livestock breeds in the state	Malvi, Nimari, Kenkatha Cattle, Bhadawri Buffalo, Jamnapari, Barbari Goats, Kadaknath Chicken
Sources: Administrative Report of Animal Husbandry Department, GoMP, Year 2020-21	

Agriculture and livestock together causes pressure on the environment. Agriculture is the largest consumer of water and the main source of nitrate pollution of groundwater and surface water. It is a major contributor to the phosphate pollution of water and release of methane, nitrous oxide and carbon di-oxide which are potent greenhouse gases (GHGs). Not only does livestock account for 18% of global GHG emissions but also India possesses the world's largest livestock population. At the same time, livestock productivity in India is considered low compared to other developing countries (Chhabra, et al. 2017). There is a unique challenge for the Animal Husbandry sector to adapt to a changing climate and reduce GHG emissions while improving livestock productivity and rural livelihoods. Within India, the state of Madhya Pradesh has one of the largest livestock populations and is considered a high-methane emitter state (Chhabra et al. 2012).

Livestock rearing is one of the most important economic activities of the state contributing significantly to the economy. The number of livestock's as well as the production of animal has seen an increase over the years. In 2012, the total livestock's which includes cattle, buffalo, horse, donkey, sheep, goats, camel, pig and mules was nearly 3.63 crores in Madhya Pradesh. By 2019 the numbers grew to 4.062 crores. According to 20th livestock's census from 2019 the total cattle, buffalo, and goat population of state increased by 11.9% and poultry increased by 39.5%. Despite a total increase in the livestock's population, the indigenous cattle population decreased by 5.32% while the cross breeds' population increased by 80.95%. Table no. 2.1 depicts comparison between 19th and 20th livestock census of number of various livestock heads in Madhya Pradesh.

Table No : Livestock Population in Lakhs (livestock Census 2012 & 2019)

Classes	2007		2012		2019		Population % change in MP in 2019 w.r.t 2012
	India	MP	India	MP	India	MP	
Cross-Breed	330	4.74	397	8.4	513	15.2	80.95
Indigenous	1660	214.4	1511	188	1421	178	-5.32
Total	1990	219.14	1908	196.4	1934	193.2	-1.63

Classes	2007		2012		2019		Population % change in MP in 2019 w.r.t 2012
	India	MP	India	MP	India	MP	
Buffalo	1053	91.3	1087	81.9	1098	103	25.76
Goat	1405	90.13	1352	80.14	1488	110.6	38.07
Poultry	6489	73.8	7292	119	8518	166	39.5

Along with a large livestock population, Madhya Pradesh possesses vast livestock diversity. However, changing climate scenarios will impact the sector. Livestock requires specific environmental conditions to produce and reproduce (Hoffmann 2010). Each breed has a range of ambient temperatures (influenced by zone and district, see Table that is conducive to their health and performance (Chase 2014). However, rising temperatures and humidity will affect ambient temperature levels, causing issues like heat and water stress. These stresses affect the animal's feed nutrient utilization, dry matter intake, milk production, and reproductive traits (Hoffman 2010). Therefore, there is a need to adapt husbandry practices based on breed sensitivity and environment.

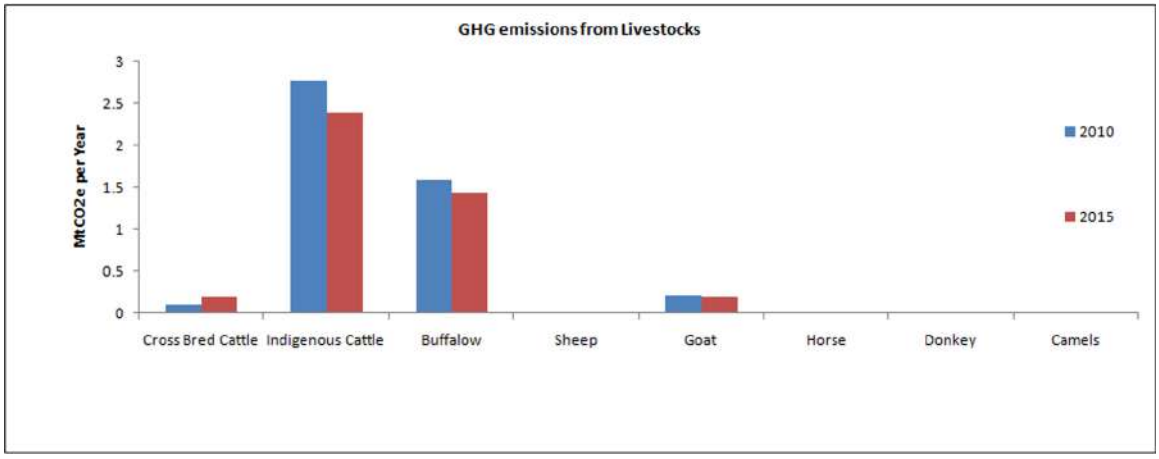
Table : Livestock Breeds in Madhya Pradesh

Breed	Zone	District
Bhadawari Buffaloes	Northern River Valley (Gird region)	Bhind, Morena, Gwalior
Jamunapari Goat		Bhind, Morena
Jalauni Sheep		Gwalior, Bhind, Morena, Shivpuri
Malvi Cattle	Malwa Plateau (Malwa region)	Ujjain, Shajapur, Rajgarh (previously in whole of the Malwa tracts)
Malvi Camel		Mandsaur
Nimadi Cattle	Nimar Valley (Nimad region)	Khargone, Barwani (previously in both East and West Nimar)
Berari Goat		Nimar
Kenkatha Cattle	Kymore Plateau and Satpura Hills (region of Ken river)	Panna, Tikamgarh, Chattarpur
Gaolao Cattle	Satpura Plateau (Satpura and Pench region)	Balaghat, Chhindwara, Betul, Seoni
Kadaknath Poultry	Jhabua Hills	Jhabua, Alirajpur, Dhar

Additionally, climate change threatens feed and fodder provision by reducing herbage yield, decreasing forage digestibility, and increasing shrub encroachment (Hidosa and Guyo 2017). In Madhya Pradesh, there is no record of fodder production, demand, and deficit. However, reports available at the country-level indicate that there is a net deficit of green fodder, dry crop residues, and concentrate feed ingredients. The deficit of green fodder and dry fodder are expected to increase by 2050. To counter this deficit, green forage supply has to grow by 1.69% annually (IGFRI 2013). There is currently no scheme by the Department of Animal Husbandry for fodder production.

Madhya Pradesh is bestowed with the highest population of cattle in the country. The present cattle population stands at 19.3 Million which is 10.01% of total cattle population of India. Out of this total population, a whopping 15% i.e around 29 lakh is constituted by stray cattle. Around 10.70 lakh female cattle are unproductive, which is around 20% of total female cattle of MP. The total GHG emission from

Livestock in Madhya Pradesh is estimated at 4.697 $MtCO_2e$ – year in which indigenous cattle's and buffalo contributes 92.31%. Methane and Nitrous oxides emits from Manure management accounts 0.5 $MtCO_2e$ –year. Figure depicts GHG emissions from enteric fermentation and manure management from livestock's sector in Madhya Pradesh.



Source: Livestock population data from Census 2019 and Emission Factor from Samiksha et. al., Table 2.7, PP 58, NATCOM-2 http://unfcc.int/resources/docs/natcs/indnc2.pdf

13.2 Initiatives in vogue

- **Vatsa Palan Protsahan Yojna**

  The main objective of the scheme is to encourage the cattle farmers to promote the Indian native breed of the state and to preserve and enrich the animals with the high genetic potential available to them.

- **National Livestock Mission (NLM)**

  This mission has commenced from 2014-15. The mission is designed to cover all the activities required to ensure quantitative and qualitative improvement in livestock production systems and capacity building of all stakeholders.

- **Intensive Cattle Development Programme**

  This programme was started as a special development programme during third five year plan. Its was envisaged to locate the projects in the breeding tracts of indigenous breeds of cattle and buffaloes and in the milk sheds of large dairy projects.

- **Pashudhan Bima Yojna**

  It is a centrally sponsoired scheme under which crossbred and high yielding cattle and buffaloes are being insured at a maximum of their current market price.

Some other schemes are being implemented for development of animal and poultry in the state viz.

i. Nandishala Yojna
ii. Gopal Puruskar Yojna
iv. Nar Bakra Praday Yojna
v. Backyard Kukkut Ikai Pradai Yojana
vi. Kadaknath Chooza Praday
vii. Nar Sookar Praday Yojna

viii. Cattle and Buffalo Breed Improvement Programme
x. Artificial Insemination and Embryo Transfer Technology (ETT) Programme
xi. In-Situ Breed Conservation Programme

13.3 Sectoral Concerns

The Animal Husbandry sector faces environment and development issues that must be considered along with the adaptation process. These issues, sampled below, provide insight issues that could increase the sector's vulnerability in Madhya Pradesh.

1. **Lack of genetic diversity & exotic breeds**

   The need to increase milk production led the country and the state in choosing specific genetic traits in some breeds for breeding purpose. The focus was on Holstein and Jersey for breeds which are exotic to India. Such exercises result in genetic uniformity and rapid inbreeding rates which weaken the resilience to diseases and climate extremes (Notter 1999). Inclusion of indigenous breeds in breeding processes could reduce the genetic uniformity.

2. **Lack of fodder availability**

   There is a lack of fodder availability due to encroachment of common grazing lands by rapid urbanisation and agriculture. Residue from agriculture which was earlier used as fodder is now lost due to the practice of residue burning. Changing climatic conditions, particularly rising temperatures, and uncertain rainfall patterns, further inhibit growth of fodder crops. Insufficient fodder can affect animals' health adversely and result in low milk production which can ultimately affect food security and rural livelihoods.

3. **Lack of land for grazing**

   With reduced pastoral land the pressure on forest ecosystems is increasing. The result is loss of biodiversity which can lead to degradation of the entire ecosystem.

4. **Large Number of unproductive and stray Cattles**

   Due to mechanization in agriculture, and cattles in their late lactation, with reduced production and competing with other for the costly feed, are often abandoned to the streets. As per livestocks census there are 7 lakh less productive and stray cattles in Madhya Pradesh.

13.4 Proposed Strategies and Actions

Strategies		Actions	Department/ Organisation	Priority	Activity budget (INR Crore)
Ensuring availability of feed and fodder	1.	Providing locally available, low cost, high nutrient feed ingredients to ensure better growth & production	DoAH, DoFW&AD	High	110.00
	2.	Nutrition enrichment and ration balancing feed management to reduce enteric emission	DoAH, DoFW&AD	High	
	3.	Promote sustainable fodder development and management practices especially in fallow & degraded lands	DoAH, DoFW&AD	Medium	
	4.	Impetus for azolla farming and for fodder conservation in the form of hay and silage	DoFWAD, DoAH	Low	

Strategies		Actions	Department/ Organisation	Priority	Activity budget (INR Crore)
Housing for animals	5.	Make available mixed ration/ complete feed of urea enriched molasses mineral blocks.	DoFWAD, DoAH	Low	150.00
	6.	Promotion of climate proofing cattle sheds	DoAH	Low	
Improving grasslands for stray cattle	7.	Checking land degradation and increasing biomass availability, through integrated wasteland development activities	DoAH, Revenue Dept.	High	48.00
Manure management	8.	Equip all dairies with manure management unit (vermi compost)	DoAH, DoFW&AD	Medium	75.00
	9.	Promote manure management at cluster level for organic farming	DoAH, DoFW&AD	High	
	10.	Biogas promotion and proper Management of litters and dung & litters and dung	DoAH, DoFW&AD	High	
Research on minimizing methane emissions from cattle's	11.	Research on methane emissions from livestock sector and manure management	DoAH, DoFW&AD, VSU	Medium	17.00
	12.	Research on technology based methods for heat stress management on livestock	DoAH, DoE, Veterinary University, Research Institute	Medium	
	13.	Upgradation of nondescript livestock with exotic and cross bred germplasm	DoAH, Veterinary Universities of GoMP	Medium	
Promote new varieties of poultry and native species of small ruminants	14.	Different varieties of low input technologies birds can be tried out for their adaptability in different agro climatic zones.	DoAH, DoFW&AD	Medium	55.00
	15.	Upgradation of local stock by ensuring availability of good indegineous breeding males.	DoAH, DoFW&AD	Medium	
	16.	Promotion of artificial insemination activities	DoAH, DoFW&AD	Medium	
	17.	Ensure production of quality semen by setting up frozen semen bank	DoAH, DoFW&AD	Medium	
Integrated approach to livestock development	18.	Promote mixed farming and Agrosilvi Pasture	DoA, DoAH	Medium	70.00
	19.	Enhance availability of quality water for livestock through watershed management practices	WRD, DoRD	Medium	
Identification, conservation & promotion of indigenous varieties having high climate resilience	20.	Identification of all locally available cattle through UID tagging & registration under INAPH	DoAH, DoFW&AD, MPCST	Medium	120.00
	21.	Development of separate milk line for cows (new A2 milk routes)	DoAH	Low	
	22.	Promote breeding of indigenous varieties of bulls, cows, buffaloes, goats and chicken by giving special impetus to research	DoAH, DoE, Veterinary University, Research Institute	High	
	23.	Promote research on understanding impacts of climate change on different livestock in the state and their productivity	DoAH, DoE, Veterinary University, Research Institute	Medium	

Strategies		Actions	Department/ Organisation	Priority	Activity budget (INR Crore)
Designing disease control regulations	24.	Promotion of E-Vet network for provision of quality & timely veterinary services at village level	DoAH, Veterinary University	Medium	30.00
	25.	Early warning systems for popular/common diseases and detection of new epidemic diseases	DoAH, MPCST	High	
Infrastructure for processing, storage and transport of livestock products	27.	Setup large scale storage and transport facilities through PPP	DoAH, DoRD	Medium	200
	28.	Extend advisory to farmers on milk harnessing and delivery norms to delivery centres near villages	DoAH, DoRD	Medium	
Capacity Building & Skill development	29.	Training and capacity building of stakeholders on sustainable livestock's management	DoAH, DoE, DoTE&SD	High	18.00
	30.	Speeding up short term trainings to the farmers on different aspects of Animal Husbandary including poultry	DoAH, DoRD	Medium	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	31.	Create Climate Change Working Group in the department	DoAH, DoE	High	7.00
	32.	Integrate climate change concerns with the departmental activities	DoAH, DoE	High	
	33.	Coordinate / liaison with National missions and programme for convergence	DoAH, DoE	High	
	34.	Coordinate / liaison with MP SAPCC M&E agency	DoAH, DoE	High	
				Total	**900.00**

14 Fisheries

14.1 Sector Overview

Fishery is one of the important sources of livelihood for economically weaker sections of society in Madhya Pradesh. It has potential for both generating livelihoods as well as providing food and nutritional value. Out of 4.30 lakh hectare water area, 4.25 lakh hectares of rivers and wetlands is used by the Fisherman Welfare and Fisheries Development Department. The department oversees the conservation and development of fisheries throughout the state. Table below shows the ownership/use of water bodies by various institutions.

Fisheries sector at a glance	
Production (expected in XI plan)	74000 tons
Water Area under fish production	4.25 lakh ha
Fish Production (2019-20)	2.01 lakh tonnes
Major fish species	Indian- Katla, Rohu, Mrigal Foreign- Silver Carp, Grass Carp, Common Carp
Sources : Economic survey report of Madhya Pradesh 2020-21	

Table : Ponds/Reservoirs Available for Fisheries in Madhya Pradesh (FW&FDD 2017)

Particulars	Category (ha)	Reservoirs (Nos.)	Water Area (Lakh ha)
Panchayat	0-10, 10-100 & 100-1000	3,131	1.0922
Fisheries Department	-	19	0.038
Fisheries Federation	>1000	23	2.163
Village Ponds	Personal/Agency	33,492	0.68
Other Institutions	-	1,914	0.097
Total	-	38,579	4.0702

On a global scale, Indian fish represents 11% of total species, 24% of total genera, and 57% of the total fish diversity (MoEF&CC 2014). Recent MP is home to more than 136 species of fishes, with Narmada including 29 of them. Important fish species include Catla, Channa, Cirrihinus, Clarias, Ctenopharyngodon, Cyprinus, Heteropneustes, Labeo, Mastacembelus, Mystus, Notopterus, Ompak, Puntius, Rasbora, Tor sp., Rita, Wallago, and Xenentodon (CIFRI 2013). However, major carps like Catla, Rohu, Mrigal, and Calbasu have more than 70% dominance in total fish production, followed by exotic carps.

Mahaseer (Tor tor) is the state fish of MP though its population rapidly decreased from 30% to 3% during 2011 to 2016. Major reasons for population loss include dam construction, overfishing and water pollution. There is a dire need to conserve native and rare, endangered, and threatened (RET) fish species.

The process of fish seed production involves producing spawns followed by rearing them in ponds or nurseries. Fish seed production is mostly done in hatcheries. Increased temperatures and low water levels can affect production of fish seed and fish food organisms that support productivity in hatcheries and natural breeding grounds.

Table : Fish Production Status in Madhya Pradesh (FW&FDD 2017)

Year	Fish Seed Production (Lakh Standard Fry)	Fish Seed Rearing (Lakh Standard Fry)	Total Fish Production (Tonnes)
2014-15	10,019	9,325	1,09,121
2015-16	9,521	9,026	1,15,017

Year	Fish Seed Production (Lakh Standard Fry)	Fish Seed Rearing (Lakh Standard Fry)	Total Fish Production (Tonnes)
2016-17	11,113	10,627	1,38,694
2017-18	11,172.28	10283.44	143419.66

The sector is receiving much-needed attention from national and state departments to maximise the potential of the sector in economic development. However, climate change impacts the sector adversely; increase in temperatures, uncertain rainfall, river flows, lake water levels and nutrient levels of the water bodies affect the production and yield and species composition (Harrod, et al. 2018). The sector is also adversely affected due to the change to non-perennial nature of water bodies, water pollution due to sewage, agricultural, and industrial pollution.

14.2 Initiatives in vogue

Draft National Inland Fisheries and Aquaculture Policy 2019

The policy aims to sustainably utilise inland fisheries and aquaculture resources to increase fish production and develop fisheries supported livelihoods. The policy encourages conservation of native fishes in riverine and wetland ecosystems, but also cage culture in reservoirs where rivers cannot be used for fish production. Under aquaculture the policy emphasises on using alkaline or saline land not suitable for crop cultivation. The policy also discusses development of supportive markets and extension services to make fisheries a viable livelihood option. However, the policy does not discuss implications of climate on natural and artificial production systems or how the department would reduce risk due to climate change.

The New Fisheries Policy and Rights for Fisheries to Three Tier Panchayats Program 2008

The policy focuses on the rights of traditional fishermen cooperatives and groups. It decentralises decision making by giving the rural development department complete authority to lease rural water bodies to locals for fishing. In addition to lower lease rates the policy supports new farmers with technical training. It advocates for community-based approaches which can support conservation of water bodies and reduces the pressures of overfishing by contractors.

1. **Pradhan mantri matsya sampada yojana:**

   The PMMSY is designed to address critical gaps in fish production and productivity, quality, technology, post-harvest infrastructure and management, modernization and strengthening of value chain, traceability, establishing a robust fisheries management framework and fishers‟ welfare.

2. **Schemes under Blue revolution**
   - Establishment of Circular hatchery
   - Cage culture in reservoirs
   - Construction of new ponds/ tanks on their own land of farmer for fish culture –under blue revolution
   - Assistance of fingerlings stockings in Reservoirs
   - Aerator Provide in Rural Tank
   - Establishment of Fish seed rearing unit
   - Establishment of fish storage facilities

- Motor cycle with Ice Box
- Establishment of Kiosk/ retail fish market
- Renovation of ponds and tanks
- Pond Culture
- Saving cum relief
- Cycle with Ice Box
- Auto ricksaw with Ice box
- Insulated truck
- Re circulatory Aquaculture System

3. **RKVY: The main objectives of the scheme are :**

   (i) To incentivise the states so as to increase public investment in Agriculture and allied sectors. to Provide assistance to fisherman for expansion of Fish Ponds/Reservoirs Fish seed Hatcheries Marketing infrastructure Mobile Transport/Refrigerated vans Cold Storage & Ice Plants

14.3 Sectoral Concerns

1. **Overfishing and Large Fish Capture**

   Increase in the demand for fish led to overfishing. Rate of fishing is faster than the replenishment of stocks. Overfishing disrupts the food chain and results in the decline of aquatic ecosystems. The average size in the population reduces, which in turn reduces the size of females, the size of their eggs, and the number of eggs laid.

