



GOVERNMENT OF PUNJAB  
INDIA

# SAPCC 2.0



## PUNJAB STATE ACTION PLAN ON CLIMATE CHANGE 2.0





“

ਪਵਣੁ ਗੁਰੂ ਪਾਣੀ  
ਪਿਤਾ ਮਾਤਾ ਧਰਤਿ  
ਮਹਤੁ ॥

ਦਿਵਸੁ ਰਾਤਿ ਦੁਇ  
ਦਾਈ ਦਾਇਆ ਖੇਲੈ  
ਸਗਲ ਜਗਤੁ ॥ ”

“

Air is the Guru,  
Water is the  
Father, and Earth  
is the Great  
Mother of all.

Day and Night are  
the two nurses, in  
whose lap all the  
world is at play.

”

# PUNJAB STATE ACTION PLAN ON CLIMATE CHANGE 2.0

Prepared by:



Punjab State Council for Science & Technology  
with support of GIZ

On behalf of:



Department of Science, Technology & Environment  
Government of Punjab

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## FOREWORD

Climate is changing at an unprecedented rate. The escalating frequency of extreme weather events impacts every facet of our society, from the environment to public health, agriculture, ecosystems and the economy. Our state has considerable reasons to be more worrisome about climate change, especially, since significant proportion of our population is relying on climate-sensitive livelihoods.

The Govt. of Punjab, committed to provide a healthy, safe and sustainable future, has developed holistic Punjab State Action Plan on Climate Change 2.0 (SAPCC 2.0). It highlights the observed as well as projected trends of climate change in the State after analysing data and taking into account recent scientific research and future scenario. It also summarises the climate actions taken on ground as well as strategies to be adopted by the State for climate change adaptation and mitigation in the ongoing decade.

Punjab being the front runner in agriculture, the strategies outlined in SAPCC 2.0 for climate proofing of agriculture & allied sectors are crucial for food security of the nation. Further, the climate actions identified in this document for other sectors are key to sustainability of our endeavours for scaling rural & urban habitats, health systems and augmentation of carbon sinks in the State.

The SAPCC 2.0 is the anchor document for integration of climate actions in the policies and programs of all development departments and research priorities of knowledge institutions in Punjab. The strategies and actions identified in it are aligned with our Nationally Determined Contributions towards climate change as well the Sustainable Development Goals.

The untiring efforts of Punjab State Council for Science & Technology, the think-tank of Department of Science Technology & Environment, Govt. of Punjab in bringing out SAPCC 2.0 with support of GIZ and Ministry of Environment, Forests & Climate Change, Govt. of India are indeed laudable.

I hope this document will facilitate actions at all levels in the State to address the envisaged impacts of climate change.

(Anurag Verma)





**Rahul Tewari, IAS**

Secretary, Science, Technology & Environment  
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## PREFACE

It has been very satisfying exercise to engage all stakeholders in the State to delve upon the challenges of key development sectors in the wake of climate change and map the progress made as well as strategize the way forward to address the same. I am, therefore, glad to present State Action Plan on Climate Change 2.0 (SAPCC 2.0). It has been prepared in alignment with country's Nationally Determined Contributions towards climate change.

The SAPCC 2.0 covers climate profile of the State viz. change in regional weather pattern due to climate change as well as future climate projections. It has been recognized that adaptation is a key component for long term response to climate change in order to protect people, livelihoods and ecosystems. Thus, to respond to impacts of climate change that are already happening, as well as to prepare for future impacts, adaptation strategies for the priority sectors have been planned. Further, mitigation strategies have also been chalked out to reduce or prevent emission of green-house gases. The implementation arrangement and monitoring & evaluation framework for the same have also been designed to ensure ease of action and assessment.

I congratulate my team of Punjab State council for Science & Technology for bringing out SAPCC 2.0 through wider participation of key departments & institutions for integration of climate action in the developmental planning.

(Rahul Tewari)





**Dr. Jatinder Kaur Arora**

Executive Director

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## PRELUDE

The Ministry of Environment Forests & Climate Change (MoEFCC), Govt. of India had advised all States to revise the State Action Plans on Climate Change (SAPCC) in line with India's Nationally Determined Contributions and Sustainable Development Goals. Thus, Punjab State Council for Science & Technology, on behalf of Department of Science Technology & Environment, Punjab prepared SAPCC 2.0 after taking inputs from all the concerned departments and knowledge institutions.

It highlights the observed trends of climate change in the State based on analysis of past 70 years' data and also indicates projected climate change in the times to come. Further, SAPCC 2.0 captures climate change vulnerability of each district of the State studied by us on indicators defined in uniform National Framework developed by Department of Science & Technology, Govt. of India. Furthermore, key achievements made with respect to strategies identified in SAPCC 1.0 including policy and programme level interventions have been outlined.

The document articulates strategies to be adopted by the State for climate change adaptation and mitigation till 2030 under seven missions finalized in consultation with relevant development departments by dovetailing with their existing schemes. These include Mission on Forests, Ecosystem & Biodiversity; Sustainable Agriculture; Water; Strategic Knowledge; Enhanced Energy Efficiency & Solar Energy and Sustainable Habitat.

The whole-of-Government approach was followed for developing this action plan. The nodal officers from all the relevant development departments of the State were identified, stakeholder consultation workshops and one-to-one meetings were held to obtain data & inputs as well as get the information collected from secondary sources authenticated. The inputs provided by State's Directorate of Environment & Climate Change were of immense help in bringing out a holistic document responsive to the needs of the State.

The Ministry of Environment Forests & Climate Change, Govt. of India provided financial support as well as technical comments. The action plan was presented to Expert Committee and National Steering committee on climate change of MoEFCC, Gol, which, approved it after a rigorous review. It is hoped that SAPCC 2.0 will strengthen collective and sustained actions for climate change adaptation and mitigation in the State.

(Dr. Jatinder Kaur Arora)





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## LIST OF ABBREVIATION

Abbreviation	Definition
°C	Degree Celsius
4SAP	4-year Strategic Action Plan
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AQI	Air Quality Index
AR	Assessment Report
BCM	Billion cubic meters
BEE	Bureau of Energy Efficiency
BHS	Biodiversity Heritage Sites
BL	Base Line
BMC	Biodiversity Management Committee
BOO	Build, Own, Operate
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CO <sub>2</sub>	Carbon dioxide
COP	Conference of Parties
CSR	Corporate Social Responsibility
DDB	Dairy Development Board
DECC	Directorate of Environment & Climate Change
DSR	Direct Seeded Rice
DST	Department of Science & Technology
EC	End Century
ECBC	Energy Conservation Building Code
EV	Electric Vehicle
GADVASU	Guru Angad Dev Veterinary and Animal Sciences University
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse gas
GIM	Green India Mission
GIS	Geographic Information System
GoI	Government of India
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
GVA	Gross Value Added
GW	Gigawatts
ha	Hectare



IMD	Indian Meteorological Department
INGO	International Non-Government Organizations
IPCC	Inter Governmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KPIs	Key Performance Indicators
KPP	Key Performance Parameter
kwh	Kilowatt Hour
L.i.F.E	Lifestyle for Environment
M&E	Monitoring and Evaluation
MC	Mid Century
MCM	Million Cubic Meters
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MIE	Multilateral Implementing Entity
MLD	Million Litres per Day
mm	Millimeter
MT	Metric Tonne
MoEF&CC	Ministry of Environment, Forest and Climate Change
MSME	Micro, Small and Medium Enterprises
MW	Megawatt
NABARD	National Bank for Agriculture and Rural Development
NAPCC	National Action Plan on Climate Change
NDC	Nationally Determined Contribution
NHM	National Health Mission
NHPC	National Hydro Electric Power Corporation
NICRA	National Innovation in Climate Resilient Agriculture
NIE	National Implementing Entity
NITI	National Institution for Transforming India
NMSKCC	National Mission on Strategic Knowledge for Climate Change
NRSE	New and Renewable Sources of Energy
NTPC	National Thermal Power Corporation
PAU	Punjab Agricultural University
PBB	Punjab Biodiversity Board
PBRs	People Biodiversity Registers
PEDA	Punjab Energy Development Agency
PES	Payment for Ecological Services



<b>PGIMER</b>	Postgraduate Institute of Medical Education and Research
<b>PMAY-U</b>	Pradhan Mantri Awas Yojana -Urban
<b>PMKSY</b>	Pradhan Mantri Krishi SinchayeeYojna
<b>PPCB</b>	Punjab Pollution Control Board
<b>PSCCKC</b>	Punjab State Climate Change Knowledge Centre
<b>PSCST</b>	Punjab State Council for Science & Technology
<b>R&amp;D</b>	Research and Development
<b>RCPs</b>	Representative Concentration Pathways
<b>RE</b>	Renewable Energy
<b>RKVY</b>	Rashtriya Krishi Vikas Yojana
<b>SAPCC</b>	State Action Plan on Climate Change
<b>SDG</b>	Sustainable Development Goals
<b>SIRD</b>	State Institute for Rural Development
<b>SLCPs</b>	Short Lived Climate Pollutants
<b>SLSCP</b>	Short Lived Super Climate Pollutants
<b>SMAF</b>	Sub-Mission on Agro-Forestry
<b>SOP</b>	Standard Operating Procedure
<b>sq km</b>	Square kilometer
<b>STP</b>	Sewage Treatment Plant
<b>TPD</b>	Tons Per Day
<b>ULBs</b>	Urban Local Bodies
<b>UNESCO</b>	United Nations Educational, Scientific and Cultural Organization
<b>UNFCC</b>	United Nations Framework Convention on Climate Change
<b>VA</b>	Vulnerability Assessment
<b>VI</b>	Vulnerability Index
<b>WHO</b>	World Health Organization



# Executive Summary

## 1.0 Introduction

Climate Change has been a cause of concern of the Scientists for well over a Century. It was only in 1988 that the UN General Assembly recognised it as a global problem and set up Intergovernmental Panel on Climate Change (IPCC) to provide scientific guidance in this area. The first IPCC special report on Global warming of 1.5°C in 2018 highlighted the adverse effects associated with +2°C and called for lowering of global warming target to +1.5°C and further suggested that global CO<sub>2</sub> emissions must reach net zero target to halt the progression of global warming.

Various studies/reports have indicated that due to climate change, the agriculture and Health sector would be the worst hit. The WHO projects that between 2030 and 2050, approximately 250 thousand additional deaths per year from malnutrition, malaria, diarrhoea, and heat stress could be attributed to climate change. Since a large share of the poor in developing countries depend upon agriculture and manual labour for their livelihoods, the projected change is likely to reduce the pace of poverty reduction and widen income inequality. The ongoing COVID-19 pandemic is an example of the large economic and human cost of diseases spread by new pathogens. Climate change will only increase the probability of such outbreaks and low-income countries with weak public health infrastructure and resources to strengthen it, will be severely hit.

## 2.0 India's Commitment towards Climate Change

India became one of the signatories of United Nations Framework Convention on Climate Change (UNFCCC) in the year 1992 with the goal of 'preventing dangerous anthropogenic interference with Earth's climate system' and launched its first National Action Plan on Climate Change (NAPCC) in the year 2008 to address climate-related issues. All the States were directed to prepare sub-national State Action Plans for Climate Change (SAPCC). The first phase of SAPCC (2014-2020) is over and all the States have been asked to develop SAPCC 2.0 (2021-2030) in line with India's NDCs and SDGs.

The Paris Agreement adopted in 2015 during COP 21 further strengthened the global response to climate change by committing to limit temperature rise to 2°C by end of this century and further strive to limit it to 1.5°C as well as increase the ability to adapt to the adverse impacts of climate change. The member countries of UNFCCC, under Paris Agreement, had decided to put forward their Nationally Determined Contributions (NDCs) which represent efforts by each country to reduce national emissions and adapt to the impacts of climate change.

India submitted its Intended Nationally Determined Contributions (INDCs) to UNFCCC in 2015 which comprised of eight goals; three of these have following quantitative targets upto 2030

- i) Cumulative electric power installed capacity from non-fossil sources to reach 40%
- ii) Reduce the emissions intensity of GDP by 33 to 35 percent compared to 2005 levels
- iii) Creation of additional carbon sink of 2.5 to 3 billion tonnes of CO<sub>2</sub> equivalent through additional forest and tree cover.

India further made following updations in its NDCs after the Conference of Parties (COP 26) held at Glasgow, UK in 2021:

- i) Reach 500 GW Non-fossil energy capacity by 2030.



- ii) Meet 50 per cent of country's energy requirement from renewable energy by 2030.
- iii) Reduce the emissions intensity of GDP by 45 percent by 2030, over 2005 levels.
- iv) Reduce total projected carbon emissions by one billion tonnes by 2030.
- v) Achieve the target of net zero emissions by 2070.

In addition, recognizing that lifestyle also has a big role in climate change, India at COP 26 also proposed a 'One-Word Movement', LiFE (Lifestyle for Environment) to the global community. This one word movement is a part of India's first NDC now which stands updated as 'To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for 'LiFE'- 'Lifestyle for Environment' as a key to combating climate change'.

Further, 27<sup>th</sup> Conference of Parties (COP 27) of UNFCCC held recently at Sharm El-Sheikh, Egypt concluded with a historic decision to establish and operationalize a loss and damage fund to support vulnerable countries hit hard by climate induced disasters like flood, drought, etc.

### 3.0 State Action Plan on Climate Change 1.0

Punjab formulated State Action Plan on Climate Change (SAPCC 1.0) for the year 2014-2020 to accelerate adaptation and mitigation actions at the State level. 95 strategies were proposed in SAPCC 1.0, of which 64 were adaptation strategies while 31 were mitigation actions. The key achievements of taking forward the climate agenda in the State, after development of SAPCC 1.0 are outlined in **Table 1**.

**Table 1: Key Achievements after Formulation of SAPCC 1.0**

Total expenditure of INR 57,783.55 million incurred for implementing SAPCC 1.0 activities under seven sectors, out of which, about 70% expenditure was towards adaptation and 30% towards mitigation strategies

#### **Focused Missions/Action Plans Rolled Out**

- Mission Tandarust Punjab (2018) with Green Punjab, Clean Water, Clean Air, Safe Food, Healthy Soil, Nutrition, Preventive Health, Khedo Punjab, Waste Management, Road Safety as Sub-Missions
- Mission Innovate Punjab (2019) with Environment as a key focus area
- State Mission on Rejuvenation of Ponds (2020)
- State Action Plan on Reuse of Treated Wastewater (2020)

#### **Key Policy Level Interventions**

- Punjab Water Resources (Management and Regulation) Act, 2020
- Punjab Water Regulation and Development Authority set up in 2020
- State Solid Waste Management Policy, 2018
- State Treated Waste Water Policy, 2017
- Punjab Municipal Green Buildings Incentives Policy, 2016



**Institutional Set Ups**

- Directorate of Environment & Climate Change
- State Climate Change Knowledge Centre in Punjab State Council for Science and Technology
- Centre for Eco-system Restoration at Punjabi University
- Environment Resource Centre jointly established by Punjab Biotechnology Incubator & Punjab Pollution Control Board
- Five Centres of Excellence for Post-harvest management
- Air quality management division at Punjab Pollution Control Board

**Research & Development**

- 41 climate resilient varieties developed for different crops
- 35 varieties of low chill temperate fruits introduced
- Cleaner technologies developed and adopted by MSME leading to particulate matter reduction of 52,000 Tonnes/annum
- Weather driven dynamic crop growth & yield simulation models developed
- Bio-electrochemical technologies for CO<sub>2</sub> utilization and iHydroMET technology for waste water treatment

**Adaptation Best Practices**

- Novel Climate Resilient cattle sheds
- Disease Forecasting Model for Livestock
- Automated weather monitoring stations
- GIS Mapping & Monitoring of Wetlands
- Micro Irrigation Systems
- Ground water monitoring stations
- Flood forecast system
- Reuse of Treated Waste Water of Sewerage Treatment Plants for irrigation purposes
- Air quality monitoring systems
- Biofuel projects of 500 MW developed to increase share of renewables

**Mitigation Best Practices**

- First-of-their kind Paddy straw based briquetting units
- Energy efficient induced draft Zig Zag firing technology for brick kilns
- Asia's Largest Single Rooftop solar plant
- Mass flow based Cleaner Technology in Steel Re-rolling Mills to replace coal with Piped Natural Gas
- Aerobic Compost pits for biodegradable & Material recovery facilities for Non Biodegradable waste management

## 4.0 State Action Plan on Climate Change 2.0

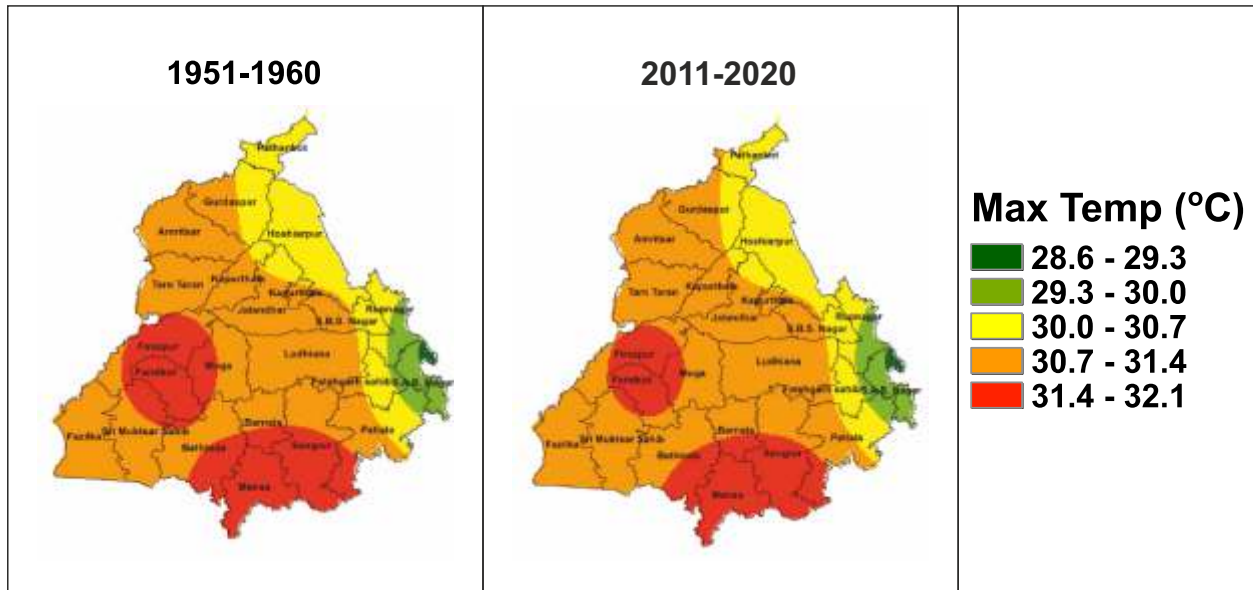
The SAPCC 2.0 has been formulated for the period till 2030 in consultation with state development departments and knowledge institutions after taking into account recent scientific research & analysis of current and projected climate change vulnerability. The various adaptation and mitigation strategies in-line with NDCs & SDGs have been planned by mainstreaming climate change concerns in ongoing programs/schemes of state development departments. A total of 63 strategies including 43 adaptation and 20 mitigation activities have been proposed under seven state missions.



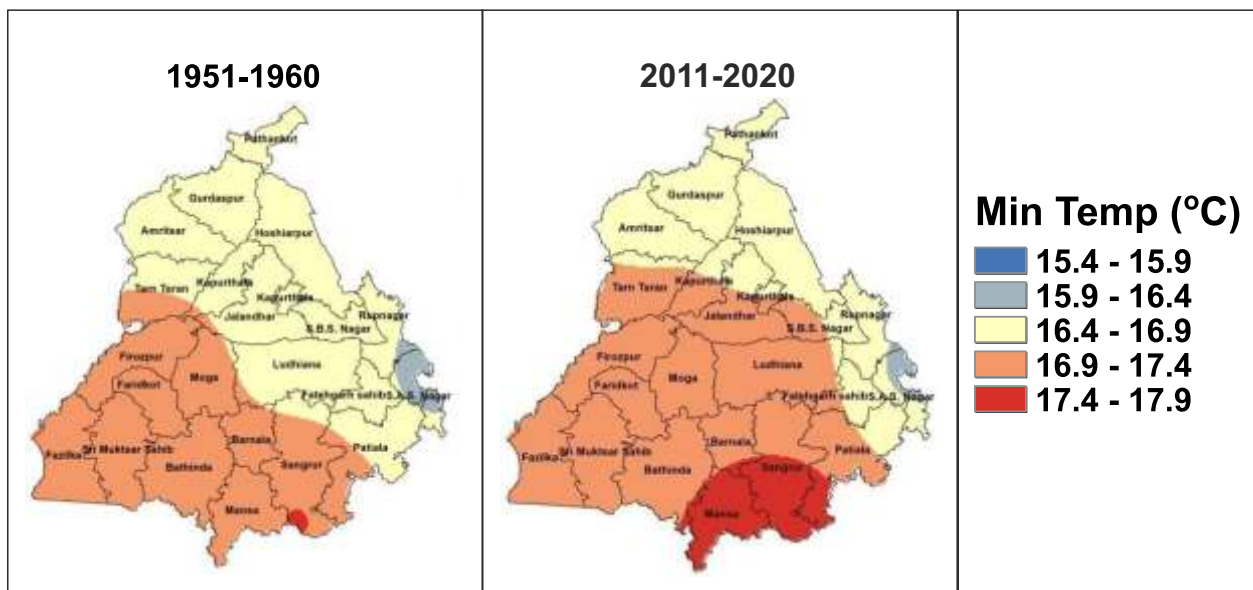
## 4.1. Observed Trends of Climate Change in the State

### 4.1.1 Temperature

The climate of Punjab is semi-arid, hot and subtropical monsoon type with cold winter and hot summer. The analysis of IMD data from 1950 to 2020 has not indicated any significant increase in maximum temperature, however, minimum temperature across the State has shown significant increase as depicted below:

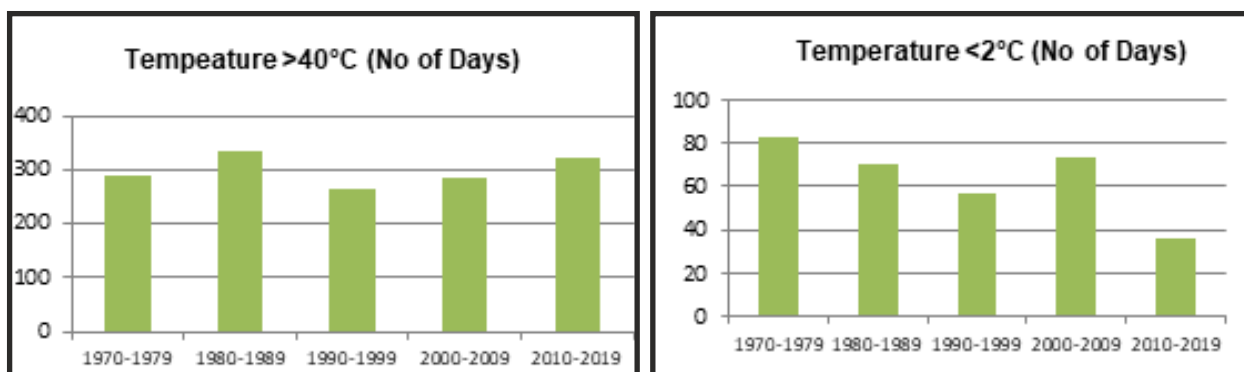


Variation in annual Maximum Temperature



Variation in annual Minimum Temperature

The number of days with temperature more than 40°C has increased from 289 during the decade (1970-1979), to 322 days during 2010-2019 whereas; number of days with temperature less than 2.0°C has reduced from 83 to 36 days.



Temperature &gt; 40°C (No. of Days)

Temperature &lt; 2°C (No. of Days)

### 4.1.1 Rainfall

The annual rainfall in the State ranged between 189-1929 mm during 1901 to 2018. However declining trend in rainfall was observed over the past six decades except in two decades (1980-1999) which has shown incidences of heavy rainfall (>100 mm) and resulted in heavy floods during the years 1984, 1988 & 1995. State has also experienced 16 years of deficit monsoon rainfall during the recent last two decades (2000-2020).

## 4.2. Projected Trends of Climate Change in the State

The IPCC has developed scenarios that act as a mechanism to assess the potential impacts on climate change. These Representative Concentration Pathways (RCPs) are referred to as pathways to highlight time dependent projection of Green House Gases (GHGs) concentrations viz. RCP2.6, RCP4.5, RCP6.0, and RCP8.5. Among these scenarios, projections are often considered for RCP4.5 and RCP8.5 scenarios. RCP4.5 represents a 'stabilization scenario', wherein range of technologies and strategies are being implemented to reduce GHGs emissions, while RCP8.5 represents 'high GHG emission scenario', where GHG emissions continue to rise throughout the 21<sup>st</sup> century.

### 4.2.1 Temperature

As per study based on CORDEX South Asia model, average annual maximum temperature for RCP4.5 scenario is projected to increase by about 1.2°C towards Mid-Century (MC) and by 2.1°C towards End-Century (EC). However, for RCP8.5 scenario, it is projected to increase by about 1.4°C towards MC and 4.5°C towards EC

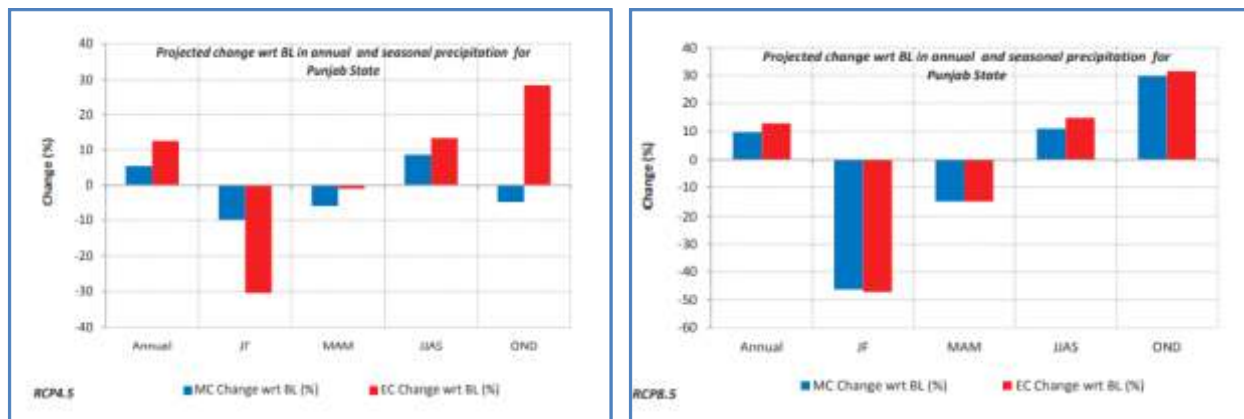
However, maximum temperature at district level in the State is projected to increase by 1.4°C to 4.3°C towards MC and EC, respectively in RCP 4.5 scenario. Significant increase in temperature is projected for the Districts Bathinda, Gurdaspur, Hoshiarpur, Ludhiana & Sri Muktsar Sahib. Further, maximum temperature is projected to increase from 1.6°C to 4.7°C towards MC & EC, respectively for RCP8.5 scenario.

Average annual minimum temperature for RCP4.5 scenario is projected to increase by about 1.3°C towards MC and by 2.5°C towards EC. Whereas, it is projected to increase by about 1.7°C towards MC and 5.2°C towards EC for RCP8.5 scenario.

The projected increase in minimum temperature towards MC does not show significant variation across the districts of Punjab for both RCP4.5 and RCP8.5 scenarios. Minimum temperature in majority of Districts is projected to increase above average baseline value.

### 4.2.1 Rainfall

Average annual rainfall in the State is projected to increase by 5.4% (MC) & 12.5% (EC) for RCP4.5 scenario and 9.8% (MC) & 12.8% (EC) for RCP8.5 scenario. The increasing trend in rainfall during post monsoon and decreasing trend in rainfall during both pre-monsoon & winter has been projected towards MC and EC for both RCP4.5 and RCP 8.5 scenarios.

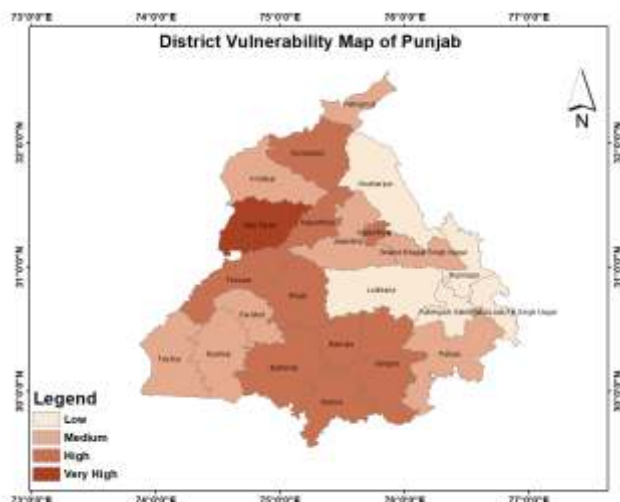


JF : Jan., Feb.; MAM : March, April, May; JJAS : June, July, August, September; OND : October, Nov. & Dec.; MC : Mid Century; EC : End Century ; BL : Baseline

The maximum increase in rainfall in districts Gurdaspur and Hoshiarpur and minimum increase in Mansa district has been projected towards MC and EC for RCP4.5 and RCP8.5 scenarios.

### 4.2. Vulnerability Assessment

Climate change vulnerability assessments are necessary for identification of vulnerable regions/sectors and prioritize strategies for adaptation and mitigation actions across State. Climate Change Knowledge Centre of Punjab State Council for Science and Technology has carried out district wise climate change vulnerability assessment of the State based on the uniform National Framework of Department of Science & Technology, Govt. of India (DST-GOI). Out of the 26 indicators suggested under framework, 15 indicators were selected in consultation with the experts based on data availability, statistical correlation, etc. to get a rational and more realistic conclusion.



Spatial representation of Vulnerability indices of 22 districts

District Tarn Taran has been found to have Very High Vulnerability while eight districts i.e. Moga, Gurdaspur, Mansa, Barnala, Ferozepur, Bathinda, Sangrur & Kapurthala have been observed under High Vulnerable category. Further, the medium vulnerability towards climate change has been observed in eight districts namely Sri Muktsar Sahib, Faridkot, Fazilka, Jalandhar, Patiala, Pathankot, Amritsar, SBS Nagar. However, remaining five districts namely Hoshiarpur, Rupnagar, Fatehgarh Sahib, SAS Nagar and Ludhiana have low vulnerability.

The vulnerability assessment at block level as well for the key sectors of the State including agriculture and water sectors is planned in near future to further facilitate identification and prioritisation of strategies for adaptation and mitigation in accordance with the vulnerability of the region.

#### 4.3. Key Challenges and Strategies for Climate Change Adaptation and Mitigation

The IPCC has stated that India, like many other developing countries, is likely to experience losses in all key economic sectors and has underlined the need for taking up immediate mitigation and adaptation measures to reduce the climate catastrophe.

Adaptation and mitigation are two complementary strategies for reducing and managing the risks of climate change. Adaptation is the practice of adjustment to actual or expected climate and its impacts in order to reduce or avoid harm or exploit profitable opportunities. Mitigation is the process of reducing emissions or enhancing sinks of Green House Gases (GHGs) to limit future climate change.

The State has selected Five missions namely Sustainable Agriculture; Forest, Ecosystem & Biodiversity; Water; Health and Strategic Knowledge under adaptation and two missions i.e. Enhanced Energy Efficiency & Solar Energy and Sustainable Habitat under mitigation strategies to manage climate change. For effective implementation of strategies identified under these missions, one Nodal Agency will steer each mission & coordinate implementation of various action plans in consultation with stakeholder Departments.

The gist of each Mission under SAPCC 2.0 including the Mission Nodal Department/ Agency, key targets, initiatives, proposed budget and strategies is as under:

##### State Mission on Forest, Ecosystem and Biodiversity

##### Mission Nodal Department: Forests and Wildlife Preservation, Govt. of Punjab

Forests play an integral part in the carbon cycle that can influence climate change. Punjab has limited land available for forests and being an agrarian state, holds about 0.19% of the total forest carbon stock of the country. The Key issues and challenges under the mission include increase in fragmentation of existing forest, incidences of forest fires, inadequate resources to manage encroachment issues, illicit felling and poaching of wild animals.

The mission aims at enhancing carbon sinks through sustainable management of forests and restoration of vulnerable ecosystems & conservation of biodiversity. The State specific targets of this mission to be achieved by 2030 have been planned in-line with the National (NDC 5 & NDC 6) and International (SDG 15) targets which include enhancing carbon sinks through extensive plantation of Trees Outside Forest (TOF) area under Sub-Mission on Agro-forestry (SMAF) and increasing area under forest and tree cover to 7.5%. For biodiversity conservation and ecosystem restoration, renovation of 616 Water bodies, reduction in trading of poached or illicitly trafficked



wildlife, conservation of wetlands & forest biodiversity of Shivalik ecosystem, rehabilitation of threatened flora & fauna and promoting conservation of potential Biodiversity Heritage Sites has been planned.

Nine strategies with Budget Outlay of INR 29,140 million have been formulated in SAPCC 2.0 which are broadly focused towards improving the stocking of existing forests, increasing tree cover outside forest, managing forest fires, conserving biodiversity, regulating ecosystem, strengthening capacities of forest officials, initiating Payment for Ecosystem Services and facilitation of better market opportunities for major and minor forest produce.

### State Mission on Sustainable Agriculture

#### Mission Nodal Department: Agriculture & Farmers Welfare, Govt. of Punjab

Punjab, being the major food grain producing State, is the 'Bread Basket of the Country'. Agriculture & allied sectors (such as dairy, poultry, horticulture & fisheries) contribute significant share in Punjab's economic growth. State has the highest per capita availability of milk in the country and making efforts for emerging as 'Dairy State of India'. But the changing climate is projected to affect agricultural & livestock productivity as well as irrigation water resources in the State.

SAPCC 2.0 specific targets and initiatives under this mission are proposed in line with SDG 1, SDG 2, SDG 6, SDG 12 & NDC 6 which include achieving productivity target of food grains, promoting organic farming, reducing use of pesticides and fertilizers and increase animal husbandry production as well as farmer's income. Further, State has planned 147 innovative irrigation projects for creation of alternate sources of irrigation, targeted 80,000 ha area under micro irrigation and 0.75 million ha under Underground Pipeline System for on-farm conservation of irrigation water and to irrigate 0.04 million ha with treated waste water. Moreover, State has planned sustainable development of subsectors i.e. livestock, fish & dairy for livelihood diversification.

Twelve strategies with Budget outlay of INR 33,458.29 million have been formulated in SAPCC 2.0, broadly proposed towards crop diversification, organic farming, shrimp culture, high density aquaculture, integrated nutrient management, agricultural crop residue management, livestock management, sustainable utilization of water resources, climate resilient crop & horticulture varieties, enhancing resilience of livestock, managing livestock health and dairy farming research.

### State Mission on Water

#### Mission Nodal Department: Water Resources, Govt. of Punjab

Water resources in the state are present primarily in the form of Surface water (21.1 Billion Cubic Meter) including rivers, streams, wetlands and village ponds. The State has three major perennial rivers i.e. the Ravi, Beas, Sutlej and one non-perennial Ghaggar river and six wetlands namely; Harike, Kanjli, Ropar, Keshopur-Miani Community Reserve, the Beas Conservation Reserve, and Nangal Wildlife Sanctuary designated as wetlands of international significance under the Ramsar Convention. However, the available surface water resources can't keep up with the rising demand for irrigation water, so groundwater resources are being overused to supply the increasing demands of agricultural, industrial and domestic sectors. Only 27% of the total area is irrigated by surface water or canals however, 73% of the area is irrigated by tube wells which indicate highly stressed ground water resources. Climate change is also expected to influence river-flow and will further influence water availability in the State.

The mission envisages at ensuring integrated water resource management by minimizing wastage,



recycling waste water, recharging underground water sources, adopting large scale irrigation programmes and by harvesting rainwater. The SAPCC 2.0 specific targets and initiatives to be achieved by 2030 are planned in line with SDG 6, SDG 14, NDC 6 & Clean water sub-mission of Mission Tandarust Punjab. The focus areas include Restoration of ground water resources in 146 blocks, Rejuvenation of Ponds, Diversification of Crops on 1,00,000 ha annually to conserve groundwater, treatment of 76 sub-watersheds in Shivalik region, Setting up of New Sewage Treatment Plants (STPs), Common Effluent Treatment Plants (CETPs), Effluent Treatment Plants (ETPs) for Dairy & Industrial waste water treatment and reuse of Treated Wastewater of STPs for irrigation purposes and supply improved service standards of piped water to all the rural habitations.

Seven strategies with budget outlay of INR 1,26,562.70 million have been formulated in SAPCC 2.0, broadly aimed at mapping water resources through GIS and remote sensing technology, managing floods in a future erratic & excess extreme rainfall scenario, enhancing water use efficiency by 20%, reducing water pollution of underground and surface water sources, reducing water logging situation in the south west districts and research & monitoring activities especially in groundwater overexploited areas.

### State Mission on Health

**Mission Nodal Department:** Health & Family Welfare, Govt. of Punjab

Increased frequency and intensity of extreme weather events can increase incidences of respiratory and heart diseases, pest, water and food related illnesses, injuries & even deaths as a result of catastrophic events like floods, storms, droughts, etc. The State key challenges under the mission include lack of expertise & policies on management of climate induced diseases, erratic data for modeling climate related health impacts, limited skilled manpower and well-equipped health centers in the Public Health Care system.

The State has taken several initiatives under National Rural Health Mission (NRHM) aimed at improving the health infrastructure, involvement of community-based health workers and Panchayats for improving delivery of health services at rural level. Thus, the state has shown significant progress under SDG 3 (Good Health & Wellbeing) in NITI Aayog's SDG Index 2020-21.

The mission focuses at access to equitable, affordable & quality healthcare services, strengthening Health system in rural and urban areas, maintaining Reproductive Maternal-Neonatal-Child & Adolescent Health and preventing Communicable and Non-Communicable Diseases. The State specific targets and initiatives to be achieved by 2030 are planned in line with SDG 2, SDG 3 & NDC 6. The major focus areas include reduction of maternal mortality ratio to 80/100,000 live births, Neonatal mortality rate to 11/1000 live births, cases of Malaria and dengue by 75% and elimination of hunger, undernourishment in population and underweight in children, building Institutional capacities for village level reporting under Integrated Disease Surveillance Program (IDSP) and Implementation of State Action Plan on climate change and human health, Nutrition Sub-mission and Preventive Health Sub-mission of the Mission Tandarust Punjab. The key elements of submissions are to ensure the quality of mid-day meals, provide 100% Nutritional food to children, lactating mothers and pregnant women, improve Health care delivery through Health Wellness Centers, improve Child Health through screening, early diagnosis and treatment for 31 identified childhood diseases, Maternal & Child Health care and reduced Anemia through Iron and Folic Acid Supplementation.



Eight strategies with Budget outlay of INR 1,310.79 million have been formulated in SAPCC 2.0, broadly intended towards developing an early warning system & mechanism for climate sensitive disease tagging, capacity building regarding climate change health impacts, managing vector and water borne diseases, improving nutritional status of vulnerable populations, reducing mortality, morbidity of mother & young children and greening health sector.

### State Mission on Strategic Knowledge

**Mission Nodal Agency:** Punjab Climate Change Knowledge Centre, PSCST, Deptt of Science, Technology & Environment, Punjab

Fostering improved understanding among all stakeholders is essential for synergizing efforts and carrying out efficient sectoral planning to address climate change. Further, capacities need to be augmented to plan appropriate adaptation/mitigation initiatives based on sectoral and regional risks.

The State key challenges & gaps under the mission are unavailability of baseline data on regional climate change vulnerable sectors, lack of synchronization between Research/Academic Institutions, Govt. departments, Industries and Civil Societies to address climate issues and limited availability of climate finance.

State Mission on Strategic Knowledge aims at creation of baseline knowledge such as vulnerability assessments at various levels and sectors, develop knowledge networks among the existing knowledge institutions engaged in R&D relating to climate science, assessing regional impact of climate change on different sectors and strengthen the capacity of all sets of stakeholders through need-based, customized training, awareness, and outreach programmes to create an effective state response. State Climate Change Knowledge Centre of Punjab State Council for Science and Technology has been instrumental in creating an atmosphere of learning and facilitating addressal of climate challenges and concerns. The Centre having been consistently rated as 'Excellent' by Deptt. of Science & Technology, Govt of India, has facilitated development of projects to address regional concerns involving relevant line departments and mobilized additional climate finance from Govt. of India. The State targets and initiatives to be achieved by 2030 under this mission are planned in line with SDG 13, NDC 1 & NDC 8. The key focus areas include promoting climate friendly practices through movement 'LiFE' - 'Lifestyle for Environment', capacity building of all set of stakeholders on climate change related issues & synergize R&D initiatives for supporting policy planning, promoting technological interventions for the use of biomass in industrial processes as key mitigation initiative, planning and organising Programmes/activities with special focus on all the updated 8 NDCs involving concerned stakeholders in the State.

Seven strategies with Budget Outlay of INR 313.60 million have been formulated in SAPCC 2.0, broadly focused on strengthening knowledge networks, capacity building of Govt. functionaries for effective implementation of SAPCC 2.0, mainstreaming climate change concerns in ongoing programs & schemes, vulnerability assessments for evidence-based planning, specialized trainings, awareness & outreach activities on climate change issues, promoting start-ups to address climate challenges.



## State Mission on Enhanced Energy Efficiency & Solar Energy

### Mission Nodal Department: Department of Power, Govt. of Punjab

Access to clean and affordable energy is the prerequisite for overall economic growth. Energy sector is main player to reduce emissions and mitigate climate change. To meet the increasing energy demand due to climate change and economic growth, there is need to increase the share of renewable energy as well as improving energy efficiency of utilities. The key challenges and gaps in the mission are unpredictability & variability in Grid, high energy cost and lack of sensitization about renewable energy projects.

Punjab is ranked 1<sup>st</sup> among the States for SDG 7 (Affordable & Clean Energy) in SDG Index published by NITI Aayog in the year 2020-21. State has performed significantly well for percentage share deployment of renewable energy in the total installed capacity. State has been conferred 1<sup>st</sup> prize in the State Performance by Ministry of Power, Gol for the year 2020 and Commendation Certificates during the years 2015 & 2019 towards Energy Conservation & Energy Efficiency.

State Government has encouraged participation of Public & Private sector for developing renewable energy projects in the state. In-line with the National goal of energy security and realizing state's potential in the Renewable Energy, consistent efforts are underway to upscale and mainstream the use of New and Renewable Energy Sources (NRSE).

The mission's objective is to strengthen the market for energy efficiency by developing innovative policies and effective market instruments. The state aims at catalyzing investment in energy efficiency in energy intensive industries to reduce carbon footprint. The State specific targets and initiatives to be attained by 2030 are considered in line with SDG 7 and NDC 4. The major focus areas are to maximize and improve the share of new and renewable sources of energy to 30% of the total installed power capacity, provide reliable electricity & modern cooking solutions (LPG/PNG, biogas) to 100% population and promote renewable energy initiatives for meeting energy requirements in rural, urban, industrial, and commercial sectors.

Seven strategies with Budget Outlay of INR 63,317.05 million formulated under SAPCC 2.0 are broadly aimed towards development of small & micro hydro projects, enhancing energy efficiency in MSME, commercial & Institutional buildings, increasing coverage of solar energy in farm, rural and urban areas and involving private sector in Renewable Energy.

## State Mission on Sustainable Habitat

### Mission Nodal Department: Local Government, Govt. of Punjab

Punjab is the 5<sup>th</sup> most urbanized State in India. The sustainable habitat sector includes adequate water supply & sanitation, effective solid waste management, efficient urban mobility & public transport, affordable housing etc. Managing the carbon footprint of urban habitats and ensuring their climate and disaster resilience is a challenging task. Rising temperatures have already increased the number of extreme weather events such as floods, droughts and storms and also spread of vector-borne diseases. All these have impacts on cities' basic services, infrastructure, housing, human livelihoods and health. Further, limited expertise in the fields of climate change and sustainable habitat management, gap between supply and demand of adequate and affordable houses in urban areas are some of the key issues in the State.

The Government of Punjab is working towards providing affordable housing for lower and middle-income groups of society, management of solid & liquid waste and improving road connectivity, etc. Thus, Punjab received 1<sup>st</sup> rank among the states in the country for SDG 11 (Sustainable Cities and



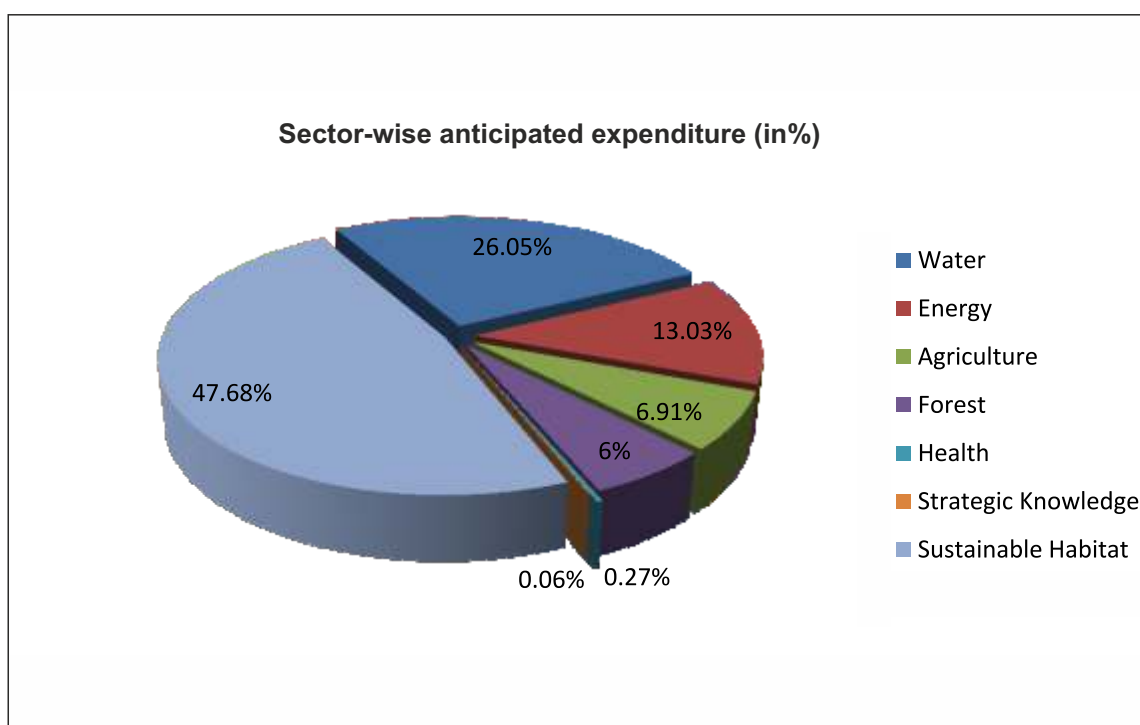
Communities) in SDG India index-2020-21.

The mission envisages to encourage better urban planning with improved disaster management, public transportation, promote alternative energy-saving technologies, support usage of pollution free automobiles, conserve natural resources and involve stakeholder participation and community interaction for sustainable habitat growth. The mission hinges on four flagship initiatives i.e. Atal Mission on Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission, Smart Cities Mission and Urban Transport Program. The state specific targets under SAPCC 2.0 for 2030 are prepared in line with SDG 6, SDG 11, SDG 12, NDC 3, NDC 5 & NDC 6. The key targets include increasing per capita availability of green space by 2.50 sqm and reducing road incidents by 5%, 100% coverage of all State towns under solid waste management and slum up-gradation including water supply, sewerage system, closed drainage & LPG connections.

Thirteen strategies with Budget Outlay of INR 2,31,644.13 million have been formulated under SAPCC 2.0, aimed at treatment of solid and liquid waste, smart urban mobility development, green building and institutions, green community spaces, rejuvenation of ponds, sustainable street lighting, integrated transport system, affordable housing, healthier lifestyle and livelihood generation.

#### 4.4 Summary of projected budget for implementation of SAPCC 2.0

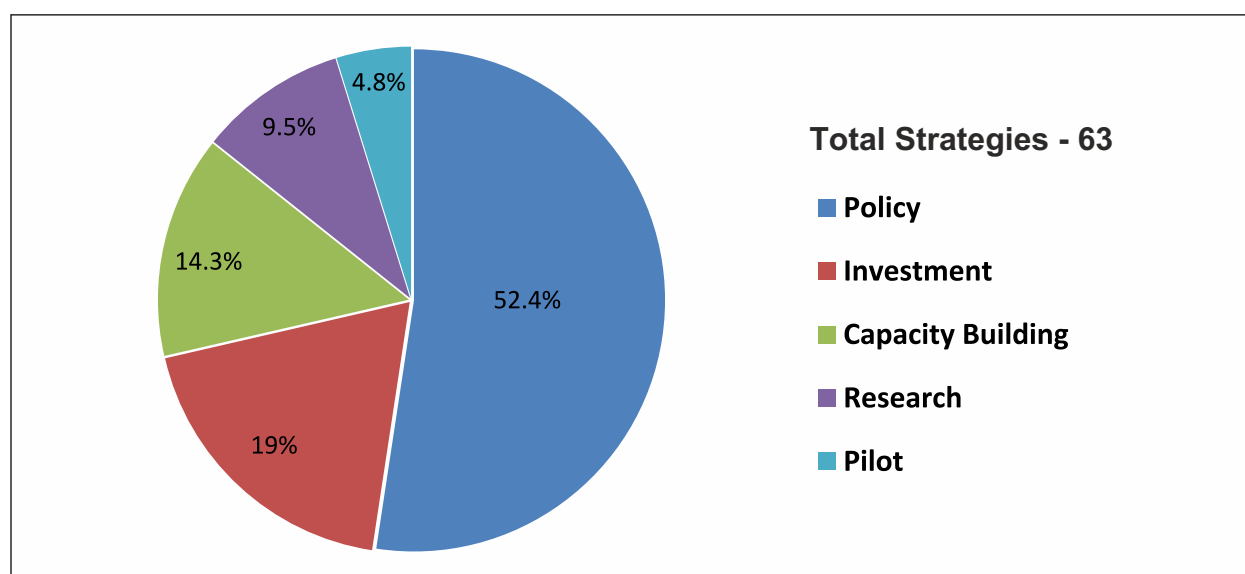
A total of 63 strategies have been identified under seven State Missions, out of which, 43 strategies are focused on adaptation and 20 strategies are mitigation oriented. The total budget of INR 4,85,746.56 million has been projected for implementation of strategies of SAPCC 2.0 till 2030. Significant proportion of the projected budget for 2021-2030 is towards four sectors i.e. sustainable habitat (47.68%) followed by water (26.05%), energy (13.03%) and agriculture (6.91%) sectors.