2. **Invasive Alien Species**

   Invasive species such as Thailand magur is known to feed on other fishes, as well as the weeds inside water bodies which reduces the food availability for local fish species. Local fish species are also unable to compete with the rate of growth of invasive alien species (Bhat and Singh 2014). Invasive species also lead to eventual decline in overall health of the ecosystem.

3. **Fishing Malpractices**

   Fishing malpractices include fishing during banned season as well as using poison, electro fishing, explosive, and small mesh size for semi-grown fishes. Such practices harm fish and other aquatic diversity.

4. **Infrastructure Development**

   Dams obstruct the natural flow of water, impede upstream migration of fishes, displace fish populations from their normal spawning grounds, and separate the population into smaller groups. The obstruction of rivers during lean periods is especially damaging.

5. **Sand Mining and erosion**

   Sand provides breeding, spawning, feeding and hiding grounds for aquatic fauna. It also acts as a pollutant filter and groundwater aquifer. Rampant sand mining in rivers of the state has caused species destruction and obstructed the perennial flow of rivers. Batagurkachuga, a schedule-1 species found in Chambal is on a verge of extinction due to sand mining (Mehta 2014). Natural soil erosion and subsequent sedimentation/siltation of rivers also affects the breeding ground of aquatic organisms and reduces their lifespan. Soil sedimentation also clogs the gills of small fishes.

6. **Water Pollution**

   Chemical leaching from fertilizer and pesticide use in agriculture, along with untreated liquid pollutants from urban and industrial waste, largely account for fish biodiversity loss. The polluting agents change the chemical balance of the water body and make it inhospitable for the life inside it.

7. **Seed availability**

   Seed availability is affected by fluctuation in temperature, which further impacts the fish pawning. Temperature fluctuation would have an impact on the suitability of species to a given location.

8. **Erratic rainfall and frequent drought conditions**

   Increase in frequency and intensity of droughts causes a decrease in fish catch posing a great threat to the communities solely dependent on fisheries.

14.4 Proposed Strategies and Actions

Strategy		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Strengthening the existing system of fish management in the state	1.	Promoting and implementing sustainable fishing practices	DoFW&FD	High	49.00
	2.	Promote rearing of indigenous species (Mahaseer, Magur, Rohu, Katla, etc) with better adaptability to changing climatic conditions	DoFW&FD	High	
	3.	Identification of aquatic invasive alien species, their management & control	DoFW&FD, Research Institutes	High	
	4.	Private sector to be engaged for increasing productivity, processing and marketing of fishes	DoFW&FD	Medium	
Study on Climate Change impacts and inland fish practices	5.	Identify parameters to develop models for protecting fish production in rivers, reservoirs and ponds with Climate Change including impact of droughts and heavy precipitation	DoFW&FD / SKMCCC	High	5.00
	6.	Identify fish species that will adapt to changing climate scenario	DoFW&FD / SKMCCC	High	
Development of infrastructure and institutions for enhancing fish production in the state for better returns on fishing business	7.	Renovation of existing and construction of new ponds/tanks to increase area under fish cultivation	DoFW&FD	High	175.00
	8.	Promotion of post-harvest infrastructure such as ice plants & cold storages, processing, refrigerated transportation, and market facilities	DoFW&FD	Medium	
	9.	New fisheries research and training centers may be established in major dams of MP to ensure scientific utilization of available water resources and development of quality fingerlings suitable for different water bodies	DoFW&FD, WRD	High	

Strategy		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Introduction of advanced technologies for change in traditional business model and "ease of doing business" for fishing communities	10.	Creation of Portal for Extending Advisory Services to Fish Farmers through Mobile applications, and connect farmers, suppliers and traders via e-commerce platforms	DoFW&FD, MAP_IT	High	101.50
	11.	High production technologies to be promoted and optimum use of available water to be ensured for fisheries by incentivising Re-circulatory Aquaculture System, Biofloc Aquaculture System, etc.	DoFW&FD, WRD	High	
	12.	Water Health Card may be developed and regularly updated for all water bodies to monitor suitability for fish cultivation	DoFW&FD, DoE	High	
	13.	Creation of database of fishermen and covering them under fisherman's insurance to provide financial support in case of loss of livelihood, accidents and death	DoFW&FD, MAP_IT	High	
Promotion policy and blending of technology for fisherman	14.	Capacity building of fishery professionals	DoFW&FD / SKMCCC	High	7.50
	15.	Capacity building of fisher men societies to make them understand the plausible changes	DoFW&FD / SKMCCC	High	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	16.	Create Climate Change Working Group in the department	DoFW&FD, DoE	High	7.00
	17.	Integrate climate change concerns with the departmental activities	DoFW&FD, DoE	High	
	18.	Coordinate / liaison with National missions and programme for convergence	DoFW&FD, DoE	High	
	19.	Coordinate / liaison with MP SAPCC M&E agency	DoFW&FD, DoE	High	
				Total	**245.00**

15 Urban Development & Transport

15.1 Sector Overview

Cities are growth engines but more often than not cities are also major source of environmental problems. City managers are expected to play a critical role in ensuring that urban areas are able to function sustainably. Few cities are able to maximize benefits to their residents while reducing the impact on the environment. The majority, however, faces a growing challenge to effectively govern, plan, develop infrastructure and support the rapidly growing population and urbanization of their communities.

Urban people have different consumption patterns than their rural counterparts. Therefore they cause greater impact on their immediate environment and in turn pollute the environment. The urban environment is an important factor in determining the quality of life in urban areas. Some urban environmental problems include inadequate water and sanitation, inappropriate or lack of waste disposal, industrial pollution. Reducing the problems and ameliorating their effects on the urban population needs lots of financial resources.

Strong urban governance is critical for making urban areas environmentally sustainable. Overlapping jurisdictions such as water, air, roads, housing, and industrial development often impact efficient governance of these vital environmental resources. Cities of Madhya Pradesh are also fraught with many environmental problems however air pollution and waste management are some of the most pressing factors responsible for the increase of environmental health related risks. Six cities of Madhya Pradesh namely Bhopal, Ujjain Dewas, Indore, Gwalior and Sagar have been listed as non-attainment cities under the National Clean Air Programme.

In Madhya Pradesh 6773 TPD of solid waste is generated out of which 5480 TDP is collected. Of the total collected waste 79.17% goes to the

Urban Development and Transport sector at a glance	
Level of urbanisation	27.5%
Towns	364 – Statutory towns 112 – Census towns
Urban Population	20.05 million
Decadal Urban Population growth rate (2001-2011)	25.6%
Total slum dwellers *(Census 2001)*	24,17,091 (15.13% of the total urban population)
Total motor vehicles registered in MP	60,10,691
Road network (km)	73,311 kms
Urban Local Bodies	360
	Municipal Corporation - 14
	Municipality - 96
	Nagar Panchayat - 250
Sources: Urban Infrastructure Report 2011, Census 2011, Census 2001,Transport Statistics 2008-09,	

Indore Smart City sold carbon credits worth Rs. 50.00 lakhs

IMC has become the first civic body in the country to start generating revenue by selling carbon credits. Revenue of Rs 50 lakhs generated by selling credits against 1.70 lakh tonnes of carbon dioxide received from the United Nations Framework Convention on Climate Change (UNFCCC) under the Verified Carbon Standard (VCS) programme.

Indore Smart City Development Limited (ISCDL)had registered three of IMC's projects — a 600-tonnes-a-day compost plant, biomethanation plant of 35 TPD capacity (Choithram and Kabitkhedi) and a 1.5 MW solar plant under the VCS programme. VCS is a global programme and standard for certification and registration of projects that focus on reduction and removal of greenhouse gases. The credits earned through listing of the projects can be monetized by sale in the international carbon market.

landfill and only 20.82% is treated and used for energy. Thus huge amount of solid waste is reaching landfill, a huge challenge which is not just limited to treatment of waste but many environmental and human health issues such as (toxic waste, leachates, emission of greenhouse gases) are associated with it.

Habitat refers to the place or area inhabited by one or more organism. The term Sustainable Habitat means conservation of our natural home. Climate Change is directly associated with unsustainable, unplanned and rapid development. The true elucidation of urbanization is related to the rapid growth of economic activities and expansion of urban population. Due to unsustainable urbanization, there are increasing issues like pollution, food insecurity, uneven water supply, vehicular emissions, improper sewerage, generation of solid wastes, health issues, etc.; therefore habitats are becoming more and more vulnerable to the impacts of climate change. Migration of people from rural to urban areas is an important component of urbanization. Higher the migration rate, more stress will be on urban infrastructure and services, increase in consumption of energy and associated greenhouse gas emissions. Thus, it becomes imperative to make urban regions more resilient to the impacts of climate change by combining adaptation and mitigation aspects into the planning process.

Table : Urban Scenario in India and Madhya Pradesh from 2011 Census

Category (As per Census 2011)	India	Madhya Pradesh
Urban Population	377105760	20069405
Share of urban population to total population	31.20%	27.63%
Decadal Urban Population Growth (2001-2011)	31.80%	25.69%
Urban Sex Ratio	926	918
Urban Literacy Rate	85%	82.85%

Source: Census India and Madhya Pradesh

The total urban population as per 2011 Census in the State is 2.01 crores, an increase from figure of 1.60 crores in 2001 census. It can be observed from the above table that Madhya Pradesh has 5.3% of India's total urban population. It is estimated that the urban population in Madhya Pradesh will increase to 3.05 crores[16] by 2026 and due to this, there will be many major challenges in managing with the rising demand for urban infrastructure and access to basic civic amenities and services by the rapidly growing population.

Table : Number of Urban Bodies in Madhya Pradesh

Sl. No.	Towns	2001	2011
1	Municipal Corporations	14	14
2	Municipality	85	96
3	Nagar Panchayat	235	249
4	Cantonment Board	5	5
5	Census Town	55	112
	Total Towns	**394**	**476**

Source: Directorate of UADD, Madhya Pradesh

Total number of towns in Madhya Pradesh has increased considerably from 394 to 476. The maximum growth in numbers is observed for census towns that have increased from 55 in 2001 to 112 in 2011. The number of municipal corporations, cantonment boards and notified areas remains same from 2001 to 2011.

[16]Population projections for India and States 2001-2026, GoI Report

The chart shows the trend of decadal urban population growth in Madhya Pradesh. It is observed that growth rate peaked to 29.3% during the year 1961-71 and then gradually decreased to 20.3% during 2001-11.

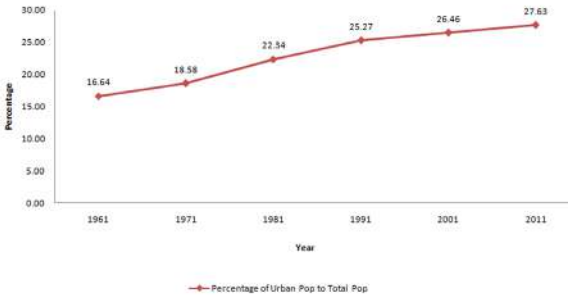


Figure : Decadal Growth of Urban Population
Source: Directorate UADD, Madhya Pradesh

The chart shows the trend in urbanization in Madhya Pradesh. The ratio of urban population to total population in the State steadily increased from 16.64% in 1961 to 26.46% in 2001. In 2011, it had further increased to 27.63%.

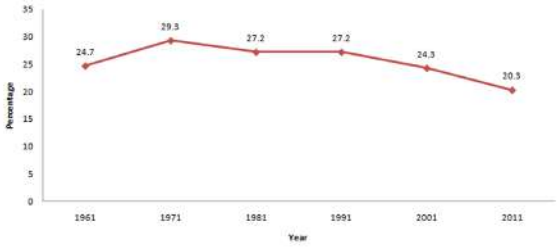


Figure : Trend in Urbanization in Madhya Pradesh
Source: Directorate UADD, Madhya Pradesh

Rapid urbanization is a major threat which makes people more vulnerable to the effect of climate change. Good urbanization should ensure that the urban areas are not only free from slums but also provide enough opportunities of productive employment and good quality of life regardless of people's income, also focusing on sustainable development taking into account environmental protection, economic growth and social equity in the planning process.

15.1.1 Transport

Road transportation is considered to be the backbone for urb an development and is needed for economic growth and social integration of urban areas. All means of transport depends on fossil fuels. Madhya Pradesh has observed a significant growth in the transport sector. The major mode of transportation in the State is road transportation. The state has been observing an increasing growth in vehicular population.

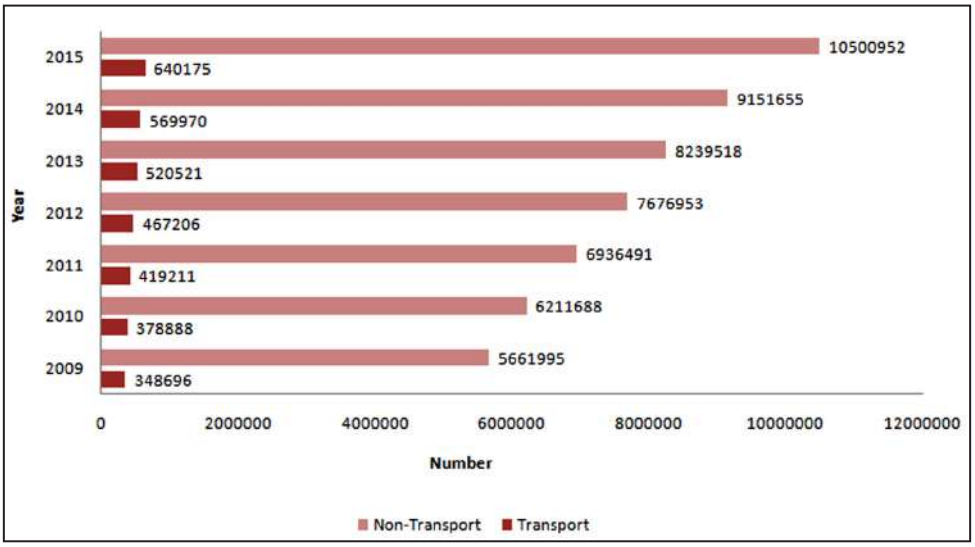


Figure : Number of Vehicles Registered in Madhya Pradesh from 2009 to 2015
(Source: Motor Vehicles - Statistical Year Book India 2016)

Both transport and non-transport system in the State has seen a boost in the past years. From 2009 to 2015, the average growth rate of vehicular population is 10.8%. The number of registered vehicles per thousand population of Madhya Pradesh is more than the national average. Road transport is highly fuel inefficient and there is over-dependence on privately owned vehicles. The State Transport Policy focuses on efficient public system taking into account Bus Rapid Transport System. MP has a focus on Metro Rail services and Intelligent Transport Systems to improve the mass transport. The state got a challenge to manage the growing number of vehicles and introduce a sustainable mass transit system so as to reduce the consumption of energy and associated greenhouse gas emissions. By 2030, the GHG emissions from transport sector will be 34.88 million tCO_2e[17].

15.1.2 Waste Management

Waste management activities such as collection, treatment and disposal of solid waste and wastewater lead to GHG emission in the form of CH_4 and N_2O gases[18]. Waste sector emissions are a result of the degradation of organic material under anaerobic conditions. Key sources of GHG emissions include solid waste disposal, domestic wastewater treatment and discharge, and industrial wastewater treatment and discharge.

In line with the IPCC reporting structure, the source categories considered in the GHG emission estimates for waste are classified as:

- Solid Waste Disposal
- Wastewater treatment and discharge
    - Domestic Wastewater Treatment and Discharge
    - Industrial Wastewater Treatment and Discharge

Total GHG emissions through waste in Madhya Pradesh are estimated to be 3.96 $MtCO_2e$ in 2015, 69.1% of which were contributed by CH_4 emissions and N_2O emissions amounted to the remaining 30.9%. GHG emissions from all three sources have shown an increasing trend from 2005 to 2015, with cumulative emissions from the Waste sector increasing by 42.5% and registering a compound annual growth rate (CAGR) of 3.6% over this period. Domestic wastewater in urban and rural areas of the state contributed to 83.4% of the Waste sector GHG emissions in 2015. Solid waste disposal and industrial wastewater accounted for 11.7% and 4.9% of the emissions respectively in 2015.

Per capita emissions through waste, estimated based on aggregated state-level emissions, increased from 42.58 kg of CO_2e in year 2005 to 50.4 kg of CO_2e in the year 2015. The per capita emissions from the Waste sector are estimated to have increased at a CAGR of 1.7% per annum from 2005 to 2015.

[17]A low carbon development paradigm, March 2014 (Inclusive and sustainable growth for Madhya Pradesh)

[18]Methane (CH4) is produced and released into the atmosphere as a by-product of the anaerobic decomposition of solid waste and when domestic and industrial wastewater is treated or disposed anaerobically. Nitrous oxide (N2O) emissions occur from domestic wastewater disposal into waterways, lakes or seas domestic wastewater due to its protein content.

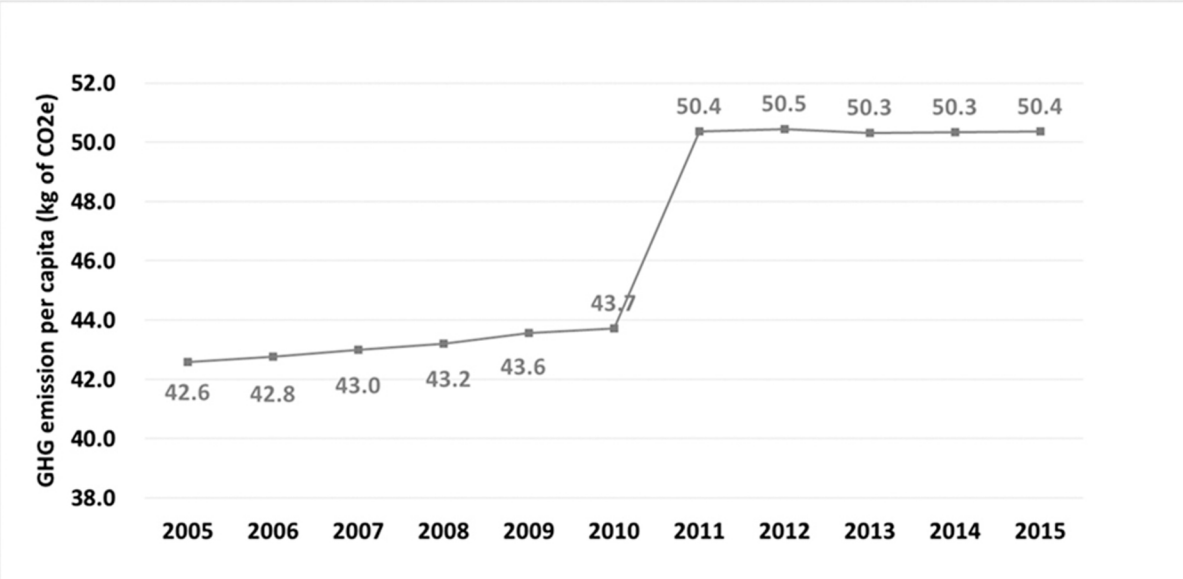


Figure : Trend of per capita GHG emissionsthrough Waste in Madhya Pradesh, 2005-2015

15.1.3 Urban Drinking Water and Sanitation

Providing safe drinking water supply and provision of sanitation facilities has become the primary responsibility of the state government. SDG Goal 6 "Clean Water and Sanitation" focuses to achieve universal and equitable access to safe and affordable drinking water and sanitation and hygiene for all. With an objective to improve the water supply situation, the State Government has undertaken various water supply projects. As per the Census 2011, about 62.2% of the urban households had received tap water, of which 50.6% from treated sources and 11.6% from untreated sources. The remaining 37.8% of urban households receives water from other sources that include bore well, open well, hand pump and other sources. Out of total urban household, 55.4% households have availability of drinking water source within premises, 30.1% near premises and 14.5% away from premises.