Sector-wise percentage of anticipated expenditure for SAPCC 2.0



The Budget for implementation of strategies under each mission has been projected after synergizing existing multiple Centre/State Schemes, programmes and public-private partnerships. While formulating strategies under SAPCC 2.0, a balanced approach has been adopted towards mitigation and adaptation. Mitigation strategies comprise of about 45.20% of the total anticipated budget while 45.30% for the anticipated budget is focused towards adaptation measures. Besides this, 9.50% of the anticipated total budget is directed towards cross-cutting strategies, which have potential for both adaptation & mitigation. Analysis of nature of strategies indicates that 52.40% of the activities are policy-based interventions followed by 19% investment actions, 14.3% are capacity building initiatives, 9.5% are research-oriented activities and 4.8% are pilot/demonstration measures.



Nature of Strategies under SAPCC 2.0

A prioritization exercise was carried out for 63 strategies (outlined in Chapters 5 & 6) identified under seven State Missions of SAPCC 2.0 in consultation with the relevant stakeholder Departments/Agencies to identify the strategies that are more aligned to the selected four parameters namely SDGs/NDCs linkages, implementation barriers, fund availability and gender & inclusiveness potential. As SAPCC 2.0 has been developed in line with NDCs and SDGs, 40% weightage was given to the criterion 'SDGs/NDCs linkages' whereas, rest of the criteria were given equal weightage of 20% each.

Based on the overall score of all the 63 strategies, strategies have been classified as High Priority, Moderate Priority & Low Priority strategies. The analysis indicates that out of 63 strategies, 52.38% are high priority followed by 44.44% moderate priority and only 3.17% are low priority strategies.

#### 4.5 Mechanism for Implementation, Monitoring and Evaluation

Implementation & Monitoring is guiding mechanism crucial to ensure the active participation of all the state departments in the overall coordination of Action Plan on climate change through the State Nodal Department and State Nodal Agency. For facilitating and coordinating the implementation of SAPCC 2.0, Department of Science, Technology & Environment (DSTE) will act as State Nodal Department and Directorate of Environment & Climate Change (DECC) as State Nodal Agency. State Nodal Agency will periodically review and monitor the progress of SAPCC 2.0 through Review &

Monitoring Committee under the chairmanship of Administrative Secretary, STE, GoP, at least once annually or as per the State's requirement.

For each mission, Mission Nodal Department/ Agency has been identified which would be responsible to monitor progress of various strategies identified for respective mission by the implementing departments and will periodically report to State Nodal Agency. Each implementing department will constitute a small working group with at least 2 members well versed with the departmental activities & finance and one Nodal officer. Nodal officer will be the interface for data/MIS updation. The State Nodal Agency and Punjab State Climate Change Knowledge Centre will plan and facilitate training on aspects of data requirement, data reporting, etc.

The Monitoring and Evaluation for SAPCC 2.0 envisages assessment of the State's overall progress towards climate resilience and also to evaluate State's contribution towards country's NDCs and SDGs. For measuring SAPCC's contribution towards climate change goals, key progress indicators have been defined under each mission to capture progress viz a viz the strategies. However, State Nodal Agency may develop more indicators in consultation with stakeholder departments during implementation phase of SAPCC as per State's requirement.





# Chapter 1

## INTRODUCTION





# 1.0: Introduction

## 1.1 Background

Climate change is affecting every region on Earth in multiple ways. Several studies have reported that there will be increasing heat waves, longer warm seasons, shorter cold seasons and their likely implications will affect agriculture, water resources, ecosystem services and livelihood opportunities. Climate change presents two challenges that must be tackled simultaneously, first, to stabilize the climate in the longer-term and second, to slow the rate of warming in the near term to reduce the risk of climate extremes. The report of Intergovernmental Panel on Climate Change (IPCC) reaffirmed the effect of anthropogenic greenhouse gas emissions on climate change and emphasized on ambitious and timely actions to minimize the consequences.<sup>1</sup> IPCC also reported that India is among the most vulnerable countries in South Asia. Further, recent studies reported that cutting Short-Lived Climate Pollutants (SLCPs) including black carbon, methane, tropospheric ozone and hydrofluorocarbons— can avoid four times more warming at 2050 than CO<sub>2</sub> cuts alone.<sup>2</sup> Maximum emissions of Non-CO<sub>2</sub> pollutants have been in the sectors viz. agriculture, livestock, transportation, waste management, etc.



Recognizing that climate change may undermine Nation's development in future, the Government of India (GoI) has been pro-actively taking up efforts towards climate action & policy planning. India had launched National Action Plan on Climate Change (NAPCC) in the year 2008 to address climate-related issues. Further, to align National strategies adopted in NAPCC with the regional priorities & developmental needs, the Ministry of Environment, Forest & Climate Change, Govt. of India (MoEF&CC, GoI) encouraged the State Governments to prepare their own State Action Plan on Climate Change (SAPCC). Punjab formulated its SAPCC in the year 2014. The State has taken a large number of initiatives as per strategies outlined in the same.

Since the formulation of SAPCC, knowledge pertaining to climate change as well as policy landscape has evolved both at the National and International levels. Internationally, the Paris Agreement has been adopted in the year 2015 to 'keep global temperature rise in this century well below 2 degrees Celsius above pre-industrial levels and to further pursue efforts to limit the temperature increase to 1.5 degrees'. India has also submitted its Nationally Determined Contribution (NDC) goals for post-2020 period. The scientific and socio-economic understanding about climate change has also advanced over the last few years.

In this context, Ministry of Environment, Forest & Climate Change (MoEF&CC), GoI advised the States to revise their State Action Plans on Climate Change (SAPCC) to better align the National and Sub-National planning and policy frameworks by taking into account the following guiding principles. **Table 1.1** highlights the approach adopted by the State to integrate these principles and the specific actions taken in this regard.

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Internationally, the Paris Agreement has been adopted in the year 2015 to 'keep global temperature rise in this century well below 2 degrees Celsius above pre-industrial levels and to further pursue efforts to limit the temperature increase to 1.5 degrees'.

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**Table 1.1 Actions taken viz-a-viz the Guiding Principles of MoEF&CC, GoI**

S. No.	Guiding Principles	Actions Taken
1.	SAPCC should be a policy document of the States/UTs outlining the major initiatives and strategies reflecting the commitments and proposed actions in the state to tackle the vulnerabilities and impacts of climate change across the socio-economic sectors.	SAPCC 2.0 is a policy level instrument prepared till 2030 in consultation with state development departments. It highlights the priority actions under each mission which can be mainstreamed into existing schemes, policies & programmes.
2.	SAPCC should envisage an inclusive, sustainable and climate resilient low carbon development pathways with a focus on climate change adaptation and mitigation within the key sectors in the States/UTs and should protect the poor and vulnerable sections of society from adverse effects of climate change.	Punjab SAPCC 2.0 has been developed as a holistic document to articulate State's commitment towards climate change mitigation and adaptation as well as to realign the state's initiatives towards climate-proof socio-economic development. <b>Chapter-5 &amp; 6</b> indicate strategies to be followed by the state departments towards adaptation and mitigation.
3.	SAPCC should take into account recent scientific assessments and projections on global warming; vulnerability; and impacts	Punjab SAPCC 2.0 has taken into account climate change projection for rainfall and temperature (maximum and minimum) under different RCP scenarios both in mid and end century in <b>Chapter-3</b> . Moreover, the current climate change vulnerability assessment carried out at regional level has also been detailed out in <b>Chapter-4</b>
4.	SAPCC should synergise with the goals of NDCs under the Paris Agreement, though the targets under NDCs are national targets. It should also contribute towards achieving other development goals including Sustainable Development Goals (SDGs).	The strategies have been identified in line with India's commitments, State's vision and SDGs. Further, these have been prioritized based on four selected parameters including SDGs & NDCs linkage, implementation potential, funding linkage and gender inclusiveness potential in <b>Chapter-7</b>
5.	SAPCC should highlight the links with national missions related to climate change.	SAPCC 2.0 reflects state's progress in the key sectors aligning with the National Missions in <b>Chapter-2</b> . Further, the strategies under the Action plan for the period 2021–2030 are in-line with National policies and priorities.

S. No.	Guiding Principles	Actions Taken
6.	The SAPCC should also be built on the evolving socio-economic development context and priorities of the state.	While framing of SAPCC 2.0, alignment has been made with recent initiatives taken up by the State in key sectors & policy framework for overall socio-economic development.
7.	States/UTs can strengthen existing climate action measures as well as launch new initiatives in their priority sectors. Some of the initiatives can be introduced in the areas of efficient and cleaner technologies, promoting renewable energy generation, reducing emissions from transport sector, afforestation and greening activities and standardising knowledge management system for adaptation and mitigation.	State Government strongly reaffirms enhancing resilience of all socio-economic sectors through appropriate adaptation & mitigation measures besides building capacities of every stakeholder to better adapt & respond to the projected implications of climate change. Significant policy measures have been taken and proposed to improve green cover, diversification of agriculture, energy efficiency, clean energy, etc.
8.	The time period of the implementation of SAPCC should be clearly brought out starting with the implementation cycle of NDCs i.e. 2021-2030 and beyond.	<b>Chapter -5</b> on Adaptation and <b>Chapter- 6</b> on Mitigation clearly states the implementation cycle of the strategies under each Mission for the period 2021-30.
9.	Financial resources required for the implementation of the action plan should primarily be leveraged from the existing budget of the State Governments and convergence with the relevant schemes and programs.	The approach of financing of activities under Action Plan has been to mainstream climate change in existing National/ State level schemes or programs. <b>Chapter-7 Annexures</b> includes detailed tables highlighting sector wise financial allocations for the proposed activities and the ongoing National/State Schemes/programmes from which fund can be accessed.
10.	The SAPCC should set out the institutional mechanism for implementation including stakeholder engagement ensuring inclusiveness along with the mechanism for capacity building and monitoring and evaluation with clear indicators for reporting.	<b>Chapter 8</b> of SAPCC 2.0 highlight the implementation and monitoring & evaluation mechanism in the State. To further strengthen the monitoring and evaluation, key progress indicators (KPIs) for each strategy have been developed. These indicators are identified based on their relevance to SDGs, NDCs, state-level 4-year Strategic Action Plan (4SAP) and in consultation with the implementing departments. These indicators are intended to harmonize the process of reporting on SAPCC progress as well as contribution to NDCs and SDGs.  In addition, a well-integrated mechanism for sustained capacity building has been articulated through anchoring the efforts of State Climate Change Knowledge Centre with the Extension divisions/training wings of the State Departments like SIRD, PAMETI, MGSIPA, etc under Strategic Knowledge Mission ( <b>Chapter-5</b> ).  Strategic Knowledge Mission also focuses on synergizing efforts & contribution of research institutions of the State for building capacities w.r.t evidence-based planning and appropriate climate actions to address sectoral challenges.

## 1.2. National-level climate policy & planning frameworks

### 1.2.1. National Action Plan on Climate Change

National Action Plan on Climate Change (NAPCC) has been India's key guiding document that came up in the year 2008. The NAPCC established 8 National missions representing multipronged, long term and integrated strategies for achieving key goals in the context of climate change as listed in **Table 1.2** below:



**Table 1.2 Eight Missions of the National Action Plan on Climate Change (NAPCC)<sup>3</sup>**

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



## 1.2.2 Nationally Determined Contributions

India submitted its 1st Nationally Determined Contributions to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. India, during COP 26 held in Glasgow, United Kingdom in 2021 expressed to intensify its climate action by presenting to the world five nectar elements, the 'Panchamrit', to accelerate country's climate change mitigation and adaptation actions.

Accordingly, in the year 2022, the Union Cabinet approved India's updated Nationally Determined Contributions to be communicated to UNFCCC (Table 1.3).

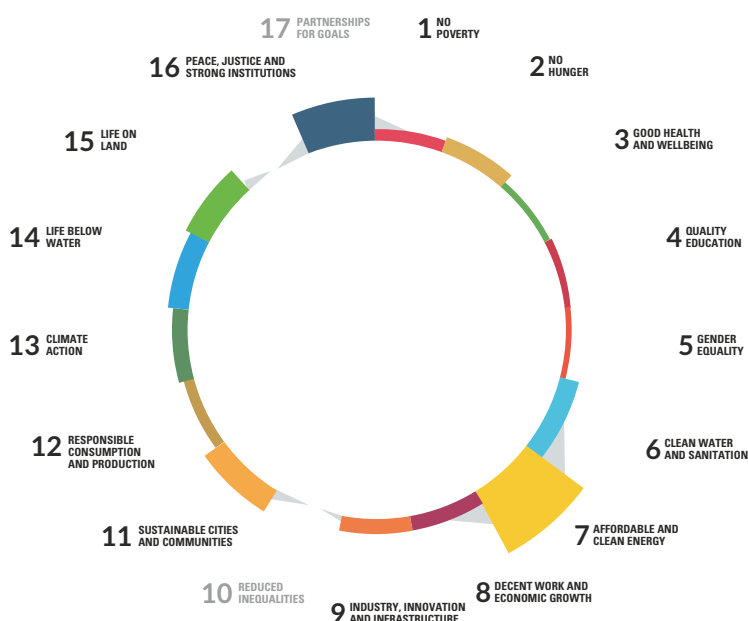
**Table 1.3 India's NDC goals**

S. No.	Goals	Quantitative/ Qualitative	Relevant NAPCC missions
1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation including through a mass movement for 'LiFE' - 'Lifestyle for Environment' as a key for combating climate change	Qualitative	All
2	To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at the corresponding level of economic development.	Qualitative	All
3	To reduce the emissions intensity of its GDP by 45% by 2030 from 2005 level.	Quantitative	<ul style="list-style-type: none"> <li>• National Solar Mission</li> <li>• National Mission for Enhanced Energy Efficiency</li> <li>• National Mission on Sustainable Habitat</li> <li>• National Mission for Green India</li> </ul>
4	To achieve about 50% cumulative electric power installed capacity from non fossil fuel based energy resources by 2030.	Quantitative	<ul style="list-style-type: none"> <li>• National Solar Mission</li> </ul>
5	To create an additional carbon sink of 2.5 to 3 billion tonnes of CO <sub>2</sub> equivalent through additional forest and tree cover by 2030.	Quantitative	<ul style="list-style-type: none"> <li>• National Mission for Green India</li> <li>• National Mission for Sustainable Agriculture</li> </ul>
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.	Both qualitative and quantitative	<ul style="list-style-type: none"> <li>• National Mission for Sustainable Agriculture</li> <li>• National Water Mission</li> <li>• National Mission for Sustaining the Himalayan Ecosystem</li> <li>• National Mission on Health</li> </ul>
7	To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.	Qualitative	All



S. No.	Goals	Quantitative/Qualitative	Relevant NAPCC missions
8	To build capacities, create a domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India & for joint collaborative R&D for such future technologies.	Qualitative	National Mission on Strategic Knowledge

The above NDC goals have been strongly linked to the other international agreements and goals, in particular, the Sustainable Development Goals (SDGs). This is illustrated in **Figure 1.1**, which shows the relevance of India's NDCs to particular SDGs. The colored rays in the **Figure 1.1** indicate NDC goals corresponding to particular SDG and larger rays reflect more linkage.



**Figure 1.1: Linkage of India's NDCs with SDGs**

As outlined in **Table 1.3** above, now, India's first updated NDC also captures citizen centric approach to combat climate change by launching 'One-Word Movement', LIFE (Lifestyle for Environment) with a vision to promote a lifestyles that is in harmony with our planet.



Further, Conference of Parties (COP 27) of the UNFCCC held recently at Sharm El-Sheikh, Egypt concluded with historic decision to establish and operationalize a loss and damage fund to provide funding for vulnerable countries hit hard by climate disasters like floods, droughts etc.



### 1.3. State-level climate policy and planning frameworks

State Government strongly reaffirms addressing vulnerabilities of the State arising due to changing climatic scenarios through Sub-National planning under the State Action Plan on Climate Change. Thus, the State Govt. has taken following initiatives:

- i) Directorate of Environment & Climate Change (DECC) has been set up under Department of Science, Technology & Environment, Punjab. Further, 'Mission Tandarust Punjab' has been launched and is being steered by DECC to make Punjab the healthiest state with healthy people by focusing on improvement of air and water quality, safe food and ensuring a good living environment.
- ii) Punjab Climate Change Knowledge Centre has been set up in Punjab State Council for Science & Technology, the think tank of Department of Science, Technology & Environment, Punjab. The Centre is supported by Deptt. of Science & Technology, Govt. of India for knowledge building of relevant stakeholders including Govt. departments, Research & Academic institutions, industries, Non-Governmental Organizations, etc. to ensure their meaningful participation for addressal of climate concerns.
- iii) "Vision Document 2030" has been prepared by Deptt. of Planning, Punjab wherein, developmental goals have been aligned with SDGs and structured into 4 pillars. Pillar I is about structural transformation of economy and revitalization of sectoral growth, having relevance to SDGs 2,7,8,9,13 and 15; Pillar II is about People's Well-being: Redefining quality parameters and processes having linkage with SDGs 1,3,4,5,6,10 and 11; Pillar III describes Strategy for Governance and Peace which is directly relevant to SDG 16 and Pillar IV highlights strategy for resource mobilization and investment and has significant linkage with SDG 17. Vision 2030



document also details the state-specific indicators along with baseline and target values, for each of the 169 targets related to the 17 SDGs.

- iv) 4-year Strategic Action Plan (4SAP) 2019-2023 is under implementation, as a roadmap to achieve Sustainable Development Goals by the State. 4SAP has focused goals, targets and performance assessment indicators for each department. The Action Plan is being monitored by the Department of Planning, Punjab as the Nodal department to oversee SDG related actions in the State. To further localize the SDGs, the Government of Punjab has also drafted District-level 4-Year Strategic Action Plan, to serve as a framework and ensure the performance of district-level key functionaries through district-level key performance parameters (KPPs).

Strategies under SAPCC 2.0 have been formulated to enhance the overall resilience of the State and are also in-line with India's NDCs, SDGs and Nation's long-term goal of achieving Net Zero by 2070. Further, linkage of the SAPCC 1.0 activities with NDCs & SDGs has also been analysed (**Figure 1.2**). The squares in **Figure 1.2** represent SAPCC actions corresponding to each SDG. The squares farther from the centre reflect more actions. Whereas, colored rays indicate NDC goals corresponding to particular SDG, while longer rays reflect more linkage.

A similar analysis for SAPCC 2.0 activities has also been carried out for prioritizing the strategies based on SDG/NDC linkage (**Refer fig. 7.5**).



**Figure 1.2: SDG-NDC-SAPCC Linkages**

## 1.4. Objectives of SAPCC 2.0

SAPCC 2.0 is developed as a forward-looking document that not only captures State's strategies towards climate change action but also includes implementation framework and monitoring & evaluation mechanism. SAPCC 2.0 covers the following:

- Progress mapping & significant achievements made under SAPCC 1.0.
- Scientific knowledge & analysis w.r.t current and projected climate change vulnerability.
- Sectoral adaptation and mitigation strategies to be carried out in the ongoing decade.
- Priority actions based on SDG-NDC linkage, implementation potential, funding linkage, etc.



## 1.5. SAPCC 2.0 - Approach & Methodology

The SAPCC 2.0 has been prepared by adopting participatory approach, keeping in view the guiding principles of MoEF&CC, GoI mentioned in **Table 1.1**. In the first instance, Nodal Officers from each department have been nominated for sustained co-ordination on climate change related actions & programs by respective development departments. Further, extensive consultations were held with relevant stakeholder departments for capturing sector's data, mapping of the progress on SAPCC 1.0 strategies, details of expenditure made on SAPCC 1.0 activities, sectoral strategies for the period 2021-30, anticipated budget for implementation of the activities, likely source of funding through integration with ongoing programs and schemes of respective departments.

Punjab State Climate Change Knowledge Centre has carried out the entire process of SAPCC 2.0 formulation & finalization with support from GIZ-India and M/s Deloitte. Besides, extensive engagements with relevant development departments and knowledge institutions in the State on one-to-one basis, the State level Stakeholders-cum-Public Consultation Workshop was also organized under chairmanship of Principal Secretary, Science, Technology & Environment, Govt. of Punjab. Further, follow-up mission wise meetings were organized to finalize sectoral strategies for the period 2021-30.

After incorporating the inputs received from respective nodal officers, the revised draft of SAPCC 2.0 was again circulated to respective Administrative Secretaries of the stakeholder departments for seeking final inputs/concurrence on the draft SAPCC 2.0. Besides, incorporating the final comments received from the respective departments, as mentioned above, the efforts have also been made to mobilize & incorporate inputs from knowledge institutions in the State. Steps involved for preparation of this comprehensive document are given below:

- I. Identification/ nomination of Nodal Officers by concerned line Departments for providing inputs about relevant sectors.
- ii. Stakeholder consultations involving all concerned departments through meetings and discussions.
- iii. One-to-one meetings of experts/consultants with stakeholder departments to capture information /data.
- iv. Preparation and sharing of framework document keeping in view the guiding principles of MoEF&CC, GoI for collection and compilation of authentic data.
- v. Assessment of progress against SAPCC 1.0 strategies i.e. for the period 2014-2020.
- vi. Preparation of draft SAPCC 2.0.
- vii. Circulation of SAPCC 2.0 to all stakeholder departments for review and inputs for finalization.
- viii. Preparation of Final SAPCC 2.0 by incorporating inputs received from all stakeholders.



## 1.6. Structure of SAPCC 2.0

### 1.6.1 State and sectoral profile

This section presents the geographic, demographic, economic and sectoral profile (forest, agriculture & allied sectors, water resources, energy, health, sustainable habitat and gender). The status of each sector, state's performance on various SDGs & NDCs and progress under National Missions/Schemes are also highlighted.

### 1.6.2 Climate Profile

In this section, the observed changes in regional temperature and rainfall pattern are described. The future climate projections and analysis for mid-century and end-century based on scientific studies are also discussed. In addition, climate change induced extreme events such as drought and floods as well as and their potential risk, loss and damage are also highlighted.

### 1.6.3 Vulnerability assessment

This section describes current district level climate vulnerability of the State based on uniform National framework developed by Department of Science & Technology, Govt. of India.

### 1.6.4 Climate Change Strategy-Adaptation

This section describes the overall adaptation strategy of the State wherein Forest, Ecosystem & Biodiversity; Agriculture; Water; Health & Strategic Knowledge sectors have been selected as the key adaptation areas in line with NAPCC. Further, the chapter discusses the climate change impacts, key issues & challenges, progress mapping w.r.t strategies of SAPCC 1.0, sectoral planning and strategies for the period upto 2030 for each of these sectors.

### 1.6.5 Climate Change Strategy-Mitigation

This section presents the overall mitigation strategy of the State, wherein Energy and Sustainable Habitat sectors have been selected as the key mitigation areas. Further, the chapter discusses climate change impacts, key issues and challenges, progress mapping w.r.t strategies of SAPCC 1.0, sectoral planning and strategies for the period upto 2030 for each of these sectors.

### 1.6.6 Financing SAPCC

This section takes stock of expenditure made during the period 2014-20 for implementing SAPCC 1.0 activities and describes the sector wise financial requirement for the activities in SAPCC 2.0 for the period upto 2030.

### 1.6.7 Implementation mechanism

This section highlights the implementation framework of SAPCC 2.0 through which, the proposed interventions will be operationalized, monitored and evaluated.

### 1.6.8 Monitoring & Evaluation

This section identifies the parameter based evaluation framework to be followed for the effective monitoring of adaptation and mitigation measures of SAPCC 2.0







## Chapter 2

### STATE PROFILE





## 2.0: State Profile

### 2.1 Geographical Profile

Punjab is located in the northwest of India, extending from latitudes of 29.30° to 32.32° North and longitudes of 73.55° to 76.50° East. It shares an international border with Pakistan in the west and is surrounded by four Indian States/UTs: Jammu and Kashmir in the north, Himachal Pradesh in the northeast, Haryana and Rajasthan in the south. Punjab state is the 19<sup>th</sup> largest in India and has an area of 50362 sq.km. The State's elevation ranges from 180 metres in the southwest to more than 500 metres at its northeastern boundaries, with an average elevation of 300 metres above mean sea level. Because of its modest size, the State is easily accessible to other states of the country, which is crucial for socio economic growth.

Other statistics of land resources are given in **Table 2.1** below.

**Table 2.1: Statistics of Land Resources** <sup>6</sup>

Parameters	Area (in thousand ha)	Percentage (%)
Total geographical area	5,036	NA
Reporting area for land utilization	5,033	100
Net area sown	4,124	81.93
Not available for cultivation	540	10.73
Forests	253	5.03
Current fallows	85	1.69
Culturable wasteland	12	0.24
Land under misc. tree crops and groves	8	0.16
Fallow land other than current fallows	6	0.12
Permanent pastures and other grazing lands	5	0.10



## 2.2 Demographic Profile

The State is divided into 23 administrative districts, with Chandigarh serving as joint capital of both Punjab and Haryana. The three largest cities in the state by population are Ludhiana, Amritsar and Jalandhar. Additionally, Mohali, Patiala and Bathinda have also seen significant population growth.

The State registered a population of 27.74 million which forms 2.29% of India's population.<sup>7</sup> Population growth in the state was high in the last decade registering an increase of 13.9% from 2001-2011.<sup>7</sup> The population density was about 6 people / ha in 2011 while it was 5 people/ha in 2001. Punjab has the highest percentage of Scheduled Caste population amongst all the States of the Country. The Scheduled Caste population in Punjab is 8.86 million, which is 31.94% of the total population.

For the sustainable development of the State, it is essential that all social classes have appropriate opportunities to grow and prosper. Since the state hosts significant percentage of marginalized population, there is additional responsibility to ensure that the impacts of climate change are contained with minimal impact on these vulnerable groups. On these lines, robust institutional mechanism for extending financial support through the Punjab Scheduled Castes Land Development and Finance Corporation (PSCFC), Punjab Backward Classes Land Development and Finance Corporation (Backfinco) and others has been operational in the State.

The sex ratio in the state has increased from 876:1000 (female: male) in 2001 to 895:1000 in 2011. The overall literacy has grown from 69.65% in 2001 to 75.84% in 2011. The literacy rate has increased from 75.23% in 2001 to 80.5% in 2011 among men and from 63.36% in 2001 to 70.7% in 2011 for women (**Table 2.2**).<sup>7,8</sup>

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The sex ratio in the state has increased from 876:1000 (female: male)  
in 2001 to 895:1000 in 2011.

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**Table 2.2: Demographic Profile of Punjab and India in 2001 and 2011<sup>7,8</sup>**

Particulars	Punjab		India	
	2001	2011	2001	2011
Population (in million)	24.36	27.74	1028.74	1210.20
Population Decadal Growth Rate (%)	19.76	13.90	17.64	21.24
Population Density (person per 100 ha)	484	551	325	382
% of SC Population	28.90	31.90	16.20	8.63
Sex Ratio (Per 1000 Males)	876	895	933	943
Literacy Rate (%)	69.65	75.84	64.83	74.04
Male Literacy Rate (%)	75.23	80.50	75.26	82.14
Female Literacy Rate (%)	63.36	70.70	53.67	64.70

Literacy rates for female in Punjab stood at 70.7%, as per Census 2011 (Rural women: 65.8% and Urban-women: 79.2%), significantly higher than the National average of 64.7%.<sup>7</sup>



Upgraded educational facilities by Department of School Education, Govt. of Punjab

## 2.3 Economic Profile

The per-capita income of Punjab in the year 2021-22 has been reported to be INR 1,67,995 in comparison with INR 1,50,326 reported at the all India level. Economic Growth in Punjab has been moderating over the past two years, in accordance to the National trends. Punjab's Gross State Domestic Product (GSDP) contracted by 3.8% in 2020-21 as compared to 6.6% at National level.<sup>8</sup>

### 2.3.1. Sectoral Economic Profile

#### 2.3.1.1. Agriculture and Allied sector

The State has the recognition of being the bread basket of the country. Agriculture and allied activities continued to contribute a large share in Punjab's overall gross value added, exceeding the share of industry. The advance estimates for agriculture and allied sectors during the year 2021-22 were expected to contribute a share of 29.1% of the Punjab's GSVA (Gross State Value Added), which translates into share of 25.8% in employment (**Table 2.3**).<sup>8</sup>

The share of livestock in State's GVA has consistently grown over the years to reach 11.2% in 2021-22, as per the Advance estimates (A).<sup>8</sup> Over the last 3 years, growth in livestock sub-sector has been the highest amongst all sub-sectors under agriculture sector. This encouraging performance of the State under various National and State-level schemes has been an indication of the State's focus on boosting the growth of livestock sector.

Punjab has been registered among the States with lowest poverty by Niti Aayog. Punjab's GSDP grew at an average rate of 4.5% between the year 2015-16 and 2021-22.



Rice fields in District Patiala

**Table 2.3: Sectoral growth rate, share and employment in Punjab's Gross State Value Added (GSVA)<sup>8</sup>**

Sectors	Real Growth Rate				Share in Nominal GSVA				
	Average for 2012-13 to 2018-19	2019-20 (P)	2020-21 (Q)	2021-22 (A)	Average for 2012-13 to 2018-19	2019-20 (P)	2020-21 (Q)	2021-22(A)	Share in Employment (2019-20)
Agriculture & allied sectors	2.2%	1.9%	3.1%	1.4%	29.2%	29.0%	30.7%	29.1%	25.8%
Industry	5.1%	0.5%	-2.1%	6.9%	24.7%	23.6%	23.4%	24.2%	31.8%
Services	7.2%	6.1%	-4.9%	8.1%	46.1%	47.4%	45.9%	46.7%	42.24%

### 2.3.1.2. Industrial Sector

The industrial sector has witnessed reduction in growth rate during the past two years. The trends in industry sector correspond to the growth at National level. The estimates indicate that growth in the sector is expected to increase to 6.9% (Table 2.3).<sup>8</sup> Within industry, mining is estimated to grow by 1.6%, manufacturing by 5.6% and construction by 8.2%. The electricity, gas and utility sector have shown a sharp recovery and registered a positive growth of 10.1% in 2021-22.

### 2.3.1.3. Services Sector

Services sector contributes the largest share to the State's GVA and is also the fastest growing sector. The sector has consistently contributed a share of over 46% of the State's GVA and witnessed a growth over 7% over the seven-year period from 2012-19. In 2019-20, the sector also grew at 6.1% and estimated to contribute a share of over 46.7% and grow at the rate of 8.1%, in the year 2021-22 (Table 2.3).<sup>8</sup> Service sector, trade, hotels, restaurants, transport, storage and communication is estimated to witness significant growth. Real estate is the other important contributor to GSVA with a share of 9% over the last eleven years and its growth rate is consistently rising in the recent past. Punjab has further potential to boost the services sector, especially in the domain of tourism.



## 2.4 Sectoral profile

### 2.4.1 Forest

Being an agrarian State, nearly 82% of the land is used for agricultural activities. The state has reported 3,08,400 ha of its geographical area under forest which includes the reserved, protected, and unclassed forests being 1.43%, 36.87% and 61.70% respectively. Due to limited land availability for the forest, improvement in tree cover outside the forest area is one of the key targets. The State is, thus, working on increasing its carbon sink by planting more trees outside the earmarked forest area.

Total carbon stock of Punjab's forests has been estimated to be 13.56 million tonnes, which is 49.72 million tonnes of CO<sub>2</sub> equivalent and is 0.19% of the total carbon stock of the country. Further, the state has been able to achieve a stable trend of Trees Outside Forest (TOF) over the past two decades despite extensive rate of urbanisation and dominance of agriculture. The forest profile of the State is summarized in **Table 2.4.**<sup>6,9</sup>



Bamboo plantation near Kukanet Forest, Distt. Hoshiarpur

Table 2.4: Forest Profile<sup>6,9</sup>

Recorded Forest Area (RFA)	3,08,400 ha
Reserve Forest (RF)	4,400 ha
Protected Forest (PF)	1,13,700 ha
Un-classed Forest (UF)	1,90,300 ha
Forest Type Groups	<ul style="list-style-type: none"> <li>• <b>Northern dry deciduous mixed forests</b> dominated by xerophytes species.</li> <li>• <b>Dry deciduous scrub forests</b> dominated by species viz. <i>Acacia catechu</i>, <i>Dalbergia sissoo</i>, <i>Bombax ceiba</i>, <i>Embllica officinalis</i>, <i>Lannea grandis</i>, <i>Toona ciliata</i> and <i>Cassia fistula</i>.</li> <li>• <b>Khair, Sisso forests are the man-made forests</b> dominated by Khair, Sisso and Eucalyptus hybrid species.</li> <li>• <b>Shivalik Chir Pine Forests</b> located at the foothills of Shivalik range mainly dominated by <i>Pinus roxburghii</i> species</li> <li>• <b>Dry deciduous bamboo forests</b> – Mainly in Dasuya Forest Division dominated with Bamboo like <i>Dendrocalamus strictus</i></li> </ul>
Total carbon stock of forests	<b>13.56 million tonnes</b> (49.72 million tonnes of CO <sub>2</sub> equivalent) which is 0.19% of the total carbon stock of the country
Growing Stock	32.92 (in million cum) <ul style="list-style-type: none"> <li>• 12.61 million cum in recorded forest area</li> <li>• 20.31 million cum in TOF</li> </ul>

The State is taking initiatives to increase area under forest and tree cover to 7.5% by 2030. In this direction, key projects include Sub-Mission on Agro-forestry (SMAF), 'Ghar Ghar Hariyali' and Payment for Ecological Services (PES).



Agro Forestry practice of Wheat &amp; Eucalyptus promoted by PAU, Ludhiana



Field demonstration of combine harvester machine by PAU, Ludhiana

## 2.4.2 Agriculture and allied sectors

Agriculture and allied sectors are the backbone of the rural economy of Punjab. The State continues to be a major food producer ensuring self-sufficiency in food grain production for past several decades. There has been a significant production of food grain in the State i.e. 31,627 (000'MT) in 2020-21 (**Table 2.5**). Furthermore, it contributes to the vital share of the production of wheat and rice in the National pool. Punjab's share of wheat and rice has increased considerably from 18% and 20.92% in the year 2018-19 to 30.50% and 24.56%, respectively in the year 2020-21.<sup>8</sup>

### 2.4.2.1 Horticulture

Horticultural activities are also integral to the growth of agriculture sector in the state. The state has taken special initiatives like establishment of Post Graduate Institute of Horticulture Research and Education in Amritsar strengthening of citrus estates and establishment of litchi, pear and guava estates. The farmers are being made aware of the latest horticulture techniques through training and field demonstrations.

The total area under horticulture including flowers, spices and aromatic plants has increased from 0.29 million ha in 2014-15 to 0.40 million ha in 2020-21. Potato is one of the principal produce of the state. The area under vegetable crops has increased from 0.21 million ha in 2014-15 to 0.30 million ha in 2020-21. Major fruits grown in the state are kinnow, guava, pear, mango, and litchi. The area under fruit crops has increased from 0.077 million ha in 2014-15 to 0.093 million ha in 2020-21 (**Table 2.5**).

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State is promoting direct seeding of rice (DSR) and cultivation of Moong with 3 late-sown varieties of paddy to limit the severely depleting groundwater and make the agrarian sector environmentally sustainable. State is also focusing on strengthening post-harvest management facilities. Three Centres of Excellence (CoE) on Fruits & Vegetables have already been set up and two new CoEs have been planned at District Ludhiana & Sangrur for Floriculture and Onion, respectively

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**Table 2.5: Agricultural Sector's summary**<sup>8,10,11,12</sup>

Agro-Climatic Zones	<ul style="list-style-type: none"> <li>• Sub-Mountain Undulating Region</li> <li>• Undulating Plain Region</li> <li>• Central Plain Region</li> <li>• Western Plain Region</li> <li>• Western Region</li> </ul>				
Types of Soil	Flood Plain, Loamy, Sandy, Desert, Podzolic, Sodic and Saline				
Gross Cropped Area (000 ha)	7,872				
Net Sown Area (000 ha)	4,124				
Cropping Intensity	190%				
Net Irrigated Area (000 ha)	4,046				
Total food-grain production (000' MT)	31,627				
Whether food surplus or deficient	Surplus				
Crops grown in state	Wheat, Paddy, Cotton, Maize, Oilseeds				
Major Crops	Wheat and Paddy				
Horticultural crops grown in the state	Fruits (Kinnow, Sweet Lime, Mango, Lemon, Litchi, Guava, Pear, Peach, Plum, Grapes, Ber, Amla, Banana, etc.) Vegetables (Potato, Tomato, Chillies, Peas, Cauliflower, etc.)				
Production and area 2014-15 vs 2020-21		2014-15		2020-21	
		Area in '000 ha	Production in 000' MT	Area in '000 ha	Production in 000' MT
	Crops	7,071	40,737	7,818	40,195
	Fruits	77	1,644	93	2,027



Demonstration field for potato crop with paddy straw incorporation at PAU, Ludhiana

### 2.4.2.2 Animal Husbandry

Livestock rearing is an important sub-sector for the state and contributes over one-third GSV to agriculture. As per the livestock census 2019, the State has nearly 1.3% of India's total livestock. The livestock sub-sector observed an average growth of 5.30% during 2012-2020. However, in the year 2019-20, the sub-sector has witnessed a significant growth of 6.5%. The achievements of the sub-sector are provided in **Table 2.6** below:

**Table 2.6: Achievements of Animal Husbandry in Punjab vs India<sup>13</sup>**

ACTIVITY	ACHIEVEMENT		
	PUNJAB	INDIA	RANK
Average milk yield tonne/day/animal (indigenous cows)	6.91	3.01	1 <sup>st</sup>
Average milk yield tonne/day/animal (indigenous buffalo)	8.44	5.62	3 <sup>rd</sup>
Average milk yield tonne/day/animal (goat)	1.46	0.45	1 <sup>st</sup>
Availability of Green Fodder kg/animal/day	31.43	7.43	1 <sup>st</sup>
Fodder area % of total cropped area	11.00	5.00	1 <sup>st</sup>



Farmer level climate resilient cattle shed demonstrated by DDB, Govt. of Punjab

### 2.4.2.3 Dairy Development

Punjab has always been ahead in the white revolution in the country. It has the highest per capita availability of milk in the country. Daily milk production in Punjab is 29.5 million litres<sup>14</sup>. The sector being labour intensive, employs many unemployed and poor sections of the society. The Punjab government is making special efforts to develop Punjab as 'Dairy State of India' particularly by increasing better cattle breeds and precision dairy farming practices. The Department of Animal Husbandry facilitated 33,83,471 artificial inseminations in 2019-20. The premier research institution of the State- Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana is working towards promoting livestock production, health and prevention of disease(s) through integrated teaching, research and extension programmes. Besides, the State has an extensive veterinary infrastructure which includes 1,367 veterinary hospitals, 1,489 permanent dispensaries & insemination units and 22 polyclinics. In 2020-21, milk and egg production increased by 29.39% and 32.56%, respectively from the year 2014-15. **Table 2.7** below provides the milk, meat and egg production in Punjab.

**Table 2.7: Milk, Meat and Egg production output in Punjab<sup>8,14</sup>**

Year	Milk (000 Tonnes)	Meat (000 Tonnes)	Eggs (000 Lakhs)
2014-15	10,351	237	42,642
2015-16	10,774	250	44,218
2016-17	11,282	249	47,826
2017-18	11,855	276	52,250
2018-19	12,599	231	55,909
2019-20	13,347	251	56,900
2020-21	13,394	224	56,512



Climate resilient model cattle shed at GADVASU, Ludhiana

### 2.4.2.4 Fisheries

Punjab is a land-locked state yet it has significant water resources like rivers, streams, wetlands, canal systems, check dams, panchayat ponds and private ponds etc. Around 41,093 acres are presently under aquaculture (fish farming, producing around 1,32,170 tonnes of fish, annually). Total fish production from notified natural water bodies in Punjab is around 32,707 tonnes during 2020-21. The State is witnessing increase in area under aquaculture over the past few years. **Table 2.8** below provides information on fish production, which indicates an overall upward trend in production.

**Table 2.8: Information pertaining to Fisheries**<sup>8,15</sup>

Year	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Fish Production from Ponds (in tonnes)	77,323	83,210	92,368	99,227	1,14,737	1,21,544	1,32,170
Fish Seed Production at Govt. Fish Seed Farms (in millions)	51.40	49.10	62.70	102.90	138.70	120.30	138.70
Individuals trained in various trainings	6,066	6,164	6,659	6,324	9,173	-	6,898

Additionally, fish culture has become a suitable solution to lessen the impact of declining water-table and stress on agriculture and sustain livelihood of marginal farmers. Moreover, water from fish ponds could be further used for agriculture to reduce need of nitrogen fertilizers upto 5-10%.

Department of Fisheries has also initiated shrimp culture in saline and water logged areas of the state. Presently, more than 800 acres of land is under shrimp farming in the districts of Sri Muktsar Sahib, Fazilka, Bathinda and Mansa. Department is also planning to diversify the species for making aquaculture more sustainable. Department of Fisheries has initiated trials for establishing commercial feasibility for fish in Sri Muktsar Sahib.



Shrimp culture in saline affected & water logged areas of South-western, Punjab

### 2.4.3 Water resources

Water resources in Punjab consist of both surface water and ground water resources. In Punjab, almost 97% of the cultivated area is under assured irrigation with nearly 80% of the water resources being used for agricultural production. Spatial & temporal variability of rainfall is high in the State. Punjab receives an annual average rainfall of 602.6 mm. **Table 2.9** below represents the summary of water resources in Punjab.



Ropar headworks, Deptt. of Water Resources, Govt. of Punjab

**Table 2.9: Water profile**<sup>11,16,17,18</sup>

Average annual rainfall	602.6 mm
Annual replenishable Ground water resources	22.79 Billion Cubic Meters (BCM)
Net Annual Ground Water Availability	20.59 BCM
Surface water availability	21.1 BCM
Number of tube wells	14.76 Lakh
Ground water monitoring systems	1,133
Sewerage Treatment Plant (STPs in operations)	130 STPs (1780 MLD)
Sewerage Network	12,039 km
Coverage of tap water supply	2.58 million (74.5%) out of 3.47 million rural households have tap water supply

### 2.4.3.1 Surface water

State has three perennial rivers - Ravi, Beas, and Sutlej along with Ghaggar, which is seasonal. Besides several choes, there are different Nadies and Khads that traverse the sub-mountainous and alluvial plains before joining respective parent rivers. The state has dams built on its rivers. The surface water availability of the state is estimated to be 21.1 BCM (Table 2.9). There are two major dams, Pong dam on river Beas and Ranjit Sagar dam on river Ravi. Additionally, there are three major barrages on River Sutlej at Nangal, Ropar and Harike for diverting the river water into canals for irrigation in the states of Punjab, Haryana and Rajasthan.

Total wetland area has been estimated about 1.71% of the total geographic area of the state. Six wetlands of the State have been recognized as wetlands of international importance under Ramsar convention namely Harike, Kanjli, Ropar, Keshopur-Miani community reserve, the Beas conservation reserve and Nangal wildlife sanctuary.

### 2.4.3.2 Groundwater

The State is mainly underlain by Quaternary Alluvium of considerable thickness, which abuts against the rocks of Shivalik system towards North-East. Groundwater is an important resource for crop irrigation, food production and industrial as well as domestic. State has witnessed improvement in stage of ground water development rate in the year 2020, as compared to the situation in the year 2011 (Table 2.10).

In terms of the apparent imbalance between available groundwater resources and groundwater draft, the National Groundwater Overexploitation Committee suggested that only 85% of the gross recharge may be considered for utilization for irrigation purposes. However, in the case of Punjab, this has been taken as 90%. The level of groundwater development is however, not uniform in the state and varies substantially between districts. Figure 2.1 illustrates the depth of groundwater at various locations.

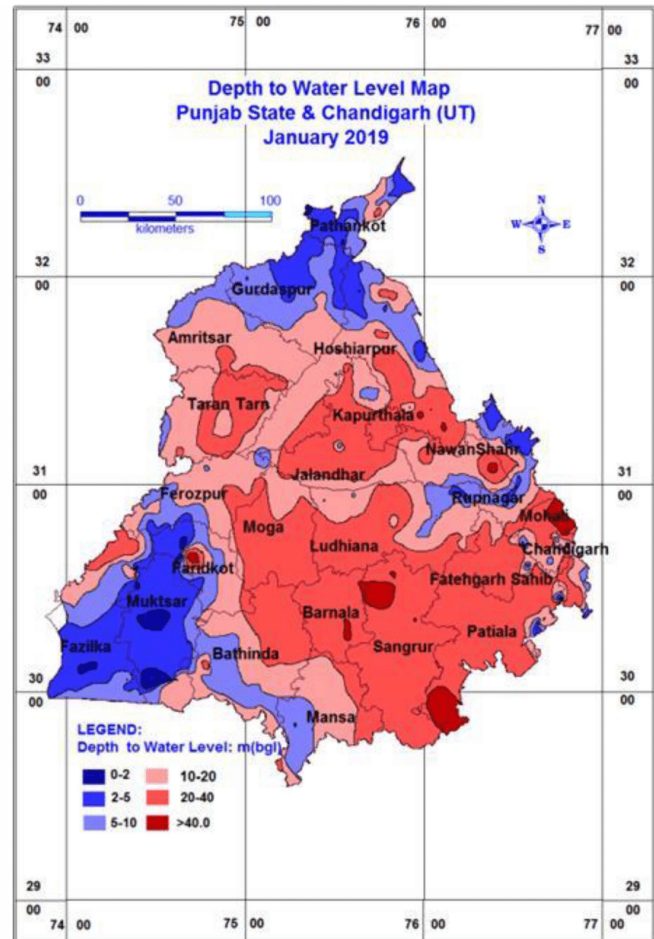


Figure 2.1:  
Spatial distribution of depth of water levels in the state  
Department of Water Resources, Punjab

**Table 2.10: Ground water Net demand, Extraction & Development<sup>19</sup>**

S No.	Year	Net Ground Water Availability (BCM)	Net Extraction (Draft) (BCM)	Stage of Development (%)
1	2011	20.32	34.88	172%
2	2020	20.59	33.85	164%

Groundwater development has further been analyzed at a more localized block level. An analysis by Central Ground Water Board (CGWB) has found that out of 150 numbers of assessed units, 117 were classified as over-exploited, while groundwater exploitation in 6 and 10 blocks was considered critical and semi-critical respectively. The safe category blocks fall either along the shivalik foothills due to its non-accessibility or in the southwestern part of the State, where water is not potable. Further, in terms of water quality, few districts have been reported to be affected with contaminants (Table 2.11).



Regional water testing facility set up at Patiala by Department of Water Supply &amp; Sanitation

**Table 2.11: Districts affected by contaminants<sup>19</sup>**

Contaminants	Districts affected (in part)
Salinity (EC > 3000 $\mu$ S/cm at 25 °C)	Bathinda, Ferozepur, Faridkot, Muktsar, Mansa, Sangrur
Fluoride (>1.5 mg/l)	Amritsar, Bathinda, Faridkot, Fatehgarh Sahib, Ferozepur, Gurdaspur, Mansa, Moga, Muktsar, Patiala, Sangrur
Chloride (> 1000mg/l)	Amritsar, Tarn Taran, Ferozepur, Muktsar
Iron (>1.0 mg/l)	Bathinda, Faridkot, Fatehgarh Sahib, Ferozepur, Gurdaspur, Hoshiarpur, Mansa, Rupnagar, Sangrur
Nitrate (>45 mg/l)	Bathinda, Ferozepur, Faridkot, Fatehgarh Sahib, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Muktsar, Patiala, SBS Nagar, Rupnagar, Sangrur

### 2.4.3.3 Irrigation

Punjab has a well developed irrigation network with almost whole of the cropped area under irrigation, however, at National level, less than half the cropped area is under assured irrigation.<sup>20</sup> In Punjab, most of the area under irrigation is through tube wells. As the area irrigated by tube wells has been increasing over the years, this has largely impacted the declining availability of groundwater in the state. Presently, tube wells irrigate 71.2% of the total irrigated area. The number of tube wells in the State has increased from 10.73 lakh in 2000-01 to 14.76 lakh in 2019-20.<sup>8</sup> Further, tube wells operating on electricity have also increased from 7.88 lakh to 13.36 lakh during the same time period. This indicated reduction in diesel operated tube wells, though better for the environment, but has not limited excessive extraction of groundwater.

According to the Report on Input Management for Resource Use Efficiency by the Ministry of Agriculture & Farmers Welfare, Gol, Punjab has a low penetration of Micro Irrigation systems. Approximately, 48,281 hectares of Punjab's area is covered under micro-irrigation, as of March 2018, which is less than 0.5% of the total area under micro-irrigation in the country. As a countermeasure, the State has been promoting micro-irrigation system, comprising sprinkler/drip irrigation that enable precision farming by making water available in a targeted manner and reducing the stress on the available water resources. In addition, State is also considering rehabilitation of canal network and construction of ponds under 'Amrit Sarovar' initiative. Further, 1,133 ground water level monitoring stations have been set up and 387 shallow piezometers have been planned in the south western region for monitoring of water quality and water logging.<sup>16</sup> **Figure 2.2** illustrates the ground water monitoring sites in the state.

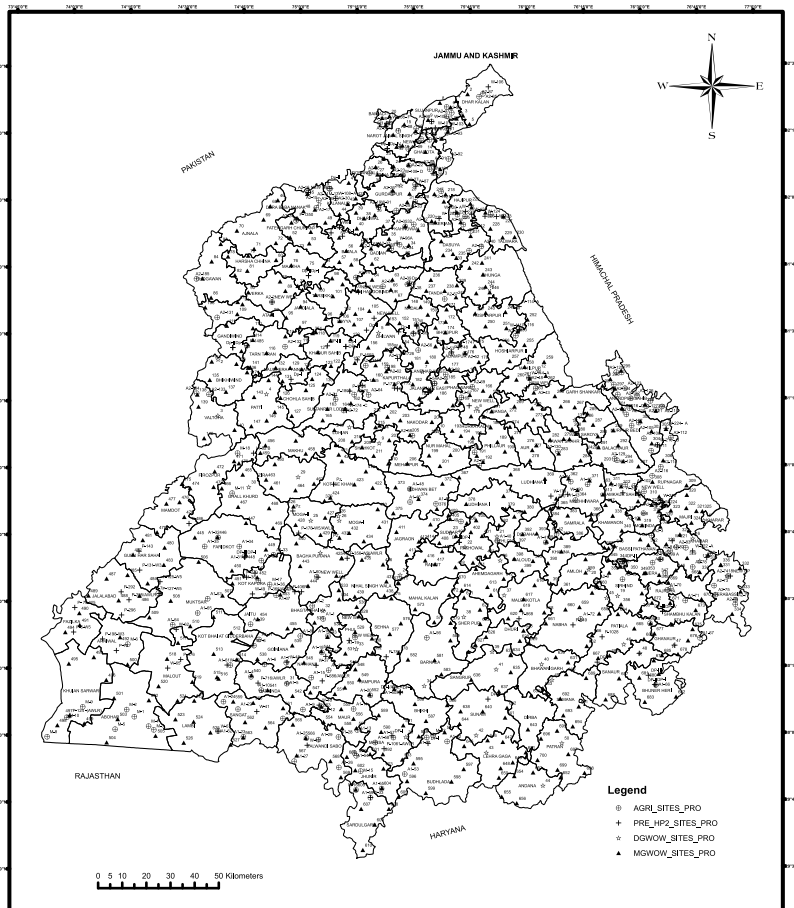


Figure 2.2: Ground water monitoring sites<sup>16</sup>

### 2.4.3.4 Drainage

State has created infrastructure of about 1,800 km long flood protection embankments and long drainage network of 7,200 km for proper drainage of rain water to save the agriculture land from fury of floods and to check the water logging in the water logged areas<sup>16</sup>. Around 1,198 km embankment strengthening works have been carried out along the rivers Beas, Sutlej, Ravi & Ghaggar. Several projects have been undertaken and further planned for flood protection works and to strengthen drainage network along major rivers and tributaries of the state.

### 2.4.3.5 Waste Water

Rapid urbanization has adversely affected water resources of the State. Out of 166 towns, 95 fall in the catchment area of river Sutlej, Ghaggar and Beas. These towns require a total of 243 Sewage treatment plants (STPs) with an overall capacity of 2,571 MLD, out of which, 130 STPs are presently operational. The summary of water treatment facilities is presented in **Table 2.12** below:

**Table 2.12: Overview of STPs<sup>17</sup>**

Total STPs required	243 STPs (2571 MLD)
STPs in operations	130 STPs (1780 MLD)
STPs under construction	55 STPs (624 MLD)
Balance STPs	58 STP (167.5 MLD)



225 MLD STP at Jamalpur, Ludhiana

## 2.4.4 Energy

**Punjab has one of the highest per capita electricity consumption in the Country, which has achieved 100% electrification long time back.<sup>25</sup>**

Access to modern and affordable energy services is fundamental in driving economic growth and powering human development. Inequalities in the availability of energy influence the developmental prospects of society, productivity, health, education, and have a long-term implication on the livelihood of the poor. The state is energy surplus with 3.76% of the total installed capacity of India. The available capacity (installed as well as allocated share) for the state in the year 2021 was estimated to be 14,388.69 MW. Electricity in the state is generated and distributed by state-owned Punjab State Power Corporation Limited (PSPCL) and transmitted by Punjab State Transmission Corporation Limited (PSTCL).

In the year 2020-21, the state has consumed 52,743.90 million kWh of electricity. The sector wise consumption included domestic consumers (33.39%), industrial (31.32 %), agricultural (24.74%), commercial (8.49%) and others including public bulk.

The energy scenario in the state is depicted in **Table 2.13**:

**Table 2.13: Punjab's Energy sector's summary**<sup>21,22,23,24,25</sup>

Total generation capacity as on 31.03.2021 (including Central share)	14,388.69 MW <ul style="list-style-type: none"> <li>• 58% Coal-based Thermal</li> <li>• 2.9% Gas based Thermal</li> <li>• 1.4% Nuclear</li> <li>• 37.7% Hydro &amp; Renewable Energy Sources</li> </ul>
Energy Requirement (MU)	600,000
Per Capita Consumption of Petroleum Products (kg)	215.3 kg against a National average of 142.6 kg
Household Electrification Status	100%
LPG Sales figures	0.99 million metric tonnes
Transmission & Distribution losses	14.97 %
Grid connected Renewable Energy (MU)	4,156.66
Use of coal	8351.50 MW of the total availability of power in the state is Coal based, out of this: <ul style="list-style-type: none"> <li>• 1,760 MW state-owned</li> <li>• 5,115.50 MW private-owned</li> <li>• 1,476 MW centrally owned</li> </ul>

**State has scored perfect 100 in SDG 7: AFFORDABLE AND CLEAN ENERGY in the year 2020-21, highlighting the state's commitment to providing affordable and clean energy to all. Further, Punjab has been ranked among top three performers under State Energy and Climate Index (SECI) Report released by NITI Aayog in 2022.**

### 2.4.4.1. Renewable Energy

The State has a cumulative grid-connected renewable energy-based power generation of 1,629.17 MW supplying power to the State grid.<sup>21</sup> The potential of different Renewable Energy (RE) technologies along with their realization is indicated in **Table 2.14** below:

**Table 2.14: Potential & realization of Resources<sup>21</sup>**

RE Technology	Potential (MW)	Achievement (MW)	Realization (%)
Solar	2,810	896	31.85
SHP Small Hydro Power	441	172.10	39
Hydro	Not Available	1018.35	-
Biomass+ Cogeneration	3,472	559.57	16.11
Waste to Energy	-	1.5	-
Overall RE	6,723	1,629.17	24.2

The country's RE generation in the year 2020-21 was 1,47,247.51 MU. In the same year, RE generation in Punjab was 2,864.47 MU, which is ~ 2 % of the Country's share.<sup>22</sup> The state has set high targets for RE generation and has launched draft Renewable Energy Policy to streamline its collective efforts towards RE. With these planned efforts, the RE share for the state is expected to rise in the future.



1 MW Solar Power setup at village Phulokhari, Bathinda

### 2.4.5 Health

Punjab is one of the affluent states of India. The state has scored 77 points on Good Health and Well-being Index (NITI Aayog) with 8<sup>th</sup> position among 29 states for 2020-21.<sup>26</sup> In addition to this, Punjab with a score of 0.63, ranks 5<sup>th</sup> out of 18 big states, on the public health aspect of the Good Governance Index, launched by the Ministry of Personnel, Public Grievances & Pensions.<sup>8</sup>

Life expectancy is one of the critical indicators to measure the quality and well-being of people. Life expectancy has been the highest among all states in India. Punjab's performance in providing antenatal care to expecting mothers is much better than the national average. Punjab has the second-highest proportion of new mothers that receive post-natal care across all states. The data from Health Management Information System (HMIS) has shown significant improvement in last 3 years, 98.5% of deliveries in Punjab have been institutional. Punjab's performance on the three anthropometric indices (stunted, wasted and underweight for children below the age of 5 years) is amongst the best across all states and significantly higher than the national average. The state has also been successful in bringing down the incidence of anaemia among children.<sup>27</sup> Health Statistics are given in **Table 2.15**.

**Table 2.15: Health Statistics**<sup>11,26,27</sup>

Parameters	Statistical Data
Total number of Hospitals	99
Total Community Health Centres (CHCs)	150
Total Primary Health Centres (PHCs)	524
Total Sub Centres	2,952
Total Medical Institutions	132
Birth Rate (%)	14.8
Death Rate (%)	6.6
Infant Mortality Rate (IMR) (per 1000 live births)	20
Maternal Mortality Ratio (MMR) (per 100000 live births)	105
Institutional Deliveries (as a % of total deliveries)	98.5
Immunization (% of fully immunized children)	76.2
Under five Mortality rates (per 1000 live births)	33

Punjab has made significant progress in immunization of children thus ensuring their health and bringing down child mortality rates. 98.5% of deliveries in Punjab have been institutional. Performance of the State has surged with 54 points in SDG Index 2020-21 ranking as compared to 2019-20.

## 2.4.6 Sustainable Habitat

The State has witnessed rapid urbanization and is considered as 5<sup>th</sup> most urbanized State in India. The sustainable habitat sector includes adequate water supply & sanitation, effective solid waste management, efficient urban mobility & public transport, affordable housing, etc.

### 2.4.6.1 Solid Waste Management

The Punjab Municipal Infrastructure Development Company (PMIDC), a Government agency is overseeing waste management activities in the State. Punjab is reported to generate 4,100 tonnes per day (TPD) of municipal solid waste.<sup>26</sup> The state is implementing a low-cost decentralized approach for scientific and sustainable solid waste management in Urban Areas to ensure compliance with Solid Waste Management (SWM) Rules, 2016 and Punjab State Solid Waste Management Policy. The state had also prepared and adopted the Model Solid Waste Management, Cleanliness & Sanitation Byelaws. The Urban Local Bodies (ULBs) have started low-cost composting through micro compost units and material recovery facilities for dry waste management. The low-cost SWM machineries, mechanical separators for remediation of legacy waste and composter machines have also been developed by involving local manufacturers for decentralized application.



Material Recovery Facility & Micro Composting Centre, Patiala

100% ULBs of the state have achieved certified Open Defecation Free status and made progress on waste collection and segregation. ECBC compliance has been made mandatory in building complexes with connected load >100 KW.

### 2.4.6.2 Transport

Punjab's transport system is one of the key contributors to state's competitiveness, however, increasing urbanization will significantly put further pressure on the urban mobility system and environmental standards.

Road connectivity has long been a priority area for the state government. The state achieved 100 percent road connectivity to all its villages in mid-seventies.<sup>28,29</sup> The road density at the state level is 1.86 km per sq. km, much more than the national average of 1.21 km per sq. km. At 3,388 kms, availability of roads in Punjab in terms of road length per million population is also higher than the national value of 3,276 kms.<sup>30</sup>

State has 12.21 million registered vehicles which is 4.3% of the total registered vehicles of the country. Considering high level of vehicular emissions in major cities i.e. Ludhiana, Jalandhar, Patiala, Amritsar & Bathinda, the state is promoting cleaner mobility. Punjab Electric Vehicle Policy, 2022 has been notified initially for a periods of 3 years with an aim to drive adoption to have 25% of annual registration as Electric Vehicles in the last year of Policy.



State has launched the Scheme 'Apni Gaddi Apna Rozgar Yojana' aimed at providing youths with entrepreneurial opportunities in the transport sector.

### 2.4.6.3 Residential/ Household Sector

The state has witnessed 16% increase in urban population during the last 5 decades.<sup>7</sup> At present, urban population is 37.48%, which is much higher than the National average of 31.16%. The share of urban population has increased from 21.72% in 1951 to 37.48% in 2011. The decadal growth of urban population during the period 2001-2011 has been 26.11% against National average of 27.60%, where as total population growth of the State during the decade was 14.22% against National average of 17.64%.<sup>8</sup> The data related to Residential and Household sectors is presented in **Table 2.16**.

It is pertinent to mention that migration from rural to urban areas has now become a common phenomenon in Punjab. The reason behind this migration is the rapid industrialization, better health & education facilities and infrastructural enhancement in the cities. Further, development of the industrial corridor along Ludhiana, Jalandhar, Amritsar and SAS Nagar highways led to the movement of population from the surrounding areas to the towns. The total number of towns in Punjab has increased from 110 in 1951 to 143 towns in 2021.<sup>11</sup>

**Table 2.16: Residential/ Household Sector**<sup>11,31,32</sup>

Total Population	2,77,43,338
Urban Population	1,03,99,146
Urban Male Population	55,45,989
Urban Female Population	48,53,157
Urban Population Growth Rate	25.9%
Urban Literacy Rate	83.70%
Male Literacy Rate	87.28%
Female Literacy Rate	79.62%
Total individual household (urban) latrine applications approved (up to Jan 2020)	98,187
Total individual household latrines (IHHL) under construction (up to Jan 2020)	3,213
Total individual household latrines (IHHL) completed (up to Jan 2020)	1,03,015

In the SDG index 2020-21, Punjab has obtained 1<sup>st</sup> rank in terms of progress under SDG 11 (Sustainable Cities and Communities)





Improved sanitation facilities in one of the Government Schools of Punjab

Around 99.1% households in the state have access to improved sources of drinking water as compared to all-India level of 89.9%.<sup>8</sup> Punjab water supply data indicates that 66.9% households have piped water as the main source of drinking water. Thus, Punjab has made significant progress in access to clean water supply to all households.

Swachh Bharat Mission (SBM) has led to rapid increase in coverage of household latrines. As on January 2020, 1,03,015 Individual Household Latrines (IHHLs), 11,009 community and public toilets have been constructed.<sup>32</sup> More than 98% of the wards of cities have 100% door to door waste collection, while 85% wards practice 100% waste segregation at the source.

As per Census 2001, the State had housing shortage of 3 lakh units of which 2.10 lakh units shortage was in urban areas and 90,000 units in rural areas. Thus, as an endeavor to provide free and subsidized houses for all urban homeless, urban poor and slum dwellers, the Government of Punjab launched the Punjab Shehri Awas Yojana (PSAY) and notified the Affordable Colony Policy.

### 2.4.7 Gender

India still struggles with gender inequalities beyond the arena of equal economic growth and access to educational resources. A differentiation based on sex and socially constructed, predefined gender roles have been engraved in India's socio-cultural fabric that has its deep cultural and historical lineage.

WHO has evidenced the gender differences in health risks that are likely to be exacerbated by climate change. Increased understanding of the links between gender equality and responding to climate change has recently risen in international agenda and SDG 5 has been dedicated to achieve gender equality and empowering all women and girls.



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State is implementing 'Mai Bhago Vidya' Scheme with the objective to encourage enrollment of Girl students in higher studies. The literacy rate for females in Punjab is 70.7%, significantly higher than the literacy rate of 64.7% for females at National level.<sup>8</sup>

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Punjab has previously been known as state with high incidence of female feticide and infanticide and other forms of discrimination against women. The sex ratio in the state has increased from 876:1000 (female: male) in 2001 to 895:1000 in 2011.<sup>7</sup>

In Punjab, there is a gender gap regarding several key socio-economic indicators. In terms of education, for example, although fewer adult women have secondary education than men do, Punjab has more women in secondary schooling than in most other Indian states. The Gender Parity Index for higher education (18-23 years) is 1.35 which is higher compared to the National targeted value of 1. Nevertheless, in terms of literacy rates, the State observed growth in female literacy rates from 63.36% (in 2001) to 70.73% (in 2011). However, gender gap exists in the state amongst the literacy levels of males and females, the gap is much narrower than national level. As per Ministry of Panchayati Raj (2020), Punjab has 41.7% Elected Women Representatives (EWRs) in Panchayati Raj Institutions (PRIs). Gender disparity is also observed in employment trends in Punjab as well as at the national level. Females have lower Labour Force Participation Rate (LFPR) and Worker Population Ratio (WPR), as well as significantly higher unemployment rates than that observed for males (**Table 2.17**).

**Table 2.17: Employment Scenario<sup>8</sup>**

Total		Rural		Urban	
Male	Female	Male	Female	Male	Female
71.7%	21.8%	70.9%	23.3%	73.0%	19.4%

The Government is mindful of the potential of women's empowerment to fuel economic and social development in the State. In this direction, many initiatives have been commenced including setting up of 'Mai Bhago Armed Forces Preparatory Institute' for girls at SAS Nagar. This is the only and unique institute of its kind in the entire country which trains young girls from Punjab for joining the armed forces as commissioned officers. Further, reservation of women in local councils has been raised from 33% to 50%. Various schemes are under implementation to uplift the social and educational status of women, improve the skewed sex ratio, providing financial benefits for bringing up the girl child, reduce the school dropout rate etc. The main aim of all these schemes is to create awareness among people and empower women<sup>8</sup>.

## 2.5 Key sectoral policies

The state has updated Punjab Development Report and formulated Punjab Vision Document 2030 to integrate its development goals with Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs).<sup>33,34</sup>

Beyond overarching development planning and priorities, Punjab has engaged in detailed sectoral planning processes. **Table 2.18** shows existing key policy documents for the sectors introduced in this chapter.



**Table 2.18: Key Act/Rules/Policies in Punjab**

Forest	<ul style="list-style-type: none"> <li>• National Forest Policy and NDC/SDG targets</li> <li>• Declaration of 3 new Ramsar sites in the year 2020</li> <li>• Green Punjab Sub-Mission under Mission Tandarust Punjab</li> </ul>
Biodiversity	<ul style="list-style-type: none"> <li>• Biological Diversity Act, 2002</li> <li>• Punjab Biological Diversity Rules, 2016</li> <li>• Notified threatened Flora &amp; Fauna of the State</li> <li>• Constituted Biodiversity Management Committees at the level of all local bodies</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Draft Agricultural Policy of Punjab</li> <li>• State Action Plan for Management of Paddy Straw</li> <li>• Healthy Soil and Safe Food &amp; Nutrition Sub-Missions under Mission Tandarust Punjab</li> <li>• Punjab Fisheries Act, 1914 and Punjab Fisheries Rules, 1985 to regulate fishing in all rivers</li> </ul>
Water	<ul style="list-style-type: none"> <li>• Punjab Water Resources (Management and Regulation) Act, 2020 for ensuring the judicious, equitable and sustainable utilization and management</li> <li>• Setting up of Punjab Water Regulation &amp; Development Authority</li> <li>• Punjab Preservation of Sub-soil Water Act-2009</li> <li>• State Action Plan on Clean Rivers (Beas, Sutlej, Ghaggar)</li> <li>• State Action Plan for reuse of treated wastewater</li> <li>• State Action Plan for Restoration &amp; Rejuvenation of village ponds</li> <li>• Clean Water Sub-Mission under Mission Tandarust Punjab</li> <li>• PUDA (Building) Rules, 1996 for Roof Top Rainwater Harvesting system</li> </ul>
Energy	<ul style="list-style-type: none"> <li>• New and Renewable Energy Policy, 2019 to set in motion &amp; accelerate the setting-up of renewable energy projects</li> <li>• Policy for promoting use of agro-biomass in Industries through incentivization</li> <li>• State Net Metering Policy for Rooftop Solar Power Plants, 2014 to offset consumption of consumers through Solar Rooftop up to 80% load</li> <li>• Punjab Municipal Green Buildings Incentives Policy, 2016 offering Incentives for Energy Conservation Building Code (ECBC) Compliant Buildings</li> </ul>
Health	<ul style="list-style-type: none"> <li>• Mission Tandarust Punjab to make Punjab the healthiest State with healthy people by taking care of its air quality, water quality, food safety and ensuring a good living environment</li> <li>• State Action Plan on Climate Change &amp; Human Health</li> <li>• Preventive Health Sub-Mission under Mission Tandarust Punjab.</li> </ul>
Urban <sup>35</sup>	<ul style="list-style-type: none"> <li>• Solid Waste Management Rules, 2016</li> <li>• Punjab State Solid Waste Management Policy, 2018</li> <li>• Punjab Solid Waste Management and cleanliness &amp; Sanitation Byelaws, 2020</li> <li>• Standard Operating Procedure (SOP) for solid waste management, 2021</li> <li>• Guidelines/SOP for Domestic hazardous waste management and sanitary waste management, 2020</li> <li>• Swachh Bharat mission- Urban guidelines</li> <li>• State Action Plan for Clean Air and Waste Management</li> <li>• Clean Air, Road Safety &amp; Waste Management Sub-Missions under Mission Tandarust Punjab</li> </ul>
Transport	Punjab Electric Vehicle Policy, 2022



## 2.6 Commitment towards NDCs-SDGs

### 2.6.1 SDGs and localized 2030 agenda

In Punjab, the overarching development frameworks and key sectoral policies presented in this section are being operationalized through detailed medium and short-term planning. To achieve the localized 2030 goals and targets, the Government of Punjab has prepared a 4-year Strategic Action Plan 2019-2023 (4SAP). Department of Planning is the Nodal Department and has established an SDG Cell for overseeing work on SDGs in the State. The concerned development departments are responsible for the implementation and monitoring of 4SAPs and Annual Action Plans.

To further localize the SDGs, the Government of Punjab has drafted District-level Four Year Strategic Action Plans, to provide a measurement framework so as to ensure the performance of District-Level Key Functionaries through District-Level Key Performance Parameters (KPPs).

### 2.6.2 State's performance on various SDGs

Punjab has been among the front runners and ranked 12<sup>th</sup> among the States in the overall ranking. The state has scored a Composite Index Score of 68 (**Figure 2.3**), which is a 6-point improvement compared to 2019-20.<sup>26</sup> Punjab has elevated from the category of Performer in 2018-19 to the category of Front Runner in 2020-21. Thus, the State has constantly improved its SDG performance indicating its commitment towards sustainable development.

#### Major Achievements

- Significant reduction in Under 5 Child Mortality
- Institutional Deliveries are 98.5%
- Gender Parity Index for Higher education (18-23 years) is 1.35
- Nearly 100% schools have basic infrastructure (electricity, drinking water)
- 94.11% of industries complied with CPCB norms
- 100% targeted habitations connected by all weather roads under Pradhan Mantri Gram Sadak Yojana (PMGSY)
- 100% of Bio-Medical Waste (BMW) treated to total quantity of BMW generated



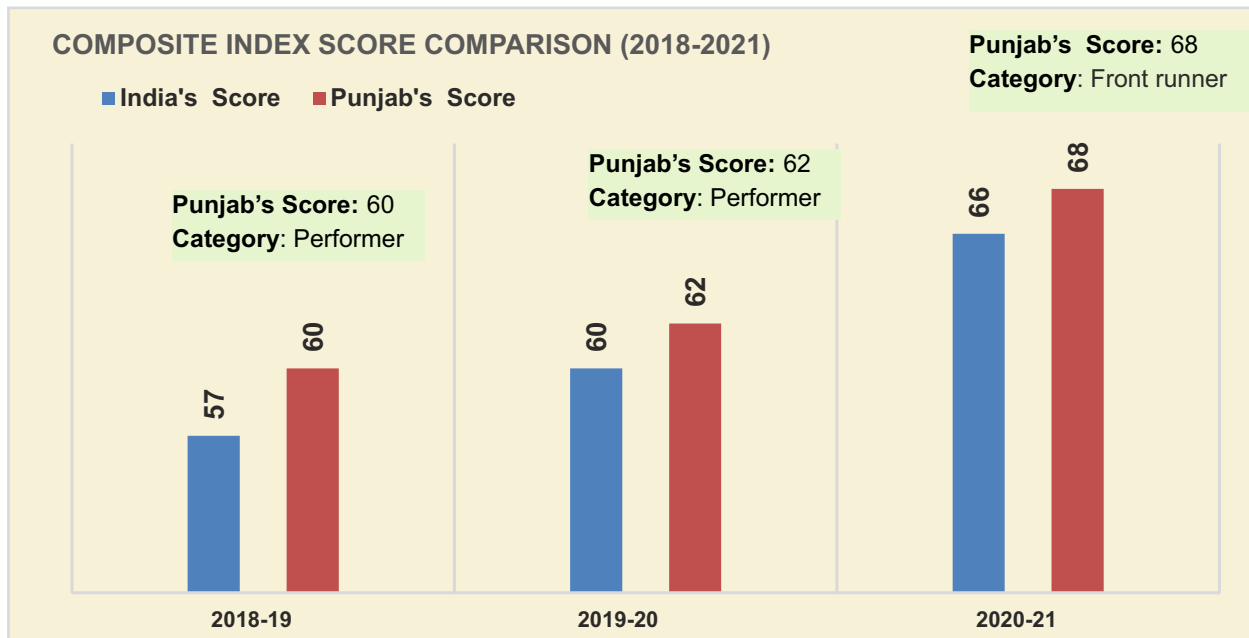


Figure 2.3: India and Punjab's Composite Index<sup>26</sup>

State has shown considerable progress towards SDG 7, SDG 11 & SDG 12 in the SDG Index 2020-21 (Figure 2.4). Punjab has obtained 1<sup>st</sup> rank under SDG 11 (Sustainable Cities and Communities) and SDG 7 (Affordable & Clean Energy). The state has established itself as an Achiever with a perfect score of 100 in SDG 7. An increase of 12 units for SDG 2 (Zero Hunger) and 36 units for SDG 12 (Sustainable Consumption & production) has been recorded.<sup>26</sup>

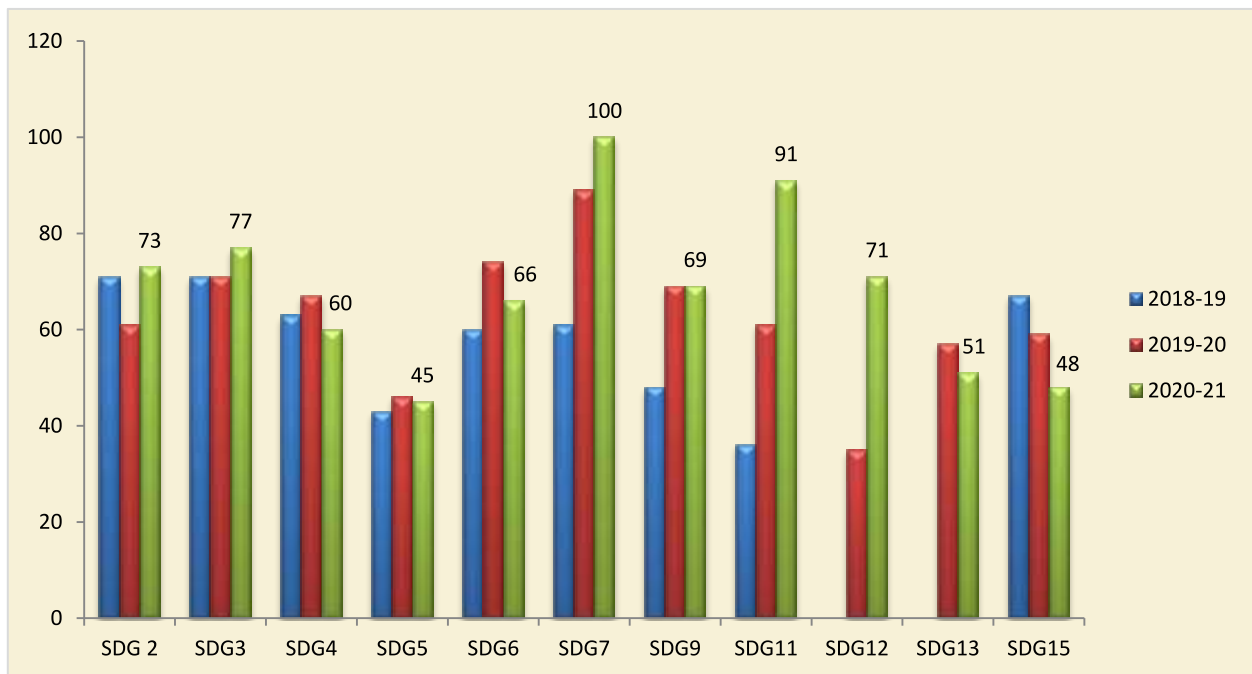


Figure 2.4: Punjab's progress towards relevant SDGs (2018-2021)<sup>26</sup>

### 2.6.3 Performance under Key NDCs & SDGs

Punjab has effectively directed efforts towards various ongoing National Missions for sustainable development and simultaneously contributed towards NDCs to combat climate change. The State's performance under key parameters of NDCs and SDGs is given in **Table 2.19**:

**Table 2.19: Performance under NDCs and SDGs**<sup>6,8,11,25,36,37</sup>

Sector	Parameters	2020-21
Forest	Forest Cover (sq. km)	1,846.65
	Growing Stock in Forest (in million cum)	32.92
Agriculture	Food grain production (000 MT)	3,162.70
	Livestock population (in million)	535.78
	Horticulture (000 MT)	2,027.17
Water	Gross Area Irrigated (000ha)	7,680
Energy	Government's goal of "Electricity for All"	Achieved 100% village electrification
	Renewable energy production (MUs)	4,156.66
Health	Total number of Hospitals	99
Urban	Slum population accommodation (no. of houses constructed)	22,873



## 2.7 Progress under National Adaptation Strategies

### 2.7.1 National Mission for Sustainable Agriculture

The State plays a key role to ensure food security and self-sufficiency in food grains to the Nation. Punjab is amongst the leading states in the country to implement the National Food Security Act (NFSA), 2013 and the National Food Security Mission (NFSM) aimed to improve the adaptive capacity of people through an assured supply of rice, wheat and pulses at affordable prices. Smart Ration Card and One Nation One Ration Card schemes are being implemented for priority households & migrants, respectively. **Table 2.20** shows the State's performance under key agriculture parameters.

**Table 2.20: Punjab's performance under key agricultural parameters<sup>26</sup>**

Parameter	Performance in 2018-19	Performance in 2019-20	Performance in 2020-21
Beneficiaries under NFSA (%)	Not tracked	Not tracked	99.20
GVA (constant prices) in agriculture (in million/worker)	Not tracked	0.24	0.26
Population below poverty line (%)	8.26	8.26	8.26
Rice and wheat produced annually per unit area (Kg/Ha)	4297.73	4169.67	4693.24

The State has also implemented project "Towards Climate Resilient Livestock Production System in Punjab" in Ludhiana, Bhatinda and Tarn Taran districts of the State under National Adaptation Fund for Climate Change. The project has demonstrated various interventions to enhance adaptive capacity of small and marginal livestock farmers and resilience of the sector in projected farming scenario.

**Punjab is top performing State with respect to annual per unit area productivity of Wheat & Rice as per SDG index report (2021) published by NITI Aayog**



Field demonstration of Zero tillage Happy Seeder at Ludhiana

## 2.7.2 Green India Mission (GIM) and creation of carbon sink

India has committed to create an additional carbon sink of 2.5 to 3.0 billion tonnes CO<sub>2</sub> equivalent through additional forest & tree cover by 2030. Punjab being an agricultural state has its limitations due to limited availability of land for afforestation purposes. However, the state is consciously and strategically making efforts to increase the green cover beyond forest areas by promoting new green initiatives including 'Ghar Ghar Hariyali' Scheme and extensive plantation in each village on the special occasions such as 550<sup>th</sup> birth anniversary of Guru Nanak Dev Ji and 400<sup>th</sup> Birth anniversary of Guru Teg Bahadur Ji, besides promoting Agro-forestry involving farmers under Sub-Mission on Agro-Forestry (SMAF).

### 2.7.2.1 Progress under Green India Mission and CAMPA

Plantation under Compensatory Afforestation Fund Management and Planning Authority (CAMPA) funds and Green India Mission has been actively undertaken in the state. The implementation of the scheme has resulted in increased tree cover & improved quality of forest over an area of 4118 ha.

The year wise plantation undertaken in divisions under various schemes during 2016-2021 is given in **Table 2.21** below.

**Table 2.21: Physical progress of GIM and CAMPA scheme<sup>38</sup>**

Name of Division	Area in ha			
	2016-17	2017-18	2020-21	Total
Mohali	250	200	220	670
Ropar	215	285	220	720
Garhshankar	200	600	220	1020
Hoshiarpur	346	262	220	828
Dasuya	275	385	220	880
<b>Total</b>	<b>1286</b>	<b>1732</b>	<b>1100</b>	<b>4118</b>

**Green Highway Project- More than 0.11 million plants have been planted on NH-54 Section between Amritsar and Pathankot.<sup>38</sup>**



Plantation under Green Highway Project, Amritsar to Pathankot section NH-54 by Department of Forest

### 2.7.2.2 Progress under Sub-Mission on Agro-forestry

Agro-forestry is the key focus of the State to enhance the income of farmers and also to diversify land use from agriculture to agro-forestry to a certain extent. Under Sub-Mission on Agro-forestry (SMAF), farmers are being given financial assistance by way of direct benefit transfer through their Aadhar linked saving bank accounts based on the plants planted in their agriculture fields and their survival.

**Table 2.22** below summarises the progress of Sub-Mission on Agro-Forestry under the categories 'General & Schedule Caste Sub-Plan (SCSP)':

**Table 2.22: Physical achievements under SMAF<sup>38</sup>**

S. No.	Year	Category	Number of Farmers	Number of Plants Planted (million)	Area Coverage under plantations (ha)	Financial Assistance (INR in million)
1	2016-17	General	641	0.67	788.10	0.00
		SCSP	91	0.06	92.40	
Total progress in 2016-17			<b>732</b>	<b>0.73</b>	<b>880.50</b>	
2	2017-18	General	1091	1.23	1277.40	25.00
		SCSP	323	0.24	302.75	
Total progress in 2016-17			<b>1414</b>	<b>1.47</b>	<b>1580.15</b>	
3	2018-19	General	2644	2.83	3209.09	21.33
		SCSP	745	0.69	848.40	
Total progress in 2016-17			<b>3389</b>	<b>3.53</b>	<b>4057.49</b>	
4	2019-20	General	2582	3.37	3821.94	53.41
		SCSP	1154	1.19	1595.82	
Total progress in 2016-17			<b>3736</b>	<b>4.56</b>	<b>5417.76</b>	
5	2020-21	General	2260	3.24	3579.46	45.11
		SCSP	1508	1.45	2044.77	
Total progress in 2016-17			<b>3768</b>	<b>4.69</b>	<b>5624.23</b>	

3.99 million stock of Eucalyptus, Sheesham and Populus have been raised in nurseries for enhancing the wood availability, livelihood generation and carbon sequestration.<sup>38</sup>



The implementation of the project will result in the following tangible and quantifiable benefits besides other significant intangible environmental benefits: -

- Increased area under Trees outside forest will contribute towards achieving India's Paris Agreement commitment to add additional carbon sink of 2.5-3 billion tonne by 2030
- Augment livelihood of the farmers and increase their adaptive capacity. The incentives to the farmers under the SMAF scheme are for their contribution in ameliorating the environment through Carbon Sequestration
- Timber grown under this project will reduce the pressure on natural forests
- Employment opportunities to the local people

### 2.7.2.3 Progress regarding promotion of Biodiversity Conservation

Biodiversity is a critical but threatened resource, which requires sustained conservation measures. The United Nations Assembly has declared the decade from 2021-30 for 'Ecosystem Restoration' to scale up the restoration of degraded ecosystems, to enhance resilience and to deal with the twin interlinked crisis of Climate Change and global biodiversity decline.

In this direction, Punjab Biodiversity Board (PBB) has been set up as a statutory body by Govt. of Punjab under Section 22 of the Biological Diversity Act, 2002 and Biodiversity Management Committees (BMCs) have been constituted at all the local bodies level. The Board is taking multi-farious initiatives for promoting conservation & sustainable utilization of biodiversity, identification of Biodiversity Heritage Sites and capacity building on biodiversity related issues.

Further, Punjab Govt. vide Gazette Notification No. S.O 402(E) dated 04.02.2014 u/s 38 of Biological Diversity Act, 2002, has notified 13 species of the flora (8) & fauna (5), which are near to extinction in Punjab. The species were identified by Punjab Biodiversity Board in consultation with Botanical Survey of India (BSI), Zoological Survey of India (ZSI), Department of Forest & Wildlife Preservation, Punjab and subject experts. The natural habitat of 13 notified species ranges from Shivaliks Belt in far north to South-Western Punjab and from agricultural landscapes to major & minor aquatic ecosystems of the State. The steps are being taken to promote rehabilitation of threatened flora & fauna.

The Board has been undertaking studies for holistic understanding of various aspects of the notified species and preparing educational & awareness material to promote their propagation through in-situ and ex-situ conservation with the involvement of Forest Department, BMCs & general public.



Bar headed geese visiting Harike wetland in winters

### 2.7.3 National Water Mission



The main objective of the National Water Mission (NWM) is to conserve water, minimize its wastage, and ensure its equitable distribution. The overall goal of this Mission is to improve water use efficiency by 20%.

Dedicated Action Plans for Clean Rivers, Reuse of Treated Wastewater and Restoration & Rejuvenation of village Ponds are under implementation in the State. A few of the achievements in alignment with National Water Mission are as under:<sup>16</sup>

- Treated water utilization projects to be tune of Rs. 200 cr. are being taken up under 15<sup>th</sup> Finance Commission funding.
- Modelling studies have been initiated to regulate water resources in future climate change scenario.
- Flood forecast system is being developed for Ranjit Sagar dam for real-time water level monitoring to avoid damages due to floods as an adaptation strategy.
- Around 0.17 million new Sewerage connections have been installed under Atal Mission for Rejuvenation and Urban Transformation (AMRUT).
- More than 0.1 million individual household toilets and >11,000 community and public toilets constructed upto January 2020.

Around 74.5% of 3.47 million rural households, have been provided with tap water supply and the State plans to cover the remaining rural households shortly. 90% of Urban areas have already been covered with water supply and remaining areas are planned to be covered under AMRUT2.0.

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**Punjab bagged National Water Mission Award for efficient utilisation of treated waste water from STP Phagwara for irrigation purposes**

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### 2.7.4 National Nutrition Mission (NNM)

Punjab is among the top scorers in Good Health and Well-being Index. Punjab also ranks 5<sup>th</sup> out of 18 big states, on the Public Health aspect of the Good Governance Index, launched by the Ministry of Personnel, Public Grievances & Pensions. Key state programs include School Health & Hygiene and Quality Mid-day Meal for ensuring nutrition and prevention of vector/waterborne diseases. Also, efforts are being made for being 'Anemia Free' State by involving Health and Family Welfare, Social Security, Women and Child Development and School Education departments.



'Anaemia Mukt Punjab' campaign has been launched with a special drive for testing and treating children, adolescent girls, pregnant and lactating women on a priority basis. Under this initiative, supplements of iron-folic acid (IFA) tablets as well as fortification of mid-day meal to children in the schools and anganwari centres is being focused. Besides, a pilot project on fortification of rice is also ongoing in Moga, Ferozpur and Ludhiana districts. The State is also strengthening its institutional capacity for early disease detection & response. State's performance on key health parameters is presented in **Table 2.23**.<sup>26</sup>

Punjab's performance on the three anthropometric indices (stunted, wasted and underweight, for children below the age of 5 years) is amongst the best across all states and significantly higher than National average.

**Table 2.23: Performance under key health parameters<sup>26</sup>**

Key health parameter	Performance in 2018	Performance in 2019	Performance in 2020-21
Maternal Mortality Ratio (per 1,00,000 live births)	122	122	129
Under 5 mortality rates (per 1,000 live births)	33	33	23
Children (9-11 months) fully immunized (%)	Not tracked	Not tracked	89
Monthly per capita out-of-pocket expenditure on health (%)	Not tracked	Not tracked	13.5
Physicians, nurses, and midwives per 10,000 population	Not tracked	56	56

The State has been implementing Integrated Child Development Services (ICDS) Scheme to provide healthy diet to needy children. The scheme is being implemented in 155 ICDS blocks which include 146 rural blocks and 9 blocks in urban slum areas of Amritsar (3), Jalandhar (1), Ludhiana (4) and Patiala (1). A well-knitted network of 27,314 Anganwadi Centres (AWCs) is operational in the State under which 1.2 million beneficiaries have been covered.

The Govt. of India has approved setting-up of National Nutrition Mission (NNM) to address malnutrition and it's roll out in a phased manner to achieve improvement in the nutritional status of children from 0-6 years, pregnant women and lactating mothers. Presently, four districts namely Faridkot, Ludhiana, Mansa & Sri Muktsar Sahib have been identified in Punjab under the scheme.

A focused scheme of Government of India 'Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (RGSEAG), is being implemented in 205 districts from all the States/UTs to empower Adolescent Girls through nutrition, health care and life skills education. Under the scheme, six (6) Districts of Punjab have already been covered and efforts are underway for covering remaining districts too.

Department of Social Security and Women & Child Development, Govt. of Punjab is regularly undertaking awareness programs for improving sex ratio, imparting technical training to women for sustained livelihood and also implementing Integrated Child Development Scheme in the State for children & working mothers.

In view of National Action Plan on Climate Change & Human Health, State has drafted its Action Plan on Climate Change & Human Health to address emerging health vulnerabilities due to air pollution, heat stress and vector-borne diseases. Health facilities of 8 cities namely Amritsar, Jalandhar, Ludhiana, Khanna, Mandi Gobindgarh, Patiala, Bathinda and Rupnagar will start demonstrating AQI (Air Quality Index) levels fetched from [http://app.cpcbcr.com/AQI\\_India/](http://app.cpcbcr.com/AQI_India/) for correlating with respiratory & other related cases.

Further, State is also making efforts to make the health facilities greener and more energy-efficient through Energy Audits & transition to more energy efficient equipments & appliances in addition to plantation within the premises of Health facilities.



### 2.7.5. National Mission on Strategic Knowledge for Climate Change

Punjab has been among the few proactive states to come up with the regional planning, after the formulation of the National Action Plan by India. Punjab State's Action Plan on Climate Change (SAPCC 1.0) was the first guiding document prepared in 2014 to accelerate adaptation and mitigation actions.

Thereafter, Directorate of Environment and Climate Change was set up under Department of Science Technology & Environment (DSTE), GoP to facilitate development & monitoring of Action Plans to improve quality of air, water and overall environment as well as steer 'Mission Tandarust Punjab' launched to make Punjab the healthiest state with healthy people. Further, Punjab State Climate Change Knowledge Centre was setup in Punjab State Council for Science & Technology under DSTE, GoP to build capacity of all relevant stakeholders to enhance their knowledge base on climate change concerns and the adaptation & mitigation measures to address the same. State has also prepared "Vision Document 2030" and 4 year Strategic Action Plan (4SAP) to guide State's development in-line with the Sustainable Development Goals.



## 2.8 Progress under National Mitigation Strategy

### 2.8.1 National Mission for Enhanced Energy Efficiency

Punjab has one of the highest per capita electricity consumption in the country and has also achieved 100% electrification, a long time back. The Government has been focusing on adequate and reliable availability of electricity for the state. To improve the quality of life of people through an uninterrupted power supply at affordable cost, the Government of Punjab signed a joint initiative with the Government of India – 24×7 Power for All.

Punjab has the World's Largest Single Rooftop solar plant of 11.5 MW capacity setup in 2016 at Dera Beas. The state has drafted its Renewable Energy Policy, which aims to meet 30% of its power requirement through Renewable Energy by the year 2030. The State has set a target to establish 4,422 MW ground-mounted, 370 MW rooftop and 105 MW canal top solar power projects by 2030.<sup>21</sup>

Under Solar Street Lighting Programme launched by the Ministry of New & Renewable Energy, Govt. of India, a total number of 99,505 Solar Street Lighting Systems have been installed in 4,479 villages of Punjab, including 55,330 Lights. Further, additional 17,000 solar streetlights are targeted in the year 2021-22.

#### 2.8.1.1 Progress under Solar Mission

Rooftop solar power plants are being promoted under net metering policy notified by the state. Solar Rooftop Power Plants of 88.5 MW cumulative capacity, have already been installed in Domestic, Institutional, Government, Commercial and Industrial sectors. In addition, state has set up 896 MW ground mounted solar plants on Build, Own, Operate (BOO) basis up till 2020 for the sale of power to the state utility (Table 2.24).<sup>21</sup>



Rooftop Solar Plant at Sidhwan Canal, Ludhiana

With 1493.95 MW of commissioned solar energy, Punjab is one of the most active states in terms of harnessing solar power

**Table 2.24: Details of solar energy realization by the state<sup>21</sup>**

Type	Realization 2014	Realization 2021
Solar Rooftop – Net Metering	NA	88.5 MW
Ground Mounted Solar Plants (BOO)	39 MW	896 MW

The progress of activities under the MNRE scheme Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM) for farmers for setting up of grid-connected solar power plants, stand-alone off-grid solar pumps and grid-connected solar pumps to provide energy security and raise their income is as under:

- Setting up of Solar power plants - Proposals for setting up of 220 MW capacity solar power plants under KUSUM Scheme/ in-pipeline, 225 substations have been selected.
- Setting up of off-grid solar pumps – 15,800 solar pumps have been installed.
- Feeder level solarisation of 25,000 Grid connected Agriculture pumps: 65 feeders have been selected, 29 Solar Power Plants of 54 MW of cumulative capacity are to be set up.

### 2.8.2 National Mission on Sustainable Habitat

The state has made following progress for the four components under Pradhan Mantri Awas Yojana-Urban (PMAY U) Scheme covering the urban areas of Punjab:

- In-situ-slum-rehabilitation: 100% survey has been completed and proposals to develop three slums at Lalru, Mohali and Patiala are underway.
- Affordable Housing Project: Affordable houses for 394 EWS in Ludhiana and 176 EWS in Patiala are under implementation.

Punjab has also been making significant progress under Pradhan Mantri Awas Yojana – Gramin, a scheme that aims to provide a pucca house with basic amenities (safe drinking water, electricity connection and cooking gas cylinder) to homeless/ households living in kutcha and dilapidated house in rural areas. Under the scheme, each beneficiary gets an amount of INR 1,56,210 through the following provisions:

- Grant of INR 0.12 million for the construction of new house.
- Additional amount of INR 24,210 per house for construction of house equivalent to 90-man days @ INR 269 per day against the unskilled wage component under MGNREGA.
- INR 12,000 for the construction of the Toilet in the house under MGNREGA or any other dedicated source.

Furthermore, the state has undertaken Smart Village Campaign for sustainable management of villages and to improve quality of rural life through management of streets and drains, community centers, cremation grounds, installation of solar lights etc. A total of 18,906 works in phase 1 of Smart Village Campaign (SVC) have been executed at a total cost of 835 Crores. Further, 58,991 works are under implementation in phase 2 of the scheme. Further, the state has been able to achieve 100% connectivity to rural habitations under Pradhan Mantri Gram Sadak Yojana to ensure access to economic and other essential services.





Recreational area developed through MGNREGA at village Alwalpur, Jalandhar

### 2.8.2.1 Progress under MGNREGA

The primary objective of MGNREGA scheme is to strengthen livelihood generation programs for the rural poor. Punjab has about 3.23 million registered workers including 1.47 million women workers. The state has spent INR 40,754 million on various works under MGNREGA has generated 134.49 million man-days to secure livelihood for vulnerable population.

### 2.8.2.2 Progress under Waste Management & Swachh Bharat Mission

Solid waste management is the focus area under Swachh Bharat Mission (SBM) and the State has already adopted decentralised Waste Management Approach in compliance of Solid Waste Management Rules, 2016 and State SWM Policy – 2018. At present, 4100 tonnes per day (TPD) solid waste is generated in all 166 ULBs. For attaining and sustaining scientific solid waste management, adoption of low cost techniques is being encouraged and intensive



Information, Education and Communication (IEC) and Capacity Building activities are being conducted continuously by deploying a dedicated team of 140 Community facilitators and around 350 Motivators. The State's performance under waste management is given in **Table 2.25**.

**Table 2.25: State's performance under Solid Waste Management during the period 2014-2020<sup>28</sup>**

Component	Target	Achievement
Door to door waste collection	100% coverage	99%
Source segregation	100% coverage	89%
Construction of Compost pits	8753	8223
Construction of material recovery facilities	305	265
Bulk waste generators compliance	395	238
On site composting of horticulture waste in parks/green belts/institutions	2764	2410
Elimination of garbage vulnerable points	1021	962
Remediation of legacy waste	143	124
Setting up of Sanitary landfill facilities for inert waste	135	35
Setting up of construction and demolition waste management facilities	135	117

Further, 166 ULBs of the state have achieved certified Open Defecation Free status. Further, 162 ULBs have achieved ODF + certification and 65 ULBs have achieved ODF ++ certification. Other achievements of the state under the Swachh Survekshan-2021 are given in **Table 2.26**.

**Table 2.26: State's achievements under the Swachh Survekshan-2021<sup>28</sup>**

National Rank	7 <sup>th</sup>
Rank in the North Zone	2 <sup>nd</sup>
Total Awards	41
Swachh Survekshan	11
Star Rating – Garbage Free Cities	06
Ranking in top 100 in their population category	103 ULBs



# CHAPTER 3

## CLIMATE PROFILE OF PUNJAB





## 3.0: Climate Profile of Punjab

The climate of Punjab is semi-arid, hot and subtropical monsoon type with cold winter and hot summer. According to Indian Meteorological Department (IMD) the annual average maximum and minimum temperature in the state ranges from 29 to 32°C and 15 to 17°C, respectively. The highest peak of temperature 44 to 45°C generally appears in May-June and, lowest temperature around 0°C occurs during December-February. The mean annual rainfall in the state ranges from 400 to 1300 mm and more than 75 to 80% of this rainfall is received under the influence of south west monsoon during the four months, June to September. The rest of rainfall is received during the remaining eight months under the influence of western disturbances. The intensity of rainfall is usually heavy in north eastern hilly parts of the State, whereas, it is scanty in south western dry regions.