Sanitation plays a critical role in public health which directly impacts the well-being of people and enhances the quality of life. Climate Change has thus impacted the urban health in direct and indirect ways. From the surveyed 383 ULBs, 362 ULBs (94.26%) are declared ODF (107 ULBs are ODF++, 234 ULBs are ODF+ and 20 ULBs are ODF) and 17 ULBs (4.43%) are non-ODF.[19]

15.2 Initiatives in vogue

15.2.1 Waste Management

- **Total Sanitation Campaign:** This campaign had been run by Government to improve the general quality of life in rural areas and accelerate sanitation coverage in rural areas through access to toilets to all by 2012.[20] The need of this campaign was to eradicate the practice of open defecation, in a community-led and people-centered manner.

[19]http://sbmodf.in

[20]WaterAid India: Sanitation Sector Financing in India, March 2012, Section 2.1. Retrieved from: http://indiawashforum.com/wp-content/uploads/2016/05/Sanitation-Financing-Report-2011.pdf

- **Nirmal Bharat Abhiyan or Clean India Campaign:** The campaign was initiated for improving general quality of life in rural areas. The objective of this campaign was toachieve the vision of Nirmal Bharat by 2022 with all gram Panchayats in the country attaining Nirmal status by encouraging cost effective and appropriate technologies for ecologically safe and sustainable sanitation[21].
- **Swachh Bharat Mission (Gramin):** The first phase of Swachh Bharat Mission (Grameen) was launched on 2nd October 2014 with an objective to cover all rural household with toilet and make open defecation free (ODF). **MP State beacame ODF State on 2/10/2018.**
- The Second phase of Swachh Bharat Mission (Grameen) started on 1st April 2020 with the target to sustain the achievements of first phase and provide the facilities of solid and liquid waste management to make **all villages clean by 2025**. The mission also emphasizes for community and PRIs participation through proper IEC and capacity building activities.
- **Swachh Bharat Mission– Urban:** Elimination of open defecation[23], Eradication of Manual Scavenging, Modern and Scientific Municipal Solid Waste Management to effect behavioural change regarding healthy sanitation practices.
- **Integrated Low Cost Sanitation Scheme:** To convert/construct low cost sanitation units through sanitary two pit pour flush latrines with superstructures and appropriate variations to suit local conditions and construct new latrines where economically weaker section households have no latrines and practice open defecation in urban areas[24]
- **Integrated Urban Sanitation Programme:** Achieve totally sanitized, healthy, livable cities and towns and to enhance living standards of the communities with special emphasis on the urban poor[25] Provide city wide sanitation facility focusing on all aspects of sanitation with support from the local communities and other stakeholders[26]
- **National River Conservation Programme - National Scheme:** To improve the water quality of the rivers, which are the major water sources in the country, through the implementation of pollution abatement works such as collection, transportation and treatment of municipal sewage, river front development, low cost sanitation, electric crematoria etc.[27]

[21]Nirmal Bharat Abhiyan Guidelines, July 2012, Section 2.1. Retrieved from: http://hptsc.nic.in/NBA_Guidelines_Final.pdf

[22]Retrieved from: http://www.swachh.mp.gov.in/aboutSBM.aspx

[23]Swachh Bharat Mission Objectives, Retrieved from: http://mohua.gov.in/cms/swachh-bharat-mission.php

[24]Prototype Interactive Public Questions & Answers, ILCS scheme, Retrieved from: http://mohua.gov.in/upload/uploadfiles/files/4ilcs.pdf.

[25]**Sanitation:** Integrated Urban Sanitation Program (IUSP) in Madhya Pradesh (Section 1), the report on work done for HUDCO Best Practices Awards 2013-14 Retrieved from: http://www.mpurban.gov.in/pdf/BestPracticesSanitation(Low Cost Sanitation Solutions).pdf

[26]**Sanitation:** Integrated Urban Sanitation Program (IUSP) in Madhya Pradesh (Section 4), the report on work done for HUDCO Best Practices Awards 2013-14 Retrieved from: http://www.mpurban.gov.in/pdf/BestPracticesSanitation(Low Cost Sanitation Solutions).pdf

[27]National river conservation plan, Background section, Retrieved from: https://nrcd.nic.in/writereaddata/FileUpload/23617950NRCP%20Backgrpund.pdf

15.2.2 Housing, Residential & Commercial

- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** The mission focuses on the water supply, sewerage facilities and seepage management, storm water drains to reduce flooding, pedestrian, non motorized and public transport facilities, parking spaces and enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centres specially for children.
- **SMART Cities Mission:** It aims to promote housing opportunities for all, reduce congestion, air pollution and resource depletion, preserve and develop open spaces, transport options, governance citizen friendly and cost effective and smart solutions to infrastructure and service. Bhopal, Indore, Ujjain, Gwalior, Jabalpur, Satna and Sagar are the 7 smart cities under SMART city mission in Madhya Pradesh.
- **Deendayal Antyodaya Yojna-National Urban Livelihood Mission (DAY-NULM):** This programme aims to reduce poverty and vulnerability of the urban poor households by enabling them to access gainful self employment and skilled wage employment opportunities resulting in an appreciable improvement in their livelihoods on a sustainable basis. the mission would aim at providing shelters equipped with essential services to the urban homeless in a phased manner. In addition the mission would also address livelihood concerns of the urban street vendors by facilitating access to suitable spaces, institutional credit, social security and skills to urban street vendors for accessing emerging market opportunities.
- **Jawaharlal Nehru National Urban Renewal Mission:** Focused attention to integrated development of basic services to the urban poor Security of tenure at affordable price, improved housing, water supply Scaling up delivery of civic amenities and provision of utilities with emphasis on universal access to urban poor.[28]

City Climate Action Plan of 7 Smart Cities of MP

SMART Cities Mission under the Ministry of Housing and Urban Affairs (MoHUA), GoI has launched "Climate Smart Cities Assessment Framework (CSC-AF)". The CSC-AF serves as a tool for cities to assess their climate readiness and provides a roadmap for adopting and implementing relevant climate actions.

CSC-AF consists of 30 indicators across five broad categories namely; (i) Energy and Green Building, (ii) Urban Planning, Green Cover and Biodiversity, (iii) Mobility and Air Quality, (iv) Water Resource Management and (v) Waste Management. One of the important indicators to assess the Climate SMART readiness of the cities is development of City Climate Action Plans (CAPs), covering both mitigation and adaptation measures.

In this endeavor, World Resources Institute (India) has collaborated with EPCO to prepare CAPs for all the 7 SMART cities of MP. The draft plans have been prepared and shared with the smart cities and now capacities of the smart city officials would be built on climate change and related urban issues.

In the next assessment under CSC-AF, the smart cities would be ranked with climate smartness according to their readiness and planning for combating climate change & its adverse impacts on smart cities.

- **Standards and Labelling Programme (for appliances):** To promote the use of energy-efficient, BEE star-labelled appliances in residential and commercial buildings
- **Unnat Jyoti by Affordable LEDs for All (UJALA):** To replace incandescent bulbs with energy-efficient LED bulbs
- **Streetlight National Programme (SLNP):** To replace conventional streetlights with smart and energy-efficient LED street lights
- **The Energy Compliant Building Code (Residential)**
- **The Energy Compliant Building Code (Commercial)**

[28]Guidelines for JNNURM, Section 4, Retrieved from: http://www.indiaenvironmentportal.org.in/files/guidelines_jnnurm.pdf

15.2.3 Transport

- **Bus Rapid Transit System (BRTS):** To promote the use of public transport in cities.
- **Madhya Pradesh Metro rail Project:** GoMP has decide to implement metro rail projects in the cities of Bhopal and Indore. The Projects are being implemented as per the DPR.

15.3 Sectoral Concerns

- Unplanned development and provisioning infrastructure, drinking water, sanitation and municipal waste collection and disposal in towns are the major challenge.
- Urban living patterns generate huge amount of solid waste and waste water which are potential source of methane.

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  Transport system thrives on fossil fuel and their combustion lead to generation of gases like CO, NO_x, Hydro carbons, SO_2 and solid particles.

  Unplanned roads with reduce capacities lead to traffic congestions, length of drives and level of emissions much more.

  Loss of green cover around urban centres may lead to development of heat islands which may rise the average atmospheric temperatures.

  Heat stress on human health may lead to morbidities, worst affected would be the urban poor and homeless who are subjected to more heat exposure.

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- Heat stress on human health may lead to morbidities, worst affected would be the urban poor and homeless who are subjected to more heat exposure.
- For insufficient quality tapped water, excess exploitation of ground water is responsible for its depletion.
- Increasing rural to urban migration due to rapid growth of the cities in the developing world is another concern. It results into fast depleting resources and high-energy consumption.
- Poor disaster management preparedness is a concern for the state in the house of natural calamities like situation of flood, earthquake and geographic disturbance.

15.4 Proposed Strategies and Actions

Strategies		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Municipal Solid Waste Management	1.	Adopt 100% segregated door to door waste collection in all ULBs	UADD	High	641.50
	2.	Completion of operations of compost and waste to energy projects which are in various stages of implementation in remaining 5 clusters (Rewa, Gwalior, Chhatarpur, Singrauli and Jabalpur C&T)	UADD	High	
	3.	Notification and mechanisms for C&D and plastic waste collection and management	UADD, DoE	Medium	
	4.	Establish legacy waste processing units for existing and abandoned dumpsites in all ULBs	UADD	High	
	5.	Commence operation of permanent MRF facilities in all clusters with waste generation of 300 TPD and above	UADD, DoE	Medium	
	6.	Commence operation of compost and waste to energy projects in 14 remaining clusters (Shahdol, Betul, Damoh Vidisha, Guna, Shivpuri, Balaghat, Badwani, Shajapur, Ratlam, Hoshangabad, Dewas, Bhind and Chhindwara)	UADD	High	
	7.	Construction of sanitary landfills in clusters/ULBs with 0.5 million or more population	UADD	High	
	8.	Scientific closure of existing dumpsites in all ULBs	UADD, DoE	High	
	9.	Establish C&D waste processing facilities for all ULBs	UADD, DoE	Low	
	10.	Commence operation of processing facilities for any leftover unprocessed waste (mainly dry waste) in the ULBs, over and above that in the MSWM Action plan	UADD, DoE	Low	
Domestic Waste water Management	11.	Capturing and utilizing methane for energy generation in all existing and new proposed Anaerobic treatment based STPs	UADD, DoE	Medium	370.00
	12.	Improved performance management of existing Aerobic treatment based STPs	UADD, DoE	High	
	13.	Installation of Decentralized Wastewater Treatment Systems (DEWAT) to treat waste water in sewer inaccessible areas	UADD, DoE	Low	
	14.	Connection of existing septic tank systems to sewerage network	UADD, DoE	Medium	
	15.	Expanding sewerage network in sync with augmentation of treatment capacity[29]	UADD, DoE	High	
	16.	Promote reuse and recycling of sewage handled through centralized sewer system	UADD, DoE	Medium	

Strategies		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
	17.	Enforce and incentivize water recycling/reuse in apartments/housing communities, commercial establishments as per building bye-laws	UADD, DoE	Medium	
Urban Water Supply Management	18.	Mandating water audits and energy audit of water utilities	UADD	High	85.00
	19.	Promote water efficient garden irrigation techniques, reduce leakage in domestic supply system, water recycling	UADD	High	
	20.	Awareness among people about reduce, reuse and recycle techniques for waste water	UADD, DoE, WRD	High	
	21.	Refurbishment of distribution system and control of UFW through replacement of GI pipes with HDPE pipes	UADD	High	
	22.	Developing regional/local manual for GW recharge and RWH techniques and Policy level interventions to promote and incentivise RWH	UADD, DoE, WRD	High	
Urban Storm Water Management	23.	Developing plans for sanitation and capacities of existing drainage system in context of changed climatic and demographic scenario	UADD	High	10.00
Enhancing Energy Efficiency in Residential & Commercial Buildings	24.	Adoption of energy efficiency measures for urban water supply and sewerage equipments, street lights and building of ULBs	UADD, DoE	High	138.00
	25.	Compulsory plantations for residential permissions in urban & rural areas	UADD, DoRD, DoE	High	
	26.	Pursue urban water supply, sewage treatment facility, street lighting and infrastructure	UADD, DoE, MPUVN	High	
	27.	Promotion of Standards and Labelling Programme	UADD, NRED	High	
	28.	Demonstration projects for energy efficient construction technologies	UADD, NRED, DoE	Medium	
	29.	Increase energy auditing and develop monitoring mechanisms to ensure energy efficiency	UADD, NRED, DoE	High	
	30.	Effective implementation of Energy Compliant Building Code (Residential) norms	UADD, NRED	Medium	
	31.	Effective implementation of The Energy Compliant Building Code (Commercial) norms	UADD, NRED	Medium	
	32.	Promotion of Street Light National Programme (SLNP)	UADD, NRED	Medium	
	33.	Promotion of Unnat Jyoti by Affordable LEDs for All (UJALA)	UADD, NRED	High	
	34.	Promotion of green building concept and incentivising best green building construction projects	UADD, DoE	Medium	

[29]Action has a direct relevance with other proposed mitigation actions – for STPs to operate in full capacity and achieve maximum mitigation and for latrines (using septic tanks) to be able to be connected to sewerage network, the expansion to address current gap is important.

Strategies		Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Sustainable Urban Transport	35.	Promotion of Electric Vehicles and building related infrastructure	UADD, DoT	Medium	102.50
	37.	Model regulations for integrating transport planning with spatial planning working on extensive public transport system on regional scale	UADD, DoT	Medium	
Urban Planning	38.	Modifications of urban development for promoting urban renewal, environment management, green infrastructure, spaces for plantation at plot level for increasing tree cover, structural safety, hazard and risk mitigation, transport planning	UADD, DoE	Medium	17.00
	39.	Identification of sensitive areas (geologically, hydrologically & geographically)	UADD, DoE	Medium	
	40.	Identification of areas for Peripheral urban development along with possible organic growth areas of hinterland	UADD, DoE	Medium	
	41.	Studies to determine the Carbon Sequestration potential of Urban Lakes	UADD, DoE	Medium	
Adoption of service of benchmarks	42.	Creation and adoption of benchmarks for sustainable management of water supply, wastewater, storm water drainage and solid waste management	UADD, DoE	Medium	6.00
	43.	Development of service level benchmarks for urban sectors	UADD	Medium	
	44.	Mandating adoption of sustainable habitat standards	UADD	Medium	
IEC activities	45.	Studies to determine the carbon sequestration potential of urban lakes & wetlands	UADD, DoE	Medium	15.64
	46.	Create educational programmes and capacity building activities for students and professionals on aspects related to sustainable urbanisation/ cities and climate change in association with technical universities/ institutes/ colleges/ schools	UADD, DoE	Medium	
	47.	Capacity building of city managers/UADD officials and consumers on best practices in energy efficiency in building and Climate Change impacts/cities and Climate Change	UADD, NRED, DoE	High	
	48.	Launch dedicated awareness drive on use of public transport	UADD, DoT	Medium	

Strategies	Actions	Department/ Organisation	Priority level	Activity budget (INR Crore)
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	49. Create Climate Change Working Group in the department	UADD, DoT, DoE	High	7.00
	50. Integrate climate change concerns with the departmental activities	UADD, DoT, DoE	High	
	51. Coordinate/ liaison with National missions and programme for convergence	UADD, DoT, DoE	High	
	52. Coordinate/ liaison with MP SAPCC M&E agency	UADD, DoT, DoE	High	
			Total	**1533.00**

16 Energy

16.1 Sector Overview

Energy sector is a critical infrastructure element for the socio-economic growth of any state.Energy and the environment have always been and will continue to be closely linked. All energy is, at bottom, either derived or captured from the environment around us. Once used, it is eventually returned to the environment as a harmless by-product or, more often than not, as harmful emissions or waste. As energy usage has increased so too have the stresses this usage imposes on the environment intensified.

Energy sector at a glance	
Sources of energy in MP	**Conventional –** Thermal, Hydro **Non Conventional–** Wind, Solar, Biomass
State owned capacity (conventional sources) 2020-21	**Thermal -** 5400 MW **Hydel -** 2465 MW
State owned power generation capacity (including renewable sources)	21,216 MW
Total power generation in the state	9001MW
Installed capacity (Conventional Sources)	**Thermal -**21150 MW **Hydel -** 2481 MW
Maximum Demand and Demand met (2010-2011)	8758 MW **Demand met –** 8331 (net shortage of 427 MW)
GHG emission from the energy sector (India)	1100.06 millions tons of CO_2eq
Sources : INCCA, MP TRIFAC	

The current energy requirement of the state is heavily dependent on conventional energy sources. MP has witnessed significant growth in the power generation, though it still faces various challenges in terms of energy access, energy efficiency and transmission & distribution loss.

Ensuring access to equitable, reliable, affordable and sustainable energy is imperative for achieving economic development, driving social growth; alleviate poverty and ensuring prosperity of any economy. For the overall development of the state, continuous and uninterrupted power for all must be ensured. Though Madhya Pradesh is one of India's largest states, with a growing per capita consumption, the state's overall per capita electricity consumption is far less than the Indian average consumption. This is mainly because of lower commercial and industrial electricity consumption.

Though access to electricity (100% household electrification) is being ensured till the last mile under Saubhagya scheme, challenge persists towards ensuring affordable and reliable electricity. From the electricity deficit state in 2012-13, Madhya Pradesh is now power surplus state, disposing excess power through the power exchange.

Table : Energy Profile of Madhya Pradesh	
Total Installed capacity	22,965 MW
State's share from Thermal	65.7%
State's share from Nuclear	1.6%
State's share from Hydropower	15.8%
Total energy demand	76,050 MU
Per Capita Electricity Consumption (2014-15)	927 kWh

Table : Energy Profile of Madhya Pradesh	
Per Capita consumption of Petroleum Products	101.9 kg
Household Electrification Status as on Sept 2018	100%
LPG Penetration as on Sept 2018	81%
Transmission and Distribution losses (2020-21)	22,081 MU

The installed power generation capacity in Madhya Pradesh is predominantly coal based followed by renewable energy-based power projects (without Large Size Hydro-LSH).

Table : Source-wise installed capacity (in MW)

Ownership	Coal	Gas	Total Thermal	Nuclear	Hydro	Total
State	5400.0	0.0	5400.0	0.0	2465.0	7865.0
Private	8870.0	0.0	8870.0	0.0	9.75	8879.75
Central	6220.0	0.0	6220.0	0.0	0.0	6220.0
Total	**20490.0**	**0.0**	**20490.0**	**0.0**	**2474.75**	**22964.75**

Source: Departmental inputs (as on Mar 2020)

Table : Source-wise generation capacity (in MW)

Ownership	Coal	Gas	Total Thermal	Nuclear	Hydro	Renewable	Total
State	5400.0	0.0	5400.0	0.0	2468.0	585.0	8453.0
Private	3352.0	75.0	3427.0	0.0	9.75	3078.0	6513.75
Central	4107.0	257.0	4364.0	342.0	894.0	300.0	5900.0
Total	**12858.0**	**332.0**	**13190.0**	**342.0**	**2474.75**	**3963.0**	**20865.75**

Source: Departmental inputs (as on Mar 2020)

Table : Monthly energy supply and peak demand (in MU)

Particulars	Apr 19	May 19	Jun 19	Jul 19	Aug 19	Sept 19	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20
Energy Supplied (DISCOMs)	5885	6443	5921	5578	5258	4972	5132	6479	7241	7195	7384	5815
Energy Supplied (State)	6144	6715	6193	5840	5498	5155	5348	6700	7477	7430	7615	6044
Peak Demand	9738	9880	9955	9845	8606	8685	8736	12921	14326	14415	14555	11877

Source: Departmental inputs (as on Mar 2020)

Electricity Demand Scenario

Boost in economic activities, increase in per capita electricity consumption, electrification level and institutionalization of central schemes like Power for All, SAUBHAGYA etc. has spur the electricity demand further. The electricity demand has increased at a CAGR of 3.88% from 2015-16 (62,375 MU) to 2017-18 (69,926 MU).

Electricity Consumption Scenario

Consumption of electricity (based on sales of DISCOM across different category of consumers) is highest across the agricultural irrigation sector followed by domestic loads during FY-2019.

Electricity Requirement

The power requirement in the state is the sum of the electricity sales figure after factoring into distribution losses, transmission losses and other external losses for FY2015-16 to 2019-20 are as follows:-

Year	Electricity Sales (MU)	Distribution Losses(MU)	Transmission Losses (MU)	External losses (MU)	Electricity Requirement (MU)	Supply to OACs	Electricity Requirement of State
2015-16	45512	14102	1762	1399	62775	1374	64149
2016-17	43284	14600	1647	1584	61115	3133	64248
2017-18	46000	16862	1798	1699	66359	2868	69227
2018-19	50311	19274	1950	1663	73198	3149	76347
2019-20	55829	14013	1874	1585	73302	2857	76159

Source: Departmental inputs (as on Mar 2020)

Electricity Availability

From the electricity deficit state in 2012-13, Madhya Pradesh is now power surplus state, disposing excess power through the power exchange. The availability of power at the Ex-bus from MP GenCo Thermal &Hydel plants in FY 2018-19 was 24246 MU & 1774 MU, respectively:-

Table : Available Generation Capacity (State Share in different Setors)

Year	Mp Genco Thermal	Mp Genco Hydel	Other Hydel	NTPC / NPC /DVC	UMPP / IPP	Renewable
2010-11	2808	917	2432	2630	100	181
2015-16	4080	917	2432	3927	2986	2508
2020-21	5400	917	2460	5252	3427	3966

Source: Departmental inputs (as on Mar 2020)

Per Capita Electricity Consumption

The per-capita electricity consumption in the state during FY 2014-15 of 739 kWh, was way below the national average of 1,020 kWh for the same period (Power for All).

Per capita consumtion of State (Units)

(Captive use not included)

2014-15	749
2019-20	929
2020-21	1008

LPG

The current level of LPG penetration in the state of 81% is lower than the national average of 94.3%. The increase in penetration owes to PMUY scheme with coverage of 37% households under the scheme.

Coal

Madhya Pradesh is the fourth largest producer of coal in the country with 16.6% (112.12 Million Tonnes) of the national production in 2017-18 with major share of non-coking variety (111.94 Million Tonnes). 97.37 Million Tonnes of coal produced in the state are however dispatched to elsewhere. The production of coal in the state has increased at a CAGR of 5.15% from 2008-09 to 2017-18.

16.2 Initiatives in vogue

- Integrated Power Development Scheme (IPDS)/Restructured Accelerated Power Development and Reforms Programme (R-APDRP)– Tominimise losses in power transmission and distribution systems by undertaking maintenance activities, feeder segregation, etc.
- Standards and Labelling Programme (for appliances)–Topromote the use of energy-efficient, BEE star-labelled appliances in residential and commercial buildings.
- UnnatJyoti by Affordable LEDs for All (UJALA)–Toreplace incandescent bulbs with energy-efficient LED bulbs.
- Streetlight National Programme (SLNP)–Toreplace conventional streetlights with smart and energy-efficient LED street lights.
- Policy for implementation of Small Hydel-Power based Electricity Projects in Madhya Pradesh, 2011- To promote small hydel installations by defining incentives and benefits to be provided to the private sector participants, etc.

16.3 Sectoral Concerns

- Substantial AT&C loss across the state DISCOM of around 29.74%. For example, M.P. Poorv KshetraVidyut Vitaran Co. Ltd supplying electricity to 51,22,103 rural households and 12,64,767 urban households are reeling under substantial AT&C losses which is also on rise in the recent year as compared to the baseline year of UDAY.
- **Reduction in PLF of Thermal Power Plant.**
  - The average Plant Load Factor of the state-owned Thermal Power Plant has reduced from 67.35% in 2018-19[1].
  - Not specific to the central sector Thermal Power Plant, but average reduction in PLF of Central Sector Thermal Power Plant has reduced from 83.9% in 2009-10 to 55.24% in 2018-19[2].
- Poor supply chain towards fostering adoption of Energy Efficiency measures across MSME sector.
- Poor power quality in the agricultural feeder often led to motor burnouts. In addition to it, inconvenient pumping hours, erratic power supply, flat tariff and poor supply chain of efficient pumps led farmers in adoption of inefficient and oversized pumps leading to enhanced energy consumption and excessive water exploitation. Such events also lead to increase in Distribution Transformer damage.
- Lack of incentives/provision for financial linkages for MSME units and non-DC industrial consumer in adoption of EE measures.
- Lack of advocacy and required push of enactment of the provision of EC Act and DSM regulations.
- Rating of DISCOMS[3] has been a major concern.
  - MP PoorvKshetra V.V. Co. Ltd – C+
  - MP Madhya Kshetra V.V. Co. Ltd – C+
  - MP PaschimKshetra V.V. Co. Ltd – B+

[1] **http://www.mppgcl.mp.gov.in/mppgenco-plf-past.html**

[2] **https://powermin.nic.in/en/content/power-sector-glance-all-india**

[3] **Based on Sixth Integrated Rating of State DISCOM**

- **Small Hydro Power Projects**
  - Environmental concerns and decline in sustained flows in river coupled with poor evacuation infrastructure facilities.
  - Absence of cluster approach, size and location of the projects keeps serious investors away.
- **Other issues**
  - Lack of research in energy storage solutions and innovations.
  - Lack of ESCO based business model coupled with lack of interest of Financial Institutions in funding stand-alone EE measures across industrial sector.
  - Lack of sector specific assessment and action plan for scaling up energy efficient efforts.
  - Lack of mandates for the utilities and public institutions to invest in energy efficiency measures.
  - Poor M&E framework in assessing impact and benefits of intervened measures.
  - Lack of co-ordinated actions amongst the departments and agencies for institutionalising different developmental and climate change mitigation initiatives in the state.

16.4 Proposed Strategies and Actions

Table : Prioritisation of the proposed activities

Strategies		Action Points	Department/ Organisation	Priority	Activity budget (INR Crore)
Enhancing efficiency in power generation	1.	Assess viability of carbon-capture technology and its commercial application in thermal power plants	ED, DoIP&IP NRED	Medium	45.00
	2.	Green Tariff may be considered to motivate clean energy generation in the state	ED, DoIP&IP NRED	Medium	
	3.	Development of policy framework for generating clean energy through clean coal approaches/ technologies	ED, DoIP&IP NRED	High	
	4.	Promote possibilities of use of fluidised bed boiler and coal gasification for refurbishment of old units	ED, DoIP&IP NRED	Medium	
	5.	Assessment of life cycle analysis of existing thermal power plants and resource mobilization for implementation of O&M measures	NRED, ED	Medium	
	6.	Completion of two thermal units of 660 MW each at Sarni and Chachai which are proposed to be having state-of-the-art technology to minimise the GHG & Particulate Emissions.	ED	High	
	7.	Promotion of off grid power generation	ED	Medium	
Improve T&D infrastructure	8.	Development of operational plan for reduction of T&D losses in Power Discoms, Transcoms	ED	High	264.00
	9.	Expansion of off-grid renewable energy systems (small scale wind and solar) to reduce T&D losses	NRED, ED	High	
	10.	Continue to promote use of energy efficient pumps and giving subsidy to farmers to motivate them in replacing old pumps to new solar pumps	DoFW&AD, DoE, MoP	High	

Strategies	Action Points	Department/ Organisation	Priority	Activity budget (INR Crore)
	11. Continue to promote energy efficiency in Street lighting and Water Pumping, Buildings	UADD, ED	High	
	12. Continue to promote aggressively Energy saving in domestic sector through Energy efficient Equipments, creating awareness about best practices for energy conservation	BEE, UADD	High	
	13. Consider to make compulsory energy audit and more buildings should be brought the existing notification	DoE, DoIP&IP	Medium	
	14. Promote effective utilization and distribution of energy: Load shifting or differential pricing during peak hours in industries	DoE, DoIP&IP	Medium	
	15. Distribution Transformer (DT) metering in urban and rural areas	ED, REC	High	
	16. Upgrade or change transformers, wires	ED	High	
	17. Improve billing efficiency and reduce theft	ED	High	
Development of low carbon society pathway	18. Formulation of favourable policies to promote Low Carbon Society policies	ED	High	5.00
	19. Awareness generation about good practices and energy efficient equipments	ED	High	
Awareness & Capacity Building	20. Capacity Building of departmental of officers about latest technologies as well as accelerate Research & Development activities for more energy efficient technologies	ED	High	5.00
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	21. Create Climate Change Working Group in the department	ED, DoE	High	7.00
	22. Integrate climate change concerns with the departmental activities	ED, DoE	High	
	23. Coordinate / liaison with National missions and programme for convergence	ED, DoE	High	
	24. Coordinate / liaison with MP SAPCC M&E agency	ED, DoE	High	
			Total	326.00

17 New & Renewable Energy

17.1 Sector Overview

MP has a rich natural resource base with huge renewable energy generation potential. The major sources of renewable energy in Madhya Pradesh are: Wind, Biomass, Small Hydro and Solar. Based on various promotional efforts put in place by the Ministry of New and Renewable Energy, GoI and New and Renewable Energy Department, GoMP, significant progress is being made in power generation from renewable energy sources in the state.

Renewable Energy Statistics of the State		
Sources	**Generaton Potential from RE Sources (MW)**	**Installed Capacity (MW)**
Solar	62,000	Total : 2,634 Ground Mounted : 2,432 Rooftop : 120 Off-Grid : 82 MW
Wind	15,400	2,520
Biopower	1,444	128
Small Hydro	800	100
Total	79,644	5,382

The current energy requirement of the state is heavily dependent on conventional energy sources. Acknowledging the increasing issues related to climate change and global warming the government of MP has given policy push for promotion of renewable energy, energy efficiency and energy conservation and has notified the promotional policies for Solar, Wind, Small Hydro and Biomass based energy production. NRED, GoMP is in process to finalize a comprehensive RE policy which will further strengthen the GoMP RE focus.

Ensuring access to equitable, reliable, affordable and sustainable energy is imperative for achieving economic development, driving social growth; alleviate poverty and ensuring prosperity of any economy. For the overall development of the state, continuous and uninterrupted power for all must be ensured. Though Madhya Pradesh is one of India's largest states, with a growing per capita consumption, the states overall per capita electricity consumption is far less than the indian average consumption. This is mainly because of lower commercial and industrial electricity consumption.

Ultra-Mega Solar Power Plant Project at Rewa

Madhya Pradesh has given priority to the renewable energy generation and today it has become the leader in solar power generation in the country. The 750 MW ultra-mega solar power generation project is among the world's largest project and has started production in full capacity. Spread across an area of 1590 hectare, it is one of the largest single site solar plants in the world providing employment to approx. 800 people. The minimum tariff of electricity produced in this project is Rs 2.97 per unit.

This project will not only provide the electricity to the state but also to Delhi Metro, a commercial institution outside the state. This project is funded by World Bank under Clean Technology Fund (CTF). In terms of environment protection, 15.7 lakh tonne of CO_2 emissions are being prevented every year by this project.

Reliable, quality and affordable power is vital for rapid growth in agriculture, industry and for overall economic development of the state. As on July 2021, allocated share of the State is 25,321[1] MW of which approximately 21.42% of total capacity is contributed by Renewable Energy (RE) sources which is indicative of MP being a power surplus state.

The existing renewable energy based installed capacity have the share of 5,405 MW (excluding large size hydro) in the state, estimated to be around 21.42% of the total allocated share and is lower than the national level which around 25.56%.

Table : Renewable Energy Profile Madhya Pradesh

Description	Share
Renewable Energy Installed Capacity (excluding large hydro)	21.42%
Renewable Energy Installed Capacity (including large hydro)	34.20%
Share of State's total Renewable Energy capacity of the national Renewable installed capacity	5.47%
Share of State's installed solar power capacity of the national solar installed capacity	5.77%
Share of State's installed wind power capacity of the national wind installed capacity	6.35%
Share of Small Hydro capacity to state's RE capacity	1.85%
Share of Wind power capacity to state's RE capacity	46.83%
Share of Bio-power power capacity to state's RE capacity	2.38%
Share of Solar power capacity to state's RE capacity	48.94%

17.2 Initiatives in vogue

- Policy for Implementation of Solar Power based Projects in Madhya Pradesh, 2012– To define the incentives and benefits to be provided for private entities and thus to promote solar power project installation.
- Solar Power Policy 2012– To promote solar park development in the state where the small developers can participate in solar power generation.
- Wind Power Project Policy of Madhya Pradesh, 2012 (As Amended on 21st February 2013) – To accelerate wind power installations by providing government-owned lands, grid connectivity, etc.
- Madhya Pradesh Biomass based Electricity (Power) Project Implementation Policy, 2011 (As Amended on 21st February 2013 & 24 August 2015)–To promote biomass-based electricity generation by defining the regulatory procedures and incentives.
- Madhya Pradesh Policy for Rooftop Renewable Energy Projects, 2016– Topromote RTPV installation in the state.

Solar Panels by the side of Upper Lake

Bhopal hosts a 500 kW solar project by the side of Upper lake without using any foundation for the PV panels. This project uses cantilever frame to support the panels on the retaining wall of the lake. The project uses 1,540 solar panels running for 1.2 km by the side of the lake.

The PV installation produces around 750,000 units annually, which is supplied to the Karbala pumping station. The pumping station pumps 40,000 cubic meters of water to a water treatment center at Shyamla Hills. The solar project leads to annual savings of almost INR 5 million ($67,000).

The project would help offset 15,375 tonnes of CO2 emission over its lifespan, which is equivalent to planting 24,600 teak trees.

The project has been implemented by MP DISCOM, MPUVN with financing from the Government of India, the Government of Madhya Pradesh, and Bhopal Municipal Corporation. The World Bank provided technical assistance.

[4]MNRE as on 31.05.2019

- Madhya Pradesh Policy for Decentralized Renewable Energy Systems, 2016– To promote consumption of captive energy generation, and third-party sale of energy generated from RE resources at decentralised locations.

17.3 Sectoral Concerns

- **Ground Mounted Solar Power**
  - There is lack of enough supply of domestic solar products.
  - Operational challenge of the grid due to erratic and non-uniform power generation from solar generators.
  - Rupee declination and volatility has been a challenge: Weakening rupee will impact investor returns in auctioned solar projects, especially when there is a significant exchange rate variation between the time of bidding and finalisation of module supply agreement.
  - Impact due to imposition of Basic Custom Duty on the upcoming project leads to increase in the tariff.
  - ALMM list restricts the market and may leads to supplier driven market which impact of cost of solar modules.
- **Roof top Solar Power**
  - Constrained space and quality of roof in case of residential societies and apartments, SMEs and 25-years roof lock in period.
  - For developers/RESCO, the fragmented and disaggregated demand contributes to higher CAPEX coupled with high transaction cost involved in collection of payment.
  - RESCO are inactive for SME consumers. Moreover, limited business planning horizon of SMEs makes them apprehensive to commit to long-term projects, such as installing a rooftop solar system which in general for 25 years horizon.
  - Higher variability at Distribution Transformer (DT) level, inadequate DT capacity, lack of awareness at operational level of DISCOM staff, unscheduled and variable load pattern, lack of incentives for DISCOM to promote RTS.
  - Provisions to encourage the net / gross metering and incentives to motivate people to design their new plants, buildings suitable for solar installations by taking measures i.e. roof orientation, positioning of exhaust and chimney, etc.
  - Allowing only 30% RE injection in a DT is a restricting factor for rooftop developers.
- **Wind Power**
  - Saturation of high potential wind site with wind turbines of small capacities, which were installed in the early regime of development of wind power in the country.
  - Enduring challenges of arbitrary back downs and limiting of intake of wind power by the SLDC.
  - Contradictory policy, on one hand additional surcharge is imposed on RE power developers to compensate backing down of conventional source and on the other hand, tender being floated for mega RE projects in the state in collaboration with SECI to procure more power.
- **Common challenge for Wind and Solar Generators**
  - Acquisition of Land: Significant challenges entail with policy makers and project developers towards land acquisition in absence of comprehensive land utilisation policy and socio-economic implications of converting agriculture and forest land for solar or wind installation.

- **Biomass**
  - Ineffective biomass supply and fluctuating price (other than bagasse-based units).
  - Unorganised market in addition to the challenges with biomass collection, transportation, processing and storage.
  - Restriction on percentage usage of alternative fuel in biomass.
- **Waste to Energy**
  - Lack of integrated waste management approach and poor segregation of waste at source.
  - Lack of planning of ULBs for supply of committed quantity/quality of waste.
  - Lack of cluster approach results in a relatively small size of the projects which makes the projects unviable.
  - Lack of space protests from locals, lack of project financing options for such projects results in project delays or no progress in project installation.
  - Lack of directives/policy to use the different technologies for different size of projects and towns. Since simple incineration may not be useful for every project.
- **Other issues**
  - Lack of emphasise on exploration of other renewable energy sources i.e. geothermal, floating solar (despite having plenty of water bodies available i.e. lakes, dams,etc).
  - Lack of awareness amongst consumer groups (SME, commercial and residential) on the benefit and cost economic of Rooftop Solar.
  - Inadequate capacity of domestic manufacturing of solar panels (limited mostly to manufacturing of cells and modules) and balance of system due to lack of scale, insufficient government support and an underdeveloped supply chain.
  - Lack of incentives led to farmer unwillingness to move from electric pump to solar pump by investing upfront his/her own money.
  - Lack of co-ordinated actions amongst the departments and agencies for institutionalising different developmental and climate change mitigation initiatives in the state.

17.4 Proposed Strategies and Actions

Table : Prioritisation of the proposed activities

Strategies	Action Points		Department/ Organisation	Priority	Activity budget (INR Crore)
Promote and incentivising Renewable Energy	1.	Promotion of RTPV installation	NRED	High	776.50
	2.	Promote activities to increase grid connected RE installation; especially for wind	NRED	High	
	3.	Meeting RPO targets and setting up new targets from 2020 onwards	NRED, MPERC	High	
	4.	Increase Renewable Energy Certificates (RECs)	NRED	High	
	5.	Increased use of solar pumpsand improvement in pump efficiency	NRED, DoFW&AD	Medium	
	6.	Formulate favourable policies to attract investors to invest in RE sector	NRED	High	

Strategies	Action Points		Department/ Organisation	Priority	Activity budget (INR Crore)
	7.	Public Private Partnership (PPP) approach may be used to attract infrastructure investment in RE Projects	NRED	High	
	8.	Solar power should be promoted in phases and institutions should be covered at first (as they can easily be mapped and reached)	NRED	High	
	9.	Review and assess impact of subsidizing Renewable Energy use	NRED, MPERC	Medium	
	10.	Promotion of wind energy generation according to the potential in MP	NRED	High	
Increase RE (grid connected / off-grid) installation	11.	Provide capex incentives / generation-based incentives	NRED	Medium	6.50
	12.	Conduct reverse bidding to reduce tariff	NRED	Medium	
Promoting research and exploring more possibilities of RE in the state	13.	Research & Development activities to be accelerated in the field of RE	NRED, MPUVN	Medium	5.00
Awareness & Capacity Building	14.	Capacity building of MPUVN/NRED officials about renewable energy, PAT, market based instruments and latest technologies	ED, NRED	High	
	15.	School/College students to be educated about RE technologies	NRED, DoE	Medium	3.00
	16.	Awareness among people and industries about the use of New / Green technologies	NRED, DoE	Medium	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	17.	Create Climate Change Working Group in the department	NRED, DoE	High	
	18.	Integrate climate change concerns with the departmental activities	NRED, DoE	High	7.00
	19.	Coordinate / liaison with National missions and programme for convergence	NRED, DoE	High	
	20.	Coordinate / liaison with MP SAPCC M&E agency	NRED, DoE	High	
				Total	**798.00**

18 Industry & Mining

18.1 Sector Overview

Industry Sector has traditionally been considered as source of growth & employment, but it is also the main contributor to environmental pollution and, therefore, it draws attention of all government and society alike.

Damages to the environment as a result of industrial processes reflects in land deterioration, water pollution, extinction of species, effects on human health and emissions causing climate change makes it amply clear that there is immense scope to make industrial development environmentally sustainable.

Industry sector at a glance	
Major Industries of M.P.	Cement, Heavy Electrical, Pharmaceuticals, Automobiles, Crockery Industry, Paper mill, Wood based Industry, Cotton Textile Industry, Sugar Industry, Traditional Industries, Food procuring & Apparel Industry
MPIDC regional offices	Bhopal, Indore, Jabalpur, Gwalior and Rewa
District Trade & Industries Centre (DTIC)	All Districts of MP
Contribution to GDP of the state (2020-2021)	23%
Mega & Large Industrial Units	Above 450
Source : Economic Survey of MP 20-21	

18.1.1 Industry

Madhya Pradesh has made significant strides in the field of industrial development in the last decade. The state government has invested more than US$ 15 Bn. (1 lakh+ crore) in support infrastructure in the last five years. The state has excellent connectivity to large markets and major metro cities such as New Delhi, Mumbai, Ahmedabad, Hyderabad and Kolkata.