### 3.1. Change in regional weather pattern due to the climate change

#### 3.1.1. Temperature

The State has experienced change in temperature during the past seven decades. The trend analysis compiled by Punjab Agricultural University (PAU)<sup>39</sup> using the gridded data of IMD has revealed variations in both the maximum and minimum temperatures (**Figure 3.1** and **Figure 3.2**). The average maximum temperature during the decades 1950-2020 ranged between 29.1–31.1°C, except during 1981-1990 and 1991-2000 which were cooler decades with temperature ranging between 28.3-31.3°C. Similarly, the average minimum temperature during 1951-60 up to 2011-18 ranged between 16.2- 17.1°C except during four cooler decades (1961-2000) in which the temperature ranged between 15.3-17.1°C. The findings of IMD analysis<sup>40</sup> for the studied period revealed an increase of 0.6°C in average minimum temperature of the region. Another study has reported that the rise in night-time temperature is more evident than the day-time temperature.<sup>41</sup> The number of days with maximum temperature >40°C has increased from 289 days during the 1970-79 to 322 days in last decade i.e. 2010-19 (**Table 3.1**) whereas, the number of days with minimum temperature <2.0° C has reduced from 83 to 36 during the same period (**Table 3.2**). Although, no significant change in maximum temperature has been observed, the minimum temperature across the State has shown significant increase at a rate of 0.03-0.06°C per year. These changes in temperature have implications for crop physiological processes and activity of the pest and diseases and may adversely affect the crop productivity.<sup>42,43</sup>

**Table 3.1: Incidence of temperature >40°C (No. of days) in Punjab**

Time Period	North Eastern Region	Central Region			Western Region	Average
	Ballowal Saunkhri	Amritsar	Ludhiana	Patiala	Bathinda	
1970-79	-	334	278	256	-	289
1980-89	144	319	279	293	646	336
1990-99	200	226	208	260	429	265
2000-2009	221	311	230	244	407	283
2010-2019	224	339	279	326	442	322
Average	197	306	255	276	481	303

**Table 3.2 : Incidence of temperature <math><2^{\circ}\text{C}</math> (No. of days) in Punjab**

Time period	North Eastern Region	Central Region			Western Region	Average
	Ballowal Saunkhri	Amritsar	Ludhiana	Patiala	Bathinda	
1970-79	-	153	91	6	-	83
1980-89	7	173	28	1	140	70
1990-99	61	141	12	5	68	57
2000-2009	78	169	31	22	69	74
2010-2019	27	99	9	2	44	36
Average	43	147	34	7	80	62



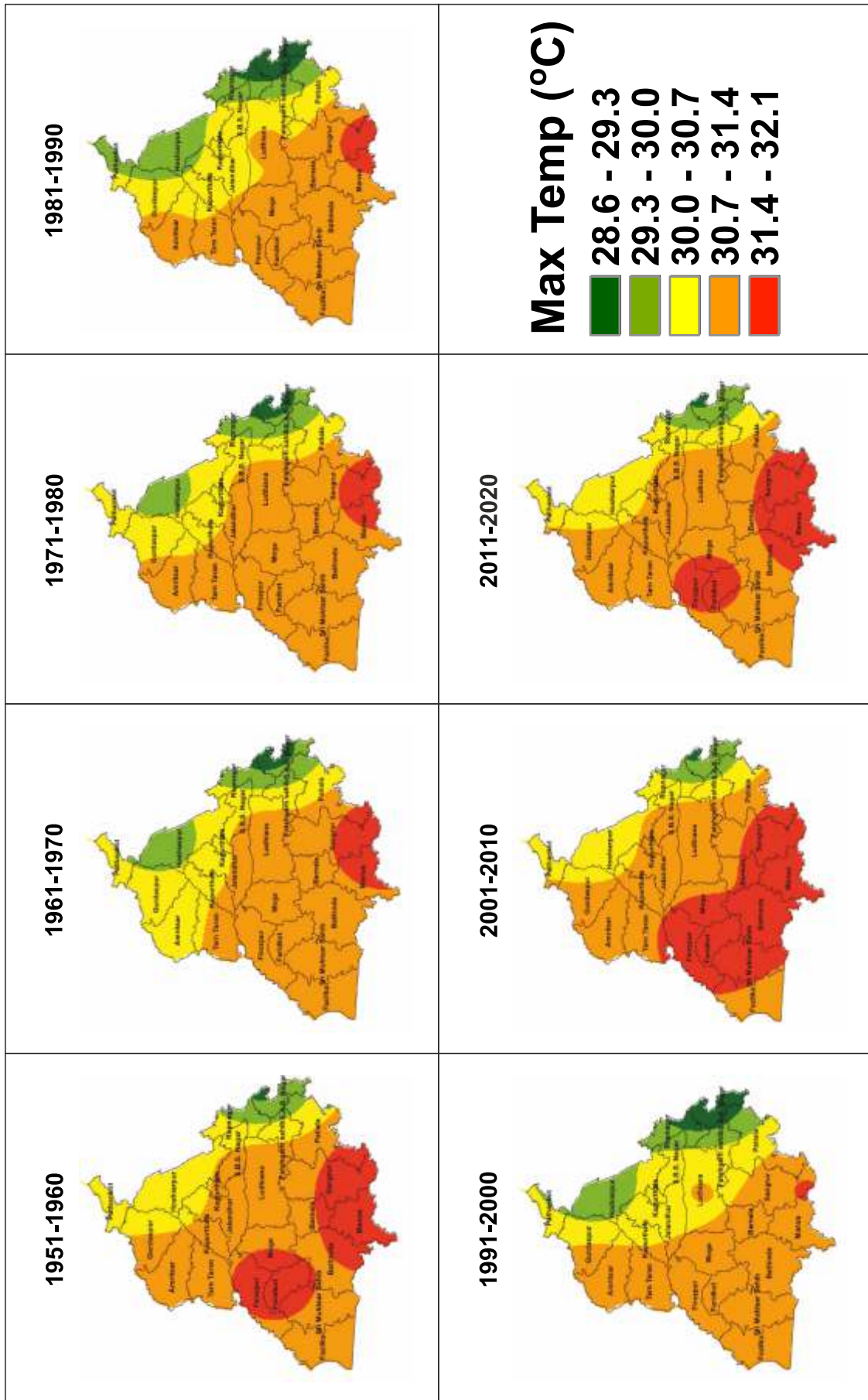


Figure 3.1: Variability in annual maximum temperature over past seven decades in Punjab

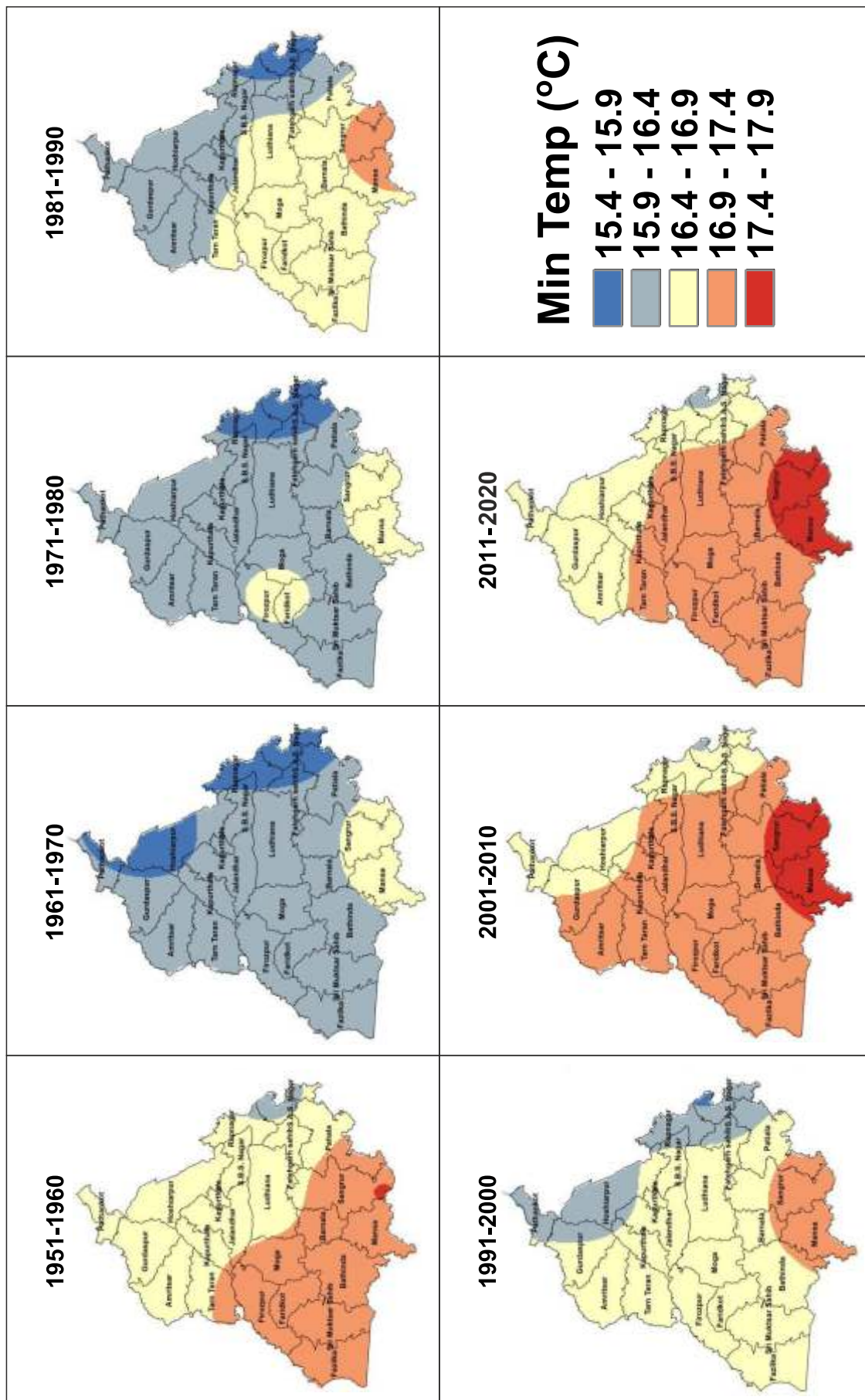


Figure 3.2: Variability in annual minimum temperature over past seven decades in Punjab

### 3.1.2. Rainfall

The IMD gridded data analysis has indicated a large variation in decadal rainfall over different regions of the State.<sup>39,41</sup> As per the data, the annual rainfall during the period 1901-2020 ranged between 335.7-1157.8 mm. However, data indicates decreasing trend in rainfall over the past six decades (**Figure 3.3 & 3.4**) except during the decades of 1931-40 and 1971-80, when higher amount of rainfall was recorded (**Figure 3.3 & 3.4**). The extreme rainfall incidence (>100 mm) during the period 1970-2019 were highest in the north-eastern region followed by western plain regions of the State (**Table 3.3**).<sup>40</sup> The incidence of extreme rainfall (>100 mm) were highest during the two decades (1980-1999) which resulted in occurrence of floods during the year 1984, 1988 & 1995. Overall the number of rainy days has decreased except during the decade 1990-99 (**Table 3.4**).

**Table 3.3: Incidence of rainfall event >100 mm (No. of days) in Punjab**

Time period	North Eastern Region	Central Region			Western Plain Region	Western Region		Average
	Ballowal Saunkhri	Amritsar	Ludhiana	Patiala	Faridkot	Abohar	Bathinda	
1970-79	-	3	2	3	-	-	-	2.7
1980-89	-	6	7	15	-	-	5	8.3
1990-99	13	7	8	7	-	-	5	8.0
2000-09	5	6	5	5	1	-	1	3.8
2010-19	7	5	7	5	1	3	2	4.3
Average	8.3	5.4	5.8	7.0	1.0	3.0	3.3	5.4

**Table 3.4: Changing pattern of number of rainy days in Punjab**

Time period	North Eastern Region	Central Region			Western Plain Region	Western Region		Average
	Ballowal Saunkhri	Amritsar	Ludhiana	Patiala	Faridkot	Abohar	Bathinda	
1970-79	-	387	361	361	-	-	-	370
1980-89	-	399	389	377	-	-	269	359
1990-99	557	452	428	413	-	-	302	430
2000-09	475	357	376	328	254	-	245	339
2010-19	483	367	410	453	268	183	310	353
Average	505	392	393	386	261	183	282	370

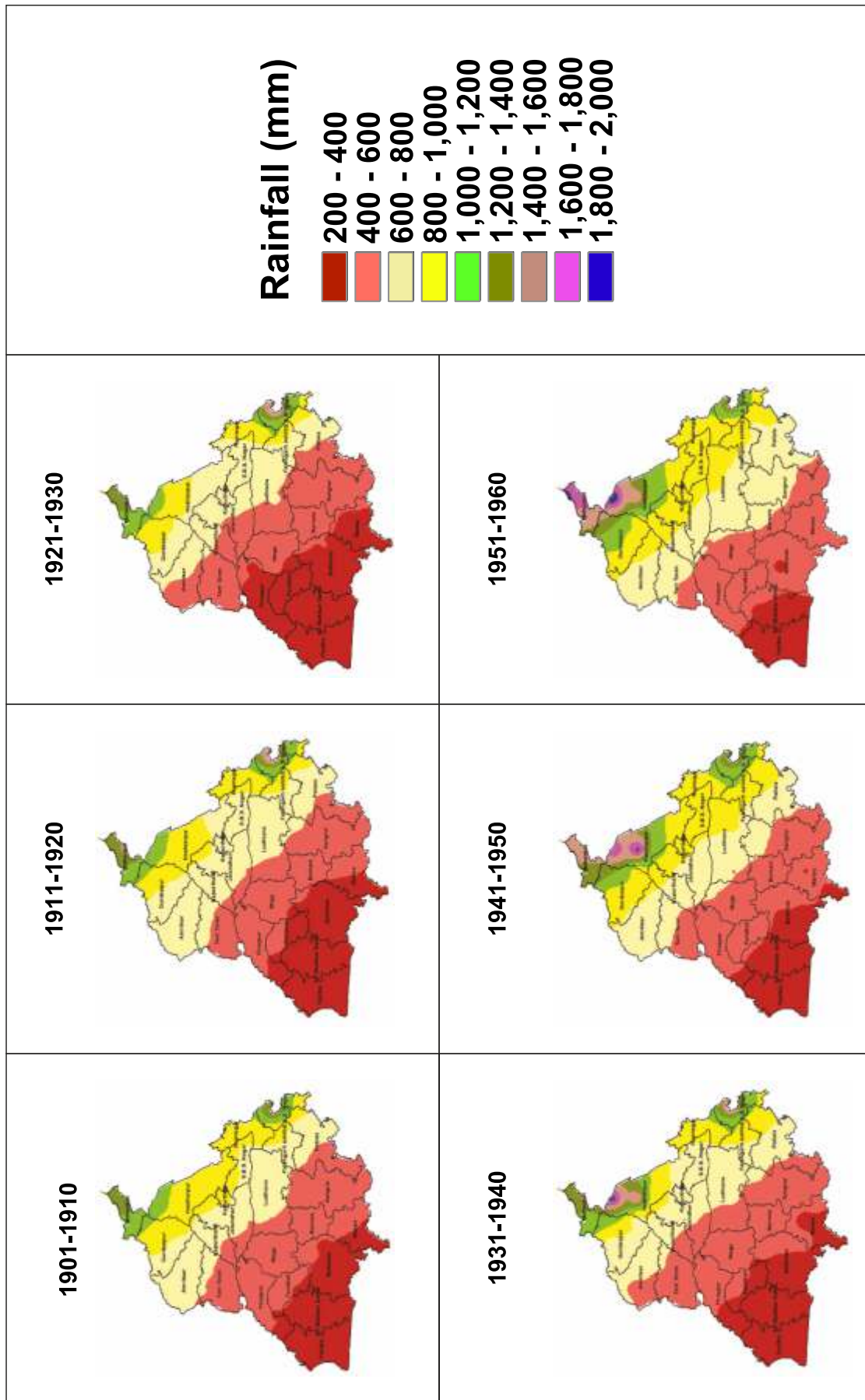


Figure 3.3: Variability in annual rainfall over past six decades in Punjab

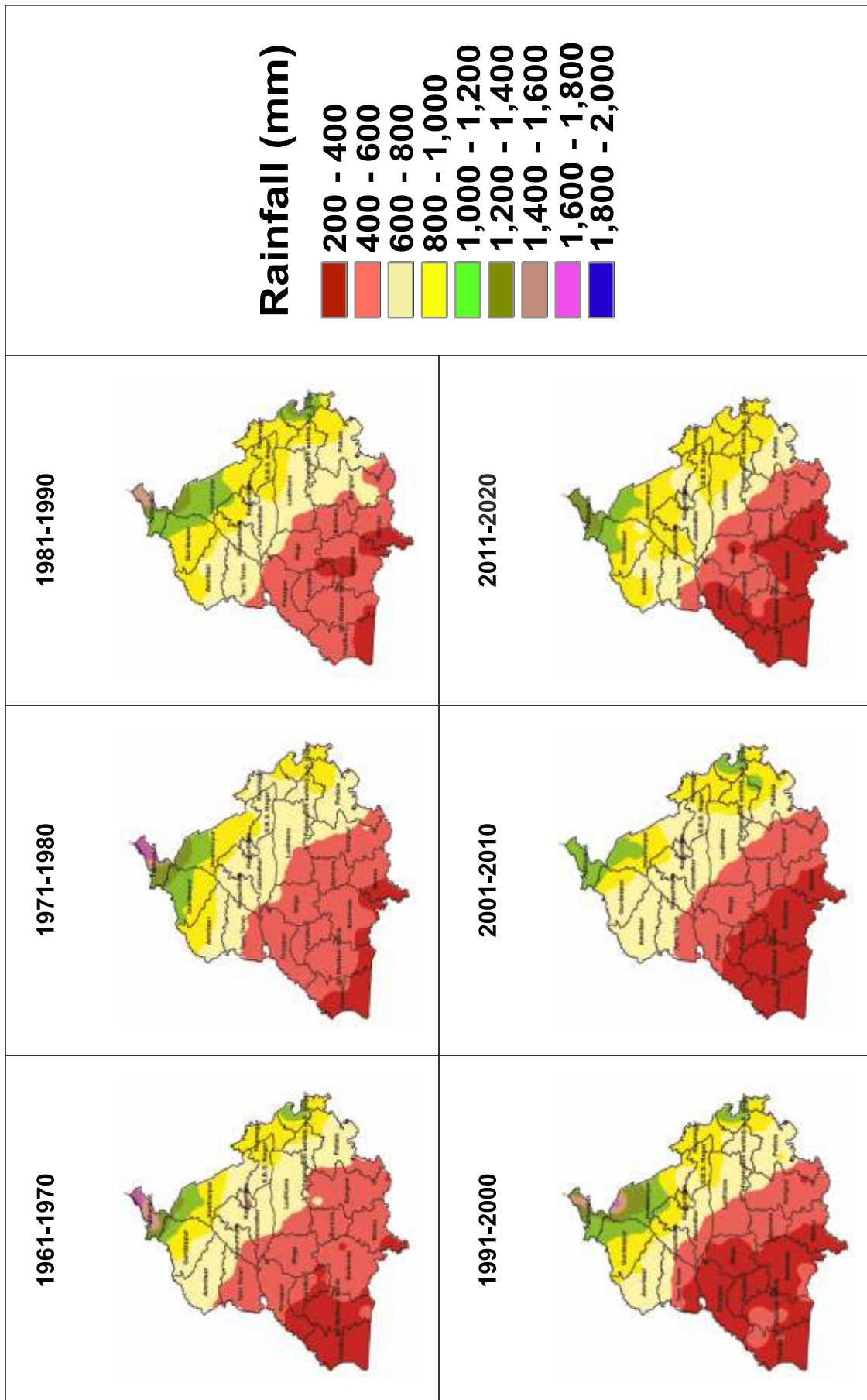


Figure 3.4: Variability in annual rainfall over past six decades in Punjab

The monsoon rainfall which constitutes 75-80% of the annual rainfall in the state has now become erratic and shows a declining trend. The duration of monsoon in the state is increasing either by early onset or late withdrawal, however, the amount of rainfall is declining (**Table 3.5** and **Figure 3.5**).<sup>41</sup> Further, Punjab experienced 16 years of deficit monsoon rainfall during the recent two decades (2000-2020).

**Table 3.5: Duration & variability of Monsoon in Punjab over past two decades**

Total Population	Onset date	Deviation from Normal (Days)	Withdrawal date	Deviation from Normal (Days)	Duration of monsoon season (Days)	Average rainfall (mm/day)	% Deviation of actual rainfall from normal
2001	24 <sup>th</sup> June	+7	18 <sup>th</sup> September	+3	87	5.51	+2.6
2002	19 <sup>th</sup> July	-18	20 <sup>th</sup> September	+5	64	5.32	-27.2
2003	5 <sup>th</sup> July	-4	27 <sup>th</sup> September	+12	85	5.28	-3.9
2004	8 <sup>th</sup> July	-7	27 <sup>th</sup> September	+12	82	3.19	-44.1
2005	29 <sup>th</sup> June	+2	28 <sup>th</sup> September	+13	92	4.51	-11.3
2006	10 <sup>th</sup> July	-9	25 <sup>th</sup> September	+10	78	5.21	-13.0
2007	4 <sup>th</sup> July	-3	2 <sup>nd</sup> October	+17	91	3.48	-32.2
2008	16 <sup>th</sup> June	+15	29 <sup>th</sup> September	+14	106	5.31	+20.5
2009	1 <sup>st</sup> July	0	28 <sup>th</sup> September	+13	90	3.38	-34.9
2010	5 <sup>th</sup> July	-4	28 <sup>th</sup> September	+13	86	5.01	-7.8
2011	26 <sup>th</sup> June	+5	26 <sup>th</sup> September	+11	93	3.64	-27.6
2012	9 <sup>th</sup> July	-8	25 <sup>th</sup> September	+10	79	3.19	-46.0
2013	16 <sup>th</sup> June	+15	19 <sup>th</sup> September	+4	96	4.91	+0.90
2014	3 <sup>rd</sup> July	-2	28 <sup>th</sup> September	+13	88	2.66	-50.0
2015	25 <sup>th</sup> June	+6	29 <sup>th</sup> September	+14	97	3.32	-31.0
2016	3 <sup>rd</sup> July	-2	5 <sup>th</sup> October	+20	95	3.67	-25.4
2017	19 <sup>th</sup> July	-18	30 <sup>th</sup> September	+15	74	4.94	-21.7
2018	28 <sup>th</sup> June	+3	1 <sup>st</sup> October	+16	96	5.85	+20.1
2019	17 <sup>th</sup> July	-16	10 <sup>th</sup> October	+25	86	5.04	-7.2
2020	25 <sup>th</sup> June	+6	30 <sup>th</sup> September	+15	98	3.95	-17.1
2021	13 <sup>th</sup> June	+18	8 <sup>th</sup> October	+23	118	3.68	-7.0
Normal	1 <sup>st</sup> July	-	15 <sup>th</sup> September	-	77	6.07	467mm

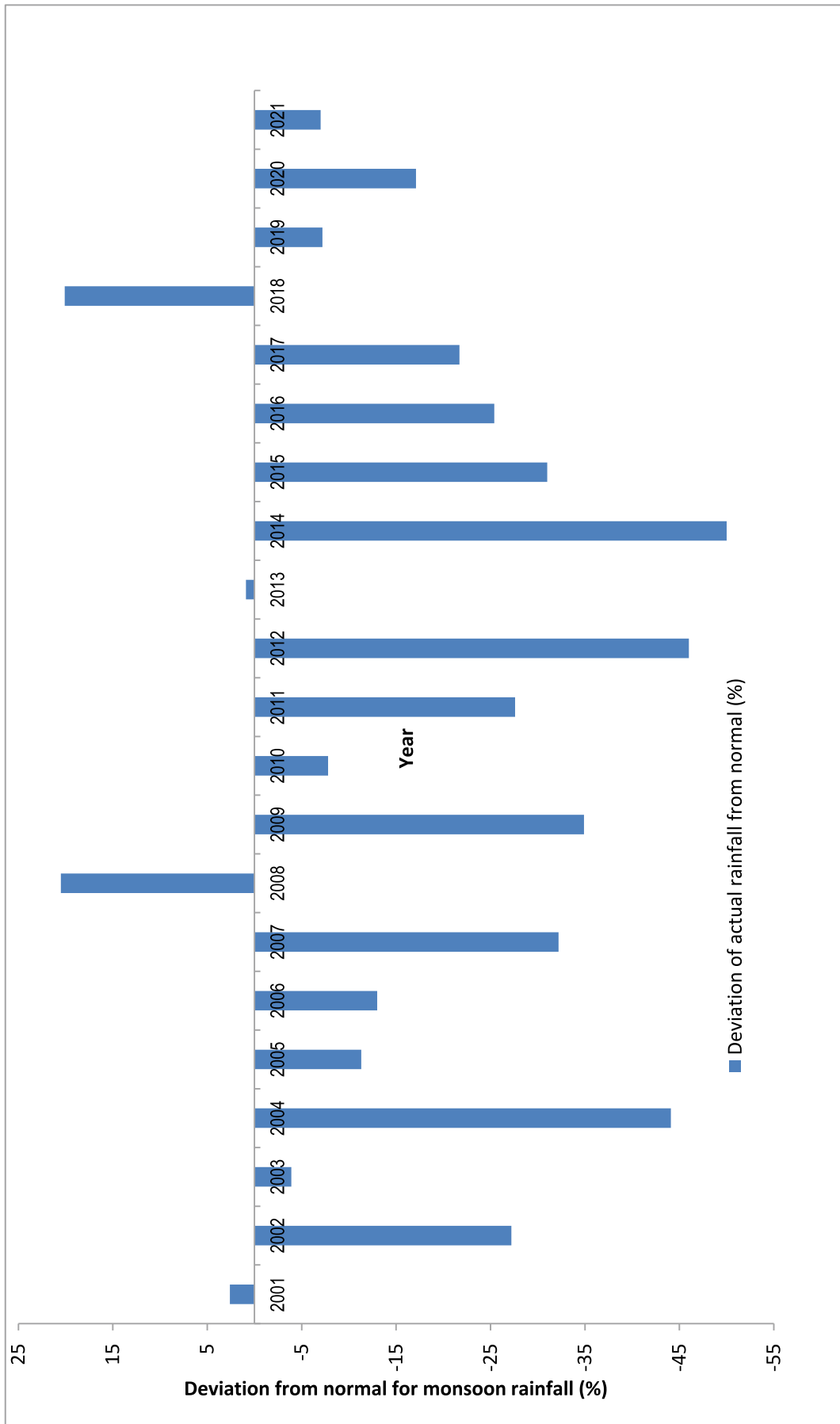


Figure 3.5: Variability in duration of monsoon rainfall from normal in Punjab (2001 to 2021)

## 3.2. Future Climate Projection & Analysis

According to the IPCC reports, the atmosphere of the earth is getting warmer due to climate change with a global mean temperature of approximately 1°C higher than that of the pre-industrial period. The IPCC has developed scenarios that act as a mechanism to assess the potential impacts on climate change. These Representative Concentration Pathways (RCPs) are referred to as pathways to highlight time dependent projection of Green House Gases (GHGs) concentrations. The RCPs are four GHG trajectories adopted by the IPCC–RCP2.6, RCP4.5, RCP6, and RCP8.5, named after a possible range of radiative forcing values in the year 2100 (Table 3.6).

**Table 3.6 : Description of Representative Concentration Pathways (RCPs)**

RCP	Description	Modelling Team
RCP 2.6	Its radiative forcing level first reaches a value around 3.1 Watt per square meter (W/m <sup>2</sup> ) during Mid-Century, returning to 2.6 W/m <sup>2</sup> by 2100. Under this scenario, emission of GHGs and air pollutants are diminished considerably over time.	IMAGE - Netherlands Environmental Assessment Agency
RCP 4.5	It is a stabilization scenario where total radiative forcing is stabilized before 2100 by employing a range of technologies and strategies for reducing GHG emissions	Mini CAM- Pacific Northwest National Laborator's Joint Global Change Research Institute
RCP 6.0	It is a stabilization scenario where total radiative forcing is stabilized after 2100 without overshoot by employing a range of technologies and strategies for reducing GHG emissions	AIM - National Institute for Environmental Studies, Japan
RCP 8.5	It is characterized by increasing GHG emissions over time leading to high GHG concentration levels	MESSAGE and IIASA- Integrated Assessment Framework at the International Institute for Applied Systems Analysis (IIASA), Austria

A number of studies have been undertaken for climate change projections based on different climate models. One such study based on Coordinate Regional Climate Down Scaling Experiment (CORDEX) South Asia, modelled climate data on precipitation, maximum temperature and minimum temperature for Mid-century (MC, 2021-2050) and End-century (EC, 2071-2100) with regard to baseline (BL, 1981-2010) for the State of Punjab<sup>44</sup> as per RCP4.5 and RCP8.5. The summary of projections for three time periods- Baseline (BL), Mid-century (MC) and End-century (EC) and for different seasons January-February (JF), MAM (March-April-May), JJAS (June-July-August-September) and OND (October-November-December) is as follows:

According to the IPCC reports, the atmosphere of the earth is getting warmer due to climate change with a global mean temperature of approximately 1°C higher than that of the pre-industrial period.

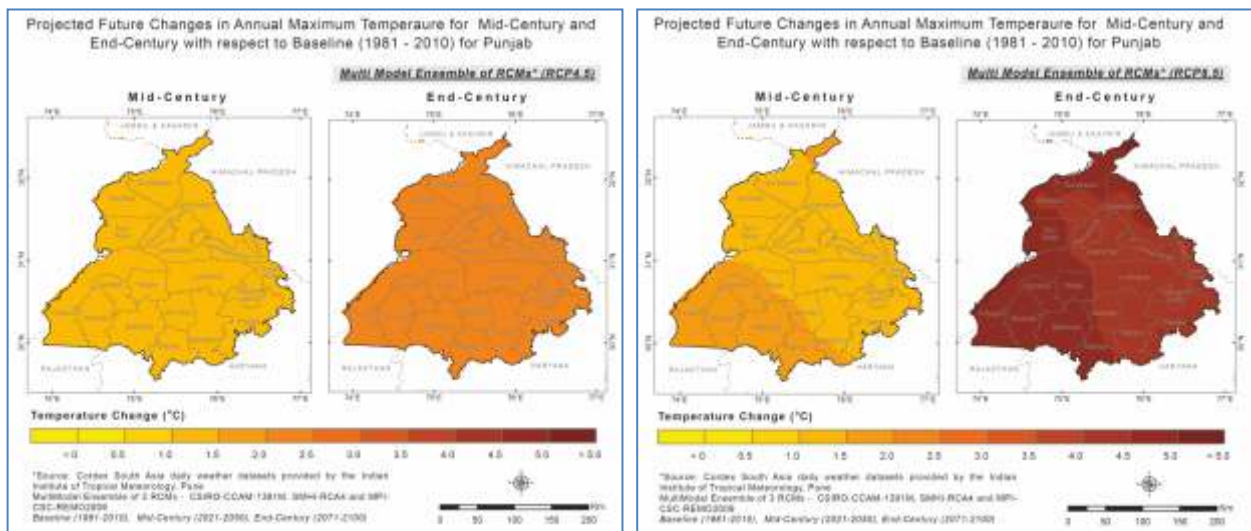


### 3.2.1 Temperature Projections for Punjab

#### Projected Maximum Temperature

- Average annual maximum temperature for RCP4.5 scenario is projected to increase by about 1.2°C towards Mid-century (MC) and by 2.1°C towards End-century (EC). However, for RCP8.5 scenario, it is projected to increase by about 1.4°C towards MC and 4.5°C towards EC (**Figure 3.6**).
- The projected increase in maximum temperature towards MC and EC does not show significant variation across the districts of Punjab for RCP4.5 scenario (**Figure 3.7**).
- The district-wise projected increase in maximum temperature varies from 1.4°C to 1.6°C towards MC. While, it varies from 4.3°C to 4.7°C towards EC for RCP8.5 scenario (**Figure 3.8**).
- Highest increase in maximum temperature is projected in pre-monsoon season (March–May) for both RCP4.5 and RCP8.5 scenarios towards MC and EC (**Figure 3.9**).

For both RCP4.5 and RCP8.5 scenarios, increase in annual and seasonal maximum temperature is projected towards MC and EC. However, RCP8.5 scenario shows higher increase than that of RCP4.5 scenario. Thus, projected increase in maximum temperature is higher in End-century than that of Mid-century.



**Figure 3.6: Spatial representation of projected changes in annual and seasonal maximum temperature for RCP4.5 & RCP 8.5 scenarios for Punjab**



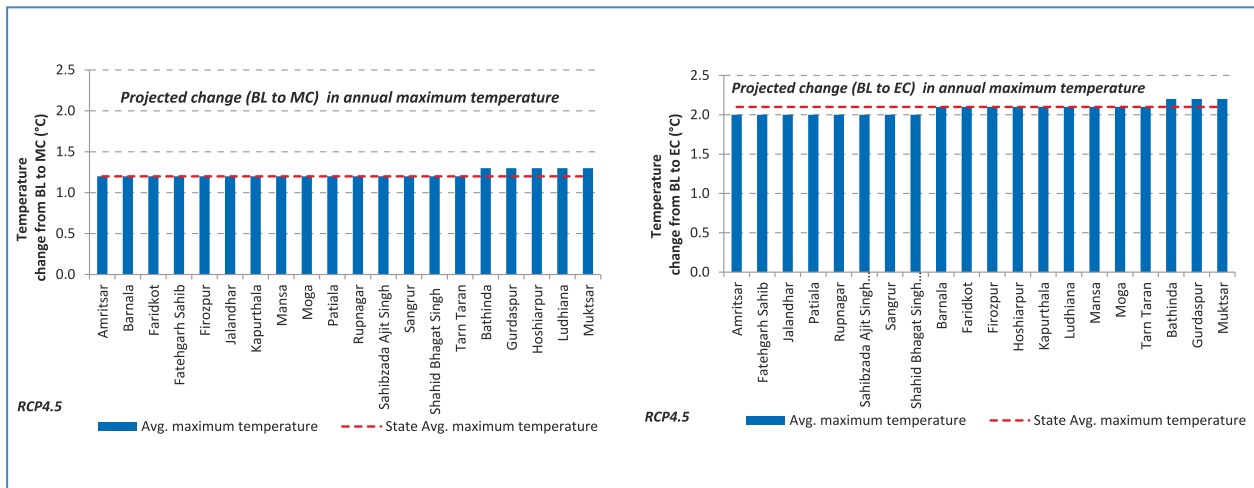


Figure 3.7: District-wise projected change in annual maximum temperature for RCP4.5 scenario

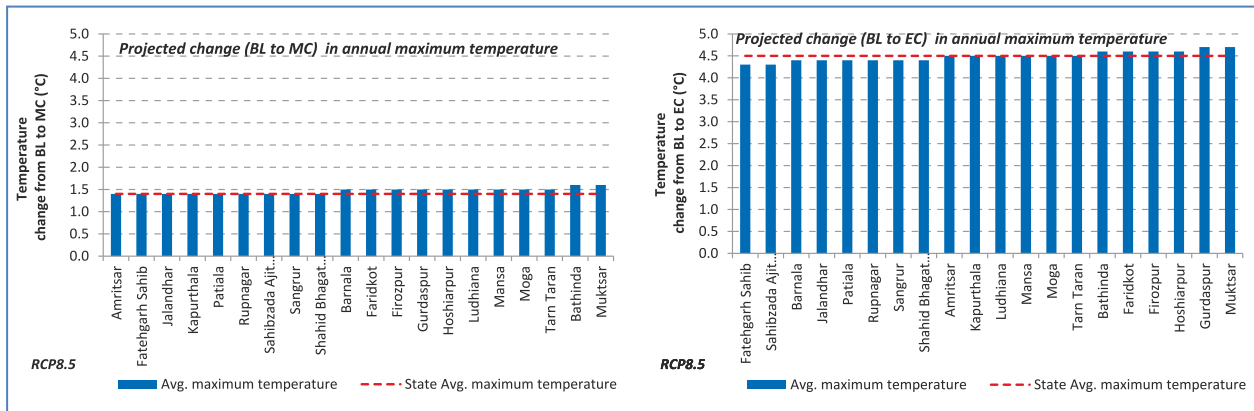


Figure 3.8: District-wise projected change in annual maximum temperature for RCP8.5 scenario

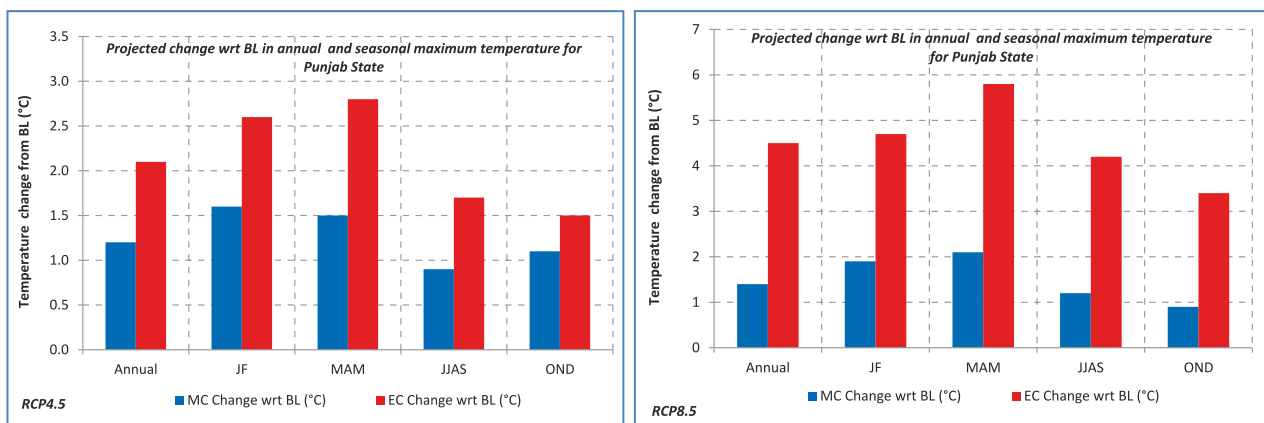


Figure 3.9: Projected change in annual and seasonal maximum temperature for RCP 4.5 and RCP 8.5

### Projected Minimum Temperature

- Average annual minimum temperature for RCP4.5 scenario is projected to increase by about 1.3°C towards MC and by 2.5°C towards EC. While for RCP8.5 scenario, it is projected to increase by about 1.7°C towards MC and 5.2°C towards EC for Punjab (Figure 3.10).
- The projected increase in minimum temperature towards MC does not show significant variation across the districts of Punjab for both RCP4.5 and RCP8.5 scenarios (Figure 3.11 & 3.12).
- The projected increase in minimum temperature towards EC varies from 2.4°C to 5.4°C for 8.5 scenario (Figure 3.11 & 3.12).
- The highest minimum temperature increase is projected in monsoon season (June - September) for RCP4.5 and RCP8.5 scenarios for both MC and EC as compared to the other seasons (Figure 3.13).

For both RCP4.5 and RCP8.5 scenarios, increase in annual and seasonal minimum temperature is projected for Punjab and its districts towards MC and EC. However, RCP 8.5 scenario shows higher increase than that of RCP4.5 scenario.

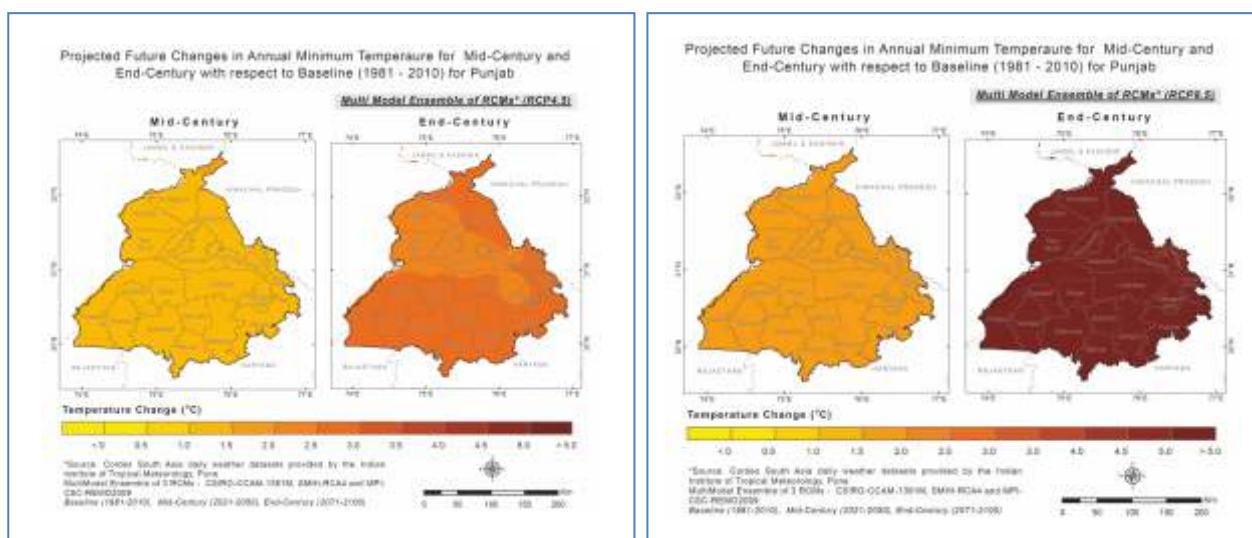


Figure 3.10: Spatial representation of projected changes in annual and seasonal minimum temperature for RCP4.5 & RCP 8.5 scenarios for Punjab

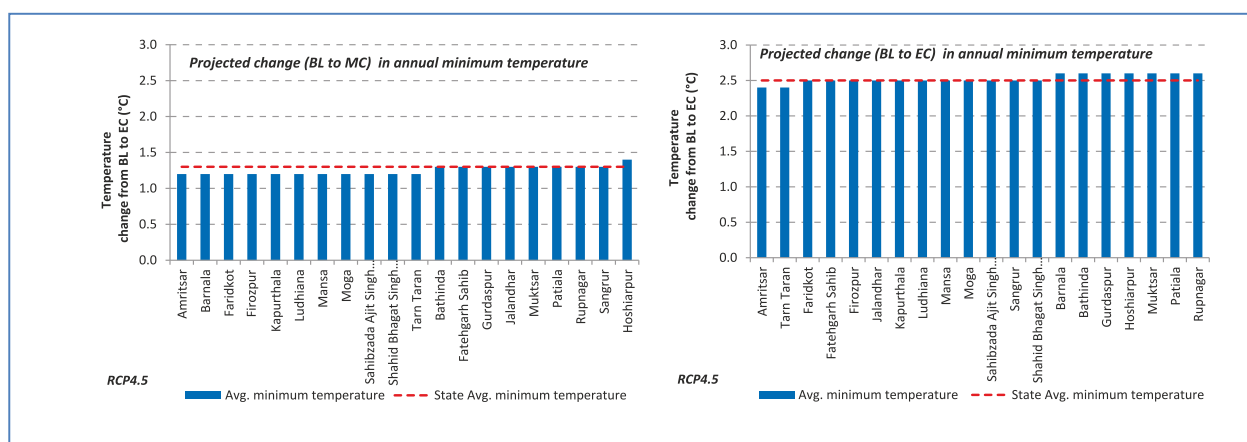


Figure 3.11: District-wise projected change in annual minimum temperature for RCP4.5 scenario

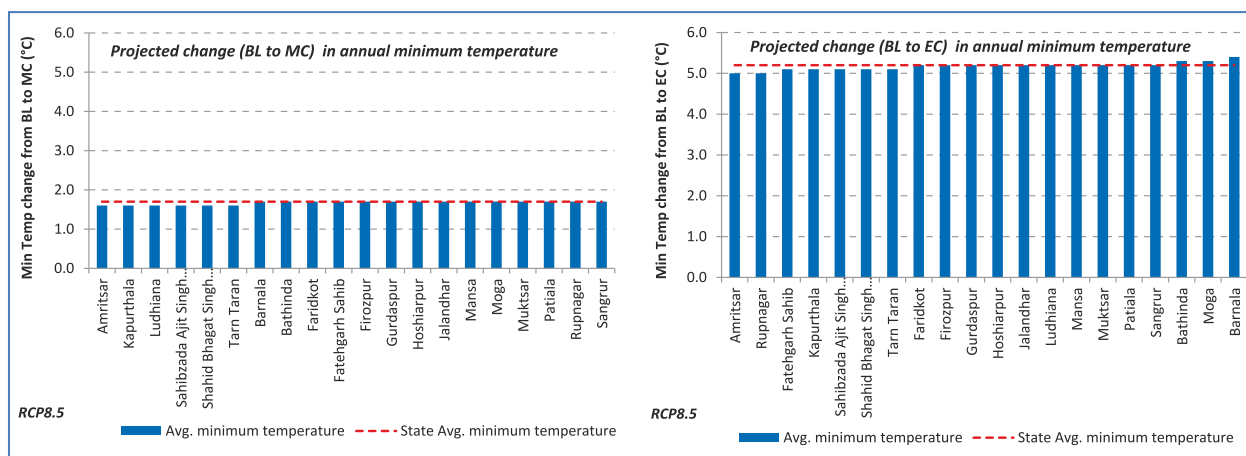


Figure 3.12: District-wise projected change in annual minimum temperature for RCP8.5 scenario

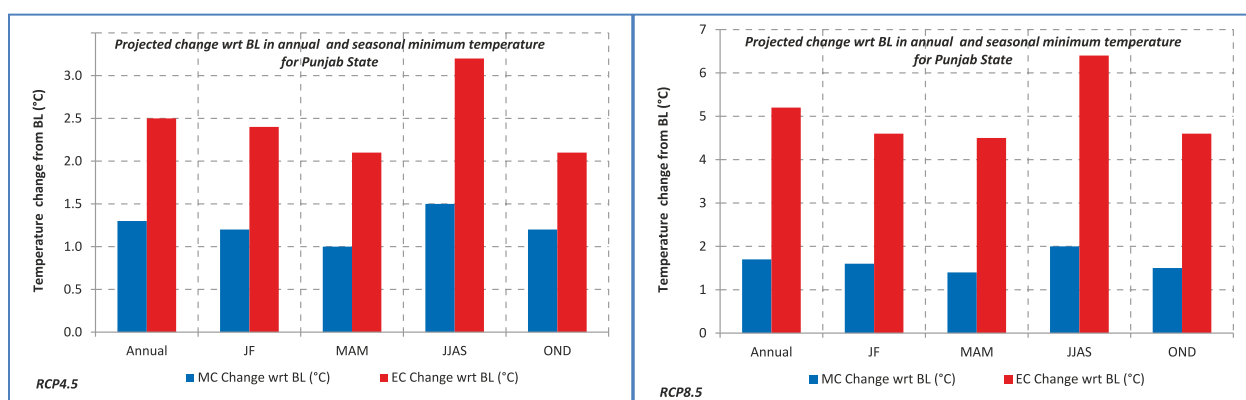


Figure 3.13: Projected change in annual and seasonal minimum temperature for RCP4.5 & RCP8.5

### 3.2.2 Precipitation Projections for Punjab

Summary of the projected change in precipitation for Punjab for RCP4.5 and RCP8.5 scenarios is as follows:

- Average annual rainfall for RCP4.5 scenario is projected to increase by 5.4% towards MC and increase by about 12.5% towards EC. While for RCP8.5 scenario, it is projected to increase by about 9.8% towards MC and 12.8% towards EC for the State (Figure 3.14).
- The Sub-mountain undulating zone of Punjab namely, Districts Gurdaspur and Hoshiarpur indicate highest increase in rainfall towards MC and EC with respect to Base Line (BL) for RCP4.5 scenario. Mansa district in South-Western zone shows the lowest increase towards both MC and EC (Figure 3.15).
- District Hoshiarpur indicates highest increase in precipitation followed by Gurdaspur & Rupnagar towards MC. Districts Gurdaspur and Hoshiarpur also show the highest increase in annual rainfall towards EC with respect to BL for RCP8.5 scenario (Figure 3.16).

In nut shell, the projected percent rainfall increase is low towards MC and EC for both the climate scenarios. In post monsoon season (October-December), the highest rainfall increasing trend is projected while in winter (January-February) and pre-monsoon season (March-May), decreasing rainfall trend has been projected towards MC and EC for both RCP4.5 and RCP 8.5 scenarios (Figure 3.17).

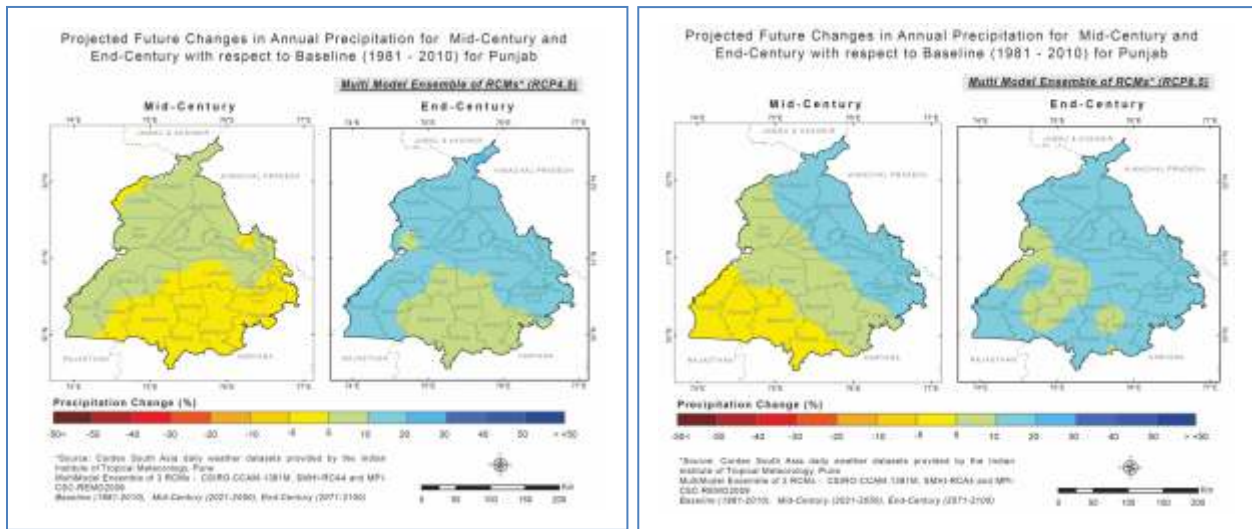


Figure 3.14: Spatial representation of projected changes in annual and seasonal precipitation for RCP 4.5 & RCP 8.5 scenarios for Punjab

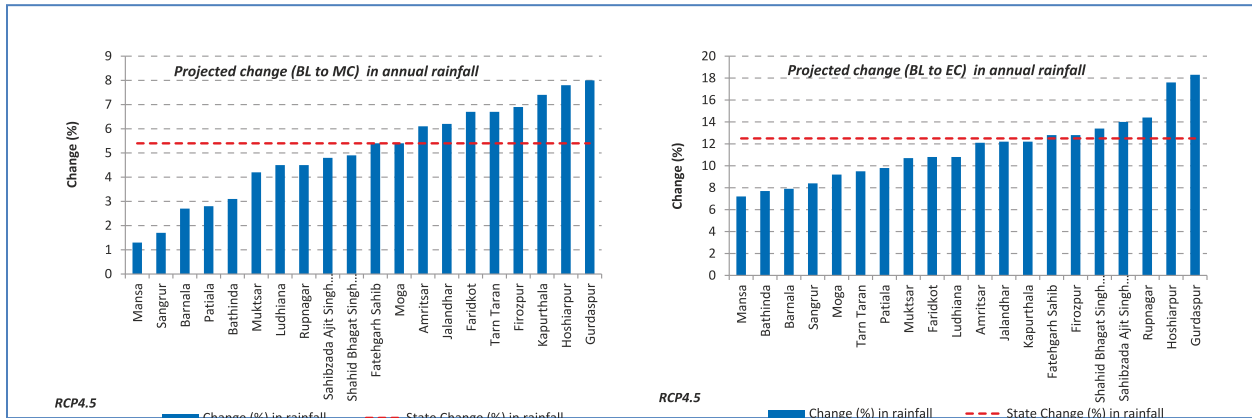


Figure 3.15: District level projected change annual precipitation for RCP4.5 scenario for Punjab

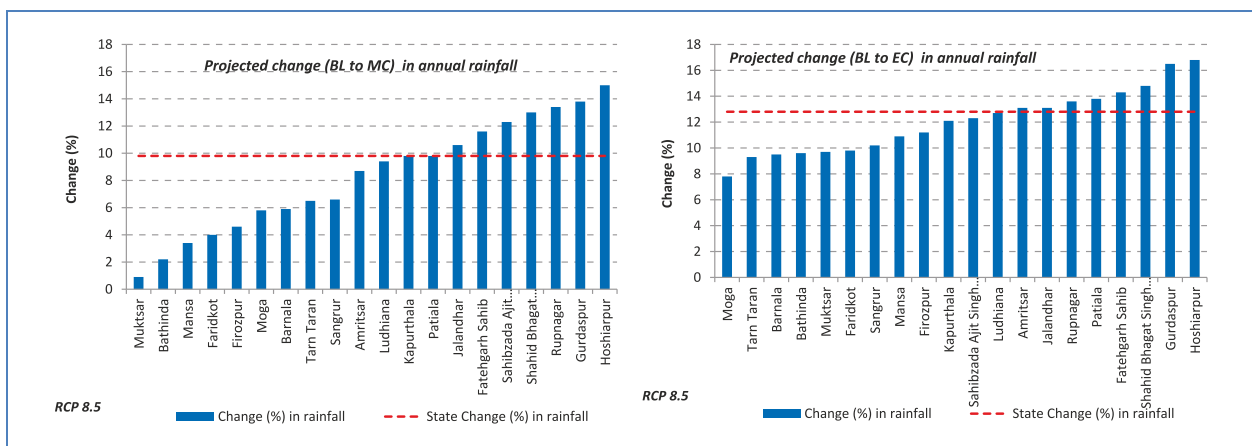
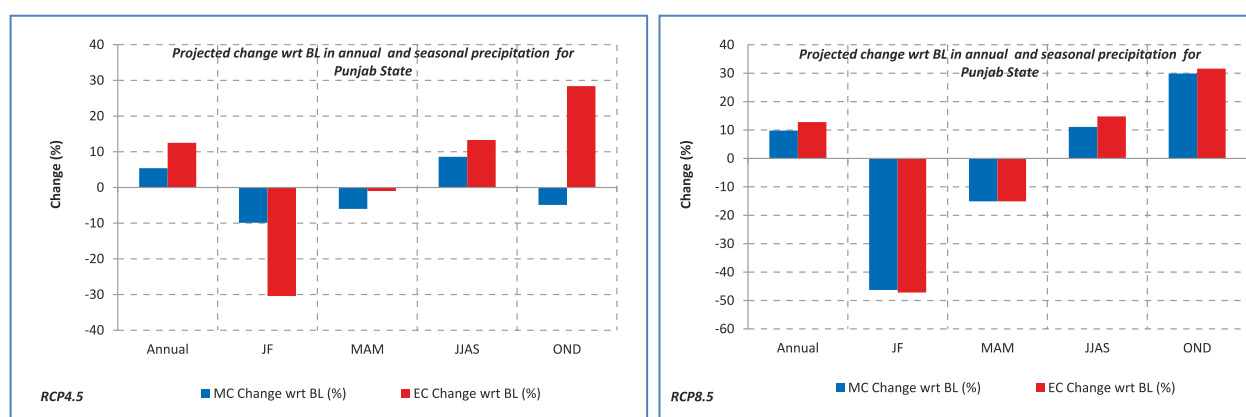


Figure 3.16: District level projected change in annual precipitation for RCP8.5 scenario for Punjab



**Figure 3.17: Projected annual & seasonal precipitation for RCP4.5 & RCP8.5 scenarios for Punjab**

The increase in mean temperatures indicates the increase in the likelihood of heat waves which can affect the human health. Furthermore, an increase in temperature will also directly influence the energy and irrigation water demand, thus, presumed to affect the food security as well. The seasonal variability in rainfall will further increase stress on water resources due to growing water demands and economic development that would elevate the use of depleting ground water resources.