Infrastructure –

The State has more than 1,20,000 Acres of Industrial Land Bank with 87 (developed/developing) industrial areas and 9 proposed industrial areas. State offers 24x7 power supplies with 24,000 MW Installed power capacity and abundant water supply with 900 MCM river Narmada water reserved for Industrial usage.

Food Basket of India –

State is blessed with flowing water of rivers Narmada, Chambal, Betwa, Son, Tava etc. lush green Agri-fields and favorable climate. The state has been at the forefront of agricultural growth in the country and is one of the leading producers of cash crops, oranges and milk. The State contributes 27 % of India's total organic crop-producing area and recorded Six-fold growth rate in horticulture production. With the assistance of forward linkage, MP has eight food parks and two spice parks. State is 4th largest producer of milk and 5th largest producer of fish, in the country.Madhya Pradesh is also 5th largest cotton producer, 4th largest producer of wheat.

Business Hub–

Ranked 4th in Ease of Doing Business; MP Industrial Development Corporation act as Single-window secretariat of the State offering 45 services of 12 Departments completely online. State offers all approvals with zero-physical touch points and strives to provide hassle-less experience to industries. State has experienced tremendous growth of over 49% in terms of new units coming up in the state and investment has jumped by 65% in last 2 years (2019-21).In last 2 year, the state has received investment interest of over 10,800 crores, registering tremendous growth of 65% between 2019-20 and 2020-21.

The investor-friendly policy, transparency and suitable environment for business have made Madhya Pradesh an attractive investment hub. Major domestic and global industries like Gokuldas, Best Corp, Dabur, TEVA, TCS, Infosys, Trident, John Deere, Bridgestone, Reliance, Rio Tinto, Cummins, Volvo, Novartis, P&G, AkzoNobel, Hershey's, and Essar, to name a few, have invested in Madhya Pradesh.The State is a leading destination for Garments and Textile manufacturing, Automobile and Engineering, Food Processing, IT and ITeS, Pharmaceuticals, and Renewable energy.

Excellent Connectivity –

Madhya Pradesh enjoys a strategic location advantage with over 230,000 km of road network, 20+ national highways pass through and 550 trains make their way across daily. State being centrally located, significant infrastructural projects of the central government cross through the State. The North-South and East-West corridor, along with national highways of approximately 8772 km, traverse through Madhya Pradesh. The upcoming Delhi-Mumbai Expressway is crossing through a 350+ KM long stretch of the western part of the State.

The Eastern dedicated freight corridor and Amritsar Kolkata Industrial Corridor passes near the border area of Madhya Pradesh and connects through Atal Progress way. Industrial regions are being developed in the Delhi-Mumbai industrial corridor influence areas lying in the State.

Strategic Location –

The strategic location of Madhya Pradesh has a perfect niche for economical & social growth. The geographically privileged State borders Uttar Pradesh, Chhattisgarh, Maharashtra, Gujarat, and Rajasthan, further connecting to all Indian states, significant markets, growth centers and metro cities such as New Delhi, Mumbai, Ahmedabad, Hyderabad and Kolkata and cater to 50% India's population through adjoining states.

Human Capital –

Madhya Pradesh has become the hub of education excellence; it is the home to universities and premier national institutes that nurture talented young minds for absorption in the industries. State has IIT, IIM, MANIT, IIITM, IIITDM and Centres of Excellence (CoEs) which offers over 2 lakh technical professionals every year.At labour costs of US$ 3.7 per day, the state has a significant cost advantage over metros and offers abundance of peaceful skilled human resource. The State's technical workforce is an added advantage for industrial development.

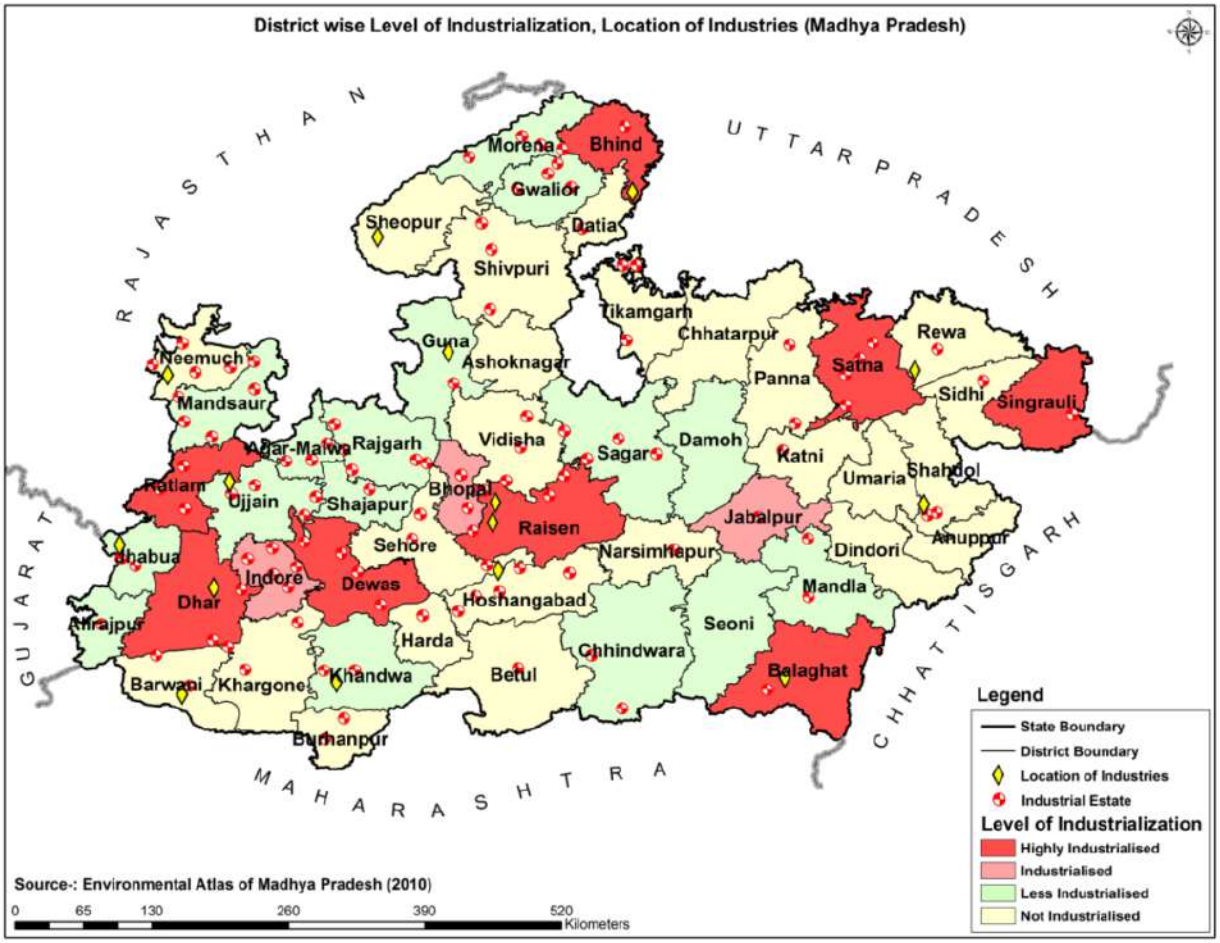
Rich in natural resources –

The only diamond-producing State of India is rich in other minerals such as Limestone, Diaspore, Pyrophyllite, Manganese and Dolomite sand, and MP has Asia's thickest coal seam coalfield. Diamond production in the state reached 25,603 thousand tonnes in 2019-20.

Sector Focused –

The state has embarked on upward growth trajectory to ensure multilateral industrial growth. It is identified 9 strategic sectors for promoting investments in Agribusiness & Food Processing, Automobile and Engineering, Warehousing & Logistics, Renewable Energy, Textiles and Garmenting, Pharmaceuticals, IT/ ITeS and ESDM, Mineral based Industries, and Chemicals & Plastics.

State primary sector Agriculture, forestry & fishing contributed around 33.83% in state's Gross Value Added in 2020-21 while secondary sector such as Manufacturing and construction contributed over 25.62%..



District-wise Level of Industrialisation

Source: Madhya Pradesh Department of Industries, 2014, Environmental Atlas of Madhya Pradesh and other sources

18.1.2 Mining

The growing number and impact of extreme weather events has led to increasing awareness in the extractives industries of the potential negative impacts of climate change. The mining industry has its own vulnerabilities and the risks climate change could pose. However, there has been little research that takes a more comprehensive look at the links between climate change and mining.

Policy makers should pay more attention to the links between mining and climate change because mining is a significant contributor to the development the state however mining is a sector that is particularly vulnerable to climate change. It is one of the major emitters of greenhouse gases and it produces fossil energy resources that also significantly contribute to global CO2 emissions.

The environmental impacts of direct and indirect mining activity occur at local and regional scales. Impacts can result in erosion, loss of biodiversity, contamination of soil, groundwater, and surface water by the chemicals emitted from mining processes. Some mining activities may have significant environmental and public health effects. Thus it calls for strict adherence to environmental regulations to ensure that the mined out area returns to its original state and there is minimum impact of mining activity on environment.

Madhya Pradesh is the fourth richest state in the country in terms of mineral resources. Industrialization in Madhya Pradesh has mainly been driven by its rich and abundant mineral resource. Mining and processing activities have caused severe environmental problems. Besides, Agro-based industries, distilleries, paper and pulp, etc. are the main source of pollution of water bodies.

The extraction of mineral resources forms the economic backbone of the State as well as a major cause of environmental degradation like loss of forest cover and cropland, accelerated erosion, silting of water bodies, air and water pollution etc.

Mineral resources play a very important role in the industrial development of the state. In terms of mineral availability, Madhya Pradesh is the fourth mineral prosperous state of the country. According to the development needs the demand of minerals increases together with industrial development. Following is the status of mineral based industries in the state of MP:-

Sr.	Industry	No. of Units	Location
1.	Cement	9	Rewa, Satna, Damoh, Katni, Sidhi&Neemuch
2.	Thermal Power	10	Shahdol, Umaria, Sidhi, Satna, Betul, Damoh, Katni, Rewa, Ujjain
3.	Coal Washeries	3	Narsinghpur, Anuppur, Chhindwara
4.	Asbestos Cement Sheet	1	Katni
5.	Ceramics	2	Ratlam, & Jabalpur
6.	Hydrated Lime	25	Katni& Satna
7.	Slate Pencil	155	Mandsour
8.	Potteries	2	Ujjain
9.	Refractories	3	Katni, Ratlam& Jabalpur
10.	Roofing (Mangalore)Tiles	8	Hoshangabad&Balaghat
11.	Marble cutting& polishing	4	Katni
12.	Granite cutting& polishing	5	Chhatarpur, Tikamgarh
13.	Flagstone cutting & polishing	150	Shivpuri, Gwalior, Panna & Vidisha

Source: http://www.mineralresources.mp.gov.in/mineral-based-industry

18.2 Initiatives in vogue

1. **Industrial Promotion Policy 2014 (Amended as of Oct 2019)**

   The Industrial Promotion Policy gives adequate emphasis on improving environmental and climate with the focus on Green Industrialization. The major highlights of the policy for environmentally sustainable development are as follows:

   i. Large & Mega industries shall be provided a capital subsidy of 50% up to a maximum of INR. 1 crore for investment in setting up of waste management systems (such as ETP, STP etc.), pollution control devices, health and safety standards, water conservation/harvesting etc.

ii. Government of Madhya Pradesh (GoMP) is also focusing on promotion of environment friendly development through green and clean technologies, conservation of natural resources, waste minimization and recycling etc.

iii. GoMP shall facilitate the polluting industries which are located inside city limit/ municipal limit / metropolitan areas to relocate to the designated industrial areas.

iv. GoMP would encourage water harvesting and recycling in all its existing and new industrial areas.

v. Facilitate setting up of effluent treatment plants and hazardous waste treatment plants in various industrial estates and cluster with private sector participation.

vi. GoMP vide its order dated 01.10.2019, allowed installation of photovoltaic (solar) power plants at industrial units located in various industrial areas of the state so that the units can benefit from cleaner and cheaper alternative source of energy with minimal impact on the environment.

2. The state also commits to ensuring environmentally sustainable and regional balanced industrial growth through the implementation of schemes like integrated Cluster Development Scheme; Handloom Development Scheme; SHG/SME strengthening scheme; R&D scheme; Institutional Youth Training Scheme for handloom and tool kits to artisans /weavers.

3. **MP Incubation and Start-up Policy**

The policy aims at accelerating the growth of the manufacturing and service sectors through private sector participation by enabling regulatory and policy environment, promoting inclusive and environmentally sustainable industrial infrastructure development in the state.

4. **Mineral Policy 2010**

The policy ensures exploitation of mineral resources for optimum and sustainable development of the state in a scientific & systematic manner addressing environmental & ecological issues.

5. **Sand Mining Policy 2017**

This policy ensures the availability of sand minerals at affordable rates to the common people with involvement of local bodies in sand mining and conservation of the river ecosystem.

6. **MP IT Investment Policy 2014**

Policy aims to develop Information Technology, Information Technology enabled Services (ITeS) and Electronic Hardware Manufacturing (EHM) as a vibrant industry for inclusive growth and creating employment opportunities in IT sector. Two other policies launched by State Government are IT policy 2014 and BPO policy 2014 for creating a world class IT infrastructure to attract IT / ITeS companies to the state.

Additionally, in line with National Scrappage Policy, State Government is coming up with Vehicle Scrappage Policy. Urban Development and Housing Department, Government of Madhya Pradesh has announced EV policy in 2019 to support the infrastructure for Electric Vehicles. In order to promote Electric Vehicles in the State, Department of Industrial Policy & Investment Promotion, Government of Madhya Pradesh is planning to come up with EV Policy for promoting manufacturing of Electric Vehicles & ancillaries.

18.3 Sectoral Concerns

1. As climate change affects the availability of natural resources, highly resource dependent industries may be negatively affected by the climate challenge because of the unavailability of inputs or raw materials. These industries include agro based industries, paper industries, forest based industries, etc.
2. Industries have the major share in GHG emissions, thus causing concerns for climate change.
3. Industries are also responsible for higher demands for water, land and energy hence increasing pressures on the natural resources.
4. Unsustainable industrial practices are also a major concern for development & environment sector.
5. Another key challenge for this sector is inefficient waste water management techniques.
6. Land Use Change
7. Soil and water Pollution
8. Deforestation
9. Soil erosion and degradation
10. Mining within or never river bed has a direct impact on the stream's physical characteristics.
11. Unscientific & unregulated sand and gravel mining leads to the severe health hazard like air quality degradation.
12. Degradation may change the morphology of the river bed which effects the aquatic habitat.

18.4 Proposed Strategies and Actions

Strategies		Actions	Department/ Organisation	Priority	Activity Budget
Effective Industrial Solid and Liquid Waste Management and Pollution Control for industrial clusters	1.	Increase usage of waste derived fuels in the cement sector	DIPIP, DoE (MPPCB)	High	**330.00**
	2.	Adopting technologies and practices for reduced wastewater generation in industries like Pulp & Paper and Fertilizer units, Dairy, Meat, Sugar and Tannery units	DIPIP, DoE (MPPCB)	Medium	
	3.	Improving water quality by reducing water pollution	DoE (MPPCB)	High	
	4.	Prominent industrial areas should have effluent / sewage treatment plants	DoE (MPPCB)	High	
	5.	Promotion of water efficiency measures	DIPIP, WRD	High	
	6.	Waste water treatment, recycle and reuse	DIPIP, WRD	High	
	7.	Promotion of water harvesting in industrial clusters	DIPIP, WRD	High	

Strategies		Actions	Department/ Organisation	Priority	Activity Budget
Review of MP Industrial Policy 2014 to address climate change concerns	8.	Build strategy to integrate Climate Change concerns leading Industrial Development	DIPIP, DoE, Research institutes	High	**7.00**
	9.	Build a mechanism to incentivise actions taken by industries towards mitigation and to promote industries to take up ISO certifications	DoE	Medium	
Sustainable technological integration in industries for GHG reduction and energy efficiency	10.	Promoting Industrial solar PV rooftop installations	DIPIP, NRED	High	**260.00**
	11.	Promote biogas to cater to the latent natural gas demand in the industries	DIPIP, NRED	Medium	
	12.	Capturing and utilizing methane for energy generation in all industrial units with organic effluent	DIPIP, NRED	Medium	
	13.	Devising interventions for industries becoming carbon-neutral in near future	NRED	High	
Controlling the emission intensity	14.	Making energy audits mandatory for industries	DIPIP	High	**3.00**
	15.	State award on emissions intensity improvement by industries	DoE, MPPCB	Medium	
Implementation of Perform, Achieve and Trade (PAT) Mechanism	16.	Facilitate implementation of PAT by the designated consumers	DIPIP, MPUVN	Medium	**1.00**
Capture the opportunities existing in the carbon market for mitigation	17.	Exploring possibilities for investment in Green and New Technology	DIPIP, MPUVN	Medium	**10.00**
	18.	Incentivise & reward GHG reduction efforts	DIPIP, DoE	Low	
	19.	Promoting energy efficiency in industrial clusters	DIPIP, DoE	Medium	
Sustainable & Eco-friendly mining practices	20.	Promote environment friendly mining practices by managing local environment and natural resources	DoMR, DoE	High	**16.00**
	21.	Implementation of safe, effective methane capture and control techniques in underground coal mines	DoMR, DoE	High	
	22.	Promote resource efficient mining operations	DoMR, DoE	High	
	23.	Restorationof destructive land through massive plantations for ecosystem conservation	DoMR, DoE	High	
Involvement of industries in CSR activities	24.	Promoting CSR budgets to bring about greates climate awareness	DIPIP	High	**2.00**
	25.	Encourage industries to align CSR activities towards GHG	DIPIP, MPUVN	High	

Strategies		Actions	Department/ Organisation	Priority	Activity Budget
Innovative strategies to help institutions become carbon – neutral in future	26.	Setting up of dedicated R&D and technology demonstration centre for low carbon technologies	NRED, Academic Institutes, Universities	Medium	**17.00**
	27.	Resource Pooling to development state specific eco-friendly technology	Research institutes	Medium	
	28.	Industrial networks should be developed based on recycling and reuse of the materials	Research institutes	Medium	
Capacity Building and Awareness Programs	29.	Creating awareness and training on energy monitoring and conservation in the MSME sector	DIPIP, DoE	Medium	**4.00**
	30.	Involvement of industries in plantation activities	DIPIP, DoE, MPFD	High	
	31.	Training on calculating and managing carbon footprint of the industry	DIPIP	High	
Build institutional mechanism for SAPCC implementation and Monitoring & Evaluation	32.	Create Climate Change Working Group in the department	DIPIP, DoE	High	**7.00**
	33.	Integrate climate change concerns with the departmental activities	DIPIP, DoE	High	
	34.	Coordinate / liaison with National missions and programme for convergence	DIPIP, DoE	High	
	35.	Coordinate / liaison with MP SAPCC M&E agency	DIPIP, DoE	High	
			Total		**657.00**

19 Environment and Cross-Cutting Issues

19.1 Overview

This section contains a review of environmental and climate change actions and initiatives taken by state government of cross-cutting aspects: energy and low carbon development; adaptation, generic institutional and planning dimensions; MP state institutional and planning dimensions and next steps.

Climate Change provides challenges around both fronts for development in the state: in the rural and urban areas. The state is marked with a complex social structure, a predominantly agrarian economy, a difficult terrain, and scattered settlements over vast area that together pose several formidable problems to service delivery systems. Climate Change has the potential to undermine existing efforts to tackle the poverty eradication in the state and the complex social development problems faced. Drought, lack of investment to produce year round cropping, a threatened forest resource will all be exacerbated by Climate Change and make the problem of delivering more and better livelihoods more difficult. Economic growth around the state's mineral resources is likely to continue and provide engines of growth providing problems associate with rapid urbanisation and providing more power from coal can be tackled.

There are significant opportunities at this time to ensure pathways allow for advanced energy efficient technologies and infrastructure that can provide the basis for sustainable development. There are opportunities to link up with the GoI Missions of policy development on: Enhanced Energy Efficiency; Sustainable Habitat; Conserving Water; and, a Green India.