### 3.3. Extreme events: risk, loss and damage due to climate change

Climate change is likely to affect the frequency and intensity of both temperature and precipitation related extreme events. The state is already facing various consequences of climate change, causing distress to all developmental and socio-economic sectors. Out of the 33 identified types of hazards by the High-Powered Committee (HPC)<sup>45</sup> on Disaster Management of the Government of India, Punjab is vulnerable to 21 types of hazards. These include climatic-induced hazards such as floods, hailstorms, heat & cold waves, drought, thunder & lightning, etc. Detrimental challenges of these hazards may directly or indirectly affect agricultural yield, water yield, net primary productivity of forest, energy security, etc. in the region.<sup>46,47</sup> A summary of the climatic events evidenced in the recent past are as following:

- Snow fall in Pathankot district during Jan 06-07, 2011.
- 400 mm rainfall in 24 hours at Ludhiana city on Aug 12, 2011.
- Extreme low temperature of -0.4 °C at Bathinda district on Feb 09, 2012.
- Prolonged winters (cold wave spell) in year 2012 compared with the past.
- District Ludhiana witnessed monthly average of maximum temperature in December 2019, which was the lowest of the preceding 22 years.
- District Ludhiana received rainfall of 1156 mm against normal of 760 mm in the year 2019.

Further, higher number of frost days was witnessed in many districts of the State during the year 2018-19 compared to previous years (Table 3.7). The State has also witnessed floods and drought many times during the last few decades. The most flood prone areas of the state are depicted in Figure 3.18.<sup>48</sup> A summary of population affected due to floods in Punjab has been tabulated in Table 3.8.<sup>48</sup> However, the state has also experienced drought six time in the years i.e. 1978, 1979, 1985, 1987, 2002, and 2004, both in rural and urban areas. Out of these, the droughts in the year 1987 and 2002 were severe, when the state declared all the districts as drought-affected. Occasionally, Punjab has also witnessed hailstorms that caused huge damage to the standing crops.



Table 3.7 : Number of frost days witnessed in different regions of Punjab

Increase in number of frost days in different districts of Punjab										
Month	Gurdaspur		SBS Nagar		Ludhiana		Bathinda		Faridkot	
	2017-2018	2018-2019	2017-2018	2018-2019	2017-2018	2018-2019	2017-2018	2018-2019	2017-2018	2018-2019
December	0	9	1	8	0	16	2	15	7	16
January	12	10	7	3	3	10	15	12	8	14
Total	12	19	8	11	3	26	17	27	15	30

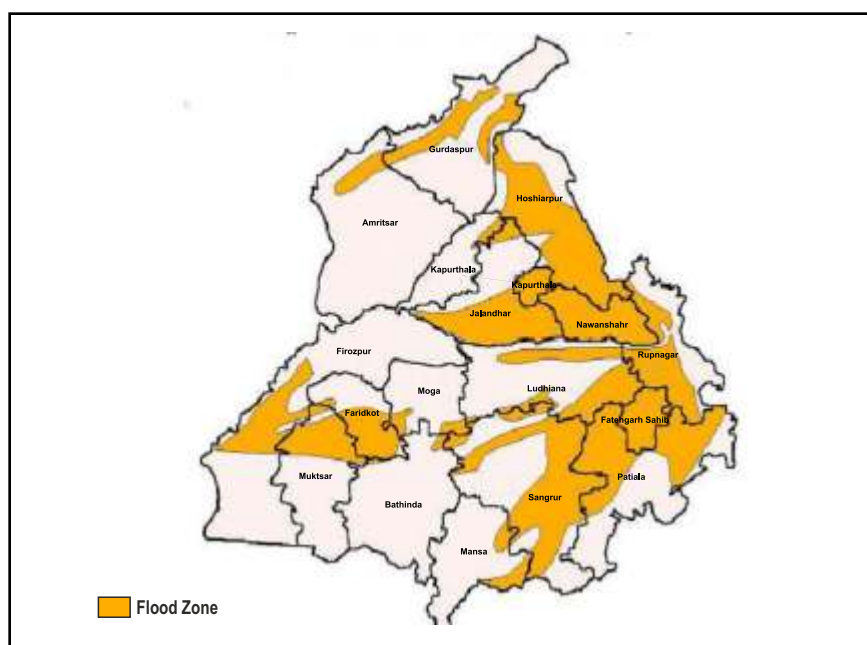


Figure 3.18: Flood prone districts of Punjab



**Table 3. 8: No. of villages/towns affected, human lives and cattles sacrificed due to floods in Punjab**

Year	Number of villages affected	Area affected (sq.-km)	Population affected	Human casualties	Cattle heads lost
1988	1483	-	200000	607	-
1994	469	-	29541	41	369
1995	6585	2788	212099	157	1310
1997	677	-	-	28	100
1998	-	126	176	22	14
1999	30	29	-	12	-
2000	81	127	319	5	88
2003	43	47	25	3	-
2004	480	610	60157	15	511
2006	442	211	405933	10	23
2007	1033	1035	405911	7	3
2008	2001	5004	389116	34	104
2010	1884	100000	-	29	112
2016	37	5477	20293	6	2
2017	-	7.13	10	-	5
2018	-	7.13	10	-	5
2019	469	58197	48063	20	20

The State has prepared its Disaster Management Plan in the context of natural and man-made disasters to facilitate execution of activities for prevention and preparedness, operations, coordination and community awareness. Further, District Disaster Management Authority (DDMA) and District Disaster Management Committees (DDMC) have been set up to prepare and execute District level Disaster Management Plans comprising measures towards preparedness, mitigation, response and recovery from disasters.





Village level Participatory Rural Appraisal (PRA) Exercise at village Cholti Kehri, Fatehgarh Sahib

# Chapter 4

## VULNERABILITY ASSESSMENT





## 4.0: Vulnerability Assessment

Vulnerability to climate change is a complex and dynamic phenomenon that involves social, physical and environmental aspects. The Intergovernmental Panel on Climate Change (IPCC) has defined vulnerability to climate change as “the propensity or predisposition to be adversely affected” and describes it as a function of sensitivity and adaptive capacity. Further, climate change impact related risks arise as a result of dynamic interactions between climate related hazards, the exposure and vulnerability of the affected human or ecological system to the hazards (Figure 4.1).

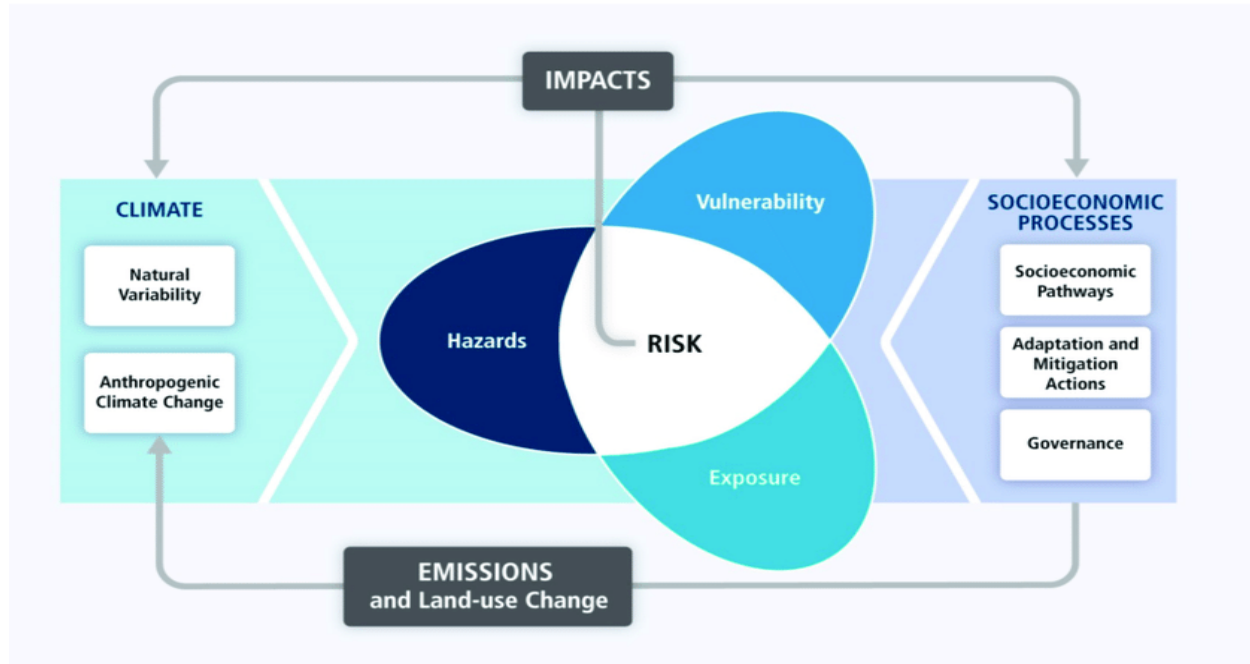


Figure 4.1: IPCC AR5 conceptual framework with risk at the center<sup>49</sup>

Thus, vulnerability assessment of various districts of Punjab due to climate change has been conducted by Punjab State Climate Change Knowledge Centre, PSCST as per the uniform National Framework of DST, GoI developed by IIT Guwahati, IIT Mandi & IISc Bangalore. Based on the similar studies carried out by all the States in 2019-22 using the said common framework, DST, GoI has released a PAN-India study Report on District Level Vulnerability Assessment titled 'Climate Vulnerability Assessment for Adaptation Planning in India'.

Vulnerability assessment of various districts of Punjab has been carried out as per the uniform National Framework of DST.

## 4.1 District level climate change vulnerability

### 4.1.1 Approach and Methodology

Department of Science & Technology, Govt. of India has developed a uniform framework of District level climate change vulnerability assessment comprising 26 indicators, based on methodological framework as described in IPCC-2014. Out of the 26 indicators suggested under framework, 15 indicators (**Table 4.1**) were selected in consultation with the experts based on data availability, statistical correlation, etc. to get a rational and more realistic conclusion. Further, equal weights were assigned to each indicator to calculate the vulnerability indices of districts. The steps followed for assessing district level vulnerability as per the uniform framework of DST, GoI are as under:

- Step 1:** Identification, definition and selection of indicators for vulnerability assessment.
- Step 2:** Classification of indicators data (indicators) into two categories i.e adaptive capacity and sensitivity.
- Step 3:** Quantification of all selected indicators using secondary sources of data.
- Step 4:** Normalization of indicators data to make the indicators comparable since values are expressed in a variety of statistical units, ranges or scales.
- Step 5:** Assigning of weights to indicators. A Principal Component Analysis (PCA)-based weight assignment technique was assigned for differential weights to indicators. But results from PCA suggested almost equal weights for all indicators, so equal weights were assigned.
- Step 6:** Vulnerability ranking of districts based on the calculated index values. Where, Rank 1 depicts most vulnerable (highest index values) & Rank 22 (no. of districts in Punjab in 2019-20 were 22) depicts least vulnerable (lowest index values).

For district level vulnerability analysis, a total of 15 indicators were selected and equal weights were assigned to each indicator to calculate the vulnerability indices of districts.



The list of indicators used for current district level vulnerability assessment along with their functional relationships is presented in **Table 4.1**.

**Table 4.1: List of indicators of Punjab's Framework for District-Level Vulnerability Assessment**

S. No.	Indicators	Adaptive Capacity / Sensitivity	Functional relationship
1	Per capita income/annum (in INR)	Adaptive Capacity	Negative
2	Livestock per 1000 rural population	Adaptive Capacity	Negative
3	Female workforce (main & marginal works) (Nos.)	Adaptive Capacity	Negative
4	Forest Area per 1000 rural population	Adaptive Capacity	Negative
5	Coefficient of variation in yield variability of food grains (Rice, wheat) (tonne/ha)	Sensitivity	Positive
6	Road density (km/km <sup>2</sup> )	Adaptive Capacity	Negative
7	Rural Banks per 1000 Rural Population	Adaptive Capacity	Negative
8	Average person days/ household employed under MGNREGA (2015-20)	Adaptive Capacity	Negative
9	Cases of Vector borne diseases per 1000 population	Sensitivity	Positive
10	Cases of Water borne diseases per 1000 population	Sensitivity	Positive
11	No. of doctors, specialists, health assistants & health workers per 1000 population	Adaptive Capacity	Negative
12	Infant Mortality Rate	Sensitivity	Positive
13	Water Scarcity	Sensitivity	Positive
14	Number of NRM works per 1000 ha	Adaptive Capacity	Negative
15	Value of horticultural (perennial) output against value of agricultural output	Adaptive Capacity	Negative

#### 4.1.2 Summary of district vulnerability assessment

The assessment indicated that the highest (0.74) and the lowest (0.47) vulnerability index was in district Tarn Taran and Ludhiana, respectively. The range of the Vulnerability was divided into four categories as under:

- Low: 0.45 to 0.55
- Medium: 0.55 to 0.60
- High: 0.60 to 0.70
- Very high: 0.70 to 0.80

Based on the categorisation, it was observed that Tarn Taran has very high vulnerability towards climate change, followed by eight districts categorised as having high vulnerability and eight districts as having medium vulnerability. The remaining five districts namely Hoshiarpur, Rupnagar, Fatehgarh Sahib, SAS Nagar and Ludhiana have low vulnerability. **Table 4.2** and **Figure 4.2** provide the district vulnerability index.

**Table 4.2: District Level Vulnerability Index (VI)**

S. No.	Districts	VI	Category
1	Tarn Taran	0.74	Very High
2	Moga	0.69	High
3	Gurdaspur	0.66	High
4	Mansa	0.64	High
5	Barnala	0.64	High
6	Ferozepur	0.63	High
7	Bathinda	0.62	High
8	Sangrur	0.62	High
9	Kapurthala	0.61	High
10	Sri Muktsar Sahib	0.59	Medium
11	Faridkot	0.59	Medium
12	Fazilka	0.59	Medium
13	Jalandhar	0.58	Medium
14	Patiala	0.58	Medium
15	Pathankot	0.58	Medium
16	Amritsar	0.56	Medium
17	SBS Nagar	0.56	Medium
18	Hoshiarpur	0.51	Low
19	Rupnagar	0.51	Low
20	Fatehgarh Sahib	0.48	Low
21	SAS Nagar	0.48	Low
22	Ludhiana	0.47	Low

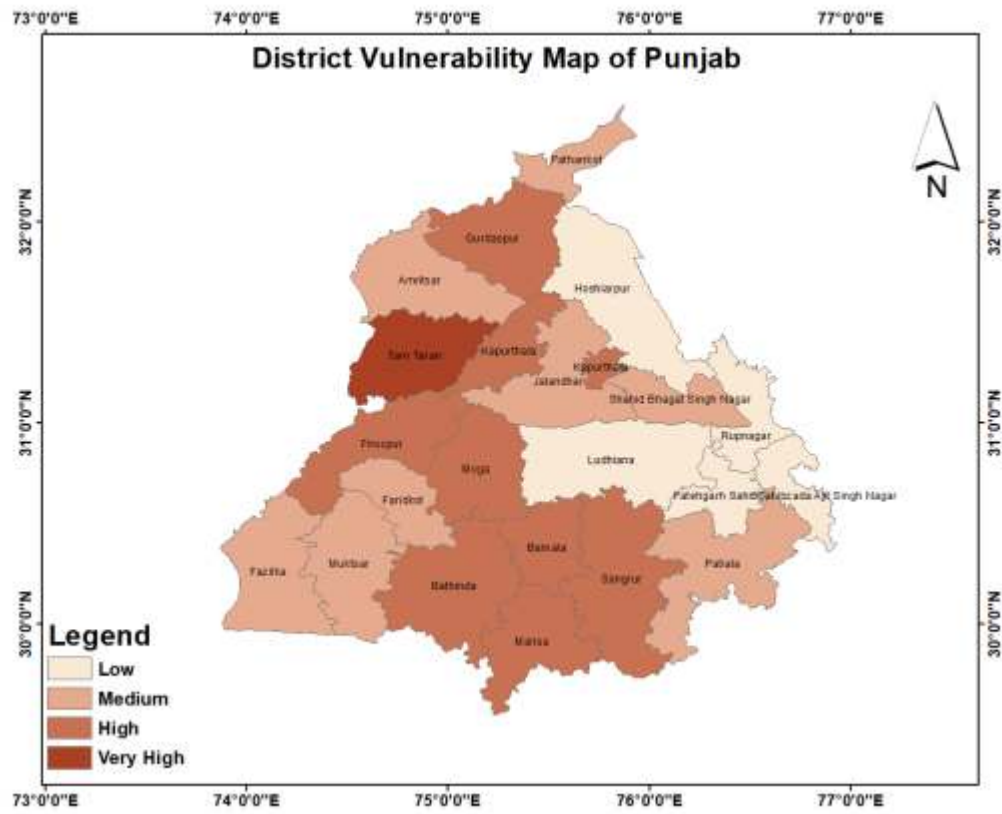


Figure 4.2: Map representing Vulnerability Index of 22 Districts



## 4.2 Sectoral vulnerability & impacts

Punjab State Climate Change Knowledge Centre, PSCST has planned to carry out vulnerability assessment studies of key sectors of the State including agriculture and water sectors, in near future. However, the broad projected impacts of climate change on the various sectors are presented in **Table 4.3**.

**Table 4.3: Projected climate change impacts on different sectors**

S. No.	Sector	Projected key impact due to climate change
1	Forest and Biodiversity	<ul style="list-style-type: none"> <li>• Change in vegetation type, ecosystem degradation and decline in ecosystem services</li> <li>• Loss in biodiversity, increase in invasive species and forest fires, etc</li> <li>• Extreme precipitation may increase soil erosion. This may lead to degradation of soil fertility, loss in soil nutrients, etc</li> </ul>
2	Agriculture & allied sectors	<ul style="list-style-type: none"> <li>• Decline in crop duration and grain yield with increase in temperature</li> <li>• Increase in incidences of pest due to longer transmission windows</li> <li>• Increase in heat stress may hinder growth of animals, reduce reproduction efficiency and decrease production of milk and eggs</li> <li>• Increase in water temperature may result in increased fish mortality and reduce productivity</li> </ul>
3	Water	<ul style="list-style-type: none"> <li>• Groundwater resources will decrease significantly with increase in temperature</li> <li>• Decline in water quality due to increased load of pollutants</li> </ul>
4	Health	<ul style="list-style-type: none"> <li>• Increase in incidences of vector borne diseases viz. Malaria, Dengue, Chikungunya</li> <li>• Heavy rainfall &amp; high temperature may increase the risk of water borne diseases</li> <li>• Warmer air temperatures influence the concentration of regional air pollutants and thus may increase allergies &amp; respiratory diseases</li> </ul>
5	Energy	<ul style="list-style-type: none"> <li>• Drought and water scarcity due to climate change may affect the energy production and reliability</li> <li>• Warmer temperatures may increase the energy demand for cooling in summers</li> <li>• Climate impacts may affect the entire energy-supply chain including infrastructure and transmission</li> <li>• Increase in O&amp;M cost of transmission and distribution system due to higher rate of failures in extreme weather events such as windstorms and floods</li> </ul>
6	Urban	<ul style="list-style-type: none"> <li>• Highly populated areas are more prone to heat island effects, causing an effective increase in ambient temperature</li> <li>• Increase in the events of flash flooding due to heavy precipitation</li> <li>• Climate changes may further lead to socio-economic changes, including migration patterns</li> </ul>

Keeping in view the importance of agriculture sector in driving economy of the State as well as its sensitivity to changes in the climate (increasing temperatures, weather variability, shifting agro-ecosystem boundaries, invasive weeds & pests and frequency of extreme weather events), relevant information from studies pertaining to agriculture sector has been consolidated.

Impact of climate change on Indian agriculture was studied under National Innovations in Climate Resilient Agriculture (NICRA).<sup>50</sup> Simulation studies using integrated modelling framework showed that rainfed rice yields in the country are projected to reduce marginally (<2.5%) in 2050 and 2080 scenarios while irrigated rice yields are projected to reduce by 7% in 2050 and 10% in 2080 scenarios. Climate change is projected to reduce wheat yield by 6-25% towards the end of the century with significant spatio-temporal variations. Climate change in 2050 and 2080 scenarios is projected to reduce the kharif maize yields by 18 to 23%. Further, kharif groundnut yields are projected to be increased by 4-7% in 2050 scenarios whereas in 2080 scenario the yield is likely to decline by 5%. Future climates are likely to benefit chickpea with increase in productivity (23-54%).

Climate change studies carried out by researchers have projected changes in yield of major crops in Punjab w.r.t different emission scenarios (**Table 4.4**).<sup>51,52</sup> Based on the studies, decline in wheat yield by 29.6-46.4%, maize by 34.6-77.8% is projected both in Mid-Century and End-Century while decline in rice yield is projected by 13.3% in End Century under, RCP 8.5 scenario. However, increase in rice yield is expected by 17.3% in Mid-Century under RCP 8.5 scenario.

**Table 4.4: Projected changes in yield of major crops in Punjab**

Crop	RCP 2.6		RCP 4.5		RCP 6.0		RCP 8.5	
	MC	EC	MC	EC	MC	EC	MC	EC
Wheat	-	-	-	-	-	-	-29.6%	-46.4%
Rice	-	-	-11.1%	-16.2%	-	-	+17.3%	-13.3%
Maize	+8.1%	-31.8%	-20.9%	-31.3%	+8.8%	-46.5%	-34.6%	-77.8%

MC- Mid Century; EC- End Century



In the year 2022 itself, abnormal increase in maximum and minimum temperatures have severely impacted crops, fruits, vegetables and animals in the state of Punjab besides other States.<sup>53, 54</sup> The heat wave coincided with grain filling and development stage of wheat, yellowing shrivelling of grain and forced maturity, resulting in reduction of crop yields by 15-25%. High temperatures also resulted in moisture stress, sun burn, flower drop and less fruit setting in horticultural crops such as kinnow, pomegranate, mango and lemon. Similarly, in case of vegetables, significant impact was observed in vegetables, especially in tomato and cucurbits. Loss of appetite and higher body temperature was also observed in milch animals, which has reportedly led to reduction of milk yield up to 15%. The extreme temperatures also resulted in drop in egg production and increased broiler mortality.

Further, climate change and gender inequalities are inextricably linked. Women are highly vulnerable and susceptible to the impacts of climate change, owing to their intrinsic physical characteristics. The ability to cope up and adapt to various climate related hazards in a similar circumstance, is different for men and women. These variations have been summarised in **Table 4.5** below.

**Table 4.5: Climate Change Impacts and specific vulnerabilities of women<sup>55</sup>**

Climate Change Impacts	Women's Vulnerabilities
Lower food production	<ul style="list-style-type: none"> <li>• Can result in macro and micronutrient deficiencies in women, especially during reproductive years, resulting in long-term negative development impacts for society as a whole.</li> <li>• Likely hike in food-price with negative repercussions for female household heads.</li> </ul>
Reduction in water availability and declining water quality	<ul style="list-style-type: none"> <li>• Access to safe water is critical to the health of women during pregnancy and their families.</li> </ul>
More natural disasters – cyclones, floods, waterlogging and droughts; infrequent rains; intense rains	<ul style="list-style-type: none"> <li>• Women disproportionately suffer the impacts of disasters, severe weather events and climate change because of inequitable distribution of roles and resources.</li> </ul>





# Chapter 5

## CLIMATE CHANGE STRATEGY- ADAPTATION





## 5.0: Climate Change Strategy-Adaptation

The world's climate will continue to change in the coming century at rates projected to be unprecedented. Since, climate risk cannot be reduced to zero, every sector and community needs to adapt itself to cope with these changes and avoid drastic losses and damages. Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts.<sup>56</sup>

Parties to the UNFCCC and its Paris Agreement have also recognized that adaptation is a key component for long-term response to climate change in order to protect people, livelihoods and ecosystems. Therefore, countries need to plan and implement adaptation actions to respond to the impacts of climate change that are already happening, as well as prepare for future impacts.

### Priority sectors for adaptation

The sectors including forest, ecosystem, biodiversity, agriculture, water and health have been identified as the key adaptation areas in line with National Action Plan on Climate Change. Accordingly, five State Missions namely Forest, Ecosystem and Biodiversity; Sustainable Agriculture; Water; Health and Strategic Knowledge have been included in SAPCC 2.0 under State's Adaptation Strategy.

Various sectoral adaptation strategies have been framed under each of these Missions for the period 2021-30. Although the chapter is adaptation-centric, many of the actions contained are yielding significant mitigation co-benefits as well. **Table 5.1** indicates the linkage of State's Missions identified under Adaptation Strategy of SAPCC 2.0 with the other relevant State Action Plans.



Nanak Bagichi Nursery at Patiala Forest division

**Table 5.1: State Missions put forward for climate adaptation in SAPCC 2.0 and other existing aligned Action Plans**

State Missions outlined in SAPCC 2.0 for climate Adaptation	Relevant Existing Action Plans
State Mission on Forest, Ecosystem and Biodiversity	<ul style="list-style-type: none"> <li>• 4 SAP (4 years Strategic Action Plan) 2019-23</li> <li>• Green Punjab Sub-Mission under Mission Tandarust Punjab</li> </ul>
State Mission on Sustainable Agriculture	<ul style="list-style-type: none"> <li>• 4 SAP 2019-23</li> <li>• Safe Food &amp; Healthy Soil Sub-Missions under Mission Tandarust Punjab</li> </ul>
State Mission on Water	<ul style="list-style-type: none"> <li>• 4 SAP 2019-23</li> <li>• Clean Water Sub-Mission under Mission Tandarust Punjab</li> <li>• State Action Plan for Clean Rivers</li> <li>• State Action Plan for Rejuvenation of Ponds</li> <li>• State Action Plan on Reuse of Treated Wastewater</li> </ul>
State Mission on Health	<ul style="list-style-type: none"> <li>• State Action Plan for Climate Change and Human Health</li> <li>• Nutrition &amp; Preventive Health Sub-Missions under Mission Tandarust Punjab</li> </ul>
State Mission on Strategic Knowledge for Climate Change	<ul style="list-style-type: none"> <li>• Mission Innovate Punjab</li> <li>• Setting up of Climate Change Knowledge Centre</li> <li>• Action Plan for capacity building of stakeholder department</li> </ul>

The chapter also includes mission-wise progress mapping vis-a-vis strategies of SAPCC 1.0. Moreover, forward-looking strategies have been brought out under each Mission after extensive consultations with relevant stakeholders departments for the period 2021-30.



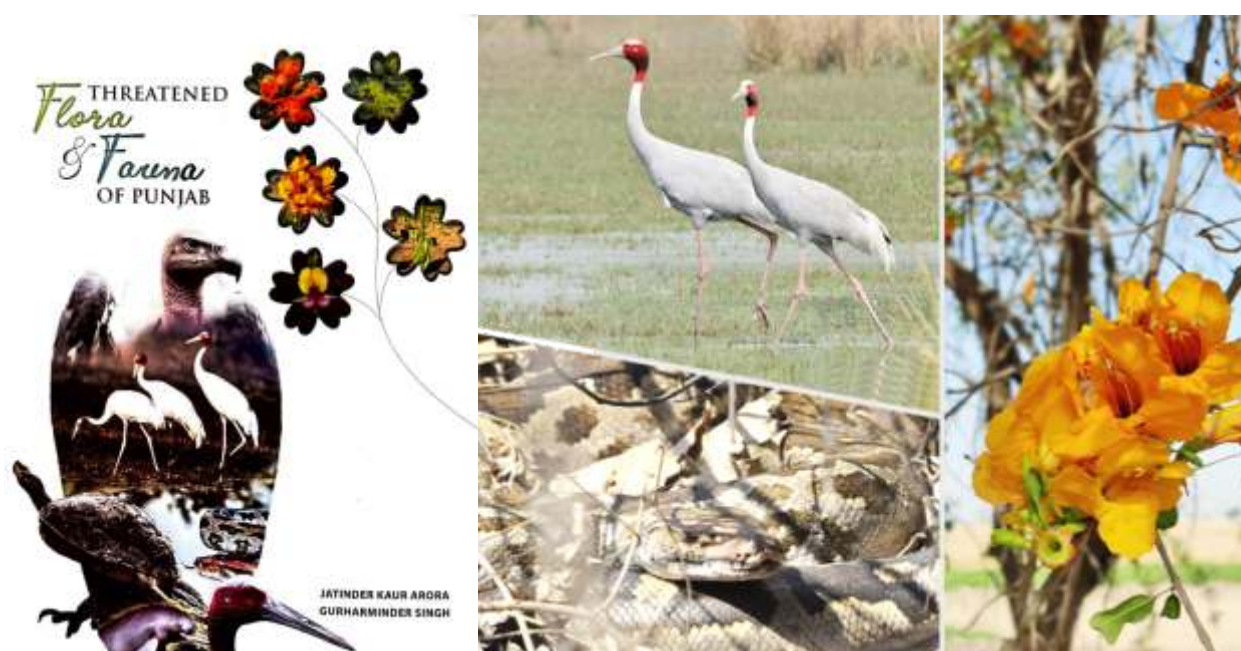
## 5.1 State Mission on Forest, Ecosystem and Biodiversity

### 5.1.1 Overview

The State holds approximately 0.19% of the total forest carbon stock of the country. State has limited land available for forestry, therefore to increase carbon sink, plantation of trees has been planned outside the forest area. A stable trend has been witnessed in Tree Outside Forest (TOF) over past 20 years, which is a significant achievement in light of extensive rate of urbanization & dominance of agriculture in the state. The total carbon stock of forests including the TOF patches is 13.56 million tonnes (49.72 million tonnes of CO<sub>2</sub> equivalent).<sup>9</sup> However, forest cover in Punjab has decreased by 2 square kilometers in 2021 as compared to 2019 (Table 5.2). The State is taking initiatives to increase area under forest and tree cover to 7.5% by 2030. In this direction, key projects including Sub-Mission on Agro-forestry (SMAF), Ghar Ghar Hariyali and Payment for Ecological Services (PES) are being implemented.

In order to strategise enhancement in carbon stock, the Department of Forest & Wildlife Preservation, Punjab has recently initiated a carbon sequestration study in collaboration with The Energy and Resources Institute (TERI) regarding environmental & economic benefits of Agro-forestry. During the year 2016-2021, around 17,560 ha area has been covered with 14.98 million plants which benefitted more than 13,000 farmers with the total financial assistance of INR 144.85 million and also contributed towards diversification by breaking the cycle of Wheat-Rice cropping. Further, the development of information systems and databases for various fast-growing and native tree species is underway in the state.

Loss of biological diversity is a global crisis, which requires sustained conservation measures. State has set up Punjab Biodiversity Board (PBB) as a statutory body and constituted Biodiversity Management Committees (BMCs) at all the local bodies level. PBB is taking multi-farious initiatives for promoting conservation & sustainable utilization of biodiversity, identification of Biodiversity Heritage Sites (BHs) and capacity building on biodiversity related issues. Initiatives are being taken to promote rehabilitation of natural habitat of 13 notified threatened flora & fauna species in the State.<sup>56a</sup>



Coffee table book on 'Threatened Flora and Fauna' published by Punjab Biodiversity Board

Further, wetlands are among the most productive ecosystems due to their ecological, biological and socio-economic values. Around 1.71% of the total geographic area of the State is under wetlands. Six wetlands namely Harike, Kanjli, Ropar, Keshopur-Miani community reserve, the Beas conservation reserve and Nangal wildlife sanctuary have been recognized as wetlands of international importance under Ramsar convention. District level Wetland Management Committees have also been set up for conservation & management of wetlands.

**Table 5.2: District-wise forest cover (in sq. km)<sup>6</sup>**

Districts	Geographical Area	Forest cover as per 2021 Assessment				% of GA	Change w.r.t 2019 Assessment
		Very Dense Forest	Moderately Dense Forest	Open Forest	Total		
Amritsar	2,683	1.00	10.47	14.11	25.58	0.95	-1.20
Barnala	1,482	0.00	1.00	7.22	8.22	0.55	-0.11
Bathinda	3,353	0.00	18.85	37.59	56.44	1.68	1.01
Faridkot	1,458	0.00	3.94	14.43	18.37	1.26	-0.11
Fatehgarh Sahib	1,180	0.00	3.74	0.00	3.74	0.32	0.00
Ferozepur	5,305	0.00	5.65	48.99	54.64	1.03	20.98
Gurdaspur	3,551	0.00	103.39	107.3	210.7	5.93	-1.63
Hoshiarpur	3,386	0.00	369.57	347.5	717.1	21.18	-7.10
Jalandhar	2,624	0.00	1.88	8.20	10.08	0.38	-0.53
Kapurthala	1,633	0.00	1.93	8.05	9.98	0.61	0.13
Ludhiana	3,578	0.00	22.86	29.86	52.72	1.47	-6.20
Mansa	2,198	0.00	0.98	8.94	9.92	0.45	-0.06
Moga	2,242	0.00	0.00	8.45	8.45	0.38	-0.44
Muktsar	2,593	0.00	5.97	13.97	19.94	0.77	1.62
Patiala	3,325	8.13	27.78	38.81	74.72	2.25	-0.09
Rupnagar	1,356	0.00	105.07	154	259.1	19.10	-2.40
SAS Nagar	1,094	0.00	74.35	66.04	140.4	12.83	-0.34
Sangrur	3,625	0.00	6.00	17.34	23.34	0.64	0.51
SBS Nagar	1,282	0.00	25.45	99.92	125.4	9.78	-6.39
Tarn Taran	2,414	1.45	4.23	12.22	17.90	0.74	0.37
<b>Grand Total</b>	<b>50,362</b>	<b>10.58</b>	<b>793.11</b>	<b>1,042.96</b>	<b>1,846.65</b>	<b>3.67</b>	<b>-1.98</b>

### 5.1.2 Impact of climate change on the forest, ecosystem and biodiversity sector

The forest sector is important for both Adaptation & Mitigation actions. Firstly, the forests act as a stabilizing force against climate change as they play an integral part in the carbon cycle that can influence climate change. Secondly, climate influences both the structure and functions of forest ecosystems and plays an essential role in ecosystem services. Hence, actions are required to better adapt forests towards climate change which would also aid in mitigating or buffering the effects of climate change.

It is important to understand that forest provides provisioning services like food, water, timber, fiber, genetic resources and medicines. The forest land also plays a crucial role in regulating water and soil quality and has a significant cultural influence such as recreational, aesthetic and spiritual benefits. It is well established by various reports that intact ecosystems are more resilient and better able to buffer the impacts of climate change in comparison to the ecosystems that are already weakened due to other stressors such as pollution or overuse. Thus, the alterations in the forest ecosystems will have influence on other systems as well.

Climate change is already forcing species to adapt either through shifting habitat, changing life cycles or development of new physical traits. As per International Union for Conservation of Nature (IUCN), Climate change is affecting at least 10,967 species, which are on Red List of Threatened Species and increasing the likelihood of their extinction.<sup>57</sup>

As discussed in Chapter 3, the temperature and rainfall pattern in Punjab has undergone significant changes and further projections also indicate substantial variations in both parameters. These climatic variations along with various anthropogenic disturbances are expected to affect the distribution and diversity of species across forest areas. Furthermore, the changing climatic conditions may worsen the threats to forests, such as fires, biodiversity loss, soil erosion, pest infestation, etc. Some of the effects of climate change relevant to the State are:

- Forests in the Shivalik region which are already fragmented because of various socio-economic pressures are further likely to get adversely affected due to changes in rainfall and temperature.
- Economically important species like *Acacia nilotica* and *Dalbergia sissoo* are declining rapidly due to the combined effect of variation in temperature and relative humidity, which is creating favorable conditions for the growth of fungi and pests, resulting in their high rate of mortality.
- Increase in incidences of forest fires and pest attacks due to an increase in temperature affecting the survival and growth of forest vegetation in the state. These could further aggravate issues related to forest-based livelihoods and man-animal conflict.
- Alteration in vegetation composition as well as changes in phenology due to climate change, can significantly affect their usability and economic value.
- Loss in diversity of wildlife, resulting in species imbalance which will increase forest vulnerability. 13 species of the flora (8) and fauna (5) are already near extinction in Punjab.

With time, these changes may become more pronounced, enhancing the vulnerability of the forest ecosystems to climate change impacts.



### 5.1.3 Key issues and challenges in the forest, ecosystem and biodiversity sector

Recent studies indicated that climate change has altered the frequency and intensity of drought, hot and dry weather which further influenced the forest ecosystems in varied ways. The major challenges include wildfires and fragmentation of forest, change in distribution of pests and invasive species resulting in loss of biodiversity and disturbance to ecological balance in the long run. Challenges categories under technical, institutional and socioeconomic aspects are tabulated in Table 5.3.

**Table 5.3: Key issues and challenges in Forestry and Biodiversity sector**

Area	Issues																		
Technical	<p>There has been an alarming issue of increasing fragmentation in the existing forest cover due to changing land-use patterns and increasing developmental pressures in Punjab. Further, the incidences of forest fires in the state have increased. As per the Forest Survey of India's report on 'Vulnerability of India's Forest to Fire', Hoshiarpur falls in the category of the highly vulnerable district while Rupnagar falls in the moderately vulnerable category. Whereas, Jalandhar, Ludhiana, and Patiala are under less vulnerable category. Trend indicates that over the years, number of forest fire alerts has increased.</p> <div style="text-align: center;"> <table border="1" style="margin: auto;"> <caption>Number of Forest Fire Alerts disseminated by Forest Survey of India</caption> <thead> <tr> <th>Year</th> <th>No of forest fire alerts</th> </tr> </thead> <tbody> <tr> <td>2013</td> <td>36</td> </tr> <tr> <td>2014</td> <td>20</td> </tr> <tr> <td>2015</td> <td>7</td> </tr> <tr> <td>2016</td> <td>45</td> </tr> <tr> <td>2017</td> <td>320</td> </tr> <tr> <td>2018</td> <td>487</td> </tr> <tr> <td>2019</td> <td>153</td> </tr> <tr> <td>2020</td> <td>635</td> </tr> </tbody> </table> </div>	Year	No of forest fire alerts	2013	36	2014	20	2015	7	2016	45	2017	320	2018	487	2019	153	2020	635
Year	No of forest fire alerts																		
2013	36																		
2014	20																		
2015	7																		
2016	45																		
2017	320																		
2018	487																		
2019	153																		
2020	635																		
Institutional	<p>Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis indicate that the department is facing an acute shortage of Range Officers responsible for the protection of forest resources. Therefore, timely and adequate strengthening of this cadre needs to be done in the interest of forest resources.</p> <p>Further, Punjab Biodiversity Board has limited staff and needs to be strengthened in view of mandated functions under Biological Diversity Act, 2002</p>																		
Socio-Economic	<p>The department has launched a drive to remove encroachments from forest land. However, removal of such encroachments and keeping them under Government control is very challenging. Adequate resources are required for the management of encroachment issues and also to control illicit felling and poaching of wild animals etc.</p>																		



### 5.1.4 Progress mapping

Department of Forest and Wildlife Preservation, Govt. of Punjab has been the Mission Nodal Agency for the implementation of the State Missions i.e. Green Punjab and Sustaining the Himalayan Ecosystem of SAPCC 1.0. The detail progress under these Missions of SAPCC 1.0 during the period 2014-20 are given in **Annexure-I**. The key achievements of Department of Forest & Wildlife, Punjab are as under:

## Key achievements

### Increasing carbon sink

- Planted > 38 million trees covering an area of more than 44,000 ha under various schemes & programs.
- Initiated Ghar Ghar Hariyali campaign to promote household forestry. Under the initiative, >8 million plants have been supplied through “ihariyali” app.
- Developed 175 Nanak Bagichis and 140 sacred groves under extensive plantation drives carried out in each village of the state to observe birth anniversaries of Sri Guru Nanak Dev Ji & Sri Guru Teg Bahadur Sahib Ji.
- Developed >130 micro forests (Oxy parks) in urban areas.
- Undertaken specific plantation of fastly declining native tree species (>4.3 million saplings of *Dalbergia sissoo* & 1.1 million *Acacia nilotica* species).



Plantation under Nanak Bagichi at Nabha, Distt. Patiala

## Biodiversity Conservation

- 100% constitution of Biodiversity Management Committees (BMCs) at all local bodies' level by Punjab Biodiversity Board involving DRDP & Local Government.
- Prepared 22 District level, 150 Block level and 13260 Village level Peoples' Biodiversity Registers (PBRs) to document biodiversity & associated traditional knowledge based on the same PBRs have been developed by all the local bodies.
- PBB implemented Food and Agriculture Organisation (FAO) technical Cooperation Programme project on promoting conservation and mainstreaming of agro-biodiversity.
- Holistic study of various aspects of 13 floral & faunal species notified u/s 38 of BDA, 2002 and biodiversity assessment of 10 potential Biodiversity Heritage Sites.
- Set up biodiversity parks in Districts Sangrur, Sri Muktsar Sahib and Bathinda by respective district administration.
- Comprehensive plantation & restoration activities for *Tecomella undulata* by Deptt. of Forests and Punjab Agricultural University (PAU) in collaboration with village level BMCs under the consistent efforts of Punjab Biodiversity Board.
- Ex-situ conservation of *Withania coagulans* through tissue culture propagation by Guru Nanak Dev University in collaboration with PBB.

## Wildlife Conservation & Ecosystem improvement

- In-situ and Ex-situ Conservation activities for endangered species by Department of Forest & Wildlife, Punjab.
  - Tiger Breeding Programme in Chhatbir
  - Reintroduction of Gharial in Beas Conservation Reserve
  - Conservation of endemic, rare and endangered Manipur Deer
  - Scientific breeding of Sarus crane which is a vulnerable species in IUCN list
  - Scientific breeding of Kalij Pheasants



Reintroduction of Gharial in Beas Conservation Reserve

- Freshwater habitat improvement initiatives for conservation of aquatic Biodiversity and Indus River Dolphin, which was declared as the State Aquatic Animal in the year 2019.
- Initiated GIS Mapping of 1381 wetlands in the State above 2.25 ha area and engaged local communities as 'Wetland Mitras' for regular monitoring by Department of Forest & Wetildlife by involving WWF, India.



Migratory birds visiting Nangal wetland

### Development of wetland eco-tourism facilities

- Generated additional livelihood opportunities to local people and helped them rationalize the exiting land use in Keshopur Community Reserve.
- Constructed nature trails to increase tourism facilities.
- Eco-Tourism Development at Harike & Ropar Wetland.
- Zero emission vehicles introduced in Chhatbir Zoo for the visitors and Animal Feed Vans.



Zero Emission Vehicles at Chhatbir Zoo, Zirakpur



### 5.1.5 Sectoral planning – Strategies for Forest, Ecosystem & Biodiversity

Punjab's overarching targets pertaining to the State Mission on Forest, Ecosystem and Biodiversity and illustrates their linkages with agreed targets at the National and International level are listed in Table 5.4.

**Table 5.4: Linkage of sectoral overarching targets with SDGs and NDCs by 2030**

International/ National Commitment	Targets	Key State Targets and Initiatives
International commitment	<b>SDG 15:</b> Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.	<ul style="list-style-type: none"> <li>• To achieve 7.5% of total land under forest</li> <li>• 616 Water bodies to be renovated</li> <li>• 70% reduction in trading of poached or illicitly trafficked wildlife</li> </ul>
National commitment	<b>NDC 5:</b> To create an additional carbon sink of 2.5 to 3 billion tonne of CO <sub>2</sub> through additional forest and tree cover by 2030	<ul style="list-style-type: none"> <li>• Increase forest &amp; tree cover to 7.5% by 2030</li> </ul>
	<b>NDC 6:</b> To better adapt to climate change by enhancing investments in development programs in sectors vulnerable to climate change, particularly Himalayan ecosystem.	<ul style="list-style-type: none"> <li>• Conserve flora, fauna, wetlands, forest &amp; biodiversity to sustain the Shivalik ecosystem</li> <li>• Take steps for rehabilitation of threatened flora and fauna of the State</li> <li>• Identification of potential Biodiversity Heritage Sites and capacity building of local communities to promote their conservation</li> </ul>



Wildlife Conservation measures involving local communities, Abohar Wildlife Sanctuary



### 5.1.6 Strategies for 2021-30 under Forest, Ecosystem, and Biodiversity sector

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code FR/N to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with FR are continuing from SAPCC 1.0



**FR/1: Improving the stock of existing forests and bringing them from degraded (canopy density < 0.4) category to medium dense forest (0.4 to 0.7) category by carrying out plantations**

Due to limitations in area available for expansion of carbon sink, under this strategy, the State envisages to achieve above goal by improving the quality of its existing forest. The State, through its rigorous conservation measures, intends to increase the area under very dense and moderately dense forest cover.

The plantations on forest land under CAMPA scheme would continue on an average of 5000 ha per year. Various existing schemes of afforestation apart from CAMPA will also be continuing, which will be targeted towards increasing of green cover of the State.

#### Intended benefits:

- Increase in density of trees in forest areas
- Increase in carbon sink



## FR/2: Afforestation in public areas, industrial sites, settlement areas, along the rivers, roadside plantation and shelterbelt plantation



Guru Nanak Pavitar Jungle, Nagar Nigam, Patiala

The state will implement afforestation activities in public areas, industrial sites, settlement areas, along the roads and rivers, etc. Tree cover will also be extended in degraded regions like areas with saline/alkaline soils, waterlogged areas and barren lands. Urban plantations will play a key role in tackling air pollution as well as the urban heat island effect. The Government has also launched Green Highway Project for carrying out plantations on newly acquired areas along National Highways. Further, Nagar Van Yojana has also been launched with an aim to create forests in urban cities with Municipal Corporations.

### Intended benefits:

- Reduction in urban heat island effect & air pollution
- Prevent erosion
- Recharging of aquifers
- Increase in carbon sink

## FR/3 Increasing tree cover outside forest area by promoting agro-forestry and household forestry in the State.

State has targeted to undertake afforestation of 74,740 ha to enhance forest stock and to increase the forest and tree cover to 7.5% by promoting area under agroforestry/urban/household forestry. Under sub-mission on agroforestry, the department has developed a mobile application to register and monitor the plantations of farmers under this scheme. As per the scheme, farmers are provided survival based financial assistance through Aadhaar linked Direct Benefit Transfer (DBT).

### Intended benefits:

- Increase in tree cover
- Increase in carbon sink
- Reduction in erosion
- Monitoring of plantation

#### FR/4: Conservation and protection of biodiversity in the State

Environment in the Shivalik region has degraded to a very large extent and urgent efforts are required to conserve and rehabilitate biodiversity of this region. In this regard, biodiversity parks have been proposed to be established, which will serve as educational destination for the children and citizens of the local areas. Furthermore, the state has laid more focus to increase cultivation of medicinal, aromatic & high value plants (e.g., Sandalwood). A State plan scheme "Conservation, Management and Development of Wildlife is aimed to promote biodiversity conservation in protected area network as well as maintenance of zoos. The important activities include:

- Steps for Rehabilitation & propagation of threatened species
- Identification of potential Biodiversity Heritage Sites
- Strengthening and capacity building of BMCs
- Updation of People's Biodiversity Registers (PBRs)
- Customized awareness activities for all the stakeholders including industry.

#### Intended benefits:

- Protection of biodiversity
- Equitable sharing of benefits arising out of commercial use of bio-resources
- Habitat conservation
- Increase in ecosystem productivity



Biodiversity Park at village Dayalpura Bhaika, Distt. Bathinda  
Source: Babushahi dt. 08.06.018

### FR/5: Forest Fire Management

Optimal use of all available methods for better protection and conservation of forest resources including management of forest fires, maintenance of fire lines, purchase of firefighting equipment, demarcation of forest boundaries, improving communication and creation of awareness among the local masses have been planned by:

- Control and Management of Forest Fires through creation of fire lines, construction of watchtowers, engagement of firewatchers and community level assistance to Joint Forest Management Committees (JFMC).
- Strengthening of Infrastructure for forest protection through improved mobility and communication network, modern information technology system, building for forest protection offices and residence for frontline staff etc.
- Working plans based on field survey and boundary demarcation

#### Intended benefits:

- Reduction in man-animal conflicts
- Prevention of forest fires
- Protection of biodiversity

### FR/N/6: Strengthening capacities and extension services of the forest department for sustainable management of forests

Capacity building and institutional strengthening of the department in relation to climate change adaptation, mitigation, fund management and policy formulation will be given high priority. The Stakeholders including media, NGOs and other organizations will be involved in spreading awareness about climate change issues. Besides these, mass awareness campaigns involving schools and college students will also be done.

#### Intended benefits:

- Greater awareness about climate change issues
- Sustainable management of forest resources
- Enhanced capacity of the department to better understanding climate change concerns and plan initiative



### FR/N/7: Development of Payment for Ecosystem Services (PES)

The implementation of Agro-forestry Programme has been planned. The farmers of the state will be provided with financial assistance @ 50% plants and maintenance cost for initial planting year plus two years in case of Peripheral or Boundary/ Low Density/ Medium Density/High-Density Planting Models of clonal Eucalyptus for the purpose of poles, paper pulp etc.

The cost, as well as assistance, will be segregated in a proportion of 50:25:25 by way of direct benefit transfer through Aadhar linked saving bank accounts based on the plants planted in their agricultural field and their survival.

#### Intended benefits:

- Increase in the tree cover
- Greater involvement of local population
- Diversification of the land under agriculture

### FR/N/8: Facilitation of better market opportunities for major and minor forest produce

Improved tree logging practices and scientific methods for the extraction of timber for economic use in wood-based industries will be emphasized to help promote sustainable timber extraction and long-term ecosystem health. Sustainable wood procurement policies and certification will be encouraged. In addition, a climate-resilient and sustainable value chain will be developed for all the major and minor forests produced from the State's forests. Better market opportunities, exploring new markets, processing, value addition, quality control checks, GI tagging, improved infrastructure, etc. will be promoted by the State.

#### Intended benefits:

- Generation of livelihood opportunities
- Sustainable management of forest produce
- Community participation in forest management



### FR/N/9: Ecosystem improvement and habitat protection for wildlife conservation.

Conserving wildlife habitats especially wetland ecosystems is of utmost importance for Punjab as degradation of habitats is threatening dependent biodiversity as well. The ecosystem management strategies will help to sustain/improve ecosystem services viz. climate moderation, flood control, water quality improvement, etc. The strategy aims to promote both *in-situ* and *ex-situ* conservation initiatives of species such as: Kalij Pheasants, *Sarus crane*, *Platanista gangetica*, *Gavialis gangeticus*, *Gyps bengalensis*, *Python morolus* etc as well as wetland management & conservation initiatives.

#### Intended Benefits:

- Conservation and rehabilitation of wetlands & other wildlife ecosystems
- Conservation of biodiversity
- Ensure sustained ecosystem services



Saras Cranes habitating Shalla Pattan Chamb, Distt. Gurdaspur

## 5.2 State Mission on Sustainable Agriculture

### 5.2.1 Overview

Punjab plays a critical role in ensuring the food security of the Nation. Despite a share of 1.53% in the total geographical area of India, its share in the central pool of rice and wheat towards the food security of the country has been significant especially after the Green Revolution. Thus, the State has been recognized as the “breadbasket” of India. Agriculture sector also continue to contribute a large share in Punjab's overall Gross Domestic Product (GDP) and total employment share. However, intensive agriculture being followed in the State has been putting a huge pressure on the limited water resources of the State as well as on the soil health. As irrigation demand is mainly met from groundwater, >70% of the geographical area has been reportedly facing overexploitation of groundwater resources. Thus, the State has been actively working to improve water use efficiency in irrigation as well as to enhance soil health.

Key initiatives in this direction include pilot launch of direct benefit transfer scheme 'Paani Bachao Paise Kamao' in six agriculture feeder areas to incentivize farmers for saving electricity than the fixed allocation. Further, promotion of conjunctive use of water, biomass mulching, organic farming, biofertilizers /biopesticides, regular soil testing and taking measures for soil and water conservation under the drive “Khet da pani khet vich” are the most significant ones.

Further, to promote diversification of land use coupled with better livelihood opportunities, horticulture is being promoted in a focused manner. Furthermore, the Government is also promoting other allied sectors such as livestock rearing, fish and dairy farming, etc to improve adaptive capacity of farmers by generating alternative sources of income and employment.

In addition, focus would also be on minimizing emissions of methane and other pollutants such as ammonia from agriculture & livestock sectors through manure additives, technology-based manure management, improving feeding and through adopting practices for minimizing methane generated per unit of animal productivity.



Source: Down to Earth dt. 20.07.2022

## 5.2.2 Impact of climate change on the agriculture & allied sectors

The changing climate has far-reaching impacts on agricultural production and poses threat to food security. With rising temperatures, it is expected that crops yields will reduce while weed and pest proliferation will increase. Further, the changes in precipitation pattern as discussed in **Chapter 3**, will enhance the chances of crop failures and decline in production. In nutshell, the overall impact of climate change on agriculture is expected to be negative except in some crops. A few of the climate change impacts on state's agriculture sector are as under:

- Changing climatic parameters have significant impact on grain yield and incidences of pest attack may rise due to longer transmission windows. As Punjab is also facing water stress, this will result in added yield losses.
- Increase in heat stress may hinder growth of animals, reduce reproduction efficiency and decrease yeild of milk and eggs. Rise in water temperature may result in increased fish mortality and productivity decline.
- Climate change induced extreme weather events such as intense heatwaves, floods and droughts are expected to challenge the wellbeing of livestock.
- It will influence the reliability of forage production and water demand for the cultivation of forage crops. It is expected that the forage plants will continue to be influenced by the changing temperatures, elevated carbon dioxide and water availability.
- The horticulture sector will also be adversely impacted by climate change. It is expected that the growth of nursery plants and the flowering pattern of subtropical fruits will be severely affected due to rise in temperature. Frosting has also been affecting tropical fruits in recent years.

### 5.2.2.1 Impact of Non-CO<sub>2</sub> Pollutants on the agriculture & allied sectors

According to India's third Biennial Update Report (BUR) to the UNFCCC, methane accounted for 19.5 million tonnes i.e 14.43% of India's total GHG emissions in 2016. India's main GHG emissions from the agricultural allied sector are of methane, which is primarily released during enteric fermentation in livestock and rice cultivation.

The productivity of agriculture sector gets significantly impacted by Short-Lived Climate Pollutants (SLCPs) or Non-CO<sub>2</sub> pollutants including black carbon and ozone. Ozone and black carbon in the atmosphere can both negatively influence plant growth as well as agricultural productivity. Ozone is toxic to a large number of agriculturally important species, affecting crop yields and nutrient composition, while Black Carbon can reduce the amount and quality of solar radiation available for photosynthesis. Both SLCPs can affect agriculture and ecosystems through changes in weather and climate, including short-term effects on temperature, cloudiness and rainfall.

Agricultural co-benefits from SLCP mitigation are expected to be large and almost immediate because SLCPs have short atmospheric lifetimes. Mitigation of SLCP emissions could effectively reduce the impacts of climate change in Punjab which will ensure longer term food security, agricultural yields and income security for the marginalized communities.



### 5.2.3 Key issues and challenges in the agriculture sector

Agriculture and allied sector has extreme vulnerability to climate change and these sectors also emit greenhouse gases which contribute to climate change. The major issues & challenges in this sector include reduction in crop yield and livestock productivity, limited climate resilient crop varieties, outbreak of crop diseases as well as also affect on soil and water resources, rural communities and agriculture workers. The key challenges of the state in this sector have been tabulated in **Table 5.5**.

**Table 5.5: Issues and challenges in Agriculture and Allied sector**

Area	Issues
Technical	<ul style="list-style-type: none"> <li>Limited appropriate crop cultivars that are of short duration, heat tolerant, less water intensive and resistant to emerging pests and diseases for changing climate scenario.</li> <li>High consumption of chemical fertilizers in agriculture which may contribute towards deterioration of soil health in the long run.</li> <li>Over exploitation of underground water resources as well as energy consumption for irrigation purpose.</li> </ul>
Institutional / Regulatory	<ul style="list-style-type: none"> <li>Paddy straw management is a major issue deteriorating soil health &amp; causing air pollution. Although Government has introduced policies/initiatives for its management through in-situ &amp; ex-situ measures to curb burning of paddy straw in the fields, lot more is to be done to completely address the issue.</li> <li>Lack of adequate poly houses, shade nets and compost beds for the sustainable growth of nursery raised plants.</li> <li>Inadequate processing facilities &amp; cold chain network for effective management of agricultural, horticultural &amp; livestock produce.</li> </ul>
Financial	<ul style="list-style-type: none"> <li>Decrease in crop and livestock productivity due to climate hazards &amp; disease outbreaks causing major economic loss.</li> </ul>
Socio-Economic	<ul style="list-style-type: none"> <li>Suicide by farmers is a major concern in the state. The major reason for which is rural indebtedness. Rural debt in Punjab is estimated to be more than INR 3,50,000 million<sup>58</sup>.</li> <li>Inadequate support &amp; management of livestock health in the emerging pest &amp; disease scenario</li> </ul>



Collection of paddy straw in the form of Bales for ex-situ applications, Distt. Patiala

### 5.2.4 Progress mapping

Department of Agriculture & Farmers Welfare, Govt. of Punjab has been the Mission Nodal Agency for proposed in the State Mission on Sustainable Agriculture of SAPCC 1.0. The detailed progress viz-a-viz strategies of Sustainable Agriculture under SAPCC 1.0 during the period 2014-20 are given in **Annexure II**. The Key Achievements under the Mission are as under:

## Key Achievements

### Crop Diversification

- Promoted cultivation of Moong with 3 late-sown varieties of paddy in between Wheat & Paddy to make the agrarian sector environmentally sustainable.
- Promoted organic farming and covered > 5,000 ha area to reduce load of fertilizers & improve soil health.
- PAU developed 25 improved crop varieties (13 crops, 4 fruits, 6 vegetables & 2 ornamental crops) and assessed their productivity for different agro-climatic zones.
- Area under Horticulture expanded to 0.4 million ha with 40% growth in 2020-21 compared 2014-15. In addition, 54 cold rooms, 17 pack houses, 4 cold stores & 1 fruit processing unit developed for post harvest management.
- Promoted shrimp culture on > 323.75 ha unproductive saline and waterlogged land in south western Punjab.



Moong cultivation by farmer, Distt Ludhiana

### Agri-residue Management

- Re-incorporated paddy straw into farm fields through more than 76,000 machines distributed during the last three years for addressing stubble burning issues thereby improving air quality & soil health.
- More than 4500 villages declared zero stubble burning in 2019 compared to 76 villages in 2018.
- PSCST demonstrated country's first-of-their-kind paddy straw briquetting plants of 25 TPD & 100 TPD capacity in districts Moga and Patiala respectively contributing to Green House Gas (GHG) reduction to the tune of 70,000 tonne CO<sub>2</sub> per annum.
- Installation of 11 biomass-based projects of capacity 97.5 MW, which consume about 1 million tonne paddy straw per year.
- PSCST & PPCB jointly demonstrated use of paddy straw pellets as partial replacement of coal in brick kilns and industrial boilers.
- PAU installed 31 weather monitoring stations in different districts of Punjab, out of which 5 are Automatic Weather Stations (AWSs)

### Livestock Management

- Designed and demonstrated novel climate resilient cattle sheds for heat stress management and sustain productivity in projected warming scenario by GADVASU & PDDDB.
- Established Indigenous Cattle Breeding Farm, Gokul Gram at Bir Dosanjh with the objective of their conservation and propagation by Department of Animal Husbandry
- Installation of domestic biogas plants at farmer's fields
- Piloted first-of-its kind weather linked insurance for cattle to compensate farmers for milk yield loss due to heat stress thereby increasing their adaptive capacity.
- Automatic Silage Baler & Wrapper Machine by AHD & GADVASU
- Biogas plants set up to recover energy from dairies by PEDDA.



First-of-its-kind paddy straw briquetting plant demonstrated by PSCST at village Kulburchan, Distt. Patiala



Model Climate Resilient Cattle Shed demonstrated at GADVASU, Ludhiana

## Food-processing

- Developed Food parks at Kapurthala, Phagwara, Fazilka, Ladhowal and Sirhind to strengthen Agri-Infrastructure in the State.
- Initiated Secondary Agriculture/ Food Processing Entrepreneurial Network in Punjab to scale up value added products development in collaboration with Centre of Innovative and Applied Bioprocessing (CIAB).

## R&D Initiatives

- Climate resilient varieties for different crops such as for Wheat (3), Basmati (3), Maize (7), Arhar (6), Sugarcane (3), Cotton (9), Soyabean (3), Sorghum (3), Mustard (2), Berseem (1) and Moong (1) for different agro-climatic zones of Punjab developed by PAU.
- Introduced 35 varieties of low chill temperate fruits (pear, peach, plum, apricot, walnut, pecan nut, etc.
- Developed various pest and diseases resistant varieties for 16 common vegetables
- Developed crop diversification packages for projected climate change scenarios and regular recommendations/advisories being disseminated to >6.5 Lakh farmers for better management of crops & livestock.
- Initiated advance forewarnings and preventive measures for late blight disease of potato and yellow rust of wheat through a web-based decision support system. Developed Mobile based 'PAU Cotfly' app by PAU as a preventive measure for management of white fly in cotton.

## Soil & Water Conservation

- Direct Seeded Rice (DSR) method promoted in suitable areas to reduce stress on State's underground water resources as well as promoted micro irrigation and underground pipeline system for on farm water conservation. These are very important to save energy as well.
- Initiated 'Paani Bachao Paise Kamao' pilot scheme launched by Department of Power for incentivising water and energy efficiency for agriculture consumers in 6 agriculture feeder areas.
- Executed soil testing programs through 58 laboratories under National Mission for Sustainable Agriculture (NMSA) and Rashtriya Krishi Vikas Yojana (RKVY) besides introduction of soil/leaf testing facilities for different horticulture estates.



Farm soil testing laboratory at PAU, Ludhiana

### 5.2.5 Sector planning – Strategies for Sustainable Agriculture Mission

Punjab's overarching targets pertaining to the State Mission on Sustainable Agriculture and illustrates their linkages with agreed targets at the National and International level are listed in **Table 5.6**.

**Table 5.6: Specific Sustainable Agriculture Mission Targets under SDG and NDC by 2030**

International/ National Commitment	Targets	Key State targets and initiatives
International Commitment	<b>SDG 1:</b> No Poverty	<ul style="list-style-type: none"> <li>About 0.55 million loans of small &amp; marginal farmers waived off. Around 1.89 million farmers provided relief under Pradhan Mantari Kisan Samman Nidhi Yojana</li> </ul>
	<b>SDG 2:</b> End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	<ul style="list-style-type: none"> <li>Double small farmer's income to INR 0.56 million/ year against INR 0.28 million / year in baseline year</li> <li>Achieve productivity of rice &amp; wheat to 5,322 kg/ha by 2030.</li> <li>Increase animal husbandry production to 19 million tonne compared to 10.77 million tonne in 2015-16.</li> </ul>
	<b>SDG 6:</b> Improving water quality, resource efficiency	<ul style="list-style-type: none"> <li>To irrigate 0.04 million ha with treated waste water</li> <li>State has targeted an area of 80,000 ha to be covered under micro irrigation and lay Underground Pipeline System (UGPS) on 0.75 million ha for on-farm conservation of irrigation water. Government has planned 147 Innovative irrigation projects for creation of alternate source of irrigation.</li> </ul>
	<b>SDG 12:</b> Ensure sustainable consumption and production patterns	<ul style="list-style-type: none"> <li>State has targeted 31.60 million tonne annually of food grain production besides reduction in use of pesticides to 0.675 kg/ha &amp; fertilisers to 195 kg/ha.</li> </ul>
National Commitment	<b>NDC 6:</b> To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture	<ul style="list-style-type: none"> <li>State is promoting organic farming and working towards enhancing irrigation efficiency.</li> <li>To develop climate resilient varieties</li> </ul>

### 5.2.6 Strategies for 2021-30 under sustainable agriculture sector

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code "AG/N" to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with "AG" are continuing from SAPCC 1.0.

#### AG/N/1: Optimum use of water resources and promoting high-density aquaculture system

Punjab is mostly dependent on ground water and canal system for agriculture. Whereas, ground water is depleting at an alarming rate, the projected change in rainfall pattern is intensifying the problem. These conditions make Punjab vulnerable to the consequences of climate change and can affect food security of the region. The judicious use of water and other resources is the need of hour. Under this strategy, the state has planned to substantially increase use of treated waste water in agriculture sector. Additionally, the State envisages to promote aquaculture for diversifying agriculture and generate better/ secure livelihood for farmers. The strategy include the following action points:

- Promote safe reuse of treated water from STPs
- Laying of underground pipeline for on-farm conservation
- Micro-irrigation to increase water use efficiency in irrigation
- Promote Direct Seeded Rice practice
- Vertical expansion of aquaculture by adopting high density aquaculture system and good quality feed using technologies such as Re-circulatory Aquaculture System (RAS) and Bio-floc.

#### Intended benefits:

- Conservation of water resource
- Diversification of land under agriculture
- Increase in adaptive capacity of farmers through alternate livelihood generation



Farmers sowing cotton seeds using drip irrigation technology in district Fazlika  
Source: The Tribune dt. 26.05.2022

## AG/2: Promote crop diversification including enhancing area under horticulture and fishery

Monoculture cycle increases the risk from high use of fertilizers and pesticides resulting in loss of soil fertility and environmental pollution. In addition, planting different crops in different zones would create natural check against crop damages due to attack of a particular insect/ pathogen. Further, wheat and paddy are not nitrogen fixing crops, thus, lead to depletion of soil nutrients. This signifies the urgent need for the diversification of agriculture in Punjab. The main objective of this strategy would be to break wheat-rice cycle by implementing the following action points:

- Increasing the crop diversification by adopting horticulture
- Crop diversification by bringing more area under crops such as basmati, cotton, maize, oil seed and pulses
- Increasing the area under aquaculture by promoting fish farming/aquaculture

### Intended benefits:

- Reduction in cases of crop failure
- Improvement in soil health
- Reduction in usage of chemical fertilizers and pesticides



High quality hybrid maize for silage making for dairy animals at GADVASU, Ludhiana

### AG/3: Promotion of integrated nutrient management in soils, decline in use of pesticides & fertilizers and promoting organic farming

It is vital to provide balanced nutrition to the crops, which can lead to better plant growth & yield. Integrated nutrient management of soils can minimize deterioration of soil health and enhance carbon sequestration. This strategy will focus on enhancing the sustainability of soil health and judicious use of fertilizers and pesticides through:

- Enhancing area under organic farming
- Distribution of soil health cards based on soil testing analysis
- Augmenting soil testing facilities and leaf analysis of horticultural crops
- Reducing dependency on fertilizers by utilizing nitrogen rich water from aquaculture in farms

#### Intended benefits:

- Improvement in soil health
- Reduce dependency on fertilizers
- Reduce GHG emissions from fertilizers



Dried slurry from community biogas plant, Haibowal, Ludhiana

#### AG/4: Proper management of agricultural crop residues

Agricultural crop residue burning contribute towards the emission of greenhouse gases (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>), air pollutants (CO, NH<sub>3</sub>, NO<sub>x</sub>, SO<sub>2</sub>, Non Methane Hydrocarbons (NMHC), volatile organic compounds), particulate matter and smoke thereby, posing threat to human health. Apart from loss of organic component of crop residues, burning of residues also affects physical, chemical and biological properties of soil. Therefore, this strategy aims at better management of crop residues by:

- Generating awareness and promoting straw mulching practices among farmers
- Providing machinery like rotavator, happy seeder or zero till drill at subsidized prices
- Promoting use of paddy straw in biomass power plants
- Promoting other *Ex-situ* crop residue management measures in the state

#### Intended benefits:

- Reduction in loss of organic matter and release of GHGs
- Curb air pollution from residue burning to minimize health issues
- Conserve soil microbes & nutrients and thereby improvement in soil health

#### AG/5: Research for developing suitable crop cultivars, short duration and climate resilient varieties of crops, vegetables and fruits

To better adapt agriculture sector to climate change, there is growing need of identifying stress tolerant crop varieties suitable under projected abiotic stresses viz. deficit/ excessive rainfall, temperature extremes, salinity, etc. for sustaining yields. Further, there is a prerequisite for integrated and efficient agronomic practices including optimal time of sowing, nutrient and pest management strategies for reaching the maximum genetic potential. This strategy is focused on research and development for developing appropriate cultivars/ varieties to enhance adaptive capacity of agriculture sector.

#### Intended benefits:

- Increase in adaptive capacity of farmers to sustain climatic stresses
- Reduction in farmer distress



Propagation of direct seeding practice using short duration varieties by PAU, Ludhiana



Enrichment treatment of paddy straw for use as animal feed at GADVASU, Ludhiana

### AG/N/6: Efficient utilization of livestock manure for energy

Methane is one of potent GHG directly contributed by dairy sector. Harnessing energy/electricity from dairy waste curbs direct GHG emissions as well as taps the energy to generate electricity for sustainable operations of cattle sheds at farmer households, dairy farms and gaushalas. This strategy focuses on generating energy from livestock manure by promotion of biogas plants and generation of electricity as well as measures to reduce emissions from livestock by improving feeding and application of new technologies & practices

#### Intended benefits:

- Reduction in methane emissions
- Promotion of renewable source of energy
- Effective management of dairy waste

### AG/N/7: Manage livestock health in the emerging pests and disease scenario

Changing climate has significant influence on disease dynamics. Increased temperature and changes in precipitation affect the spread of vector-borne diseases transmitted by flies, ticks, mosquitoes etc. as well as increases the rate of disease transmission between hosts. There is high probability of emergence of new diseases that can impact the livestock health. Resilience of livestock sector towards emerging diseases/ pests in climate change scenario is imperative to sustain productivity and income of farmers. Thus, this strategy is directed towards mapping the existing pests and disease profile of various livestock viz-a-viz climate parameters, disease forecasting model and adequate vaccination to better adapt livestock population.

#### Intended benefits:

- Reduced disease burden and loss in productivity
- Increase in adaptability of livestock sector to climate change
- Sustained income of farmers



Vaccination for swine flu at pig farm, GADVASU, Ludhiana

### AG/N/8: Development and Management of Climate-resilient sheds

Due to rising temperature, animals suffer heat stress which leads to decline in the milk productivity. Thus, there is a need for climate proofing of cattle sheds. Punjab has successfully demonstrated climate resilient sheds at farmer level in three districts (Ludhiana, Bathinda & Tarn Taran) which has resulted in maintaining productivity levels during the heat stress period. Due to climate friendly and comfortable housing, milk productivity has increased by >20% and disease incidences have reduced by >35%. State plans to replicate climate resilient sheds in other districts of the State, as an adaptation measures in climate change scenario.

#### Intended benefits:

- Enhanced milk productivity during heat stress conditions
- Increase in adaptive capacity of farmers through sustained income

### AG/N/9: Conservation and propagation of indigenous breeds of livestock

The indigenous breeds have many merits over exotic breeds including better disease resistance, less prone to impacts of heat stress and parasitic infections etc. Thus, this strategy aims at conserving and revitalizing the native cattle breeds as they are more tolerant to climatic change.

#### Intended benefits:

- Enhancing resilience of livestock sector
- Conservation of indigenous gene stock



Total mixed ration feeding at dairy farm, GADVASU, Ludhiana

### AG/N/10: Promote shrimp culture and other suitable species in saline and water-logged area to generate livelihood opportunity

South-western districts of Punjab are adversely affected with the problem of water-logging and high soil and water salinity. These saline affected lands can be utilized more scientifically with fish farming, which have more productivity than agriculture. Shrimp is an export commodity fetching very good income of INR 0.3 to 0.4 million/acre. Hence, Government has planned to scientifically explore and promote culture/ farming of suitable species in saline affected & waterlogged areas of Punjab aiming at generating adequate livelihood opportunities for the farmers.

#### Intended benefits:

- Utilization of saline and water-logged area
- Opportunity for income generation

### AG/N/11: Smart and resource efficient dairy farming

Smart dairy farms can reduce the environmental issues by optimizing the use of resources and limit methane production associated with over feeding. This can be done by providing optimal ration through Total Mixed Ration (TMR) so that each animal consumes only required level of nutrients. The strategy will focus on providing requisite nutrients in the form of TMR and maize silage to maintain optimum fodder requirement of animals at different age/ lactating stage.

#### Intended benefits:

- Resource optimization
- Providing balanced nutrition to livestock
- Limit methane emissions

### AG/N/12: Research for enhancing resilience of livestock sector

Climate change brings new uncertainties, risks and exacerbates existing challenges of livestock sector. The resilient capacity of an animal refers to its ability to recover normal biological functions after exposure to an adverse or stressful condition. Regular research is required to better understand impacts of changing climatic conditions on animal performance, its productivity, fertility, disease tolerance and w.r.t efficient dairy practices to enhance resilience of livestock sector

#### Intended benefits:

- Enhanced resilience
- Information for evidence based decision making



## 5.3 State Mission on Water

### 5.3.1 Overview

The state has significant surface water resources like rivers, streams, wetlands and village ponds. The surface water resources are being managed through well-organized canal irrigation system. However, the available surface water resources are unable to meet increasing demand of water for irrigation, thus, increasing pressure on ground water resources. The groundwater resources of the state are being over exploited to meet increasing demand of water in agricultural, industrial & domestic sector. There is a noticeable gap in demand and supply of water in North & Central Zones of the State (**Table 5.7**). Although in the south the demand harmonizes with the availability, but the area faces issue of water logging and water salinity. Thus, there is a need for a holistic strategy to address these issues in the wake of climate change.

The state is aiming at water resource conservation and abatement of water pollution through various initiatives. The most notable efforts in this direction include setting up of Punjab Water Regulation & Development Authority for ensuring the judicious, equitable & sustainable utilization and management of water resources. In addition, Department of Local Govt. has amended and notified building byelaws and made rainwater harvesting mandatory in all buildings above 200 sq yard. Further comprehensive Action Plans for Clean Rivers and rehabilitation of village ponds are being implemented in the State.

Department of Water Supply & Sanitation, Punjab has also envisaged ensuring availability and sustainable management of water and sanitation for all by the end of 2030, in-line with the SDG-6. As outlined in NITI Aayog's report 2020-21, 80.68% of rural population of the state already has access to safe and adequate drinking water within premises through Pipe Water Supply (PWS) and 92.4% of rural population has improved source of drinking water. Regular testing of ground water sources is also being carried out for basic chemical parameters, heavy metals and bacteriological parameters as per the safe standards of drinking water.



**Table 5.7: Status of water use demand vs availability**

Zone	Demand (in Million litre)	Availability (in Million litre)	Deficit (in Million litre)
North zone	4,26,563.37	3,15,071.77	-1,11,491.6
Central zone	1,565.51	1,303.93	-261.58
South zone	8,80,506	8,80,506	0

The Government is also actively working to improve on-farm water use efficiency by enhancing the adoption of precision irrigation and other water-saving technologies under the Pradhan Mantri Krishi Sinchayee Yojna (PMSKY) scheme. The scheme includes following four components:

- “Har Khet ko Paani” which involves repair, restoration and renovation of water bodies
- “Per Drop More Crop” includes introduction of water-saving technologies
- “Watersheds” includes effective management of runoff water and improved soil and moisture conservation
- “MGNREGA” includes repair and renovation of village ponds as well as construction of rainwater harvesting facilities.

**Table 5.8** represents number of completed projects and details of expenditure incurred by the State. Under, PMKSY expenditure to the tune of INR 518.1 million has been incurred during the period 2014-22 for watershed development.

**Table 5.8: Progress under Pradhan Mantri Krishi Sinchayee Yojna - Watershed Development Component**

FY-Year	Funds Released (INR. in million)	Expenditure incurred (INR in million)	Projects Completed (Nos.)
2014-15	17.1	170.9	519
2015-16	102.5	52.5	187
2016-17	0	83.2	322
2017-18	56.5	43.6	124
2018-19	119.8	32.5	144
2019-20	12.8	25.4	64
2020-21	nil	93.2	550
2021-22	nil	16.8	84
<b>Total</b>	<b>308.7</b>	<b>518.1</b>	<b>1,994</b>

According to the State Irrigation Plan of Punjab, 14,974.37 Million Cubic Meter (MCM) per year is the expected increase in the groundwater recharge in all districts under different components of the scheme. The maximum increase in groundwater recharge is expected to be 11,949.05 MCM under the component of 'Per Drop More Crop' followed by 'Har Khet Ko Paani' (2,324.814 MCM), 'Watershed' (527.774 MCM) and 'MGNREGA' (172.728 MCM).

The Department of Soil & Water Conservation has covered 49,567 ha area by utilizing INR 4,069 million between the years 2014 - 2020 for the following:

- 90% assistance for community underground Pipeline Projects for conveying irrigation water from canal outlet to tail-end fields of the farmers.
- 50% subsidy provided for individual farmers on Underground Pipeline Projects
- Subsidy up to 80% provided for the farmers on Micro-irrigation (Drip & Sprinkler) system to ensure optimum utilization of irrigation water
- Installed underground pipeline from sewage treatment plants (STPs) of various towns/cities for utilization of treated water for irrigation of nearby agricultural fields of farmers.

### 5.3.2 Impact of climate change on water sector

As Punjab is an agricultural economy which is highly dependent on natural resource management, it becomes vital to understand the significance of the impact of climate variability on the soil and water parameters. Globally, various reports have indicated that land will become significantly drier as a result of global warming. Further, a decline in annual rainfall over the decades has already been observed. Few projected impacts of climate change on the water sector are as under:

- Climate change is expected to influence river flow and change the average water availability in the State. Further, climate change will not only increase water demand but will also have shrinking effect on water availability. This shifting balance will raise concern for water resource management.
- An economic survey indicated that 100 mm decline in rainfall levels will result in farmer's income to fall by 15% and 7% during the kharif and rabi seasons, respectively.<sup>59</sup> Furthermore, survey also indicated 15% to 18% average reduction in agricultural incomes with climate change implications. Thus, highlighting the need for effective measures to enhance resilience of agriculture sector.
- Evapotranspiration from crops is expected to increase by 6–8% as a result of projected rise in temperature. This would increase the demand for irrigation by 100 mm to 133 mm for a crop requiring 500 mm water, considering flood irrigation method, which is predominantly followed in the State.



### 5.3.3 Key issues and challenges in water sector

Climate change is expected to influence water resources, disturbing weather patterns leading floods & droughts. This may intensify the existing challenges of water availability viz-a-viz demand and water contamination, thus, affecting both quantity and quality of water in future. Gist of key challenges are highlighted in the **Table 5.9**.

**Table 5.9: Key issues and challenges in water sector**

Area	Issues
Technical	<p>Irrigation demand</p> <ul style="list-style-type: none"> <li>• Increasing water demand for irrigation due to water intensive cropping pattern.</li> <li>• The canal network is more than a century old and is now functional at 30% below its designed capacity.</li> <li>• Limited penetration of micro irrigation in the state.</li> </ul> <p>Water pollution</p> <ul style="list-style-type: none"> <li>• Increased consumption of NPK by 56% in last twenty years contributing to surface and ground water pollution.</li> <li>• Rapid increase in urbanization &amp; industrialization has polluted freshwater resources both in physicochemical and biological terms.</li> </ul>
Institutional / Regulatory	<ul style="list-style-type: none"> <li>• Need of strict monitoring &amp; enforcement of water extraction in problematic areas</li> <li>• Severe problems including water logging and brackish water in south western part of the State. Presently, State needs holistic strategy to mitigate these problems. There is a need for greater synergy between departments of Agriculture, Soil &amp; Water Conservation, Drainage and Water Supply &amp; Sanitation for planning suitable measure to address water logging situation of the region.</li> </ul>
Financial	<ul style="list-style-type: none"> <li>• Adequate funding is required for enhancing water resource efficiency of the State.</li> </ul>



Promoting reuse of treated waste water for irrigation



### 5.3.4 Progress mapping

Department of Water Resources, Govt. of Punjab has been the mission Nodal Department for the State Mission on Water of SAPCC 1.0. The detailed progress viz-a-viz strategies of Water Mission under SAPCC 1.0 during the period 2014-20 are given in **Annexure III**. The Key Achievements under the Mission are as under:

## Key Achievements

### Water conservation & monitoring

- Established Punjab Water Regulation & Development Authority for proper management and conservation of water resources. Some of the notable policy level initiatives include:
  - Constitution of Punjab State Council for Water Management and Development
  - Draft Punjab Guidelines for Groundwater Extraction and Conservation, 2020
- Set up >1,100 ground water level monitoring stations and installed 208 injection wells and 9 piezometers to monitor ground water recharging.
- Developed Water Conservation & Management Master Plan for the State involving Israel based water company M/s Mekorot.
- Promoted Micro Irrigation (Drip & Sprinklers) on >7,000 ha and underground pipeline system on 0.14 million ha for on-farm water conservation.
- Constructed 183 water harvesting & recharging structures for storage, irrigation and natural recharge in Kandi area.
- Conserved more than 1000 cusecs of water saved and stabilized > 1 lakh ha of area through relining of Rajasthan and Sirhind feeders.
- Watershed Management works carried out at >0.13 million ha of wastelands & degraded lands.



Piezometer installation to monitor ground water level by Department of Water Resources

### Flood Management initiatives

- Flood forecast system being developed for Ranjit Sagar dam by Department of Water Resources, Punjab for real-time water level monitoring to avoid damages due to floods as an adaptation strategy.
- Embankment strengthening of >1800 km undertaken for flood protection along Rivers Beas & Sutlej.
- More than 7,200 km drainage network developed/ maintained to save agriculture from flood hazards and regulate water logging in south western region.
- Constructed 13 low gravity dams on various rivulets in Kandi region to control the flash flooding from hilly areas.
- Conducted flash flood protection works along border areas of the State for strengthening of river banks.



Strengthening of river banks & flood management works at Ranjit Sagar Dam, Pathankot

### Waste water treatment & Pollution abatement

- Introduced State Treated Waste Water Policy, 2017 to encourage use of treated waste water in construction works.
- 130 STPs (1759.5 MLD) constructed and 55 STPs (625.5 MLD) under construction in urban towns.
- Ensured supply of safe treated water to >2000 quality affected rural habitations.
- About 67% of the total sewage generated in urban area treated using advanced technologies such as Fluidized Bed Reactor (FBR) and Membrane Bio-Reactor (MBR).
- Installation of Online Continuous Monitoring System (OCMS) in industries (>50 KLD Discharge).
- Implementation of State Action Plan on Clean Water (Beas, Sutlej, Ghaggar) and Action Plan for Reuse of Treated Wastewater

### 5.3.5 Sector planning – strategies for State Water Mission

Punjab's overarching targets pertaining to the State Mission on Water and illustrates their linkages with agreed targets at the National and International level are listed at **Table 5.10**.

**Table 5.10: Water sector Targets under SDG and NDC by 2030**

International / National Commitment	Targets	Key State targets and initiatives
International Commitment	<b>SDG 6:</b> Clean Water and Sanitation: Ensure Availability and sustainable management of water and sanitation for all by the end of 2030	<ul style="list-style-type: none"> <li>• To cover all the rural habitations with improved service standards of piped water supply and water connections at their door steps.</li> <li>• To stabilize irrigation in command area of 1.076 million ha by 2022-23.</li> </ul>
	<b>SDG 14:</b> Conserve and sustainably use the oceans, seas and marine resources for sustainable development	<ul style="list-style-type: none"> <li>• Restore ground water in 146 blocks</li> <li>• Diversify Cropping on 1,00,000 ha/year to conserve groundwater</li> <li>• Treatment of 76 sub-watersheds in Shivalik region</li> </ul>
National Commitment	<b>NDC 6:</b> 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	<ul style="list-style-type: none"> <li>• To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly water resources</li> </ul>



Additional state targets have been formulated under the Clean water sub-mission of **Mission Tandarust Punjab**.<sup>60</sup> The key focus areas of this sub-mission are listed in **Table 5.11** along with expected outcomes. Further specific activities and quantitative targets are detailed in the **Action Plan for Clean Reivers**.

**Table 5.11: Key focus areas under the Clean Water Sub-Mission of Mission Tandarust Punjab**

Key Focus Areas	Expected Outcomes
Setting up of New STPs	Enhanced availability of treated water to meet growing demand of water in agriculture
Setting up of New CETPs	Common Effluent Treatment Plants (CETPs) provide collective treatment of industrial effluents from a cluster of small and medium scale industries of similar category.
Setting up of ETP for Dairy Waste	Dairy Industries generate wastewater having high Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). ETPs using anaerobic process may treat the waste water as well as produce biogas/renewable energy
Rejuvenation of water related ecosystem i.e. Ponds/ drains	Disposal of wastewater in the ponds is a major public health concern as the stagnant water emits bad smells and leads to many diseases. Ponds, after rejuvenation, can be used to catch rainwater to recharge the aquifers
Conservation & augmentation of groundwater	Reuse of Treated Wastewater from STPs for irrigation purposes reduces consumption of ground water
Carcass handling plant at Ludhiana	Deep burial of carcasses may contaminate soil with pathogens which can then be leached to ground water and result in water borne diseases



225 MLD STP at Jamalpur, Ludhiana



### 5.3.6 Strategies for 2021-30 under Water sector

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code "WR/N" to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with "WR" are continuing from SAPCC 1.0.

#### WR/N/1: Water resource (including river courses, tributaries, canals) mapping through GIS and remote sensing technology

Water resources are limited and in future climate change scenario, the need for sustainable management of these resources is prerequisite. The rising need has also made it mandatory to utilise surface and ground water judiciously. By the means of GIS and satellite remote sensing techniques, the water resources and the water demand can be quantified resulting in baseline information for Government to better manage the water resources. The action points would include:

- Remodel drainage crossings of canals such as Sutlej Yamuna link, Bhakra main line, Bhakra main Branch that are obstructing the free flow of Ghaggar river to avoid flash floods.
- Continue with flood protection works along river Ravi in flood prone areas.

#### Intended benefits:

- Greater awareness of available water resources
- Enhanced institutional capacity for appropriate planning
- Promote judicious use of water resources

#### WR/2: Manage Floods in a future erratic and excess extreme rainfall scenario.



Flooding results in loss of life and economic damage. The damaging effects of floods are complex causing major infrastructure damage, including disruption to roads, rail lines, airports, electricity supply systems, water supplies and sewage disposal systems. Hence, it is important to better equip the State with flood control measures for significantly reducing the loss of life and economic damage. Currently, Flood Forecasting project is being implemented in Ranjit Sagar Dam to develop real time inflow forecasting system with a customized GIS tool for the dissemination of reservoir water level forecasts with sufficient lead time. Through this strategy, State aims to develop flood control measures to enhance its adaptation capacity.

#### Intended benefits:

- Better resource management
- Enhanced adaptation to climate extremes

#### WR/3: Contain the likely enhanced water logging situation in the south west districts of Punjab

South-western districts of Punjab are adversely affected with the problem of water-logging and high soil and water salinity. This has resulted in an estimated more than 0.2 million ha of land to have meagre to zero agriculture production. A project of installing shallow piezometers will be commenced in the region for monitoring of water quality and water logging. Through this strategy, State aims to reclaim these water-logged areas for agriculture and aquaculture purposes using scientific and good practices.

#### Intended benefits:

- Generate livelihood opportunities
- Reclaiming the area for agriculture/ aquaculture



Validation & demonstration of Shrimp farming technology for south western Punjab by GADVASU, Ludhiana

#### WR/4: Research and monitoring of activities for effective decision making

Research and development play a vital role to manage the water resources. There is a need for quantification of water resources and estimation of current and projected demand for effective decision making. Research and monitoring activities will not only provide baseline and projected data for effective resource management but will also help in developing appropriate strategies to mitigate impact of climate change on water resources.

##### Intended benefits:

- Enhanced institutional capacity for appropriate planning
- Increased preparedness to mitigate effect of climate change

#### WR/N/5: Undertake a focused approach to augment groundwater especially in problematic/ overexploited areas.

Ground water table in Punjab has been declining due to rising demands of agricultural, domestic & industrial sector. To address the situation of declining water- table, the State has already initiated steps such as development of water conservation and management plan in collaboration with M/s Mekorot-Water, Israel to achieve sustainable use of water resources. This strategy aims to effectively monitor the ground watertable and explore available alternatives to reduce dependency on ground water.

##### Intended benefits:

- Monitoring of Ground water- table for judicious use
- Better decision making for effective management of water resources



### WR/6: Enhance water use efficiency by 20%

The strategy envisages improving efficiency in water use in different sectors through all possible measures viz. controlling leakage from distribution pipes, metering of unauthorized connections, promotion of water use efficiency in agriculture and industrial sectors, differential pricing of water use etc.

#### Intended benefits:

- Increased water use efficiency
- Reduced stress on available water resources

### WR/7: Abate continued water pollution of underground and surface water sources

Sustaining water quality is highly important to provide safe drinking water to the growing population and limit entry of pollutants through food chains. State has been emphasising on improving surface & groundwater water quality through various measures. This strategy is in the same direction and includes following action points:

- Control industrial water pollution at source and residual pollution at discharge points into the rivers
- Abate water pollution due to agricultural runoff and domestic waste water discharge in water resources

#### Intended benefits:

- Reduced water pollution
- Access to clean water



## 5.4 State Mission on Health

### 5.4.1 Overview

Health indicators of the state like life expectancy, Neonatal Mortality Rate (NMR), Under 5 Mortality Rate (U5MR) are better than that of National SDG Index score. The state has shown significant progress under SDG 3 (Good Health & Wellbeing) as per Niti Aayog's SDG Index Report 2020-21. Proportion of institutional deliveries out of the total deliveries has been reported as 98.5 percent and there is a significant reduction observed in Under 5 Child Mortality in the State<sup>26</sup>.

Health care facilities at Community Health Centre (CHC) level in the state are comparable to the National average, however, Punjab has performed better than other states w.r.t secondary and tertiary health care infrastructure. The State has been taking several initiatives under National Rural Health Mission (NRHM) aimed at improving the health infrastructure. Upgradation of health facilities, Janani Suraksha Yojana (JSY) to promote institutional delivery through cash incentives, introduction of community-based health workers known as Accredited Social Health Activists (ASHA) and involvement of Panchayats in health functioning at the village level by creating village Health & Sanitation Committee (VHCS), which are few notable efforts under NHRM<sup>34</sup>.

State has undertaken various key initiatives for health sector including campaign for 'Anaemia Mukht Punjab' and formulation of dedicated State Action Plan for Climate Change & Human Health. The Action plan focuses on strengthening health preparedness and response towards climate related illnesses and create awareness among general population (vulnerable community), health-care providers and policy makers regarding impacts of climate change on human health.

Further, efforts have been initiated to make the health facilities greener and more energy efficient which can directly reduce GHG emissions. Green Teams have been designated with officers of Health Department to ensure that offices under their supervision become more energy efficient. Health facilities in 8 cities namely Amritsar, Jalandhar, Ludhiana, Khanna, Mandi Gobindgarh, Patiala, Bathinda and Rupnagar initiated display of Air Quality Index (AQI) levels.

Further, to make Punjab the healthiest State with improved environment quality, the State has launched Mission Tandarust Punjab. The Focus of Mission has been to minimize environmental & public health hazards and enhance State's resilience towards emerging climate change challenges.

### 5.4.2 Impact of climate change on the health sector

Global trends suggest that climate change can negatively affect human health through a number of ways, but the commonly experienced Challenges are increased frequency and intensity of heat waves leading to rise in heat related illnesses and strokes. Further, climate extremes like Floods, Cyclones, Hurricanes, Droughts etc. directly cost lives. Rising temperature also increases the level of 'ground level ozone' and other 'climate altering pollutants', which further exacerbate cardio-respiratory and allergic diseases. Apart from these, rate of transmission and spread of infectious/ vector-borne diseases is projected to increase whereas, changes are expected in water-borne illnesses besides effect on nutritional value of food commodities.

Recent studies have reported significant associations between exposure to black carbon (short- and long-term) with respiratory diseases and cardiopulmonary mortality. Ozone is the second SLCP, directly associated with air pollution related health effects. Specifically, there is strong evidence that



ozone is associated with respiratory problems, with impacts ranging from changes in lung function and increased incidence of asthma to premature mortality.<sup>26</sup>

### 5.4.3 Key issues and challenges in the Health sector

World Health Organization (WHO) highlighted that Climate Change affects social as well as environmental well being that are determinants of health including clean air, safe drinking water etc. which may manifest into particular health conditions viz malnutrition, diarrhea, malaria, heat stroke etc. The key challenges/gaps of this sector have been tabulated in **Table 5.12**.

**Table 5.12: Key gaps identified in the Health sector**

Area	Issues
Institutional	<ul style="list-style-type: none"> <li>• Inadequate early disease warning systems</li> <li>• Erratic data for modelling climate change related health impacts</li> <li>• Limited in-house expertise on climate change to align programs/schemes</li> </ul>
Technical	<ul style="list-style-type: none"> <li>• Shortage of skilled technical manpower to deal with climate change related health issues in the Public Health Care system</li> <li>• Limited reach of well-equipped health centres in rural areas</li> </ul>
Financial	<ul style="list-style-type: none"> <li>• Limited funds for effective health services in the wake of emerging challenges due to climate change</li> </ul>
Regulatory/ Policy	<ul style="list-style-type: none"> <li>• Lack of clear policy on climate change induced vector management (preventive), air quality linked disease control &amp; management.</li> </ul>



### 5.4.4 Progress mapping

The detailed progress viz-a-viz strategies of Health sector under Sustainable Habitat Mission of SAPCC 1.0 during the period 2014-20 are given in **Annexure VI**. The Key Achievements under the sector are as under:

### Key Achievements

- Constitution of State level Governing Body, State Task Force of Climate Change & Human Health and formulation of dedicated Action Plan for Climate Change & Human Health.
- 100% collection & treatment of Bio-Medical waste through common bio-medical waste treatment facilities and online tracking of bio-medical waste for effective monitoring.
- Launched 'Anaemia Mukt Punjab' campaign with a special drive for testing and treating children, adolescent girls, pregnant and lactating women on a priority basis.
- Launched Mission Tandraust Punjab to make Punjab the healthiest State by Department of Science Technology and Environment Govt. of Punjab . Under the Mission, Annual Action Plans are being implemented to address the health issues under its two sub-missions i.e. Nutrition and Preventive Health. Few outcomes under Mission Tandraust Punjab are:
  - Distribution of new recipes under supplementary Nutrition Programme for better nutrition.
  - Regular nutritive quality monitoring of Mid-Day meal to curb malnutrition among children.
  - More than 59,000 wellness sessions conducted across the State wherein >2 Lakh persons screened & consultations provided
  - More than 3.87 lakh pregnancies registered out of which >41,000 pregnancies identified as high-risk for continuous monitoring.
- Initiated a pilot project on fortification of rice which is ongoing in Moga, Ferozepur and Ludhiana districts.



### 5.4.5 Sector planning – Strategies for Health sector

State's overarching targets pertaining to the Mission on Health and illustrates their linkages with agreed targets at the national and international level are listed in **Table 5.13**.

**Table 5.13: Specific target under SDG and NDC by 2030<sup>34</sup>**

International/ National Commitment	Targets	Key State targets and initiatives
International Commitment	<b>SDG 2:</b> End hunger, achieve food security, improved nutrition & promote sustainable agriculture	<ul style="list-style-type: none"> <li>• Reduce Hunger Index of the State</li> <li>• Eliminate calorie undernourishment in population to 0%</li> <li>• Minimize underweight in children</li> </ul>
	<b>SDG 3:</b> Ensure healthy lives and promote well-being for all at all ages	<ul style="list-style-type: none"> <li>• Reduce maternal mortality ratio to 80/100,000 live births</li> <li>• Reduce Neonatal mortality rate to 11/1000 live births</li> <li>• Completely eliminate Malaria and reduce cases of dengue by 75%</li> </ul>
National Commitment	<b>NDC 6:</b> 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	<ul style="list-style-type: none"> <li>• Increase per capita health expenditure budget</li> <li>• Build Institutional capacities for village level reporting under Integrated Disease Surveillance Program (IDSP)</li> <li>• Implementation of State Action Plan on Climate Change and Human Health.</li> </ul>



Additional State targets to the State Mission on Health have been formulated under the **Nutrition Sub-mission** and **Preventive Health Sub-mission** of the **Mission Tandarust Punjab**. The key focus areas including expected outcome of these sub-missions are listed in 5.14 and 5.15.

**Table 5.14: Key Focus Areas and Expected outcomes under Nutrition Sub-Mission**

Key Focus Areas	Expected Outcomes
Ensure the quality of mid-day meals	Improve nutritional contents of the meals in schools
Improve the nutrition level in slum areas of the State	Nutritious food for poor people of Punjab
100% Nutritional food to children, lactating mothers and pregnant women	Better health of pregnant women, lactating mothers and children
Ensure the nutrition level in all the children	Reduced mortality and morbidity among children due to low birth weight, malnutrition, pneumonia, diarrheal diseases, non-communicable diseases etc.