Both of these Climate Change challenges around the urban and rural nexus, could benefit from having a strategic integrated cross-sectoral approach devised at state level, with reference to the national and global frameworks at the next stage.

For long-term economic development opportunities in MP which has a growing industrial sector needs to be globally competitive, it might be advantageous to devise a strategy which promotes the most cost-effective and efficient technologies across the sectors.

19.2 Environment and Climate Change

In Madhya Pradesh the subject of "Environment" is dealt by Environment Department. Madhya Pradesh is leading in terms of defining the state organisational arrangements and in doing analytical work and technical studies pertaining to Climate Change. The state Government has established a State Knowledge Management Centre on Climate Change (SKMCCC) within Environmental Planning & Coordination Organization (EPCO), which is under the Department of Environment. EPCO has also been declared as State Designated Agency for Climate Change issues in MP. As a part of the SKMCCC activities, a number of technical studies and plan preparations are being initiated. All of these initiatives highlights demonstrated its pro-activeness and taken the lead in addressing Climate Change issues in a systematic fashion.

19.3 Gender and Climate Change Concerns

Empowerment of women and socially excluded groups by facilitating greater involvement in governance, opportunities for financial inclusion and through better targeting is the priority of the State Government. Weaker sections of the society like women and children are the most vulnerable to Climate Change impacts and so, there is a need to address concerns of these sections of the society in a focussed manner. To understand the impacts of CC on women/ children, there is a need of 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.

"Ankur" Plantation Program

Increasing the green cover by plantation is an effective Ecosystem based climate actions that reduces the effects of climate change. In view of the present scenario of nCoViD-19 there is a need to make people realize the importance of oxygen.

Tree plantation is considered as an effective activity for the restoration and strengthening of the ecosystem. Connecting to the theme "Ecosystem Restoration" of World Environment Day – 2021, a mega plantation drive “Ankur” has been launched by the State Government of Madhya Pradesh on June 5, 2021. SKMCCC established in Environmental Planning & Coordination Organization (EPCO) Department of Environment, GoMP is coordinating the program.

The main objectives of the program is to ensure wider public participation for increasing tree cover, ground water conservation and off-setting the atmospheric carbon to keep the air, pollution free and enhance the availability of oxygen in the atmosphere.

Under this program, a mobile based app “Vayudoot Ankur” has been developed and general masses have been encouraged to associate with this program by downloading the app and planting tree/trees in their nearby location and upload the pictures of the plant. First picture has to be uploaded at the time of plantation and second one after a month’s time post plantation. After launching of Ankur programme, planting a tree in home premises is mandatory for beneficiaries of PMAY.

Climate Change is now impacting every corner of the globe. In many regions, severe droughts and rising temperatures are leading to food insecurity and loss of livelihoods. These risks disproportionately affect the women and girls, who are key providers of food, water and energy, but have fewer resources with which to adapt to changing conditions. However, in some regions the impacts of climate change are also leading to important shifts that are transforming traditional gender norms around economic activity, decision–making and leadership. These gender dynamics are not understood and they are generally lacking in climate security policy making and practice to date. Climate change generates a range of risks across the security spectrum. In the fragile contexts, the impacts of climate change can exacerbate conditions that threaten security, such as loss of livelihoods or competition over scarce resources.

The MPSAPCC acknowledges the fact that the empowerment of women would result in overall development of society both at micro and macro level. Active participation of women in economic activities and decisions, would contribute towards overall economic development. Gender balance and empowerment of women has always been a top priority of the Government of Madhya Pradesh.

The state has in the recent past, implemented many innovative women empowerment programs and policies for girl child protection to improve gender ratio. It has also developed innovative beneficiary-oriented schemes for the girl child. The road ahead is to deepen these strategies to make women equal partners in the social and economic development of the state.

It is important to remember, however, that women are not only vulnerable to climate change but they are also effective actors or agents of change in relation to both mitigation and adaptation actions. Women are often excluded from decision-making process on issues related to access to and the use of land and resources critical to their livelihoods. In view of women's role for afford livelihood resources and shaping family, capacity building is necessary component.

Concerns regard to gender & climate change

- Unequal power relationship between men and women.
- Gender dimensions of climate change to be fully and properly understood and addressed in all the sectors.
- Gender relations are context-specific.
- Adequate resources for developing and implementing gender-sensitive responses.
- Gender aware and inclusive accountability mechanisms.

19.4 Initiatives in vogue

State Knowledge Management Centre on Climate Change (MP SKMCCC) has been established in EPCO. MP SKMCCC is one of the first Knowledge Management Centre on Climate Change in the country to be set up at the state level. SKMCCC is working in line with the National Mission for Strategic Knowledge on Climate Change (NMSKCC) and is also the state unit for NMSKCC.

The objectives of SKMCCC are to integrate climate change concerns into development planning process through:-

- Connecting science with policy and practice
- Carrying out research studies on climate change
- Formulate and implement pilot projects on CC adaptation aspects
- Organize training and capacity building and awareness programs
- Provide scholarships and internships to research scholars and students
- Create Strategic Knowledge networks and institutional partnerships

19.4.1 Projects at SKMCCC

- **DST support for strengthening of SKMCCC**

  Establishmentof SKMCCC was mentioned in the Madhya Pradesh State Action Plan on Climate Change (MP SAPCC). SKMCCC functions with an objective to create, collate, compile, synthesise and disseminate knowledge related to climate change in MP. Total cost of the project is worth Rs. 2.81 crores. DST has rated the progress of project & activities as **"Excellent"**in their review meetings.

- **Enhancing Adaptive Capacity to Climate Change through Developing Climate Smart Villages in Three Vulnerable Districts of Madhya Pradesh under NAFCC**

  SKMCCC has formulated and implementing a project on developing 360 climate smart villages in three vulnerable districtsof Madhya Pradesh, namely, Rajgarh, Satna and Sehore (120 villages each) and got it sanctioned by MoEFCC under National Adaptation Fund on Climate Change (NAFCC). Total cost of the project is worth Rs. 24.87 crores. NABARD is the National Implementing Entity for NAFCC. The execution of the project is being done in association with Department of Farmers Welfare & Agriculture Development, Govt. of MP.

- **Enhancing Adaptive Capacity to Climate Change through Conservation of Traditional Water Supply Sources (Wells and Bawdies) of Indore City**

The project has been sanctioned under Climate Change Action Programme (CCAP) of MoEFCC. The project costs worth Rs. 5.00 crores. Indore Municipal Corporation is implementing the project. A total of 330 open and step wells are being restored as part of the project.

- **EPCO-UNDP Project Phase-III**

This project has been the phase–III of the sustained partnership with UNDP. MoEFCC had identified three Indian states where UNDP in collaboration with SDC is supporting a project on strengthening three states (Madhya Pradesh, Sikkim and Uttarakhand) for the implementation of the SAPCC. The project in MP aims to assist the State on climate change in the implementation of the SAPCC with focus on water sector.

- **Enhancing Adaptive Capacity to Climate Change through Conservation of Traditional Water Supply Sources (Wells and Bawdies) of Burhanpur City**

MoEFCC has sanctioned a project under Climate Change Action Programme worth Rs. 5.00 crores. The project is being implemented with the support of Burhanpur Forest Division and Burhanpur Municipal Corporation. The specific objectives of the project are:-

- Inventorize traditional water supply sources (well, bawadies, etc.) of Burhanpur city.
- Promote traditional water conservation system by restoration and renovation of 71 traditional water storing bodies viz. wells and bawadies in Burhanpur.
- Expeditious implementation of catchment treatment of kundi bhandara network including activities such as plantation, grassland development, soil moisture conservation etc.
- Rainwater harvesting and promote artificial recharge in areas near to traditional water bodies viz. wells and bawadies
- Facilitate community engagements for effective management of traditional water conservation system

Projects in Pipeline

- **Development of Climate Smart Agricultural and Forest Communities using a Landscape approach in 3 blocks of Betul District of MP**

  Theproject concept note has been prepared for seeking support from National Adaptation Fund on Climate Change (NAFCC). The main objective of this project is to build the resilience of the ecosystem and small & marginal communities dependent on natural resources to sustain climatic variability and extremes.

- **Increasing climate resilience of Nimadi breed in Barwani and Khargone districts of Madhya Pradesh**

  The project concept notehas been prepared in association with Animal Husbandry Department for National Adaptation Fund on Climate Change (NAFCC) with the following objectives:-

  i) To ensure sustainability of livestock production through scientific interventions assisted reproductive technologies, environment-friendly housing and measures for control of diseases

  ii) To ensure sustainability of incomes for small and marginal livestock farmers under on-going and projected warming scenario.It is envisaged that implementation of project activities may ensure fodder availability, climate resilient cattle sheds and nutritional supply which will lead to reproduction and enhanced milk production thereby reducing vulnerability to climate change.

19.4.2 Activities at SKMCCC

i) Revision of State Action Plan on Climate Change

Ministry of Environment, Forest & Climate change (MoEFCC) has advised the states to revisit & revise their respective State Action Plans on Climate Change (SAPCC) synergising with the Nationally Determined Contributions (NDCs). Being the nodal agency on climate change issues in the state, EPCO has been doing the task.

ii) Chief Minister's Scholarship for PhD on Climate Change

SKMCCC is anchoring & coordinating prestigious scheme of Chief Minister's Scholarship for PhD on Climate Change, making MP one of the pioneering states in the country. This scholarship has been set up in 21 premier universities/ research institutes located in Madhya Pradesh.Till FY 2020-21, total 16 candidates have been awarded the scholarships.

iii) Research Studies commissioned by SKMCCC

Promoting quality and strategic climate research is one of the important objectives of SKMCCC. To address this objective SKMCCC has developed a transparent system of inviting research proposals from premier academic and research institutions. Following research studies have been commissioned to 3 premier research institutes located in MP.

- ICAR – Indian Institute of Soil Science, Bhopal "Assessing the potential impact of climate smart technologies on soil health and nutrient accounting in selected vulnerable districts of MP"
- State Forest Research Institute, Jabalpur "Sequestered carbon in roadside plantations: an assessment of potential contribution to climate mitigation in Jabalpur smart city"
- Indian Institute of Forest Management, Bhopal "Developing M&E framework of climate smart interventions in 3 districts of MP for Climate Smart Village project"

iv) Faculty Development Program on Climate Change

In compliance to the instructions of Her Excellency Governor of Madhya Pradesh, Faculty Development Programme on Climate Change is being organised by SKMCCC, EPCO. The trainings will be imparted on various aspects of climate change, environment and sustainable development to the faculties of 23 universities located in the state of Madhya Pradesh. Each batch of training program consists of 35-40 participants.

v) Certificate Course on Climate Change (C4)

A special training certificate course on climate change has been launched by SKMCCC inMarch 2018 with an objective to develop a cadre of professionals on climate change. The course covers a range of issues on Climate Change, Environment and Sustainable Development.

The programme is advertised and applications are invited online. The pedagogy of the course comprises 10 days of dedicated classroom sessions, field visit, and self-study assignments followed by presentations. On successful completion, the participants are awarded certificate of participation.

vi) Climate Change Appreciation Course (CCAC)

Climate Change Appreciation Course (CCAC) are being organised by course is an introductory course to climate change that covers broad range of topics related to climate change and environment.

vii) City Climate Action Plan of 7 Smart Cities of MP

SMART Cities Mission under the Ministry of Housing and Urban Affairs (MoHUA), GoI has launched "Climate Smart Cities Assessment Framework (CSC-AF)". The CSC-AF serves as a tool for cities to assess their climate readiness and provides a roadmap for adopting and implementing relevant climate actions.

CSC-AF consists of 30 indicators across five broad categories. One of the important indicators to assess the Climate SMART readiness of the cities is development of City Climate Action Plans (CAPs), covering both mitigation and adaptation measures.

In this endeavour, EPCO has collaborated with World Resources Institute (India) to prepare CAPs for all the 7 smart cities of MP. The draft plans have been prepared and shared with the smart cities and now capacities of the smart city officials would be built on climate change and related urban issues. This will help the 7 smart cities to score better ranking in the next assessment under CSC-AF.

viii) Preparation of District Climate Action Plan

District Climate Action plans of 8 districts of the state are being prepared. EPCO is coordinating the exercise at the state level.

ix) MP Climate Change Knowledge Portal

For wider dissemination of climate change related information and meeting SKMCCC's objectives, an interactive & user friendly knowledge portal has been developed. The portal offers information, publications and other knowledge resources related to climate change issues of MP. The portal includes some unique features like dynamic analysis of observed & projected data, assessing vulnerabilities of districts, rainfall & temperature trends, strategies chalked out in SAPCC, dedicated section for kids involving short stories and activities for engaging and encouraging young minds. The portal has been hosted on the server of State Data Centre (SDC) with URL www.climatechange.mp.gov.in.

19.5 Proposed Strategies and Actions

Strategies		Actions	Department/ Organisation	Priority	Activity budget (INR Crore)
Dedicated high end research to provide policy makers with inputs to evaluate and respond to the threat of Climate Change	1.	Improve understanding of Climate Change at policy level on- water, food security, land use change, disease transmission, GHG, carbon market etc. in collaboration with relevant institutes/departments	DoE, EPCO, SKMCCC	High	27.50
	2.	Preparation of district Climate Change action Plan	DoE, EPCO, SKMCCC	Medium	
	3.	Promote MP specific research through providing scholarships to PhD candidates through HCM Scholarship for PhD on Climate Change	DoE, EPCO, SKMCCC	High	
	4.	Promote research on carbon sequestration, climate change and lakes & wetlands conservation issues	DoE, EPCO, SKMCCC, SWA	High	

Strategies		Actions	Department/ Organisation	Priority	Activity budget (INR Crore)
Strengthening of monitoring systems of various initiatives of the climate sensitive sectors	5.	Monitoring the impact of various initiatives of the climate sensitive sectors by remote sensing based database.	DoE, EPCO, SKMCCC, MAP_IT	High	257.00
	6.	Conversation of lakes and wetlands in the state.	DoE, EPCO, SWA, SKMCCC	High	
Enhance awareness of people by educating them about Climate Change	7.	Support for Community level groups, PRIs and institutions (including educational) for information, education and communication about Climate Change	DoE, SKMCCC	High	5.00
	8.	Organise educational courses viz. Climate Change Certificate Course, Climate Change Appreciation Course, Diploma Course on Climate Change, etc.	DoE, EPCO, SKMCCC,	High	
Capacity Building Programs	9.	Capacity building at various levels (eg. Policy makers, officials, media, NGOs etc) on mitigation and adaptation to Climate Change	DoE, EPCO, SKMCCC	High	2.50
Integration of Gender Issues in planning of climate change actions	10.	Focussed research to understand impacts of Climate Change on women/ children in different context like urban/ rural	DoE, DoRD, FD, UADD, EPCO, SKMCCC	High	10.00
	11.	Capacity building program to promote women entrepreneurship on climate change related aspects to reduce their vulnerability			
Mainstream of Climate Change concern	12.	Training to sensitize district officials and DPC members to integrate Climate Change concern	DoE, EPCO, SKMCCC	High	27.50
	13.	Strengthening of Madhya Pradesh State Knowledge Management Centre on Climate Change.	DoE, EPCO	High	
Provide Knowledge Support to policy makers and practioners	14.	Knowledge & technical support to all the departments for project formulation to access climate finance	DoE, EPCO, SKMCCC	High	7.50
	15.	Developing M& E framework to ensure effective implementation of SAPCC	DoE, EPCO, SKMCCC		
	16.	Carry out Green Audits for colleges campus, universities, government buildings, offices, hospitals to reduce carbon footprint	DoE, EPCO, SKMCCC	High	
Greening the state through technology driven climate actions	17.	Promoting plantation activities with public participation using mobile & web based technology	DoE, EPCO, SKMCCC	High	100.00
				Total	**437.00**

20 Transforming barriers into enablers of climate actions and bridging the gap

20.1 Overview

The concept of barriers is increasingly used to describe the obstacles that hinder the planning and implementation of climate change actions. Considerable barriers emerge in developing and implementing climate change adaptation and mitigation strategies. Despite the international significance attached to climate change actions, there remains a lack of understanding of the barriers that impede the effective implementation of adaptation and mitigation strategies.

Understanding the nature of barriers is important so as to find strategic ways of dealing with them. However, our current understanding is limited and highly fragmented across the climate change fraternity. There is a need for bringing conceptual clarity and convergence of ideas by applying a systematic review to assess the current state of knowledge on barriers to climate actions in general and SAPCC in special.

The growing literature on barriers reveals not only commonly reported barriers, but also conflicting evidence, and few explanations of why barriers exist and change. Many study reviews show that:-

- Barriers to climate change adaptation have hardly been defined in the literature and no clear indicators exist so as to identify and assess them systematically.
- An impressive number of barriers have been reported, but the list of possible barriers is seemingly endless.
- The most frequently reported barriers relate to the institutional and social dimensions of adaptation.
- Barriers are identified as configurations of climate and non-climate factors and conditions that emerge from the actor, the governance system, or the system of concern.
- Although interventions to overcome barriers are recommended by most studies, empirical studies on interventions are scarce.

There is thus a need for research that focuses on the interdependencies between barriers and considers the dynamic ways in which barriers develop and persist. Such research, which would be actor-centred and comparative, would help to explain barriers to adaptation and provide insights into how to overcome them.

Despite a wealth of financial, technical, and human capacity, it remains a challenging task to transform this capacity into effective climate change adaptation and mitigation action. Indeed, mitigative and adaptive capacities only represent the potential to achieve the ultimate goals of greenhouse gas and vulnerability reduction. Better understanding of barriers that constrain the implementation of adaptation strategies would pave the way to transform barriers into enablers of climate actions.

20.2 Barriers

Some of the common barriers encountered and experienced during the implementation of MP SAPCC are financial barriers, socio-cultural barriers, institutional barriers, technological barriers and a lack of information on climate change which are listed below.

- Intensity of stakeholder consultations
- Institutional mechanisms for steering the process
- Conceptual Clarity
- Coordination Challenges
- Uncertainties relating to impact of climate change
- Access to regional climate data in desired and usable format and scale
- Availability of State specific climate research and evidence, time series data
- Temperature projections robust; yet precipitation projections uncertain
- Challenges of vulnerability assessment
- Connect to State development plans (both sectoral and holistic)
- Climate change actions at the State level – long wish list
- Framework and basis for prioritization of actions
- Uncertainty of source of funding (State/ Central/ Externally aided)

20.3 Generic institutional and planning dimensions

Formulating and revisingSAPCC to actually charting an implementable action plan and then organising its delivery will be a major challenge. More detailed planning work and analysis will be necessary. SAPCC could provide the starting point.

A preliminary identification has been made of institutional and planning capacities within MP through discussions with some key officials and project staff. There is a need to assess these more precisely and then monitor to plot progress. It is suggested that a systematic capacity assessment as to manage these risks and vulnerabilities is undertaken identifying key institutional and planning gaps at the state level and their inter linkages with national and local level planning.

Section- IV

SAPCC Financing, Implementation and M&E

21 FINANCING THE SAPCC

21.1 Financing Strategy

Creative financing strategy by the states is the need of hour. From the experience of last SAPCC, it has become apparent that additional finance is hard to come by and state will have to mobilise financial resources on their own to implement the recommendations of SAPCC. Therefore, it is important that high impact areas have to be identified from the state's ongoing sectoral activities for mainstreaming and tagged. In addition more and more private sector involvement should be pooled in for high priority activities in a systematic way including public-private partnership mechanism.

In addition there will be additional climate finance from international climate funds (Green Climate Fund, Global Environment Facility, Adaptation Fund) Bilateral Cooperation (additional financial and technical support for climate change outcomes like SDC, GIZ, JICA, DFID), Multilateral facility (loan and grant projects through WB, ADB, UNDP, etc.), National Climate Fund (National Adaptation Fund for Climate Change, Small Grants programme, mission-specific allocation, regular schematic allocation having climate relevance).

However, securing funds from these sources is no easy task. The process is too complicated leading to long gestation period before the project is sanctioned. Support of donor and consulting is needed even for project formulation as department officials are not attuned to develop project in the template prescribed by these funding agencies. This has resulted in lukewarm response from department to develop projects. There is greater need for simplifying the process and also building the capacity of states to conceive and write quality projects on climate change adaptation and mitigation aspects of the states.