**Table 5.15: Key Focus Areas and Expected outcomes under Preventive Health Sub-Mission**

Key Focus Areas	Expected Outcomes
Improve Health care delivery through Community Health Officers / Health Wellness Centers	Screening and Diagnosis for communicable and non-communicable diseases
Improve Child Health through screening, early diagnosis and treatment for 31 identified childhood diseases (RBSK – Rashtriya Bal Swasthya Karyakram)	Diagnosis and treatment of diseases at early stage to enhance effective treatment
Maternal & Child Health care	Reduction in Maternal Mortality Ratio and Infant Mortality Rate
Reduced Anemia through Iron and Folic Acid Supplementation (National Iron Plus Initiative + National Deworming Day)	Healthy Children in schools
Family Planning Services	Reduction in unintended pregnancies
Vaccination	Safeguard against diseases



### 5.4.6 Strategies for 2021-30 under Health Sector

Mission health is introduced in SAPCC 2.0, therefore all the strategies are new hence coded as "HEL/N" All the activities that are proposed for health sector are transformative in nature i.e. the activities which are newly proposed for the upcoming years.

#### HEL/N/1 - Developing early warning and alert systems in specific areas for heat waves and Air Quality Index

The strategy aims at enhancing readiness of people & health systems for timely & appropriate response. Following action points have been identified as focus areas:

- Enhancing the institutional capacity to monitor air quality & understanding on related health impacts
- Raising awareness by providing AQI alerts through different mediums
- Developing tele-assistance services for heatwaves and AQI based concerns
- Installation of displays for temperature and weather forecast

#### Intended benefits:

- Monitoring local air quality and informed decision making based on robust data
- Raising public awareness on climate change related health issues



### HEL/N/2 - Developing Mechanism for climate sensitive disease tagging

Climate Change influences the transmission of water/vector-borne diseases. It has also resulted in emergence and re-emergence of various infectious diseases. Considering the future climate change scenario, having an integrated disease surveillance and early warning system for climate-sensitive diseases is vital for better health management. Hence, to reflect the impact of climate change on health and developing robust data set for efficacy in future planning, State has planned to develop a mechanism for tagging of climate sensitive disease.

#### Intended benefits:

- Contain disease outbreaks due to timely tagging of specific vector/water borne disease
- Better management of climate sensitive illnesses
- Enhanced adaptive capacity of health care sector

### HEL/N/3 - To create awareness among general population, vulnerable community, health-care providers and policy makers regarding impacts of climate change on human health

The focus of this strategy will be to increase understanding of impacts of climate change on human health through awareness & outreach programs. This will also involve building capacities of health work force (ASHA workers, para medical staff) for prevention, mitigation and risk management of climate sensitive illness.

#### Intended benefits:

- Increased capacity of institution for appropriate response
- Greater awareness about climate change impacts on human health



#### HEL/N/4 - Strengthen mechanism for management of vector borne diseases through surveillance and establishment of sentinel sites

Due to erratic rainfall pattern and untimely event abrupt climate changes, the number of cases of vector borne diseases is likely to increase. In addition, due to large livestock population, the chances of spreading of zoonotic diseases are also increasing. The department will take measures for identifying, controlling and monitoring breeding sites of common vectors like mosquitoes and treat/eradicate such sites with the support of Department of Local Govt. or concerned Municipal bodies.

##### Intended benefits:

- Contain disease outbreaks
- Effective management of vector borne diseases

#### HEL/N/5 - Strengthening/ developing management strategies for water borne illnesses.

Water borne diseases are expected to increase in intensity as well as in terms of frequency, in the coming decades, hence it is critical to have mitigation and adaptation plans in place. Through this strategy, State aims to strengthen and develop better management strategies for water borne illnesses. Measures for controlling and monitoring water infected areas envisaged to be identified through disease tagging in daily OPDs and treatment of such sites involving Department of Local Govt., concerned Municipal bodies or District Administrations.

##### Intended benefits:

- Contain disease outbreaks
- Effective management of water borne diseases



- Reduce burden of hospitalization through preventive measures

HEL/N/6 - Improving nutritional status of young children, adolescent girls and pregnant women as well as reducing mortality and morbidity among young children due to low birth weight, malnutrition, etc.

The linkage between climate change and nutrition is multifaceted. Decline in nutritional value of food stuff is expected with climate change which thereby, increases challenge of ensuring optimal nutrition at critical stages. This strategy, therefore, focuses to better understand and effectively manage climate-related nutritional concerns and associated health risks especially, in children and women for better adaptation.

#### Intended benefits:

- Ensure optimal nutrition especially during critical developmental stages
- Increased adaptive capacity to withstand emerging health issues due to changing climate

HEL/N/7- Reducing maternal mortality rate by improving quality of health care at the rural community level.

Pregnant women are considered as the most vulnerable group due to increased sensitivity to the impacts of climate change. Climate change is expected to increase the risk of infant and maternal mortality, birth complications and deteriorate reproductive health, especially in rural areas. Thus, climate change will have a substantial impact on the health and survival of the next generation. With this strategy, State aims at improving the quality of health care at the rural community level.

#### Intended benefits:

- Increased institutional capacity for delivering adequate health services in rural areas
- Reduced infant and maternal mortality rate



## HEL/N/8 - Greening of health sector and enhancing energy efficiency of the healthcare buildings

State proactively planned to undertake measures to initiate greening of the health sector by adopting environment-friendly technologies and using energy-efficient technologies. The main objective of this strategy is to reduce the carbon footprint of health care sector.

### Intended benefits:

- Reduction in associated GHG emissions
- Increase in energy and resource efficiency
- Increased green cover & enhanced carbon sink



## 5.5 State Mission on Strategic Knowledge for Climate Change

### 5.5.1 Overview

Climate change has been affecting every single corner of the world and has serious implications on National economies. To combat climate change, both adaptation and mitigation strategies need to be well planned and coordinated for maximum efficiency, particularly in the context of evolving scientific knowledge and specific developmental pressures and needs.

With the vision to support all other 7 National Missions under National Action Plan on Climate Change (NAPCC) with adequate capacity & strategic knowledge, National Mission on Strategic Knowledge for Climate Change (NMSKCC) was adopted as one of the 8 core Missions of NAPCC. NMSKCC is aimed at creation of knowledge networks among the existing knowledge institutions engaged in R&D relating to climate science, assessing regional impact of climate change on different sectors & capacity building on subject.

Further, to support sub-national planning and build regional capacities, State Climate Change Knowledge Centers have been set up by Department of Science & Technology, Govt of India. Punjab State Climate Change Knowledge Centre (PSCCKC) set up in PSCST has been instrumental in creating an atmosphere of learning and facilitating addressal of climate challenges and concerns. The Centre has facilitated development of projects to address regional concerns involving relevant line departments and mobilized additional climate finance from Govt. of India under relevant programs/schemes.

The Centre has also technically supported revision of State Action Plan on Climate Change for the period 2021-2030, in line with Nationally Determined Contributions as well as SDGs and State flagship initiatives. State Mission on Strategic Knowledge on Climate Change under SAPCC 2.0 has been envisioned to be implemented & co-ordinated through PSCCKC with holistic approach by involving premier Universities, Research Institutions and Training & Extension wings of State Line Departments.

The State has also established a separate Directorate of Environment & Climate Change (DECC) to coordinate & monitor Climate Change Action Plan, promote climate-resilient activities, and stimulate adaptation & mitigation measures for generating effective state's response to tackle climate change challenges. Recent key initiatives undertaken include joining of Global Network of Under2 Coalition by the State and initiation of Special Activity Projects under Mission Tandarust Punjab.



### 5.5.2 Need of capacity building for appropriate response for climate change

Climate change impacts such as rising GHG emission, rising temperature and erratic patterns of rainfall have emerged as the biggest developmental challenge. Challenges of climate-sensitive sectors including agriculture, forests, water resources, fisheries and public health have already been exaggerated in recent years. Projected changes in the temperature and rainfall could further affect these vulnerable sectors and pose challenges including crop failure, threaten food security, urban flash flooding in certain pockets, heat island conditions, destruction of natural ecosystems and increase in vector borne diseases. In light of these impacts, achievement of developmental goals would be adversely affected.

There is a great need to build deeper understanding among various stakeholders for synergizing efforts and appropriate sectoral planning. Adequate capacities are also required for formulating adaptation/mitigation projects based on regional and sectoral vulnerabilities. Thus, Strategic Knowledge Mission aims to develop baseline knowledge such as vulnerability studies at various scales/sectors and build capacities of all set of stakeholders through need-based customized training/awareness & outreach programmes for generating effective State response.

### 5.5.3 Key issues and challenges in Strategic Knowledge sector

The key challenges of this sector includes considerable gap in understanding of scientific data about climate change and limited institutional capacities in almost all the state line department to plan & execute sectoral climate change strategies. Further, other gaps and issues related to this sector have been tabulated in **Table 5.16**.

**Table 5.16: Key issues and challenges in Strategic Knowledge sector**

Area	Gap
Institutional	<ul style="list-style-type: none"> <li>• Synchronization between Research/Academic Institutes, Govt. departments, Industries and Civil Society</li> </ul>
Technical	<ul style="list-style-type: none"> <li>• Limited availability of baseline data for systematic vulnerability analysis at block/village level</li> <li>• Micro scale planning for timely and appropriate addressal of local climate concerns</li> <li>• Minimal research on impacts of climate change on regional vulnerable sectors</li> </ul>
Regulatory/ Policy	<ul style="list-style-type: none"> <li>• Requisite policies for convergence of schemes aiming at related goals</li> <li>• Inter-departmental co-ordination for better convergence and clarity of goals.</li> <li>• Gap between research organizations and policy makers to effectively plan strategies for adaptation to climate change.</li> </ul>

### 5.5.4 Progress mapping

Punjab State Council for Science & Technology, Department of Science Technology & Environment, Punjab has been responsible for Strategic Knowledge Mission of SAPCC 1.0. The detailed progress viz a viz Knowledge Mission related strategies of SAPCC1.0 is given in **Annexure IV**. The key achievements under this Mission are as under:



## Key Achievements

### Institutional framework

- Setup a separate Directorate of Environment & Climate Change to steer environment & climate change related issues of the State.
- Established Punjab State Climate Change Knowledge Centre in PSCST with the support from DST, Govt for strengthening regional knowledge base & build capacities to tackle climate change issues.
- First Global Centre of Excellence (GCE) for the development of 'Agritech and Water' established and M.Tech course with specialization in Water Resources & Environment initiated at IIT Ropar.
- PBTI-PPCB Joint Environment Resource Centre set up to facilitate environment related research, advisory and skill up-gradation needs of industry, government departments & other stakeholders of Punjab/ adjoining states.
- Interpretation Centers established at Harike & Rupnagar wetlands and Chhatbir Zoo and Center for Eco-system Restoration set up at Punjabi University, Patiala.
- Set up laboratory for environmental (air, water and soil) analysis in Central University of Punjab



State Level Stakeholders' Meet for finalization of sectoral strategies

## R&D initiatives

- R&D Institutes and relevant development departments of the State have developed innovative processes/technologies to address emerging environment & climate change challenges:
  - Weather driven dynamic crop growth & yield simulation models, crop weather relationship models, weather-crop-insects/diseases interactions developed to support planning of agriculture sector in climate change scenario.
  - Assessed changes in hydro-climatic extremes in Punjab & predicted future flood events for Bhakra dam under changing climate.
  - Technology of rice straw biomass torrefaction to biocoal for power generation
  - Introduced bio-electrochemical technologies for CO<sub>2</sub> utilization & wastewater at point sources and iHydroMET technology for waste water treatment at household level.
  - Developed Protein based biosensor for monitoring of Arsenic and Cadmium in water & soil.
  - Conducted more than 74 patent searches in Environment/Climate Change domain through Patent Information Centre.

## Capacity Building

- Initiatives of PSCCKC conferred with RCE Recognition award instituted by United Nation University of advance study of sustainability towards transformative learning to encourage climate action A knowledge network has been created with 14 Universities/Institutions and 4 Industrial Associations to promote research on climate change issues in the State
- Undertaken intensive training & capacity building programs for varied set of stakeholders involving Govt. functionaries, Researchers, Students, Farmers, NGOs, etc. with outreach >0.55 million
- Conducted skill up-gradation and training programs for industrial workers and farmers on climate resilient technologies & practices for enhancing their adaptive capacities.
- A monthly bulletin 'Hari Dharti Neela Akash' initiated by PHDCCI to publicize actions towards climate change mitigation & adaptaion.



Agricultural machinery displayed at Kisan Mela, PAU, Ludhiana

## Project Facilitation & Implementation

- Mobilized additional climate finance of INR 877 million in the State through various adaptation/mitigation projects addressing regional vulnerabilities in the wake of climate change.

Various technological adaptations/mitigation best practices established include:

- Novel Climate Resilient cattle sheds
  - Weather Linked Livestock Insurance System based on Temperature and Humidity Index
  - Converted Coal based Re-rolling mills to cleaner PNG fuel
  - Set up paddy straw based briquetting units to promote green fuel
  - Converted majority of brick kilns in the State to induced draft zig zag energy efficient technology & large number of induction furnaces to side suction hood for effective reduction in air pollution.
- Demonstrated cleaner technologies benefitting 1300 Industries and brought in private sector investment of INR 3,000 million in the State towards cleaner technologies, which led to particulate matter reduction of 52,000 Tonnes/annum leading to improved work zone environment of ~25,000 industrial workers.



Climate Resilient Cattle Shed demonstrated at GADVASU for training of farmers



PNG based Steel Re-rolling Mill at Mandi Gobindgarh, Fatehgarh Sahib

### 5.5.5 Sector planning –Strategic Knowledge for Climate Change

Punjab's overarching targets pertaining to the State Mission on Strategic Knowledge for Climate change and illustrates their linkages with agreed targets at the National and International level are listed in **Table 5.17**.

**Table 5.17: Specific Strategic Knowledge Mission targets under SDGs and NDCs**

International/ National Commitment	Targets	Key State targets and initiatives
International commitment	<b>SDG13:</b> Take urgent action to combat climate change and its impacts	<ul style="list-style-type: none"> <li>• Dissemination of weather alerts &amp; crop/livestock advisories to all the farmers of the State</li> <li>• Dissemination knowledge on Disease Forecasting Model for Livestock</li> <li>• Promotion of <i>in-situ</i> and <i>ex-situ</i> crop residue management through knowledge dissemination</li> <li>• Promotion of Heat Stress Management practices for livestock</li> </ul>
National commitment	<b>NDC 1:</b> To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation including through a mass movement for 'LiFE' - 'Lifestyle for Environment' as a key for combating climate change	<ul style="list-style-type: none"> <li>• Promotion of one word movement 'LiFE' - 'Lifestyle for Environment' as a key to combating climate change through disseminating climate friendly practices</li> </ul>
	<b>NDC 8:</b> To build capacities, create a 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.	<ul style="list-style-type: none"> <li>• Capacity Building of stakeholders on climate change related issues and synergizing R&amp;D initiatives for supporting policy planning</li> </ul>

Additional targets and areas of work of relevance to the State Mission on Strategic Knowledge for Climate Change originate from the Mission Innovate Punjab. Mission Innovate Punjab was launched by the Department of Science, Technology & Environment, Govt. of Punjab through Punjab State Council for Science & Technology to facilitate ecosystem for promoting innovations. The key elements, objectives and focus areas of Mission Innovate Punjab are depicted as under:

## Mission Innovate Punjab

### Key Objectives



Champion Research and Innovation across sectors and domains



Advocate Policies for Development of Research and Innovation Ecosystem



Facilitate Universities in Adopting the Global Standards of Research



Facilitate Institutions & Universities in adopting Industry Collaborations



Promote Translation of Research into knowledge Led Enterprises

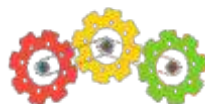


Draw up States' grand Challenges for research Alignment by Universities & Research Institutions

### Focus Area



ENVIRONMENT AND CLIMATE CHANGE



MANUFACTURING



CLEAN ENERGY



PUBLIC HEALTH

The goals of the Mission Innovate Punjab are focused on the creation and dissemination of context-specific technological knowledge as well as techno-economically viable innovations, which are in relevance to the State Mission on Strategic Knowledge for Climate Change.

The outcomes/fulfilment of key missions regarding climate change adaptation require following:

- Facilitation, Networking, and participation of universities and R&D/academic institutions, Industry & Developmental Departments for preparation of strategies, development & demonstration of technologies and Innovation plans for achieving State Development Goals.
- Capture global innovations/ best practices and International/National dynamics for infusion in the key relevant sectors.
- Facilitating inter-institutional networking as well as National & International collaborations for the flow of technological know-how and effective solution-finding.

Punjab State Climate Change Knowledge Centre (PSCCKC) will continue to foster capacities of all set of stakeholders on climate change issues & advancements in scientific understanding evolving at Regional, National & International level. Relevant sectors or key domain areas that would benefit from improved knowledge under different Missions such as Sustainable Agriculture; Forest, Ecosystem & Biodiversity; Health; Energy efficiency & Solar; Sustainable Habitat and Strategic Knowledge; etc. are presented in **Table 5.18**.

**Table 5.18: Key Domain areas under Strategic Knowledge Mission**

S.No	Mission	Partnering Department/ Institution	Target Groups	Key areas for Capacity Building
1	<b>Sustainable Agriculture</b>	Punjab Agricultural Management & Extension Training Institute (PAMETI), Krishi Vigyan Kendra (KVKs), Punjab Agricultural University (PAU), Agriculture Technology Management Agency (ATMA), Training Centres of Dairy Development Board (DDB), Fisheries & Animal Husbandry Department (AHD), Deptt of Agriculture and Farmers Welfare, Farmers Commission, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU)	Field Officials, Farmers, Youth entrepreneurs in Dairy /Fishery, NGOs, etc.	Climate resilient crops/ practices, Management of agricultural crop residues, Trainings for resource efficient dairy/ fishery, etc.
2	<b>Strategic Knowledge</b>	State's Pro-active Research/Academic Institutions	Researchers, students of Universities/Colleges/Schools and start-ups to align R&D with regional Climate change concerns.	Research areas for addressing sectoral challenges of the State and research projects
3	<b>Forest, Ecosystem &amp; Biodiversity</b>	Deptt. of Forests and Wildlife, WWF-India and Punjab Biodiversity Board	Field officers, Biodiversity Management Committees, Village Panchayats, NGOs, Self Help Groups, Schools and Colleges.	Skill development in bio-resource processing, wetland/ biodiversity conservation, identification of Biodiversity Heritage Sites (BHSs), implementation of Access and Benefit-Sharing (ABS) and documentation of traditional Knowledge
4	<b>Sustainable Habitat</b>	State Institute of Rural Development & Panchayati Raj (SIRD), Punjab Pollution Control Board (PPCB), Deptt. of Transport and Local Government.	Field Officers, Industries, Resident Welfare Association (RWAs), Self Help Groups, Panchayats, Drivers, Schools/Colleges, Public etc.	Low Carbon Transport system, Energy Efficiency, Green Buildings, Air Pollution Road safety, etc.

S.No	Mission	Partnering Department/ Institution	Target Groups	Key areas for Capacity Building
5	Enhanced Energy Efficiency & Solar	Punjab Energy Development Agency (PEDA)	Govt. Deptts, Industries/MSMEs, Village Panchayats, General public, Schools and Colleges.	Appropriate technologies to enhance energy efficiency, energy auditing, conservation measures & farm level solar power generation, etc.
6	Health	Department of Health & Family Welfare, Department of Community Medicine and School of Public Health, PGIMER, Chandigarh, AIIMS Bathinda, Baba Farid University of Health Sciences, Faridkot.	Officials of Public Health, Anganwadi, Panchayats, General public, School and Colleges	Heat/ Nutrient Management, vector borne, and water borne diseases in Climate Change scenario, etc.



#### 5.4.6 Strategies for 2021-30 under Strategic Knowledge Mission

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code "SK/N" to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with "SK" are continuing from SAPCC 1.0.

### SK/1- Manage, Interpret, Disseminate data & Information

Climate change being a multidisciplinary subject, access to different types of data sets is required to interpret the trends not only of climate but the drivers of climate change as well. These data are already being generated by various departments/institutions of the State as a part of their respective mandate.

Under the strategy, data pertaining to different activities (such as landuse, production, pollution, infrastructural, population, economy, natural resources, etc.), details of programs & projects being implemented in the State and policies/Acts/Notifications governing the programs will be sought from the stakeholder departments for planning appropriate local adaptation/mitigation programs.

### SK/N/2- Strengthening Knowledge Networks in the domain of Environment & Climate Change to address research issues and promote technology development for enhancing State's resilience

The strategy would focus on strengthening of knowledge networks for R&D in resource efficiency, sharing and exchange of data of relevance to climate change and responses thereby, enhancing the research capability in climate change studies.

Under the strategy, researchers' network of domain specific technical expertise in the State will be created to facilitate inter-institutional exchange of expertise and best practices. Decentralized resource centres will be set up in academic/research institutes for percolation of climate change knowledge at grassroot level. Multifarious efforts towards database development on research papers on climate change issues, historic data and repository of climate resilient practices/technologies will be taken up for planning appropriate local adaptation/mitigation programs.

### SK/N/3- Capacity building of Govt. functionaries/ for effective implementation of SAPCC 2.0 involving training/ extension centres of state institutions

Creation of awareness and suitable capacity at different levels of Government is also important to facilitate implementation of appropriate measures. Therefore, the strategy would focus on capacity-building of Govt functionaries engaged in the implementation of SAPCC w.r.t climate change concerns and the actions required under relevant Mission. Under this strategy, dedicated training wings/institutes of the State Departments like SIRD, PAMETI, MGSIPA, Extension divisions, etc. would be partnered for integrating sessions in training schedules. Specific modules for each department will be designed involving National & International experts.

### SK/N/4- Trainings for upcoming researchers in climate change domain for better aligning research & promote start-ups to address sectoral challenges

The Climate Change Centre under Knowledge Mission will continue to foster institutional capacities to deal with regional concerns. Strong partnership has been established with 14 key Universities & Institutions to jointly address the issues of state importance pertaining to environment and climate change which will also include development of sectoral data base on climate relevant aspects. These linkages will be further strengthened to promote R&D to align with climate change concerns of the State and develop inter-sectoral Climate Change Adaptation and Mitigation projects for enhancing State's preparedness to tackle regional short term and long-term concerns.



Capacity of Startups working in the area of Climate Change and Environment will also be strengthened to develop cost effective tech-based solutions to environmental challenges, which will be facilitated for pilot scale field demonstration through relevant stakeholder departments.



Training of Govt. functionaries by PSCCKC, PSCST on communicating green initiatives

### SK/N/5-Mainstreaming climate change concerns in ongoing programs & schemes through evidence-based planning of adaptation actions

Under the strategy, policy and decision makers from all relevant departments will be sensitized w.r.t evidence based and climate-proofed planning of all the sectors through dovetailing of relevant programs/schemes.

For precise planning, block level Vulnerability Assessment (VA) will be carried out besides VA for important sectors of Agriculture & Water to draw comparable observations for, enabling the Government officials, implementers, decision makers and adaptation funding agencies to assess which region is more vulnerable, what has made them vulnerable and how these vulnerabilities might be addressed. Moreover, it also provides basis for judicious allocation of State's resources/funds for enhancing adaptive capacity of relatively most vulnerable regions/communities on priority.

### SK/N/6-Specialized trainings for dairy farmers/youth entrepreneurs for sustained milk productivity in climate change scenario & minimizing methane emissions from dairy

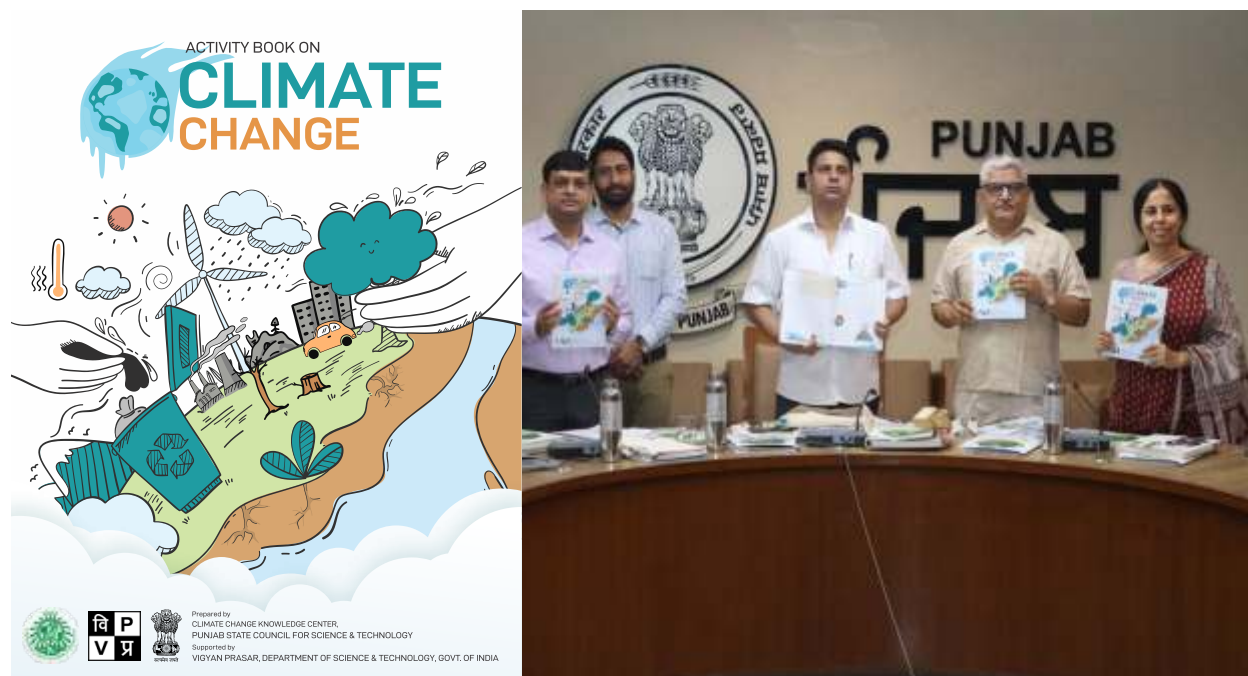
Farmer level special awareness camps & certified dairy trainings will be undertaken in collaboration

with Dairy Development Board (DDB) & GADVASU for introducing new technologies/ conservatory practices to benefit dairy entrepreneurs. Youth will be trained for adopting dairy as profession and thereby contribute towards Milk productivity and State's GDP. Handholding to the trained youth will be provided for setting up dairy units, secure bank loans, subsidy from Govt schemes and regular training for sustained production through improved and climate friendly practices to minimize methane emissions. Certified trainings are envisioned jointly with DDB through their training and extension centers, wherein farmers/youth entrepreneurs will be trained.

### SK/N/7-Awareness & outreach activities for school students, women and industrial workers for building an informed and resilient society

Skill development programmes for industry workers on cleaner technologies and practices, Women training programs for alternate livelihood as adaptation measure through NGOs and community-based organisation (CBOs) will also be undertaken. In addition, extensive awareness through target specific resource material in vernacular language, animated short films/videos, documentaries, pamphlets focusing promotion of low carbon lifestyles will be targeted.

Public awareness for communities on climate change is also equally important for bringing appropriate response. Under the strategy, climate change cell/knowledge galleries will be set up in academic institutions and will be continued outreach programmes for students through 5500 Eco-clubs in the State.



'Activity book on Climate Change' published by Punjab State Climate Change Knowledge Centre, PSCST



Mini Hydel Project at Khatra , Ludhiana

# Chapter 6

## CLIMATE CHANGE STRATEGY – MITIGATION





## 6.0: Climate Change Strategy – Mitigation

Climate change mitigation refers to efforts intended to reduce or prevent emission of greenhouse gases. Mitigation efforts can be made by adopting new technologies and renewable energy, replacing equipments with more energy efficient, changing management practices and consumer behavior.<sup>61</sup> Recent IPCC's Working Group AR6 report provides an updated global assessment of climate change mitigation progress. The report emphasizes the role of sub-national sector planning for cities, businesses, indigenous people, local citizens, youth and public-private entities in the global effort to address climate change.<sup>62</sup> Increase in anthropogenic emissions has persisted across all major groups of GHGs since 1990. Therefore, need of appropriate plan for mitigation at the national and sub-national levels has grown consistently across a range of sectors.

While **chapter 5** focuses on State's adaptation strategy, several strategies and activities imply substantial mitigation co-benefits, such as those under Forest & Livestock sectors. This chapter focuses on mitigation strategy of the State in-line with National and State-level goals/initiatives, which due to their intertwined nature may also yield important adaptation co-benefits.

This chapter focuses on the following State Missions:

- 6.1: State Mission on Enhanced Energy Efficiency and Solar Mission
- 6.2: State Mission on Sustainable Habitat



Solar Power Plant at Golden Temple, Amritsar

## 6.1 State Mission on Enhanced Energy Efficiency and Solar Mission

### 6.1.1 Overview

Global energy accounts for more than 4% of carbon dioxide emissions in 2021 due to increasing demand of coal, oil and gases. Global CO<sub>2</sub> emissions from energy sector and industrial processes rebounded in 2021 to reach their highest ever annual level. About 6% increase from 2020 pushed emissions to 36.3 gigatonnes (Gt). The Energy sector is a main player to reduce emission and to mitigate climate change. The state of Punjab is energy surplus with 3.76% of the total installed capacity of India. The available capacity (installed as well as allocated share) was estimated to be 14,388.69 MW in 2021 in the State. Punjab is now being recognized for leading role in harnessing renewable energy<sup>34</sup> and has been ranked 1<sup>st</sup> among States for SDG 7 (Affordable & Clean Energy) in SDG Index published by NITI Aayog in the year 2020-21. State has performed significantly well for percentage share deployment of renewable energy in the total installed capacity.<sup>26</sup>

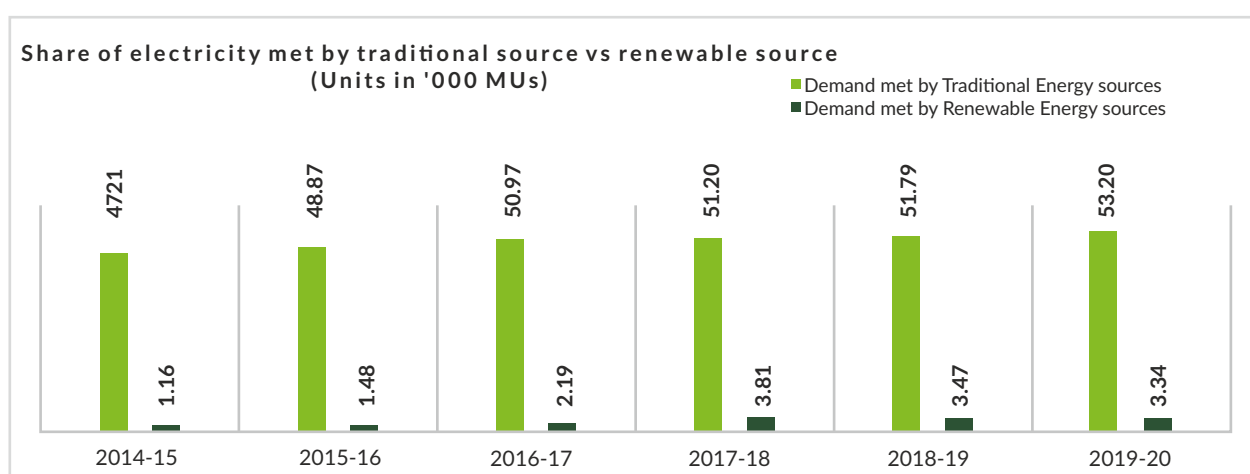
The electricity availability in Punjab has improved in the past decades but demand is further likely to increase in view of economic growth and the rising population. In order to meet the rising demand, there is strong need to tap renewable energy sources. In this direction, State Government has encouraged participation of Public & Private sector for developing renewable energy projects in the state. In-line with the National goal of energy security and realizing state's potential in Renewable Energy, constant efforts are underway to upscale and mainstream the use of New and Renewable Energy Sources (NRSE). **Table 6.1** presents the percentage of renewable energy share of the total installed power generation capacity in the State.



**Table 6.1 : Share of Renewable Energy**

S. No	As on August, 2022	Installed Capacity (in MW)	% of RE against total installed capacity	Targeted cumulative capacity to be installed (in MW) till 2027
1	Solar Power Projects ground mounted	815.5	6.00	1251
2	Rooftop Solar	60.5	0.44	295
3	Solar Net-metering	88.5	0.65	215.5
4	Canal top Solar	20	0.15	20
5	Biomass Power	97.5	0.72	967.6
6	Co-generation	462.07	3.40	518.13
7	Mini-Hydro	172.10	1.26	183.38
8	Waste to Energy	1.5	0.01	3.0

Over the years, the energy demand met by renewable sources is shown in **Figure 6.1**. As a way forward, State aims to meet 43% of its power requirement through renewable energy by the year 2030.<sup>34a</sup> With the planned efforts, the RE share for the state is expected to rise in the future.

**Figure 6.1: Share of electricity met by traditional source vs renewable source**

The state has huge potential of CBG (Compressed Biogas) projects based on agrowaste and has allotted 43 compressed biogas projects based on paddy straw and agro waste. These projects will consume about 1.6 million tonnes paddy straw per annum for production of 495.08 tonnes compressed biogas per day which will further, generate employment, reduce green house gases and uplift rural economy.

Further, State has taken up key projects & programmes for enhancing access to renewable energy. State had signed Power Sale Agreements (PSA) with Solar Energy Corporation of India (SECI) for procurement of 500 MW of hybrid Power and Power Purchase Agreement (PPA) for procurement of 250 MW Solar Power from projects. State is also planning to setup 100 Tonnes Per Day (TPD) paddy straw based Torrified pellets. In addition, procurement of 750 MW Solar Power under Central Public Sector Undertaking (CPSU) Schemes through National Hydro Electric Power Corporation (NHPC) and National Thermal Power Corporation (NTPC) has been approved.

### 6.1.2 Impact of climate change on the energy sector

Climate change scenario is increasing challenges for energy demand, its production and transmission. Rising temperature are leading to increase in number and severity of extreme weather events, changing precipitation patterns, etc. that will affect energy production and delivery. The supply of fossil fuels, thermal and hydropower generation and transmission will also be affected. Significant cuts in GHG emissions from energy can be achieved through a variety of measures. These include cutting emissions from fossil fuels, switching to lower-carbon fuels (for example from coal to gas), improving energy efficiency in transmission & industrial process, increasing use of renewables and reducing final energy demand.

Researchers have also identified that several climate induced extreme events such as drought, severe storm, etc. can disrupt operations at power-plant which can further negatively influence the power supply. Cooling demand may rise in every sector due to rising temperature in climate change scenario. Further, power lines, transformers and electricity distribution systems would face increased risks of physical damage from projected increase in frequency & intensity of events such as storms, wildfires, etc. Hence, it can be concluded that climate change will not only burden the energy sector by stressing the available resources due to rising demands but will also put production capacity at risk of climate vagaries.

In Punjab, there has been about 16% increase in energy demand from 2014-15, which was 48,863 MU to 56,542 MU in 2019-20 (Figure 6.2). The demand of electricity for irrigation due to variation in precipitation and enhanced evapo-transpiration rate will further increase.

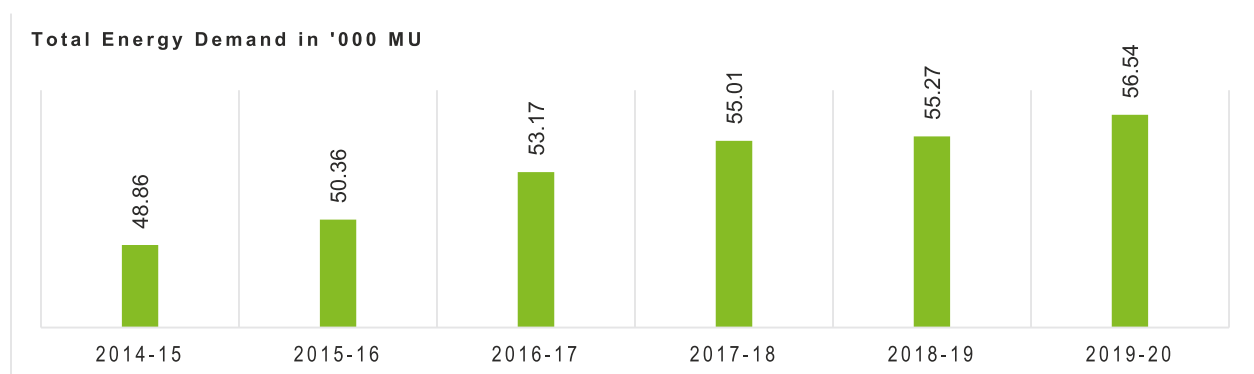


Figure 6.2: Status of energy demand

### 6.1.3 Key issues and challenges in Enhanced Energy Efficiency and Solar Mission

Climate change is posing energy security a risk at all levels including production & transmission and energy infrastructure. Further, high energy cost and inadequate finance are major hindrance to adoption of renewable energy technologies.

The key challenges in the state under this sector have been tabulated in **Table 6.2**. These have been taken into account while framing future plan and strategies.

**Table 6.2: Key Sectoral issues identified in Enhanced Energy Efficiency and Solar Mission**

<b>Financial</b>	<ul style="list-style-type: none"> <li>• Inadequate finance/funds for end consumers to afford the upfront/ capital cost of renewable energy technologies.</li> <li>• High energy cost of renewable biomass based power plants and standardized Power Purchase Agreements</li> </ul>
<b>Institutional and Regulatory</b>	<ul style="list-style-type: none"> <li>• Targets under New &amp; Renewable Energy Policy need to be revisited &amp; aligned with state goals.</li> </ul>
<b>Technical (including infrastructural)</b>	<ul style="list-style-type: none"> <li>• Grid unpredictability and variability is the major challenge for sustainability of RE projects.</li> <li>• Agricultural sector consumes about 24% of the total electricity generated in the state viz-a-viz average of 20% electricity consumption for agricultural purposes at National level.</li> <li>• Lack of gas-based resources and limited wind potential. Therefore, non-solar capacity needs to be fulfilled by small hydro and biomass/ co-generation.</li> </ul>
<b>Sensitization</b>	<ul style="list-style-type: none"> <li>• Lack of accessible information and sensitization about the quality, cost and benefits of adopting renewable energy technologies and energy efficiency measures for their widespread adoption</li> </ul>



### 6.1.4. Progress Mapping

Department of Power, Government of Punjab has been the Mission Nodal Department for the State Mission on Enhanced Energy Efficiency and Solar Mission. The detailed progress under Mission on Enhanced Energy Efficiency and Solar as part of stock taking exercise for SAPCC 1.0 strategies are presented in **Annexure V**. The key achievements of this sector are given as under:

### Key Achievements

State has been conferred 1<sup>st</sup> prize in the State Performance by Ministry of Power, Gol for the year 2020 and Commendation Certificates during the years 2015 & 2019 towards Energy Conservation & Energy Efficiency

### Renewable energy initiatives by PEDA

- Installed Ground Mounted Solar Plants of 815.5 MW & Solar Rooftop Power Plants of cumulative capacity 60.5 MW under Power Purchase Agreement (PPA) mode.
- 11 Biomass power projects of cumulative capacity 97.50 MW commissioned in the State utilizing 0.88 million MT of paddy straw annually.
- Commissioned 59 bagasse co-generation projects of capacity of 462.07 MW.
- Installed more than 91K solar street lights in 4077 villages of Punjab.
- Allocated 43 compressed biogas projects of total capacity 495.08 TPD.
- Signed PSA and PPA for procurement of 750 MW of Hybrid and Solar Power from projects.
- Approved procurement of 750 MW Solar Power under CPSU schemes through NHPC & NTPC.



Bio-CNG plant set up in District Sangrur

## Energy Efficiency

- Undertaken regular energy audits in Government/ Commercial settings and replaced inefficient electrical appliances with BEE 5 Star rated appliances.
- Installed 35 energy efficient motor pumps for drinking water supply at Mohali, Rajpura, and Pathankot.
- Installed 14814 LED lights, 1626 energy efficient fans, 31 BEE star rated ACs and >500 LED street lights in villages

## Research and Development in new technologies

- Signed MoUs with 12 reputed institutions related to Research and Demonstration in Energy Conservation & Energy Efficiency.
- Initiated pilot demonstration of Agri-solar photovoltaic projects.

### 6.1.5 Sector planning-strategies for Energy sector

Punjab's overarching targets pertaining to the State Mission on Enhanced Energy Efficiency & Solar Mission and their linkages with agreed targets at the National and International level are listed in the **Table 6.3**.

**Table 6.3: Specific Energy sector target under SDGs and NDCs by 2030**

International / national Commitment	Targets	Key State targets and initiatives
International Commitment	<b>SDG 7:</b> Ensure access to affordable, reliable, sustainable, and modern energy for all	<ul style="list-style-type: none"> <li>• Aims to increase share of renewable energy to 30%</li> <li>• Provide modern cooking solutions (LPG/PNG, biogas) to 100% rural/ urban population</li> <li>• Provide reliable electricity to 100% population</li> <li>• 25 MW to be saved every year as per Bureau of Energy Efficiency, Ministry of Power, Government of India.</li> <li>• Establish 4,422 MW ground-mounted, 370 MW rooftop and 105 MW canal top solar power projects.<sup>34</sup></li> </ul>
National Commitment	<b>NDC 4:</b> Achieve about 50% of cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030	<ul style="list-style-type: none"> <li>• Maximize and improve the share of new and renewable sources of energy to 30% of the total installed power capacity in the state.</li> <li>• Promote renewable energy initiatives for meeting energy/lighting needs in rural areas and supplement energy needs in urban, industrial and commercial sectors.</li> </ul>

### 6.1.6 Strategies for 2021-30 under Enhanced Energy Efficiency and Solar Mission

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code "EN/N" to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with "EN" are continuing from SAPCC 1.0 and will be continued till 2030.

#### EN/N/1: Addressing climate change through development of solar and other clean energy technologies to power clean and sustainable future

Increased use of fossil fuels without actions to mitigate greenhouse gases will have global climate change implications. With a substantial increase in the share of renewable energy, these challenges can be mitigated to some extent. The objective of this strategy is to increase the share of solar and other clean energy in the state to mitigate climate change. The key focus of this strategy would be:

- Development of solar parks & promoting use of solar rooftop/canal top plants
- Enhancing share of solar/ other renewable energy in total generation capacity
- Biomass based power/ co-generation plants
- Compressed Bio-Gas Projects based on Agro-Waste

#### Intended benefits:

- Reduction in GHG emissions.
- Reduction in fossil fuel consumption
- Gainful utilization of biomass



## EN/2: Promote energy efficiency in residential, commercial & institutional buildings such as hotels, malls and Govt. buildings

Enhancing energy efficiency is an important mitigation measure. Thus, the objective of this strategy is to optimize energy utilization in buildings through efficient measures intended to reduce GHG emissions. This strategy will lead a dual benefit of cost saving besides GHG reduction. The key action points under this strategy would be:

- Energy audits and installation of LED lights
- Replacing old appliances with energy efficient appliances

### Intended benefits:

- Reduction in electricity consumption
- Financial saving due to reduced energy consumption
- Reduction in GHG emissions

## EN/N/3: Increased coverage & utilization of solar as well as other renewable energy sources in urban and rural areas

With the implementation of this strategy, State is aiming to reduce the grid energy demand and enhance utilization of other reliable renewable energy sources. The key action points under the strategy would include:

- Installation of solar lights
- Installed rooftop solar panels & water pumps on private and public buildings
- Setting up of Biogas energy projects

### Intended benefits

- Reduction in pollution
- Reduction in GHG emissions
- Greater affordability to renewal energy sources

## EN/N/4: Develop small and micro hydro projects

Hydro power projects harness renewable source of energy. Small and micro hydro projects ensure that the environmental impacts are minimized and sufficiently compensated. The focus under this strategy will be on developing infrastructure for harnessing the hydel energy through small and micro hydro-projects.

### Intended benefits:

- Contribute towards renewable share of energy in the State
- Enhanced income generation opportunities



### EN/N/5: Introduction of farm-level solar power generation to reduce irrigation energy demand

Agriculture sector in Punjab has high energy demand for irrigation and number of other activities such as land preparation, seeding, harvesting, etc. Thus, consistent and reliable energy resources are critical for sustenance of agriculture sector. This strategy aims at harnessing solar energy, which will reduce the irrigation energy demand as well as provide additional income to farmers:

#### Intended benefits:

- Reduction in energy demand
- Reduction in GHG emissions
- Opportunity of additional income for farmers



Agriculture Solar water pump

### EN/N/6: Enhancing private sector involvement in renewable energy sector

Strategy focuses on attracting investment from private sector in NRSE projects and encourage participation of community/civil society. Following action points are broadly envisaged under the strategy:

- Electricity Duty exemption
- Pollution clearances exemption of Solar Projects
- Power wheeling @ 2%

#### Intended benefits:

- Involvement of private sector
- Enhance opportunities for employment generation

### EN/7: Enhancing energy efficiency & energy conservation in MSMEs

Transition towards an energy efficient economy is highly imperative for the manufacturing sector, including Micro, Small and Medium Enterprises (MSMEs), which account for significant energy consumption.

#### Intended benefits:

- Directly contributes towards reduction of GHG emissions
- Reduction in pollution as well as input costs



Bio CNG plant set up by IIRM Energy Ltd., Khanna, Distt. Ludhiana

## 6.2 State Mission on Sustainable Habitat

### 6.2.1 Overview

Managing the carbon footprint of urban habitats and ensuring their climate and disaster resilience are important and challenging tasks for government across countries, including India. To foster sustainable development, mainstreaming climate change mitigation and adaptation measures in urban planning and policy frameworks is critical. The State has witnessed rapid urbanization and is considered as the 5<sup>th</sup> most urbanized State in India. The three cities of the State namely Ludhiana, Amritsar and Jalandhar have been identified to be developed as Smart Cities through ensuring adequate water supply & sanitation, assured electricity, effective solid waste management, efficient urban mobility & public transport, affordable housing, etc. The Government of Punjab has launched the Punjab Shehri Awas Yojana (PSAY) as an endeavor to provide free and subsidized houses for all urban homeless, urban poor and slum dwellers. Additionally, State is also working towards providing affordable housing for lower and middle income groups of society. Accordingly, State has notified the Affordable Colony Policy with an intention to encourage planning and development of small size plots and houses at affordable rates.

Further, Government of Punjab has also signed the MoU for Pradhan Mantri Awas Yojana -Urban (PMAY-U). More than 0.1 million houses have been sanctioned under PMAY-U in the State, out of which 47,157 have been completed. Further, investments worth INR 1,969 Cr have been made within the State under PMAY-U projects. In addition, 22,873 houses have been constructed against the State target of 24,000 houses allocated by GoI under Pradhan Mantri Awas Yojana Gramin PMAY(G) during the period 2016-20 and rest are underway.

For solid waste management in urban areas, Solid Waste Management Rules, 2016 are being implemented and Punjab State Solid Waste Management Policy have been formulated and Model Solid Waste Management, Cleanliness & Sanitation Byelaws have also been prepared. Road connectivity has long been a priority area for the state government. For promoting cleaner mobility, a policy for promoting Electric Vehicles (EV) & EV Component Manufacturing and supporting EV adoption in the State has been notified.



Forest complex building at SAS Nagar designed on the principles of energy efficiency

### 6.2.2 Impact of climate change on the Sustainable Habitat

Climate change poses significant challenge for the achievement of sustainable development and also threatens livelihood of millions of people.

- Rising global temperatures increase the number of extreme weather events such as floods, droughts and storms, as well as increases the spread of tropical diseases. All these have costly impacts on cities' basic services, infrastructure, housing, human livelihoods and health.
- The warming climate combined with the urban heat island effect will exacerbate air pollution levels in cities.
- Public health is directly influenced by climate extremes, which may disrupt supply and management of resources such as water supply, drainage systems, electricity and fuel supplies. Hence, climate change can impact the quality of life in both urban and rural areas.

Vulnerability to specific impacts of climate change is highly localized and greatly varies with non-climatic stresses such as poverty, unequal access to resources and food security.

### 6.2.3 Key issues and challenges for Sustainable Habitat

Sustainable habitat sector is facing a range of climate change challenges including pressure on natural resources (air, water & soil), urban infrastructure (housing and transport), health care system, etc. The key challenges of this sector have been tabulated in **Table 6.4**. These have been taken into account while framing future plan and strategies.

**Table 6.4: Issues and Challenges for Sustainable Habitat**

Sector	Issues/Challenges
Financial	<ul style="list-style-type: none"> <li>• Paucity of central assistance on climate-relevant activities for Sustainable habitat</li> <li>• High unemployment rate especially in urban areas</li> </ul>
Socio-Political	<ul style="list-style-type: none"> <li>• Sustainable habitat sector is facing a range of climate change challenges including pressure on natural resources (air, water, soil), urban infrastructure (housing and transport), health care systems, etc.</li> <li>• Increase in gap between supply and demand of adequate and affordable houses in urban areas.</li> <li>• Inadequate sanitary conditions and lack of basic amenities and slums in urban/ semi-urban agglomerations.</li> </ul>
Institutional/Regulatory	<ul style="list-style-type: none"> <li>• Limited expertise in the fields of climate change and sustainable habitat management</li> </ul>



### 6.2.4. Progress Mapping

Departments of Local Government has been the Nodal Department for the State Mission on Sustainable Habitat under SAPCC 1.0. The detailed progress under sustainable habitat Mission as part of stock taking exercise for SAPCC 1.0 strategies are presented in **Annexure VI**. The key achievements of this sector are given as under:

## Key Achievements

### Sustainable cities

- Energy Conservation Building code (ECBC) Compliance made mandatory for building complexes with connected load more than 100 KW or air conditioned areas >500 sqm
- Notified Punjab Municipal Building Byelaws, 2018 regarding mandatory installation of rooftop solar PV & solar water heaters in residential/non-residential plots
- Rainwater harvesting made mandatory in all commercial/public/industrial setup having an area > 1 acre
- For 24x7 water supply in Amritsar, Jalandhar & Patiala, work is under execution with the support from World Bank / Smart City / AMRUT
- 500 MW of biofuel projects developed to increase share of renewable

### Abate Pollution

- Installed 11 real time water quality monitoring stations in rivers
- Set up air quality management division at Punjab Pollution Control Board
- Under National Air Quality Monitoring Programme (NAMP), monitoring air quality in 9 critically polluted towns through 24 monitoring systems and 10 additional Continuous Ambient Air Quality Monitoring Stations (CAAQMS) are under installation.