21.2 Proposed Approach

Table no. : Tangible, measurable and time-bound financing goals and responsibilities for key stakeholders involved

Goal	Activity	Need	Way Forward / Examples
GOAL 1- Ensure predictable, stable and enhanced public financing for SAPCC from the state budget	Integrate climate vulnerability assessments into ongoing schemes to build convergence with the SAPCC.	While the SAPCC maps multiple operational schemes aligned to it, it is important to establish institutional linkages that are required to mainstream climate action in these schemes, in terms of how ongoing activities or interventions can be tweaked or prioritized to integrate SAPCC recommendations.	This exercise is proposed to be initiated for selected 10-15 schemes such as MGNREGA. Eventually, it will be rolled out for other schemes as well in a phased manner.
	Climate tagging and reporting during the annual budget	At present, there is no way to track financial flows towards activities that support climate resilient, low carbon growth on an annual basis, and to determine whether the funds allocated are sufficient or have been efficiently utilized. It builds confidence and buy-in among other investors and stakeholders in the government's commitment towards building climate resilience.	This intervention will be initiated with the support of finance department. To start with, climate markers are proposed to be introduced in the state's budget management system for schemes mapped in SAPCC. This can be followed by a more detailed assessment of climate relevance/ vulnerability of each scheme.
	Create a fiscal incentive mechanism for promoting inter-departmental coordination to implement SAPCC interventions.	Coordination between different key departments is often a key for effective implementation. Currently there is no mechanism to incentivize line departments to work together on climate issues.	Setting up an annual corpus or extrabudgetary mechanism administered by Environment Department/Finance Department to finance or provide top up amounts to cross-sectoral projects involving two (or more) line departments may be considered.
	Mandating a certain percentage or a fixed amount of respective departmental budgets to be spent on climate change activities	This intervention would help in addressing the lack of dedicated funding for climate action within departments. The funds can be utilized for different purposes like climate-proofing existing programs, piloting new initiatives and supporting new research studies.	It is proposed to start with small amounts and increase this limit progressively to ensure that departments can absorb this requirement.

Goal	Activity	Need	Way Forward / Examples
GOAL 2: Enhanced engagement of private sector	Align CSR investments to achieve climate goals	While MP has been receiving significant CSR funds in relevant sectors, private companies need to be made aware about climate vulnerabilities of the state, and how they can contribute in building resilience through their CSR investments. Such workshops can help build awareness among private sector on the climate risks and opportunities in alignment with the SAPCC. It may also contribute to increasing CSR fund flows in the state while also targeting them to flow to the highly vulnerable districts.	2-3 events is proposed to be organized annually bringing together diverse stakeholders such as CSR units, district officials etc. targeting different sectors. One potentially low hanging fruit in MP is exploring the opportunity to invest in climate resilient agriculture.
	Enhance PPP financing for climate actions identified in SAPCC, particularly adaptation actions.	The successful leveraging of PPP for solar and waste management shows how it can be an effective means of financing low carbon and climate resilient initiatives in the state.	Currently PPP projects in climate-relevant sectors such as agriculture, forest and animal husbandry are limited, which can be explored going forward.
	Greening of public procurement at the state level	Governments are among biggest purchasers of goods and services from the private sector. Based on the past global and Indian experiences, greening mandate for public procurement can provide a huge boost to local industries to shift to environment-friendly products and processes	The state is already considering this intervention. It is proposed to: - Strike a balance between mitigation and adaptation sectors - Include public private partnership projects - Support this intervention by facilitating measures such as financial or technical support for micro and small industries, SHGs.
	Climate change mentors for start-ups, MSMEs and private sector	Climate change presents both challenges and opportunities to the private sector. Start-ups and MSMEs particularly due to their small size of the enterprises, have limited ability to have dedicated climate change professionals within their team.	MP Start up policy, 2019 provides for establishment of mentor's network to bridge the information gap for start-ups on multiple fronts.This can help with their business orientation to identify cost effective opportunities to build resilience, deal with climate related disasters and shift towards greener strategies.

Goal	Activity	Need	Way Forward / Examples
GOAL 3: Promote the use of blended/ innovative financial instruments and policies	Support development and launch of new financial products for vulnerable communities	Access to cheaper and innovative financial products, including risk management solutions such as insurance, can help in reducing the vulnerability of frontline population and groups most affected by climate change by enabling them to adopt localized solutions which cater to their requirements and unique situation	Moving forward on this intervention requires a detailed assessment of financing challenges among the frontline populations and subsequent engagement with appropriate stakeholders such as NBFCs, insurance or reinsurance companies, banks, fintech companies, etc. on developing and launching innovative solutions.
	Issuance of climate/resilience bonds by urban local bodies of the state for implementation of projects identified under SAPCC	The borrowing space at the state-level is very limited; therefore, it is important for ULBs to raise their own resources. Issuance of climate/ resilience bonds can help in attracting a new class of investors who are keen on supporting climate actions. Increasingly, these investors are offering better pricing to the issuers, thereby, reducing borrowing costs. It will also help the state in raising its overall profile among investors.	MP's urban local bodies are already leading the way in terms of raising their own resources for developing necessary infrastructure under the smart city framework. Next steps could be to understand on how they can better align their projects to address climate vulnerabilities.
	Exploring new revenue sources to mobilize funds for climate actions		The state government may consider appropriate use of new taxes, fees or development charges to raise additional funds for climate action. Green tax on vehicles is one of the most common examples which has been implemented in MP in the past. Other potential examples are congestion tax, land-value capture financing, etc.
	Exploring other market-based mechanisms for climate action at the state-level	Market-based mechanisms are recognized financing technique for supporting climate action globally as well as in India. Often, they provide good alternate to direct measures such as imposing taxes or restrictions by letting the private sector adjust and decide their incentives.	There are some interesting potential opportunities worth exploring. One such opportunity is in terms of selling carbon credits in international markets. Indore Municipal Corporation (IMC) has already done it, and similar efforts can be further replicated across the state. MP can also tap into the growing global interest in Ecosystem based climate actions (EbCA), and develop a detailed investment and financing strategy to roll out identified, targeted NbS in the state to attract potential investors. An example of a potential NbS is the landscape-restoration opportunity identified in Sidhi district. With its large forest cover, MP can also consider implementing Payment for Ecosystem Services (PES) in the state, which can be an innovative way of supporting the livelihood of marginalized and vulnerable communities.

Goal	Activity	Need	Way Forward / Examples
GOAL 4: Build institutional capacity of public institutions to support climate actions and mobilize resources	Capacity building of state officials on climate risk management and integration of climate information in budgeting, policy/ project design and decision making	Building sustained institutional memory and capacity building across different levels --- including district and state, is needed to both mainstream and prioritize climate into different developmental strategies, and to mobilize resources to efficiently implement such interventions.	Several districts in MP are already in the process of having climate proofing and capacity building workshops for various government officials. To build continuity, it is proposed to create a consortium of relevant local research institutions, universities and CSOs to partner with external agencies who can ensure sustained, periodic efforts over longer time periods on capacity building initiatives.
	Setting-up of a dedicated climate finance unit to build engagement with external stakeholders and provide research and technical support to state departments on climate finance issues	Active outreach with a diverse set of internal and external stakeholders will help the state in achieving its resource mobilization objectives.	Initially, contracting of an experienced climate finance consultant can be considered to handhold the establishment of this unit. Multilateral banks/UN agencies will be requested to provide technical resources/ support to the state.

Goal	Activity	Need	Way Forward / Examples
GOAL 5: Improved engagement with bilateral and multilateral as well as philanthropic donors and funders	Mapping of their priorities and interest in supporting climate actions in the state.	Scale, nature of assistance, and priorities of funders are increasingly becoming dynamic, depending on several factors including their mandate, strategy and financial position. Creating and maintaining an updated database mapping funders with their priority sectors, type of financial assistance, current level of engagement in the state, alignment with existing investment opportunities, ongoing discussions, etc. can help the state make more streamlined decisions while deciding whom to approach for specific climate projects. Moreover, it would help the state in maintaining competitive edge over other states.	It is proposed that the state would look at the funders who would be interested to take forward and scale up existing projects under climate smart agriculture, Ecosystem based climate actions, forest and biodiversity conservation etc. Climate Finance Unit should be made responsible for this activity.
	Developing a credible pipeline of climate-relevant proposals for technical assistance as well as funding that can be supported by them	Developing climate proposals for concessional funding often takes longer than business as usual projects, as investors look for additional elements such as linkage to local climate vulnerabilities and national climate goals, environmental and social risks, theory of change, scaling and replication potential, gender integration, etc. to ascertain that their investments actually contribute towards climate mitigation and adaptation. Working towards developing a credible pipeline of such projects will help in reducing the turnaround time required from the submission of proposal to the approval of funding.	Identifying and developing concept notes and proposals for the Green Climate Fund can be a good way to target scaling up of existing projects, like those under the NAFCC, to cover wider geographies and benefit a larger no. of people. The state has already a shelf of project concept notes for GCF / NAFCC. Efforts are on foot to approach knowledge based organisations like WRI to help state in formulating GCF projects.
	Showcasing of work done in relevant international fora to attract new partners in the state	Often donors and responsible investors have limited visibility of investment opportunities that are available to them at the state level. Showcasing past projects, ongoing work and future opportunities can help in reducing informational asymmetry, and generating interest and new leads which can translate to future funding.	The UNFCCC COPs could be a great platform for sharing some of the work that MP has been and engage with key global players and stakeholders. A session on climate investment opportunities can also be included in the state's investment events or summit for interested investors.

22 IMPLEMENTING THE SAPCC

22.1 Implementation Strategy

Plan is nothing planning is everything however implementation of the action plan is even more important. The states calculated the cost of SAPCC implementation and reported some indicative number. However, in the absence of assured source of financial support, the SAPCC implementation would remain incomplete. Therefore, SAPCC implementation must be backed by a mechanism for not only as a mode of ensuring that the detailed activities are implemented as planned, but also, as a method for systematic review and programme improvement.

The interdepartmental coordination is crucial when it comes to effectively implementing the climate relevant strategies. A systematic approach along with sincere political will and synergetic efforts of all the departments are must for effectively implementing proposed strategies. On ground for every strategy proposed in the SAPCC, the principle implementing department along with collaborative departments has been identified. Moreover, if required, further association with other departments as well as agencies is also possible depending on the planned intervention.

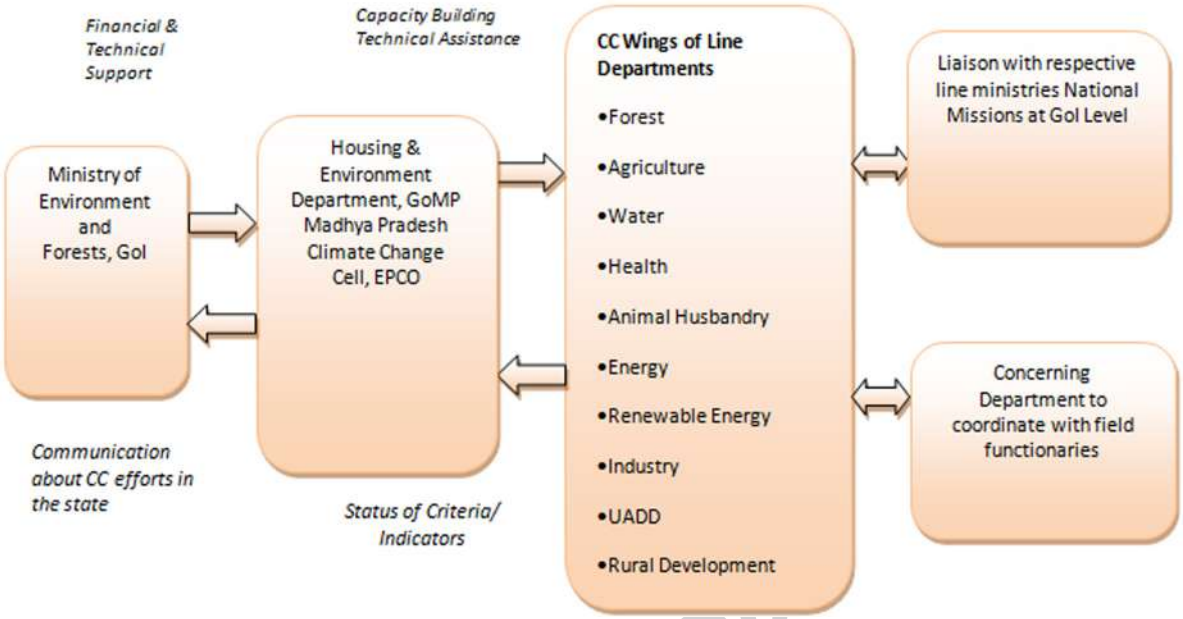
22.2 Monitoring & Evaluation

Monitoring & Evaluation (M&E) of SAPCC is as important as the implementation of SAPCC itself. However, in a federal system, states look upto central government to advise and create consensus on the M&E framework. M&E is also dependent on the finances made available to the states and subsequently line departments.

Key objective of monitoring of SAPCC is to include elements related to NDC that has implication on GHG effects, sustainable development impacts, and implementation progress of various actions relating to vulnerability reduction. Our GHG emission inventory is national in nature and reported as part of BUR process. Various mitigation actions that has impact on our GHG emissions (e.g. enhanced share of renewable, better energy efficiency, etc.) need to be captured at state level (if already implemented or even if it is planned). At the national level of course, energy intensity, NAMA, etc. can be measured, for project level aggregation NCDMA registry; international climate finance (mitigation) tracking tools can be used. For adaptation, possible tracking for SDG at the national/state level, reduction in vulnerability in specific sectors/projects are possible.

The Paris Agreement has necessitated countries to have harmonized measurement and reporting systems for the countries as per their NDC mitigation commitments. Indian NDC also has several areas in adaptation that needs systematic monitoring and assessing the change in vulnerability due to the investments made. Some of these investments are through the budget and some others are off-budget supported through bi-lateral and multilateral agencies, philanthropic bodies, and national and international climate funds. All this information has to be consolidated and a seamless harmonization of measurement and reporting is required at state level.

In the revision process of SAPCC, an attempt has been made to suggest a structured process of monitoring which is given as follows:



Key to M&E system is the proper institutional arrangement. It is proposed that the M&E system will be grounded in the existing institutional framework driven by SKMCCC within the Environment Department with higher level executive bodies providing policy guidance and governance. The SKMCCC will act as the technical secretariat and will interface with executing departments/line departments for data collection. Each department to constitute a small working group with at least two members in the working group well versed with the departmental activities & finance. The working group can be headed by a Nodal Officer who will interface with SKMCCC for data/MIS updation.

The working group members and nodal officers will be trained on kind of data requirement and their frequency. In addition to the line department officials, members drawn from the finance, statistics and planning will also be part of the training process.

The proposed M&E protocol will be activity/strategy based and indicators (both categorical and outcome wise) that should fit the protocol which is given below:-

M&E Dashboard

Sl #	Activity Code	Sector	Activity	Climate relevance (A=Adaptation; M=Mitigation; B=Both*	Category (e.g. Policy; Tech Demo/Pilot; Investment; CB, R&D)	Linked to SDG (if yes number)	Linked to NDC (if yes category key word)	Allocation in INR	Climate relevance (%)	Adjusted allocation in INR	Source (On Budget, Off Budget)	If Off Budget (Category: Bilateral, Multilateral, CSR, INGO)
1												
2												

Based on the above approach, the stakeholder departments will identify

- Total no. of mitigation actions
- Total no. of adaptation actions

- Total no. of adaptation actions with mitigation co-benefits
- Climate relevant budget for adaptation and allocation and their breakup. However, in the absence of budget coding, the climate relevance % can be subjective.
- Sectoral actions

Indicator system

The indicators can be classified broadly in to the following categories (a) output indicator – as outlined in the physical progress (b) process indicators. Some of the examples of indicators are given below:

Sector	Indicators	Level	Remarks (periodicity and challenges)
Agriculture and allied	Reduced key risks and adverse impacts of climate change	Outcome	Aggregate indicator, impact indicator-medium to long-term periodicity
	Irrigation Intensity or % of area under irrigation	Output	May be annual, easy to report
	Cropping intensity	Outcome	Annual easy to report
	Agricultural insurance policy including new crops	Process	Presence of the policy will reduce the risk
	Crop diversification (areas under different crops)	Both output and process	Paddy to Non-paddy may reduce the risk due to climate
	% of individuals who have diversified sources of income	Outcome	Challenges in attribution of rise in income, sometimes direct cash transfer an adaptive policy may result in temporary rise in income
Water	Enhanced food and water security	Outcome	Aggregate indicator, impact indicator-medium to long-term periodicity
	Rise in ground water level	Output	May be short to medium term (pre-monsoon post monsoon reporting possible)
	State water policy addressing climate risks specific to the state	Process	Presence of the policy
Forest	Increased ecosystem resilience in response to climate variability and change	Outcome	Aggregate indicator, impact indicator- long-term periodicity can be combined from various provisioning services
	Increase in plantation area	Output	Short term (if area) to medium term (if based on survival percentage)
	Incentive or Policies on tree outside forest, urban forestry	Process	Presence of the policy

Sector	Indicators	Level	Remarks (periodicity and challenges)
Energy	Reduction in energy intensity of state GDP	Outcome	Short to medium term considering all factors and leakage
	Share of renewable energy in the energy mix of the state	Output	Easy to report
	Implementation of energy conservation building code in public building	Process	Easy to report from compliance
Urban habitat	% Reduction in Migration of local population directly and indirectly dependent on concerned sectors for their livelihoods	Outcome	Aggregate indicator (short to medium term reporting possible after survey)
	Open defecation free status	Output/Process	Short term
	Amount of solid-waste converted to energy	Output	Short term
	Smart city policy on bi-cycle tracks or car pooling	Process	Short term, presence of policy

The above list is only indicative and the process of indicator selections should be possible after wider consultation with departments. First priority is climate relevant scheme specific indicators (mostly output indicators) that the department report as routine. The second is project level indicators as defined in the result framework. The third is sector/mission level indicators as defined under mission document or state/ national priority (e.g. doubling farm income, reduction of energy intensity of GDP).

Tools and methods for harmonization

Key aspects in this is to choose indicators/proxy that has relevance to SDG/INDC

- IPCC defined methods on emission inventory (since the state level inventory is not available, proxies on share of renewables, energy efficiency, etc. can be reported).
- For project level emission reduction, Co-benefit tracking tools, sustainable development potentials can be tracked and consolidated. If required, state share reflected in NAMAs can be reflected.
- For adaptation investments, change in vulnerability (mostly the change in adaptive capacity and sensitivity) to be tracked. Those should follow IPCC methods and tools. This tracking can be spatial or temporal.
- The project level vulnerability reduction can be tracked against committed targets based on the project level assessment reports.
- Policy level assessment can be done by tracking policy goals and targets for various sectors.
- Finance data for effective harmonization requires budget coding, without that the nodal department can discuss with technical working groups to fix climate relevance % based on scheme components.

Data Management System

- Collect a relevant economic and social data to develop the state circumstances (macro)
- Collect departmental level data based on the proposed strategies by the departments and their output and outcome
- Collect project level data from project MIS (may be externally aided and off budget projects)
- Delegate responsibility for the collection of particular data sets to authorized individuals and agencies of the government.
- Work with industry associations/ NGOs for collecting relevant data having impact on NDC/SDG

Capacity Building

Generally, awareness and capacity to plan and deliver on climate change strategies is low at cutting edge. Therefore, efforts should be made to demystify the climate strategies proposed by the departments at regular interval. The process will be facilitated by the focal department and technical working group members (both department and inter-department) will take part in it. This process should be a quarterly affair each year.

Data frequency

The data sets may be divided into two categories (a) static e.g. GDP data (b) dynamic data. In essence nothing is static, but some statistics are annual or more. The dynamic datasets change more frequently. However, for such data sets monthly or quarterly cycle of updation will be adequate.

Data consolidation and validation

The data will be validated by the focal department/cell in assistance with experts and also the nodal officers who in turn will provide clarification if any after due consultation with sectoral working group members.

Reporting

The dashboards for key indicators will have regular updation. The climate strategy and action plans should be revised every five years as is the process now. The monitoring of results will be part of that stock taking.

References

CWC. 2015. *National Register of Large Dams.* Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti, New Delhi: Central Water Commission, Government of India.

Fanack Water. 2017. Impact of *Climate Change on Water Resources.* https://water.fanack.com/impact-of-climate-change-on-water-resources.

KPMG . 2010. *Water sector in India: Overview and focus areas for the future.* KPMG India, 1.

MoEF. 2013. *National Wetland Atlas. New Delhi:* Ministry of Environment and Forests, Government of India .

Ramsar. 2002. *Ramsar Sites Information Service.* https://rsis.ramsar.org/ris/1206.

SKMCCC. 2014. *Madhya Pradesh State Action Plan on Climate Change.* Department of Environment, Environmental Planning & Coordination Organization, Bhopal: State Knowledge Management Centre on Climate Change, Government of Madhya Pradesh, vii.

UNEP. 2000. *Climate Change and Dams.* United Nations Environement Programme.

World Bank. 2012. India Groundwater: a Valuable but Diminishing Resource. March 6. Accessed August 5, 2019. https://www.worldbank.org/en/news/feature/2012/03/06/india-groundwater-critical-diminishing.

Chase, Larry. 2014. "Climate Change Impacts on Dairy Cattle."

Chhabra, Abha, KR Manjunath, Sushma Panigrahy, and J.S Parihar. 2017. "Greenhouse Gas Emissions from Indian Livestock (2013)." *Climactic Change (117)* 329-44.

DoAH. 2018. *Annual Report 2017-18.* Bhopal: Department of Animal Husbandry, Government of Madhya Pradesh.

Hidosa, D, and M Guyo. 2017. "Climate Change Effects on Livestock Feed Resources: A Review." *Journal of Fisheries & Livestock Production Vol 05, No. 04* .

Hoffmann, Irene. 2010. "Climate Change and the Characterization, Breeding and Conservation of Animal Genetic Resources." *Animal Genetics* (41) (." Animal Genetics 41 (2010): 32-46.) 32-46.

IGFRI. 2013. Vision 2050. Indian Grassland and Fodder Research Institute.

Notter, D R. 1999. "The importance of genetic diversity in livestock populations of the future." *Journal of Animal Science, Volume 77, Issue 1, https://doi.org/10.2527/1999.77161x 61-69. https://doi.org/10.2527/1999.77161x.*

Rojas-Downing, Melissa, Pouyan Nejadhashemi, Timothy Harrigan, and Sean Woznicki. 2017. "Climate Change and Livestock: Impacts, Adaptation, and Mitigation." *Climate Risk Management 16 145-63.*

MPFD. (2017). *Annual Report 2016-17.* Madhya Pradesh Forest Department, Government of Madhya Pradesh.

Dale, V. H., Joyce, L. A., Mcnulty, S., Neilson, R. P., Ayres, M. P., Flannigan, M. D., et al. (2001). Climate Change and Forest Disturbances. *BioScience Vol 51, No. 9 , 723.*

Hergarten, M., Liagre, L., & Froede-Thierfelder, B. (2003). *Forests and Climate Change Adaptation: A Twofold Approach.*

FSI. (2017). *State of Forest Report.* Forest Survey of India, Ministry of Environment, Forests and Climate Change, Government of India.

Snyder, M. (2014). *What Is Forest Fragmentation and Why Is It A Problem?* enter for Northern Woodlands Education.

Rojas-Downing, M., Nejadhashemi, P., Harrigan, T., & Woznicki, S. (2017). Climate Change and Livestock: Impacts, Adaptation, and Mitigation. *Climate Risk Management 16 , 145-63.*

Chhabra, A., Manjunath, K., Panigrahy, S., & Parihar, J. (2017). Greenhouse Gas Emissions from Indian Livestock (2013). *Climactic Change (117) , 329-44.*

DoAH. (2018). *Annual Report 2017-18.* Bhopal: Department of Animal Husbandry, Government of Madhya Pradesh.

Hoffmann, I. (2010). Climate Change and the Characterization, Breeding and Conservation of Animal Genetic Resources. *Animal Genetics* (41) , 32-46.

Chase, L. (2014). Climate Change Impacts on Dairy Cattle.

Hidosa, D., & Guyo, M. (2017). Climate Change Effects on Livestock Feed Resources: A Review. *Journal of Fisheries & Livestock Production Vol 05, No. 04 .*

IGFRI. (2013). Vision 2050. Indian Grassland and Fodder Research Institute.

Notter, D. R. (1999). The importance of genetic diversity in livestock populations of the future. *Journal of Animal Science, Volume 77, Issue 1, https://doi.org/10.2527/1999.77161x , 61-69.*

FW&FDD. (2017). Annual Report 2016-17. Bhopal: Fisherman Welfare and Fisheries Development Department.

Harrod, C., Ramírez, A., Jørgensen, V. J., & Smith, S. F. (2018). How climate change impacts inland fisheries . In FAO, *Impacts of climate change on fisheries and aquaculture-Synthesis of current knowledge, adaptation and mitigation options (pp. 375-392).* Rome: Food and Agriculture Organization of the United Nations (375-392).

SKMCCC. (2018). *Climate Change Vulnerability Assessment for Madhya Pradesh.* Environmental Planning & Coordination Organization, Department of Environment. State Knowledge Management Centre on Climate Change, Government of Madhya Pradesh.

MoEF&CC. (2014). India 3rd National Report to *National Biodiversity Action Plan.* Ministry of Environment, Forests and Climate Change, Government of India.

CIFRI. (2013). *Fishes of Madhya Pradesh.* Kolkata: Central Inland Fisheries Research Institute, Indian Council of Agricultural Research.

Bhat, B., & Singh, T. K. (2014). Introduction of Exotic Aquatic Species for Aquaculture in India: Some Perspectives. (V. Sinha, & P. Jayasankar, Eds.) *Aquaculture: New Possibilities and Concerns ,* 157-172.

Lakra, W., Mohindra, V., & Lal, K. K. (2007). Fish genetics and conservation research in India: status and perspectives. *Fish Physiology and Biochemistry, 33 (4),* 475-487.

CWC. (2015). *National Register of Large Dams, Central Water Commission.* (Ministry of Jal Shakti, Government of India) From http://cwc.gov.in/national-register-large-dams

Mehta, S. (2014, August 01). *Nat Geo Traveller.* From http://www.natgeotraveller.in/hope-floats-the-slow-and-steady-recovery-of-the-chambals-turtles/

ICAR-National Bureau of Fish Genetic Resources. (n.d.). *Salient Achievements.* From http://www.nbfgr.res.in/en/page/salient-achievements

EPCO. (2018). *Climate Change Vulnerability Assessment for Madhya Pradesh.* Bhopal: Environment Planning and Coordnation Organisation, Government of Madhy Pradesh.

CDC. (2019). *Health Impacts of Climate Change.* Retrieved August 5, 2019 from https://sfclimatehealth.org/health-impacts-of-climate-change/

DoPH&FW. (2018). *Annual Report 2017-18.* Bhopal: Department of Public Health and Family Welfare, Government of Madhya Pradesh.

SKMCCC. (2014). *Madhya Pradesh State Action Plan on Climate Change.* Environmental Planning & Coordination Organization, Department of Environment. Bhopal: State Knowledge Management Centre on Climate Change,Government of Madhya Pradesh.

Department of Public Health & Family Welfare. (2017-18). *Annual Report. Bhopal:* Government of Madhya Pradesh.

KPMG . (2010). *Water sector in India: Overview and focus areas for the future.* KPMG India.

Fanack Water. (2017). *Impact of Climate Change on Water Resources.* From https://water.fanack.com/impact-of-climate-change-on-water-resources

SKMCCC. (2014). *Madhya Pradesh State Action Plan on Climate Change.* Environmental Planning & Coordination Organization, Department of Environment. Bhopal: State Knowledge Management Centre on Climate Change, Government of Madhya Pradesh.

MoEF. (2013). *National Wetland Atlas.* New Delhi: Ministry of Environment and Forests, Government of India .

Ramsar. (2002). *Ramsar Sites Information Service.* From Ramsar Convention: https://rsis.ramsar.org/ris/1206

CWC. (2015). *National Register of Large Dams.* Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation. New Delhi: Central Water Commission, Government of India.

UNEP. (2000). *Climate Change and Dams.* United Nations Environement Programme.

World Bank. (2012, March 6). *India Groundwater: a Valuable but Diminishing Resource.* Retrieved August 5, 2019 from https://www.worldbank.org/en/news/feature/2012/03/06/india-groundwater-critical-diminishing

Gulati, A., Rajkhowa, P., & Sharma, P. (2017). Making rapid strides - Agriculture in Madhya Pradesh: sources, drivers, and policy lessons. *Indian Council for Research on International Economic Relations (ICRIER), Working Paper No. 339.*

FAO. (2016). *Climate Change and Food Security: Risks and Responses.* Food and Agriculture Organization of the United Nations.

MoSPI. (2018). *Statistical Yearbook of India.* New Delhi: Ministry of Statistics & Programme Implementation, Government of India.

DFW&AD. (2018). *Annual Report.* Bhopal: Department of Farmers' Welfare and Agriculture Development, Government of Madhya Pradesh.

DFW&AD. (2018). *Annual Report.* Bhopal: Department of Farmer Welfare and Agriculture Development, Government of Madhya Pradesh.

ISRO. (2016). *Desertification and Land Degradation Atlas of India.* Ahmedabad: Space Applications Centre, Indian Space Research Organisation, Department of Space, Government of India.

ENVIS. (2015, February 13). *Soils of Madhya Pradesh.* Retrieved August 14, 2019 from http://www.mpenvis.nic.in/index2.aspx?slid=476&sublinkid=271&langid=1&mid=1

MAPCOST. (2007). *GIS and Maps.* Retrieved August 14, 2019 from http://www.nchse.org/mpgis/images/mpimages_schoolarch/soilofmp.jpg

Mall, R. K., Singh, R., Gupta, A., Srinivasan, G., & Rathore, L. S. (2006). *Impact of Climate Change on Indian Agriculture: A Review. Climatic Change (78) ,* 445–478.

MoA&FW. (2015-16). *Impact of Chemical Fertilizers and Pesticides on agriculture and allied sectors in the country.* Government of India. Ministry of Agriculture and Farmers Welfare, 16th Lok Sabha Standing Committee on Agriculture.

Lebel, L., L. Li, C., Krittasudthacheewa, M., Juntopas, T., Vijitpan, T., Uchiyama, et al. (2012). *Mainstreaming Climate Change Adaptation into Development Planning.* Bangkok: Adaptation Knowledge Platform; Stockholm: Stockholm Environment Institute.

Mogelgaard, K., Dinshaw, A., Ginoya, N., Gutierrez, M., Preethan, P., & Waslander, J. (2018). *From Planning to Action: Mainstreaming Adaptation into Development.* Washinton DC: World Resources Institute.

Dinshaw, A., Ginoya, N., Preethan, P., Arivudai, N. A., & Gutierrez Rivera, M. (2018). *Mainstreaming Adaptation in Action: Case Studies from Two States in India.* Washington DC: World Resources Institute.

CDC. 2019. *Health Impacts of Climate Change.* Accessed August 5, 2019. https://sfclimatehealth.org/health-impacts-of-climate-change/.

Department of Public Health & Family Welfare. *2017-18. Annual Report.* Bhopal: Government of Madhya Pradesh.

DoPH&FW. 2018. *Annual Report 2017-18.* Bhopal: Department of Public Health and Family Welfare, Government of Madhya Pradesh.

SKMCCC. 2014. *Madhya Pradesh State Action Plan on Climate Change.* Department of Environment, Environmental Planning & Coordination Organization, Bhopal: State Knowledge Management Centre on Climate Change,Government of Madhya Pradesh, vii.

Bhat, B. Vishnu, and Tarun Kumar Singh. 2014. "Introduction of Exotic Aquatic Species for Aquaculture in India: Some Perspectives." Edited by V.R.P. Sinha and P Jayasankar. *Aquaculture: New Possibilities and Concerns* (Narendra Publishing House) 157-172.

CIFRI. 2013. *Fishes of Madhya Pradesh.* Kolkata: Central Inland Fisheries Research Institute, Indian Council of Agricultural Research.

CWC. 2015. *National Register of Large Dams, Central Water Commission.* Ministry of Jal Shakti, Government of India. http://cwc.gov.in/national-register-large-dams.

FW&FDD. 2017. *Annual Report 2016-17.* Bhopal: Fisherman Welfare and Fisheries Development Department.

Harrod, Chris, Alejandro Ramírez, Valbo, John Jørgensen, and Simon Funge Smith. 2018. "How climate change impacts inland fisheries ." In *Impacts of climate change on fisheries and aquaculture-Synthesis of current knowledge, adaptation and mitigation options,* by FAO, 375-392. Rome: Food and Agriculture Organization of the United Nations (375-392).

ICAR-National Bureau of Fish Genetic Resources. n.d. Salient Achievements. http://www.nbfgr.res.in/en/page/*salient-achievements.*

Lakra, W.S., Vindhya Mohindra, and Kuldeep K. Lal. 2007. "Fish genetics and conservation research in India: status and perspectives." *Fish Physiology and Biochemistry* (Springer) 33 (4): 475-487.

Mehta, Sejal. 2014. *Nat Geo Traveller.* 01 August. http://www.natgeotraveller.in/hope-floats-the-slow-and-steady-recovery-of-the-chambals-turtles/.

MoEF&CC. 2014. *India 3rd National Report to National Biodiversity Action Plan.* Ministry of Environment, Forests and Climate Change, Government of India.

SKMCCC. 2018. *Climate Change Vulnerability Assessment for Madhya Pradesh.* Department of Environment, Environmental Planning & Coordination Organization, State Knowledge Management Centre on Climate Change, Government of Madhya Pradesh.

Chase, Larry. "Climate Change Impacts on Dairy Cattle." 2014.

Chhabra, Abha, KR Manjunath, Sushma Panigrahy, and J.S Parihar. "Greenhouse Gas Emissions from Indian Livestock (2013)." *Climactic Change* (117), 2017: 329-44.

DoAH. *Annual Report 2017-18.* Bhopal: Department of Animal Husbandry, Government of Madhya Pradesh, 2018.

Hidosa, D, and M Guyo. "Climate Change Effects on Livestock Feed Resources: A Review." *Journal of Fisheries & Livestock Production Vol 05, No. 04 ,* 2017.

Hoffmann, Irene. "Climate Change and the Characterization, Breeding and Conservation of Animal Genetic Resources." *Animal Genetics* (41) (." Animal Genetics 41 (2010): 32-46.), 2010: 32-46.

IGFRI. *Vision 2050*. Indian Grassland and Fodder Research Institute, 2013.

India, Govt. of. *Basic Animal Husbandry Statistics.* Nrushi bhawan, New Delhi: Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, 2012 & 2019.

Notter, D R. "The importance of genetic diversity in livestock populations of the future." *Journal of Animal Science, Volume 77,* Issue 1, https://doi.org/10.2527/1999.77161x, 1999: 61-69.

Rojas-Downing, Melissa, Pouyan Nejadhashemi, Timothy Harrigan, and Sean Woznicki. "Climate Change and Livestock: Impacts, Adaptation, and Mitigation." *Climate Risk Management* 16, 2017: 145-63.

https://www.icrisat.org/actionable-policies-to-make-indian-agriculture-climate-resilient/

Annexure- 1

ENVIRONMENTAL PLANNING & COORDINATION ORGANISATION
Department of Environment, Government of MP
Paryavaran Parisar, E-5, Arera Colony,
Bhopal - 462 016 (MP)
Tel. (0755)-2466859 Fax: (0755)-2462136
No. 2489 /SKMCCC/EPCO/2019
Date: 6/9/2019

Office Order

In accordance with the common framework for SAPCC revision and in continuation with the office order issued vide no. 712-713 dated 30 May 2019, a multi-disciplinary core group for revision of Madhya Pradesh State Action Plan on Climate Change comprising following members is hereby constituted as follows:-

Sr.	Name & Designation	Status
1.1	Executive Director EPCO	Chair
2	**Nodal Officers from following departments :-**	
2.1	Agriculture Department	Member
2.2	Horticulture Department	Member
2.3	Fisheries Department	Member
2.4	Animal Husbandry Department	Member
2.5	Forest Department	Member
2.6	Water Resources Department	Member
2.7	Public Health Engineering Department	Member
2.8	Rural Development Department	Member
2.9	Urban Administration & Development Department	Member
2.10	Transport Department	Member
2.11	Energy Department	Member
2.12	New & Renewable Energy Department (MPUVN)	Member
2.13	Industries Department	Member
2.14	Mining Department	Member
2.15	Science & Technology Department	Member
2.16	Family Welfare & Health Department	Member
2.17	MP Pollution Control Board	Member
Subject Experts		
3	Dr. Ram Prasad Ex-PCCF, GoMP; Ex-Director, IIFM and Ex-VC, BU	Member
4	Padmshri Babulal Dahiya Biodiversity Conservationist	Member
5	Director, Indian Institute of Soil Sciences, Bhopal	Member
6	Director, Tropical Forest Research Institute, Jabalpur	Member
7	Dr SD Upadhyaya Director Instructions, JNKVV Jabalpur	Member

Contd.

ENVIRONMENTAL PLANNING & COORDINATION ORGANISATION
Department of Environment, Government of MP
Paryavaran Parisar, E-5, Arera Colony,
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Tel. (0755)-2466859 Fax: (0755)-2462136
No. /SKMCCC/EPCO/2019
Date:

8	Dr. Ashwini Kulkarni Scientist-G, IITM Pune	Member
9	Dr. S. Satapathy Retd. Director, Climate Change Division, MoEFCC, GoI	Member
10	Dr. AK Gosain Retd. Professor and Head, Civil Engineering, IIT Delhi	Member
11	Dr. Amitabh Pandey Associate Professor, IIFM, Bhopal	Member
12	Dr. VK Sethi VC, RKDF University & Ex-Director, UIT RGPV, Bhopal	Member
13	Dr. Venkateshwarlu Retd. VC, Parbhani Agriculture University	Member
14	Ms. Aditi Kapoor Alternative Futures, New Delhi	Member
15	Mr Sanjay Vashishth Director, Climate Action Network – South Asia (CANSA)	Member
16	Ms. Ritu Bhardwaj Institute for Industrial Productivity	Member
17	Dr. Renu Mishra Professor, Taxonomy, Satya Sai College, Bhopal	Member
18	Mr. Ishan Agrawal Team Leader Foundation for Ecological Security (FES), Mandla	Member
19	Mr. Siddharth Patil, ACWADAM	Member
20	Dr. Pankaj Kumar, Assistant Professor, IISER Bhopal	Member
21	Ms. Swati Jain State Consultant, PHE Department, Bhopal	Member
22	Mr Manohar Patil, Executive Engineer, EPCO	Member
23	Representative from UNDP India Country Office New Delhi	Member
24	Dr. Nambi Appadurai, Director, Climate Resilience Practice World Resources Institute (WRI) India	Member
25	Mr. Srinivas Krishnamurthy Green House Gas (GHG) Platform India	Member
26	Shri Lokendra Thakkar State Nodal Officer for Climate Change in MP and Coordinator, SKMCCC	Member Convener

Contd.

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The core group would provide guidance and technical inputs on the climate change vulnerability, adaptation & mitigation aspects of MP SAPCC. The core group would also review the process and progress of the MP SAPCC revision.

The core group would meet as and when required during the formulation of SAPCC v 2.0. An honorarium of Rs. 5000/- as sitting fee per meeting will be paid to the external members of the committee. For outstation members, stay, travel & local conveyance arrangements will be made by EPCO.

The expenses to be incurred in the formulation of MP SAPCC v 2.0 will be booked in the budget head received from State Government of MP for SKMCCC and/or from MoEFCC, GoI. With the permission of the chair, core group may co-opt more subject experts if need arises.

Action approved by PS, Environment & DG, EPCO

Executive Director

Endt. No. 2490 /SKMCCC/EPCO/2019, Bhopal Date: 6/9/2019

Copy to:-

1. Principal Secretary, Environment & DG EPCO for kind information please.
2. All the members of the core group for kind information please.
3. Administrative Officer, EPCO for kind Information please.
4. Accounts Officer, EPCO for kind information please.
5. Coordinator, SKMCCC for kind information & necessary actions please.

Administrative Officer

State Knowledge Management Centre on Climate Change (SKMCCC)
Environmental Planning & Coordination Organisation (EPCO)
Department of Environment, Government of Madhya Pradesh
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