### Integrated Transport System

- Installed Intelligent traffic management system at 25 locations
- Introduced and initiated installation of Charging Stations for E-Vehicles
- Initiated EV charging infrastructure development in Amritsar district
- Promoted use of fly ash in paved tiles/ as embankment fill in road projects
- Approved policy on E-vehicles and introduced 842 Euro-6 compliant buses along with phasing out of Euro-3/ Euro-4 buses



## Waste Management

- Notified State Treated Waste Water Policy, 2017 to promote reuse of treated waste water.
- Achieved 99% door to door collection of solid waste and 89% of segregation of waste at source
- 68% sewage is treated and constructed 130 STPs (1759.5 MLD) which is the highest by any State in India
- Construction of sewage treatment facility with capacity of 285 MLD in Jamalpur and Baloke for treatment of effluent flowing into the Buddha Nalah of Ludhiana
- Set up more than 8,223 compost pits for management of biodegradable solid waste besides, >265 Material Recovery Facilities (MRFs) and initiated establishment of two Waste-to-Energy projects at Bathinda and Amritsar for management of non-biodegradable waste fraction

## Green initiatives

- Developed additional 78 ha urban area as green buffers under urban greenery initiatives besides maintenance of 15 ha parks under Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme
- Constructed >11,000 public toilets and >0.6 million individual toilets in rural areas and installed around 0.55 million LED lights in public areas
- Planted >11.2 million trees by the Gram Panchayats and Forest Department and generated 154 million mandays under MGNREGA scheme
- Remodeled and rejuvenated 587 Ponds and installed 982 street/ solar lights under Smart Village Campaign



Door to Door Solid waste collection and training on waste segregation in towns of Punjab

### 6.2.5 Sector Planning – Strategies for Sustainable Habitat

Punjab's overarching targets pertaining to the State Mission on Sustainable Habitat and their linkages with agreed targets at National and International level are illustrated in **Table 6.5**.

**Table 6.5: Specific Sustainable Habitat target under SDG and NDC by 2030<sup>26</sup>**

International/ National Commitment	Targets	Key State targets
International Commitment	<b>SDG 6:</b> Ensure availability and sustainable management of water and sanitation for all	<ul style="list-style-type: none"> <li>To cover 100% population with equitable access to safe and affordable drinking water</li> <li>100% treatment of sewage waste through STPs</li> </ul>
	<b>SDG 11:</b> Make cities and human settlements inclusive, safe, resilient, and sustainable	<ul style="list-style-type: none"> <li>The present per capita availability of green space is 2.07 sqm, which is proposed to be increased to 2.50 sqm.</li> </ul> <p><b>Other targets under SDG 11 are as under:</b></p> <ul style="list-style-type: none"> <li>Water supply coverage from 86% in 2011 to 100%.</li> <li>100% coverage of all towns under solid waste management.</li> <li>100% Slum up-gradation in all towns of the State, including water supply, sewerage system, closed drainage and LPG connections.</li> <li>Reduction in road incidents by 5% of the baseline (i.e. 6,391 in 2014).</li> </ul>
	<b>SDG 12:</b> responsible consumption and production	<ul style="list-style-type: none"> <li>All Urban Local Bodies have started using waste segregation techniques and have achieved 99% door to door waste collection. Further, State targets to enforce effective ban on plastic carry bags in line with notification.</li> </ul>
National Commitments	<b>NDC 1:</b> To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation including through a mass movement for 'LiFE' - 'Lifestyle for Environment' as a key for combating climate change	<ul style="list-style-type: none"> <li>100% Door to Door collection of MSW</li> <li>Enforcement and monitoring ban on plastic carry bags</li> </ul>



105 MLD STP at Balloke, Ludhiana



### 6.2.6 Strategies for 2021-30 under Sustainable Habitat Mission

Strategies under the Mission are planned in consultation with stakeholder Departments. The planned strategies are further classified with the code "SH/N" to depict the newly introduced strategies in SAPCC 2.0. Whereas, strategies coded with "SH" are continuing from SAPCC 1.0.

#### SH/N/1: Upscaling of Liquid and Solid waste treatment and its compliance

The overall goal of waste management is to reduce its ill effects on human health & environment for a sustainable future and superior quality of life. The objective of this strategy is to effectively manage/treat waste generated in the State by adopting better solid and liquid waste management strategies. The action points under the strategy would be:

- Installation of STPs
- 100% door to door collection and segregation of waste at source
- Construction of compost pits and MRFs
- Maximize recovery out of recyclable / non-recyclable fractions of waste
- Elimination of garbage points from vulnerable sites
- Compliance by Bulk Waste Generators
- Treatment & management of legacy waste
- Harnessing energy from waste
- Promoting industries complying with pollution standards

#### Intended benefits:

- Reduction in GHG emissions through waster management
- Reduction in soil, water and air pollution
- Generate livelihood opportunities in formal / informal sector



Material Recovery Facility at Dasuya, Distt. Hoshiarpur

### SH/N/2: Developing sustainable street lighting system

Traditional lighting systems consume more energy. Increasing the coverage of energy efficient streetlights and solar based lights in rural areas will contribute towards reduction in the energy demand as well as GHG emissions.

#### Intended benefits:

- Adopting a cleaner and renewable source of energy.
- Reduction in energy demand & GHG emissions
- Reduced dependency on fossil fuel.

### SH/N/3: Development of green community space

Green spaces are considered as 'lungs' of villages, towns and cities, which contribute to improvement of physical and mental health of local community. The immediate ecological benefits of green spaces are reduction in the heat envelopes, cleaner air and reduced noise pollution leading to improved quality of life.

#### Intended benefits:

- Reduction in air pollution
- Increase in carbon sink due to enhanced green space
- Combat heat island effect in urban areas

### SH/N/4: Rejuvenation/ rehabilitation of village ponds

The village ponds are considered to be place of recreation besides contributing to rich ecology of the area. With this strategy, State aims to restore / rehabilitate the village ponds as well as to maintain the ecological balance of the area and enhance groundwater recharge.

#### Intended benefits:

- Ground water recharge
- Ecological restoration of area



Energy efficient street lighting by PEDDA at Mohali



Rehabilitation of pond at Village Jodhpur, Distt. Fatehgarh Sahib

### SH/N/5: Undertake natural resource conservation measures in/around habitations

With the increase in population at an alarming rate, exploitation of natural resources has been observed. Hence, there is a need to manage and conserve the resources to maintain ecological balance and save them for future generations. This strategy aims to initiate actions to enhance the judicious use of natural resource and adopt nature-based solution to better adapt with the projected climate change scenario

#### Intended benefits:

- Mindful utilisation of resources
- Prevent over consumption/wastage of resources

### SH/N/6: Strengthen the livelihood generation through MGNREGA

The main objective of this strategy is to enhance the climate change adaptive capacity of the population by generating the livelihood opportunities. This would include

- Reducing input cost with sustainable agro-ecological practices
- Formation & standardization of non-farm enterprises with technology and marketing support

#### Intended benefits:

- Improving resilience of communities
- Generating livelihood opportunities



Mini forest development under MGNREGA at village Badesh Kalan, Distt. Fatehgarh Sahib

### SH/N/7: Promoting affordable housing

Access to adequate, safe and affordable housing is the first indicator of the 11<sup>th</sup> Sustainable Development Goal. Adequate housing is necessary requirement as it allows people to lead healthy & secure lives. Hence, adequate availability of affordable, low-carbon, climate-resilient housing is pivotal for ending poverty and build adaptive capacity of Vulnerable Communities.

#### Intended benefits:

- Improved adaptive capacity
- Better livelihood & health of community

### SH/N/8: Strengthening sanitation facilities in rural schools and create herbal/kitchen gardens for promoting healthier lifestyle

The main objective of this strategy is to ensure that every school in state has well-maintained sanitation and hygiene facilities. Having access to these basic facilities are necessary for healthy school environment and to develop or support appropriate health and hygiene behaviours. It is also aimed to demonstrate/set up herbal/kitchen gardens to enhance awareness of students/communities on healthier eating habits and sustainable lifestyles.

#### Intended benefits:

- Better health and access to sanitation
- Strengthening education and awareness



### SH/N/9: Develop Smart Urban Mobility

The objective of this strategy is to enhance the capacity of cities to absorb the demand from growing populations, overcome congestion and reduce air pollution. The key action points would include:

- Intelligent traffic management
- Development of Low carbon transportation
- Installation of EV charging sub stations
- Development of Smart Parking Spaces

#### Intended benefits:

- Carbon resilient cities
- Reduction in GHG emissions and pollution

### SH/10 Promote a sustainable integrated transport system

With this strategy the Government is aiming at reducing congestion, improving operational efficiency, reducing noise and air pollution by introducing integrated transport system. The main action points would include:

- Introduction of fast-moving fleet corridors
- Efforts towards emission reduction from diesel operated heavy loaded trucks
- Increased density of public transport system
- Introduction of metro transport

#### Intended benefits:

- Carbon resilient cities
- Reduction in pollution/ GHG emission



### SH/N/11: Bioremediation of landfill sites for legacy waste management and setting up of sanitary landfills for inert waste

Unscientifically constructed landfills create irreversible damage to the environment. They generate leachates, emit greenhouse gases, pollute groundwater, etc. There is a need to reclaim the prevailing dump sites for optimal use of land as well as recycling of the untapped resources. Thus, this strategy is focused on legacy waste management and development of sanitary landfills in scientific manner.

#### Intended benefits:

- Reduction in methane emissions
- Reduction in air and water pollution

### SH/12: Enhance drainage capacity of existing storm water drainage system in towns to address issue of excessive runoff

The objective of this strategy is to reduce the flash flood risk in the projected climate change scenario by enhancing the capacity of existing stormwater drains. The strategy also aims at developing the climate smart infrastructure to reduce surface runoff and increase groundwater recharge.

#### Intended benefits:

- Resilience towards climate induced disaster such as flash floods
- Ground water recharge

### SH/N/13: Development of Green Buildings, official spaces/institutions

The focus of this strategy is to develop cities with healthier spaces and greater resource efficiency and to help in carbon sequestration. The action points under this strategy includes:

- Increasing the number of certified green buildings
- Promoting rainwater harvesting units
- Promoting use of solar based appliances

#### Intended benefits

- Enhancing the resilience of cities
- Enhanced carbon sequestration
- Reduced heat island effect





## Chapter 7 FINANCING SAPCC





## 7.0: Financing SAPCC



Climate finance is necessary to address emerging challenges of climate change, therefore all funding channels/avenues needs to be explored by the State for tackling such challenges. High priority actions must be determined for generating timely response, firstly through mainstreaming sectoral and departmental resources. Additionally, more systematic private sector financial participation needs to be explored for priority programmes, such as Public-Private Partnerships (PPP). Understanding about the financial requirements of respective sectors and how financial resources could be mobilized for climate action is crucial among government departments and stakeholders. The distribution of resources should aim to strike a balance between mitigation and adaptation.

To facilitate the provision of climate finance, the Convention established a financial mechanism to provide financial resources to developing countries. The Global Environment Facility (GEF) has served as an operating entity of the financial mechanism. There are possibilities of securing additional climate finance from multiple international climate funds (Green Climate Fund, Global Environment Facility, Adaptation Fund), bilateral cooperation (like SDC, GIZ, JICA, DFID), multilateral facilities (Loans and grant through World Bank, Asian Development Bank (ADB), United Nation Development Programme (UNDP), etc. and National Climate Fund (National Adaptation Fund for Climate Change, Small Grants Programme, Mission-Specific Allocations, etc.).

Financing a State-Level Action Plan can require multiple channels of finance to ensure that each activity is suitably funded. To ensure the same in the state of Punjab, various types of financing windows are listed along with source of funds against each of them. A variety of instruments can be used to access funds. The key sectors in which the funds can be used along with the modalities and processing period are presented in **Table 7.1**.

**Table 7.1: Funding agencies and key sectors for fund utilization**

Financing Window	Source of Fund	Instrument	Key sectors	Access modalities and processing period
International Climate Fund (budget additional)	Green Climate Fund (GCF)	Loan and grant, guarantee, equity	Food & water, health, Livelihood infrastructure and built environment, ecosystem (for both adaptation and mitigation)	Micro up to 10 million USD Small (10-50) million USD Medium (50-250) million USD Large (>250) million USD National Designated Authority (MoEFCC) as focal point Through (Direct Access Entity and multilateral access entities) approved as NIE (National Implementing Entity) or MIE (Multilateral Implementing Entity) by NDA (MoEF&CC) 1-2 years, an elaborate process
	Adaptation Fund	Grant, but Loan as co-finance (by NIE or MIE) maximum up to 50% of the project cost	Natural resource systems (addressing climate risks), ecosystem, hazard	Regular project size >1 million USD, Small <1 million USD Through NDA through NIE and MIE. 8-12 months process Maximum cap for a country is 10 million USD
National Fund	Global Environment Facility (GEF)	Grant	Based on the sectors under the star allocation both for adaptation and mitigation. 1) Food systems, Land Use and Restoration 2) Sustainable Cities 3) Sustainable Forest Management (under GEF7 series)	Full-sized project > 2 million USD  Medium size (up to 2 million USD)  Enabling activity (strategy development under a convention) Minimum 12 months

Financing Window	Source of Fund	Instrument	Key sectors	Access modalities and processing period
	National Adaptation Fund on Climate Change (NAFCC)	Grant, Co-finance, convergence fund from state	Agriculture, horticulture, agroforestry, environment, allied activities, water, forestry, urban, coastal and low lying system, disaster management, human health, marine system, tourism, habitat sector and other rural livelihood sectors to address climate change related issues. Climate scenarios, capacity building, consultation, monitoring	Though no upper limit is specified, however, the typical maximum for a State is about Rs 25 crore.  NABARD, NIE (National Implementing Entity)  About 6 months for preparation and sanction  Maximum preparation cost is INR 0.10 million, NIE fee capped at 3% of the project cost
Bilateral and Multilateral projects/ programmes	Programs/ Projects linked to clear climate outcomes	Loan, Grant	Sectoral (both for adaptation and mitigation)	On a State partnership basis and through the concurrence of the National Government
International Non-Government Organizations (INGOs)	Programs/ Projects linked to clear climate outcomes	Grant	Sectoral (both for adaptation and mitigation)	On a State partnership basis and through the concurrence of the National Government
Corporate Social Responsibility (CSR)	Programs/ Projects linked to clear climate outcomes	Grant	Sectoral (both for adaptation and mitigation)	As per statutory requirement under Company Act for the eligible companies, private foundations with voluntary pledge with programmatic convergence
National and State Schemes	Regular schematic (may not be additional)	Budget (grant in aid) State, Central & centrally sponsored schemes	Sectoral (both for adaptation & mitigation)	Schemes need to be classified as climate-relevant. Currently, there is no standard approach available
Budgetary (Mission specific)	As per Mission guidelines	Both demands driven and also as per target	Sectoral (both for adaptation & mitigation)	Some of these have been specified in the report such as Green India Mission, CAMPA, etc.

Climate finance refers to local, national or transnational financing, which is drawn from public, private and other alternative sources to support mitigation and adaptation actions that will address climate change. The State has been able to leverage the following climate finance channels (Table 7.2)

**Table 7.2: Climate Finance Channels**

Climate Finance Channel	Programs Funded
Asian Development Bank <sup>63</sup>	Punjab Development Finance Program <b>USD 200.5 Million</b> 2014-2019
Department of Science & Technology, Govt	Punjab State Climate Change Knowledge Centre (Phase – I & II) <b>INR 5.26 Crore</b> 2014-25
Adaptation Fund	Towards Climate Resilient Livestock Production System in Punjab <b>INR 17.39 Crore</b> 2015-2020
Climate Change Action Plan	Technological Adaptation for gainful utilization of Paddy Straw as fuel to replace fossil fuels <b>INR 2.33 Crore</b> 2016-2020
Corporate Social Responsibility	<b>INR 695.58 Crore</b> 2014-2020 Key areas: Environment Sustainability, Education & Healthcare

It is important for all Government agencies and stakeholders to understand and assess the financial needs of their domain, as well as to understand how these financial resources can be mobilized. The provision of resources should also aim to achieve a balance between adaptation and mitigation.



There are four broad steps to be taken for financing in the climate change domain. The typical process to be followed in the climate finance area is explained stepwise in **Table 7.3**.

**Table 7.3: Four broad steps to be taken for the financing in climate change domain**

Step	Description	Action Points
Step 1	Identify high priority strategy having linkage to SDGs/NDCs	Identify relevant schemes in the state budget and put in the right demand. The expenditures can be treated a climate relevant expenditure based on how many components of the project activities have been covered.
	Identify activities linked to National Missions	Mobilize resources form relevant Missions based on the specific strategy/ target
Step 2	Map identified activity/ strategy to CSP, external aided projects or sources under bi-lateral or multilateral cooperation.	Explore funding modalities of identified centrally sponsored scheme and specific template/ format to prepare proposal Look for grants from CSR and INGO sources
Step 3	Exploring the option of funding from special climate funds available Nationally	For NAFCC, steps involve the preparation of a project concept note, followed by a preliminary scrutiny by National Implementing Entity (NIE). If agreed, a detailed project report is submitted through NIE to National Designated Authority. Executing agency signs the grant agreement and the project cycle operation starts. Baseline and end-line assessments conducted by external agencies track outcomes as per the project result framework.
Step 4	Exploring the option of funding from special climate funds available internationally.	Assess the concept based on the result/impact areas and investment criteria for GCF: <ul style="list-style-type: none"> <li>• Impact potential</li> <li>• Paradigm shift potential</li> <li>• Sustainable development potential</li> <li>• Needs of the recipient</li> <li>• Country/state ownership</li> <li>• Efficiency and effectiveness</li> </ul> Once the concept is assessed, the proposal is to be submitted to NDA through NIE or MIE as per the format. After approval by the relevant board, a subsidiary agreement is signed with NIE/MIE. Executing agency starts the project cycle operation

## 7.1 Financing under SAPCC 1.0

### 7.1.1 Climate Change Financing - Adaptation

This section highlights the sector-wise expenditure incurred for the activities that were proposed in the SAPCC 1.0 to strengthen our actions on climate change adaptation. Total 64 adaptation strategies were adopted for the period 2014-2020 under SAPCC 1.0, on which an expenditure of INR 40,264.5 million has been incurred by the State (**Table 7.4**). Mission wise details of expenditure made viz-a-viz outlined strategies are presented in **Annexures I-IV**. Summary of expenditure under different Missions is as under:

- **Green Punjab & Sustainable Himalayan Ecosystem Missions:** Expenditure of INR 1,834.07 million made on 28 strategies of SAPCC 1.0. Major initiatives undertaken in Forest & biodiversity sectors include soil conservation measures in foothills of Shivalik hills, natural regeneration of degraded lands and for enhancing tree cover outside forest.
- **Sustainable Agriculture Mission:** Expenditure of INR 13,968.82 million made on 18 strategies of SAPCC 1.0. Key activities were focused on promotion of integrated nutrient management in soil, crop diversification and sustainable management of the crop residues.
- **Water Mission:** Expenditure of INR 24,142.9 million made on 9 strategies of SAPCC 1.0. The major initiatives undertaken are research and monitoring activities, enhancement of water use efficiency and to contain water logging situation.
- **Strategic Knowledge Mission:** Expenditure of INR 318.71 million made on 6 strategies of SAPCC 1.0. Key activities were focused on development of new innovative climate friendly technologies, their demonstration and extension.



### 7.1.2 Climate Change Financing - Mitigation

This section highlights the sector-wise expenditure incurred for the activities that were proposed in SAPCC 1.0 to strengthen our actions on climate change mitigation. Total 31 mitigation strategies were adopted for the period 2014-2020 under SAPCC 1.0, on which an expenditure of INR 17,519.05 million has been incurred by the State (**Table 7.4**). Mission wise details of expenditure made viz-a-viz strategies are presented in **Annexures V-VI**. Summary of expenditure under different Missions is as under:

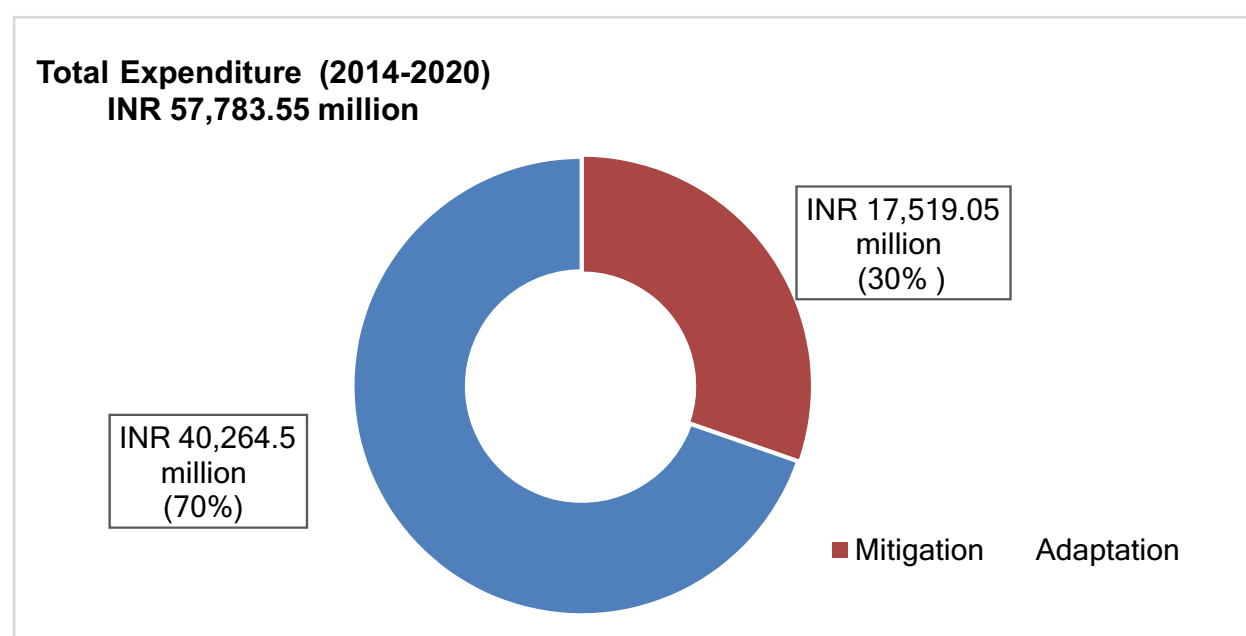
- **Enhanced Energy Efficiency and Solar Mission:** Expenditure of INR 5,446.73 million made on 14 strategies of SAPCC 1.0. Key activities were focused on promotion of roof top Solar Photo-Voltaic Power, increased coverage of solar & energy efficient lighting.
- **Sustainable Habitat:** Expenditure of INR 12,072.32 million made on 17 strategies of SAPCC 1.0. The major initiatives undertaken were towards waste management & building designs under ECBC/GRIHA norms.



**Table 7.4: Total expenditure incurred during 2014-2020 towards strategies outlined in SAPCC 1.0**

S. No	Missions	Total Strategies	Expenditure in (INR million)
<b>A. Adaptation Strategies</b>			
1.	Green Punjab & Sustainable Himalayan Ecosystem	28	1834.07
2.	Sustainable Agriculture	18	13968.82
3.	Water	9	24142.9
4.	Health	3	NA
5.	Strategic Knowledge	6	318.71
	<b>Total</b>	<b>64</b>	<b>40264.5</b>
<b>B. Mitigation Strategies</b>			
6.	Enhanced Energy Efficiency and Solar Mission	14	5446.73
7.	Sustainable Habitat	17	12072.32
	<b>Total</b>	<b>31</b>	<b>17519.05</b>
	<b>Grand Total</b>	<b>95</b>	<b>57783.55</b>

Data given above indicates that a significant portion of climate related expenditure in the State was directed towards water, followed by sustainable agriculture and sustainable habitat sectors, in accordance with the strategies outlined in SAPCC 1.0. Further, 70% of the total expenditure incurred during 2014-2020 was towards adaptation measures and 30% funds were invested towards mitigation actions (Figure 7.1).

**Figure 7.1: Total expenditure in adaptation and mitigation sector during 2014-2020**

## 7.2 Financing SAPCC 2.0

The approach of SAPCC 2.0 financing has been to mainstream climate change in existing National/ State level schemes or programs. Mission wise budget requirement viz-a-viz strategies along with the plausible schemes and channels for accessing finance are presented in **Annexures (VII-XIII)**. Following section represents summary of the financial requirements proposed towards State's Adaptation & Mitigation strategies.

### 7.2.1 Climate Change Financing - Adaptation

This section highlights the Mission-wise budget proposed for the strategies aimed at strengthening state's adaptation response under SAPCC 2.0. Total 43 adaptation strategies have been formulated for the period 2021-30 under SAPCC 2.0 and anticipated budget of INR 1,90,785.38 million has been proposed by the State (**Table 7.5**). Gist of proposed budget under each Mission is as under:

- **State Mission on Forest, Ecosystem and Biodiversity:** Total 9 broad strategies have been proposed to achieve the objectives of State Mission on Forest, Ecosystem & Biodiversity with the anticipated budget of INR 29,140 million through different schemes. Major schemes/programs identified for accessing finance for the initiatives proposed in forest & biodiversity sectors include GIM, CAMPA, SMAF, Green highway project, Ghar Ghar Hariyali, Green Punjab Mission, Forestry watershed development projects, etc.
- **State Mission for Sustainable Agriculture:** Total 12 broad strategies have been proposed under the Mission for promoting sustainable agriculture in the State with the anticipated budget of INR 33,458.29 million. Of this, major share (INR 27,949.14 million) has been proposed for promotion of integrated nutrient management in soils, declining the use of pesticides & fertilizers and promoting organic farming and crop diversification. Major schemes/programs identified for accessing finance for the initiatives proposed in Agriculture, Horticulture, Animal Husbandry & Fisheries sectors include NHM, PMKSY, NMSA, RKVY, SMAM, GOBAR-DHAN, etc.



- **State Mission on Water:** Total 7 broad strategies have been proposed under the Mission for water resource management in the State with the anticipated budget of INR 1,26,562.7 million. Out of this, significant amount (INR 1,09,972.7 million) has been proposed for water resource mapping through GIS and remote sensing, contain the enhanced water logging situation in the south west districts, enhance water use efficiency by 20% and abate continued water pollution of underground and surface water sources. Few central /State schemes have been identified for accessing finance for the initiatives proposed for water sector.
- **State Mission on Health:** Under dedicated Mission on Health introduced in SAPCC 2.0, 8 broad strategies have been proposed with the anticipated budget of INR 1,310.79 million. Out of this, major budget (INR 1,066.30 million) has been proposed for reducing the maternal mortality rate by improving quality of MCH care at the rural community level and strengthening mechanism for management of vector borne diseases through surveillance and establishment of sentinel sites. Major schemes/programs identified for accessing finance for the initiatives proposed in Health sector include National Programme for Climate Change and Human Health, IDSP, National Vector-Borne Disease Control Programme, RBSK - SABLA, etc.
- **State Mission on Strategic Knowledge:** Total 7 broad strategies have been proposed under the Mission for building adequate knowledge base & capacity within the State to better address emerging challenges of climate change. Budget of INR 313.60 million has been anticipated for the strategies under the Mission. Out of the total budget, major amount (INR 310.10 million) has been proposed for strengthening of knowledge networks, promote technology development/ demonstration, capacity building, etc. Major schemes/programs identified for accessing finance for the proposed initiatives include NMSKCC, DST, GoI; MoEF&CC, GoI; SPIPA GiZ-India; NABARD; Green Skill Development Programme, NDDB, etc.



## 7.2.2 Climate Change Financing-Mitigation

This section highlights the Mission-wise budget proposed for the strategies aimed at strengthening state's mitigation response under SAPCC 2.0. Total 20 mitigation strategies have been formulated for the period 2021-30 under SAPCC 2.0 and anticipated budget of INR 2,94,961.18 million has been proposed by the State.

- State Mission on Enhanced Energy Efficiency and Solar Mission:** Under the Mission, 7 strategies have been proposed with the anticipated budget of INR 63,317.05 million. Out of the total budget, considerable amount (INR 58,670 million) has been proposed for enhancing generation/ deployment of renewable energy capacity, promotion of other clean energy technologies and introduction of farm-level solar power generation to reduce energy demand from irrigation. Major financing channels identified for accessing finance for the proposed initiatives include multiple Centre/State Schemes and Public-Private Partnership.
- State Mission on Sustainable Habitat:** Total 13 broad strategies have been proposed under the Mission to better address emerging challenges of climate change. Budget of INR 2,31,644.13 million has been anticipated for the strategies under the Mission. Out of the total budget, major share (INR 1,58,000 million) is allocated towards enhancing drainage capacity of existing storm water drainage system to address issues of excessive run off, rejuvenation of village ponds, smart urban mobility, integrated transport system, waste management and strengthening the livelihood generation related activities. Major financing channels identified for accessing finance for the proposed initiatives include Swachh Bharat Mission, AMRUT, MGNREGA, Pradhan Mantri Awaas Yojana, Smart City Mission, etc.



### 7.2.3 Total financing Requirement

In total, 63 strategies have been proposed for various Adaptation & Mitigation measures under SAPCC 2.0 with the projected budget of INR 4,85,746.56 million. The sector wise proposed budget expenditure details are given in **Table 7.5**. Sector level analysis of the proposed budget indicates that about 47.68% of estimated budget is directed towards sustainable habitat sector, followed by 26.05% towards water sector, 13.03% towards energy, 6.9% towards agriculture, 6% towards forest, 0.27% towards health & 0.06% towards strategic knowledge sectors.

Although the percentage share of the anticipated expenditure is low in case of the Health sector and Knowledge mission, the Government has developed key strategies for climate-proofing the health sector and to enhance the capacity of different departments through knowledge mission through integrating other programs/schemes. **Figure 7.2** provides the sector-wise and percentage of anticipated expenditure for SAPCC 2.0.

**Table 7.5: Sector wise anticipated expenditure in (INR million) for 2021-2030**

S. No	Missions	Proposed Strategies	Proposed Budget in (INR million)
<b>State Adaptation Strategy</b>			
1.	Forest, Ecosystem & Biodiversity	09	29,140.00
2.	Sustainable Agriculture	12	33,458.29
3.	Water	07	1,26,562.70
4.	Health	08	1,310.79
5.	Strategic Knowledge	07	313.60
	<b>Total</b>	<b>43</b>	<b>1,90,785.38</b>
<b>State Mitigation Strategy</b>			
6.	Enhanced Energy Efficiency and Solar Mission	07	63,317.05
7.	Sustainable Habitat	13	2,31,644.13
	<b>Total</b>	<b>20</b>	<b>2,94,961.18</b>
	<b>Grand Total</b>	<b>63</b>	<b>4,85,746.56</b>

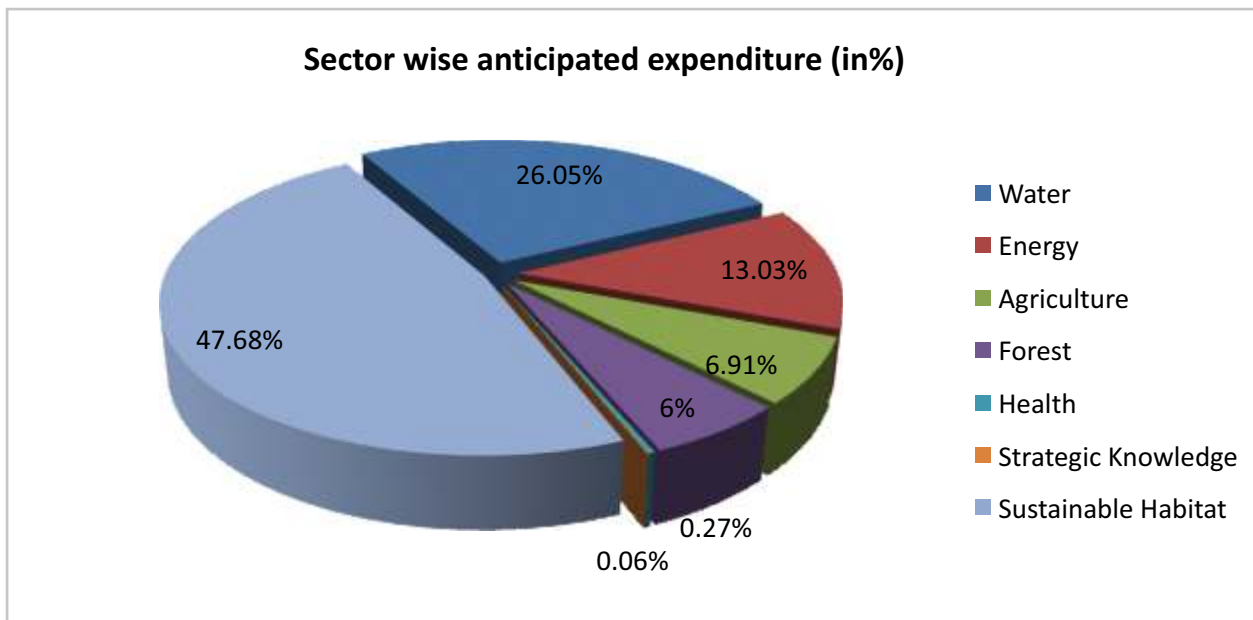


Figure 7.2: Sector wise anticipated expenditure (in %) for 2021-2030

Further, analysis of the anticipated budget in terms of types of measures indicates a balanced approach towards mitigation and adaptation measures adopted under SAPCC 2.0. Mitigation measures comprise of about 45.20% of the anticipated budget whereas, adaptation measures comprise for 45.30% of the total anticipated budget. Besides, 9.50% of the anticipated total budget is directed towards cross-cutting strategies, having both adaptation & mitigation potential (Figure 7.3).

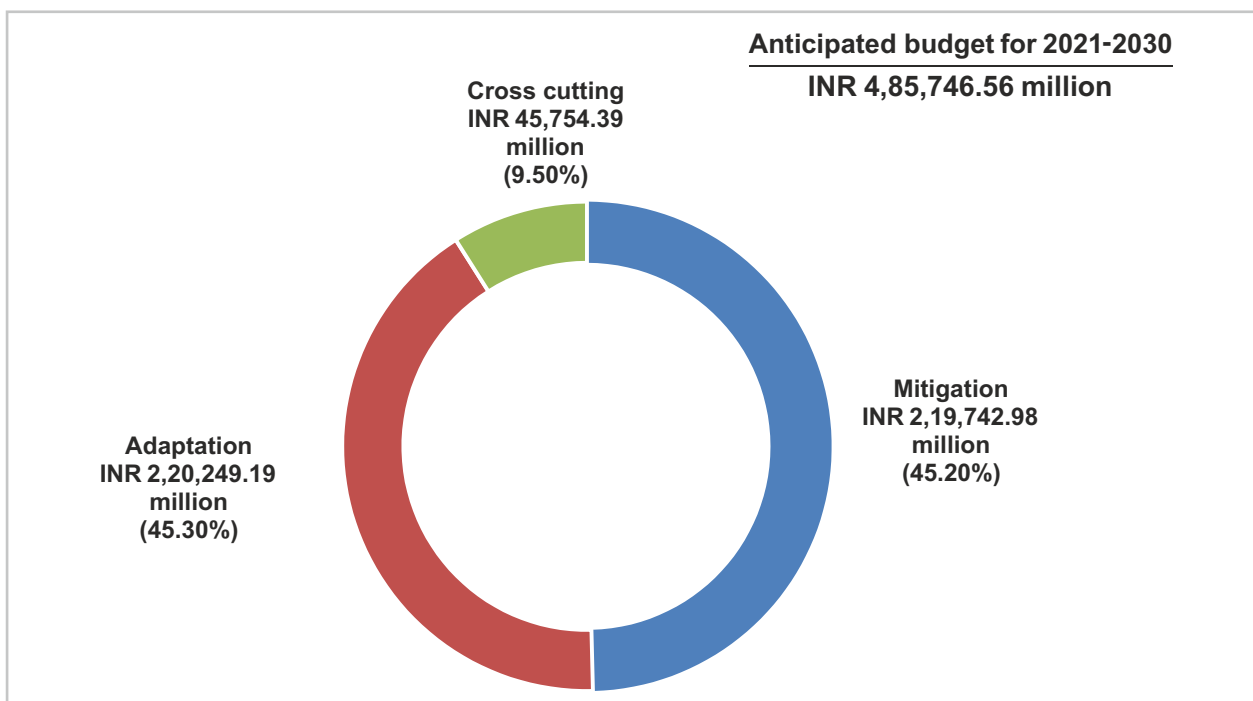


Figure 7.3: Anticipated expenditure with regard to type of measures

The nature of strategies indicates that out of the total 63 strategies, about 52.4% of the strategies are policy oriented followed by 19% investment, 14.3% capacity building, 9.5% research and 4.8% are pilot oriented initiatives (Figure 7.4).

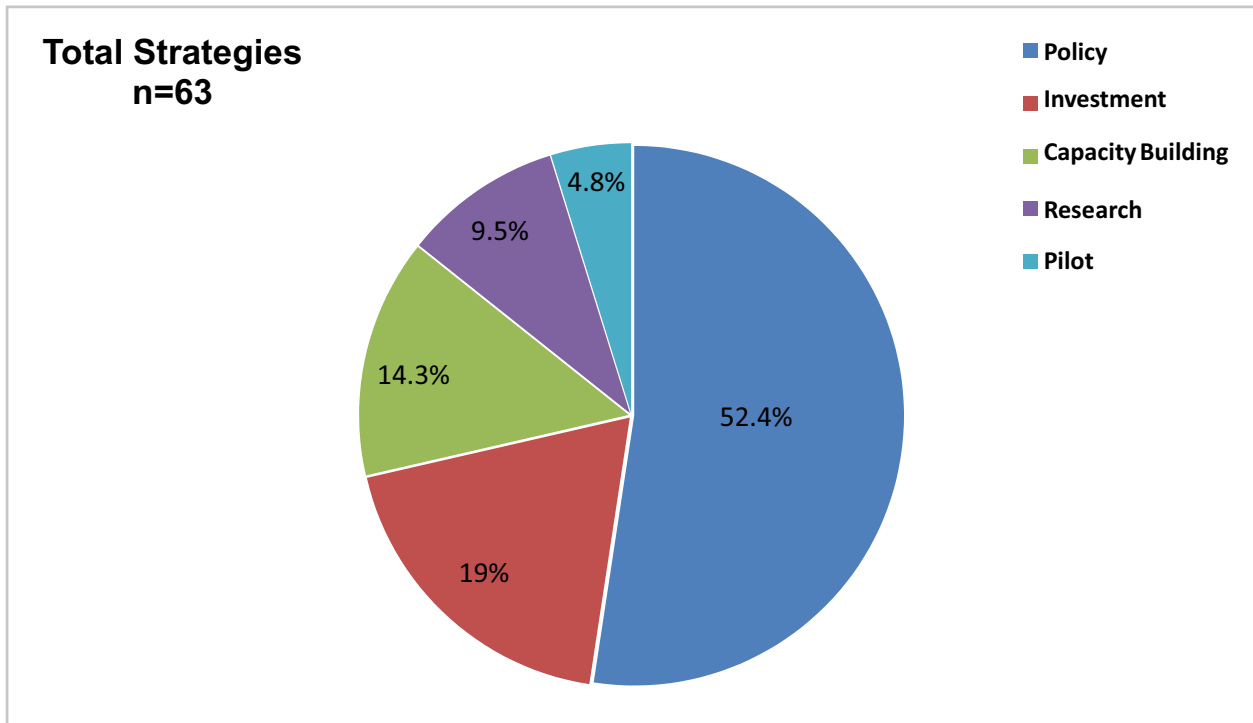


Figure 7.4: Nature of the strategies under SAPCC 2.0

### 7.3 Prioritization of strategies of SAPCC 2.0

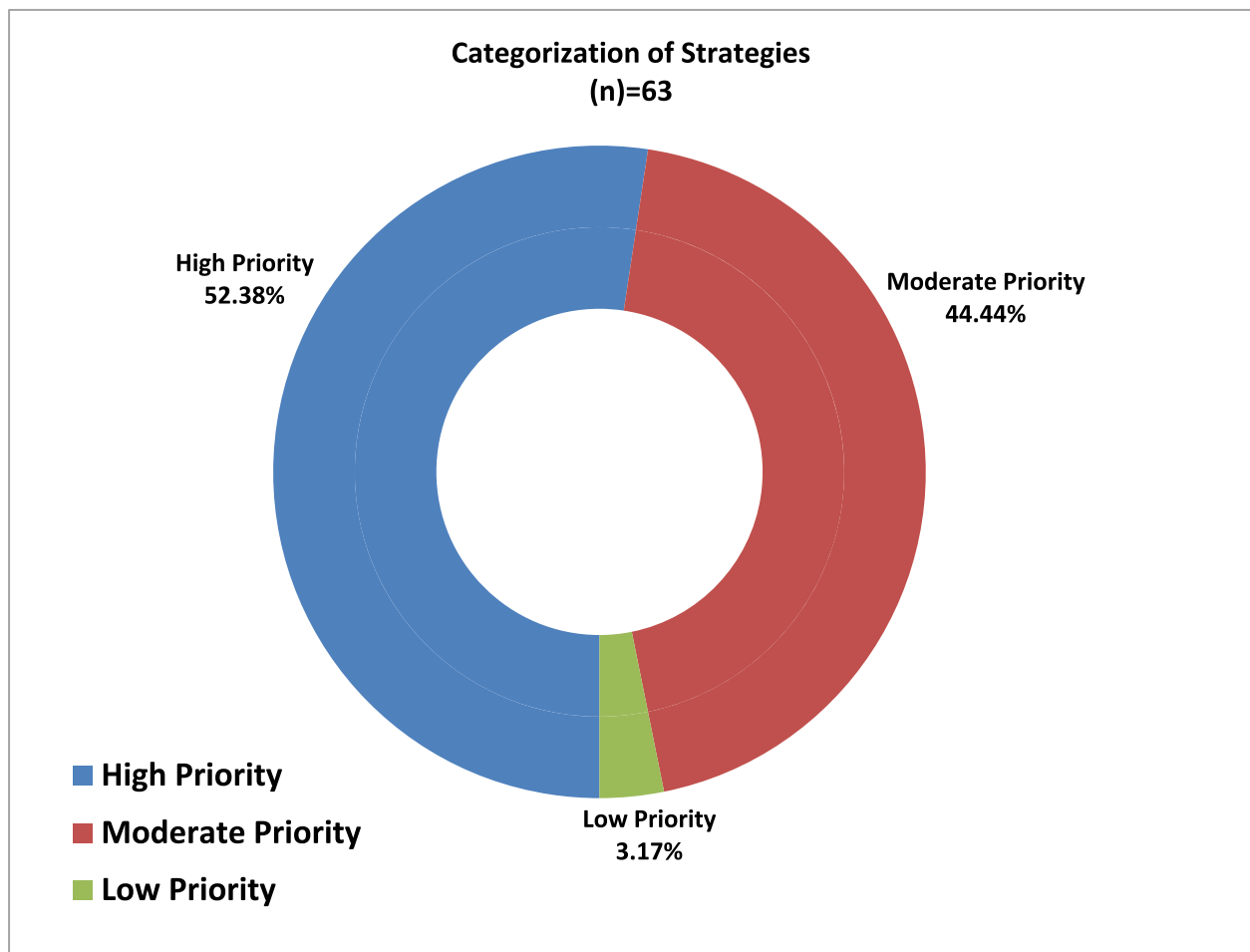
A prioritization exercise was carried out for 63 strategies (outlined in Chapters 5 & 6) identified under seven State Missions of SAPCC 2.0 to identify the strategies that are more aligned to the selected four parameters. As SAPCC 2.0 has been developed in line with NDCs and SDGs, 40% weightage was given to the criterion 'SDGs/NDCs linkages' whereas, rest of the criteria viz. minimum implementation barriers, fund availability & gender inclusiveness potential were given equal weightage of 20% each. Score card exercise was carried out for assigning scores to the strategies on the scale 1-3. Criteria scores, then, were assigned the weights mentioned above, as determined in consultation with the relevant stakeholder Departments/Agencies. The criteria wise details are as under:

- **Linkages to SDGs/NDCs:** The strategies contributing to one or more SDGs as well as to the NDCs goals were given respective score on a scale of meager (1), reasonable (2) to significant (3). Further, as mentioned above 40% weight was earmarked to this criterion.
- **Implementation potential:** The strategies were assessed for any implementation barriers and given a score on 1 (high barriers) to 3 (low barriers) scale. Further, 20% weight was earmarked for this criterion.
- **Funding linkage:** Strategies were also assessed based on linkages with existing Government schemes/programs and their potential to seek additional climate finance from other sources. Based on the same, strategies were given a score from 1 (low funding linkage) to 3 (high funding linkage). 20% weight was assigned for this criterion.



- **Gender and inclusiveness potential:** The assessment of strategies was also carried out based on their focus on gender equality and inclusiveness and weight of 20% was earmarked for this criterion.

Based on the overall score of all the 63 strategies identified under 7 State Missions, strategies have been classified as High Priority, Moderate Priority & Low Priority strategies. The analysis indicates that out of 63 strategies, 52.38% are high priority followed by 44.44% moderate priority and only 3.17% are low priority strategies, as indicated in **Figure 7.5**. Further, sectoral level analysis w.r.t prioritization of strategies is indicated in **Table 7.6**.



**Figure 7.5: Priority analysis of strategies under SAPCC 2.0**

**Table 7.6: Sector Specific Priority analysis**

Sectors		High Priority	Moderate Priority	Low Priority	Total
Energy	Number	2	5	0	7
	% of total	3.17%	7.94%	0.00%	11.11%
Sustainable Habitat	Number	6	6	1	13
	% of total	9.52%	9.52%	1.59%	20.63%
Agriculture	Number	5	7	0	12
	% of total	7.94%	11.11%	0.00%	19.05%
Water	Number	5	2	0	7
	% of total	7.94%	3.17%	0.00%	11.11%
Health	Number	5	3	0	8
	% of total	7.94%	4.76%	0.00%	12.70%
Forest, Ecosystem & Biodiversity	Number	6	2	1	9
	% of total	9.52%	3.17%	1.59%	14.29%
Strategic Knowledge	Number	4	2	0	6
	% of total	6.35%	3.17%	0.00%	9.52%



## 7.4 Sectoral High Priority Strategies

The list of high priority strategies identified through sectoral analysis is as under:

### Forestry, Ecosystem & Biodiversity

- (1) Increasing tree cover outside forest area by promoting agroforestry and urban/house hold forestry in the State.
- (2) Improving the stocking of existing forests and bringing them from degraded (canopy density <0.4) category to medium dense forest (0.4 to 0.7) category by carrying out plantations.
- (3) Afforestation in urban areas, industrial sites settlement areas, along the rivers, roadside plantation, and shelterbelt plantation.
- (4) Conservation and protection of biodiversity in the State.
- (5) Development of PES (Payment for Ecosystem Services)
- (6) Ecosystem restoration and habitat protection for wildlife and biodiversity conservation.

### Sustainable Agriculture

- (1) Optimum use of water resources and promoting high density aquaculture system
- (2) Promote crop diversification including enhancing area under horticulture and fishery
- (3) Manage livestock health in the emerging pest and disease scenario.
- (4) Demonstration of climate resilient sheds
- (5) Smart and resource efficient dairy farming

### Water

- (1) Manage floods in a future erratic and excess extreme rainfall scenario.
- (2) Contain the likely enhanced water logging situation in the south west districts of Punjab due to the projected increase in rainfall in the region.
- (3) Undertake a focused approach to augment groundwater especially in problematic/ overexploited areas
- (4) Enhance water use efficiency by 20%
- (5) Abate continued water pollution of underground and surface water sources which is likely to increase due to increase in industries and population

### Health

- (1) Developing mechanism for climate sensitive disease tagging
- (2) Improving nutritional status of young children, adolescent girls, pregnant women and to reduce mortality and morbidity among young children due to low birth weight
- (3) Reducing the maternal mortality rate by improving quality of MCH care at the rural



community level

- (4) Developing and early morning alert system in specific areas for heat waves and AQI.
- (5) Greening health sector and enhancing the energy efficiency of the health care buildings.  
rural community level

### Strategic Knowledge

- (1) Strengthening Knowledge Networks in the domain of Environment & Climate Change to address research issues and promote technology development for enhancing State's resilience
- (2) Capacity building of Govt. functionaries/ for effective implementation of SAPCC 2.0 involving training/extension centres of state institutions
- (3) Specialized certificate trainings for dairy farmers/youth entrepreneurs for sustained milk productivity in climate change scenarios & minimizing methane emissions from dairy  
Enhanced
- (4) Awareness and outreach activities for school students, women, industrial workers building an informed and resilient society.

### Energy Efficiency & Solar

- (1) Addressing climate change through the development of solar and other clean energy technologies to power a clean and sustainable future.
- (2) Increase coverage of solar lighting in urban and rural areas

### Sustainable Habitat

- (1) Development of green community space.
- (2) Strengthen livelihood generation.
- (3) Strengthening sanitation facilities in rural school and create herbal/ kitchen gardens for promoting healthier lifestyle.
- (4) Promoting affordable housing in rural areas
- (5) Bioremediation of landfill site for legacy waste management and setting up of sanitary landfills for inert waste
- (6) Enhance drainage capacity of existing storm water drainage system in towns







## Chapter 8

# IMPLEMENTATION, MONITORING & EVALUATION MECHANISM





## 8.0: Implementation, Monitoring & Evaluation mechanism

The State recognizes the need for institutionalizing a calibrated implementation mechanism ensuring active involvement of relevant state departments with the overall coordination through the State Nodal Agency i.e. Directorate of Environment & Climate Change (DECC) under Department of Science, Technology & Environment, Government of Punjab. This chapter highlights the steering mechanism through which interventions will be planned, operationalized and monitored.

### 8.1 Implementation Framework of the SAPCC

Implementation of strategies envisaged under the SAPCC 2.0 will entail contribution of participating State Departments and agencies by adoption of a cross cutting state wide approach for expected results. The State Steering Committee on Climate Change will steer and oversee monitoring through State Nodal Agency to ensure that planned strategies are effectively executed and achieve intended benefits. Directorate of Environment & Climate Change (DECC) will function as State Nodal Agency for monitoring implementation of SAPCC 2.0 and periodically review progress through Review and Monitoring Committee under the chairmanship of Administrative Secretary, STE, Govt. of Punjab. For each mission, Mission Nodal Department/ Agency has been identified who would be responsible to monitor progress of all the granular activities and periodically report to State Nodal Agency. Punjab State Climate Change Knowledge Centre set up in PSCST will integrate contributions of Academic & Research Institutions regarding progress on R&D pertaining to climate change as well as take up capacity building of Nodal officers/Government functionaries in consultation with State Nodal Agency for better comprehension and implementation of climate change strategies.

The Institutional framework for implementation of SAPCC 2.0 is given in **Figures 8.1 & 8.2:**

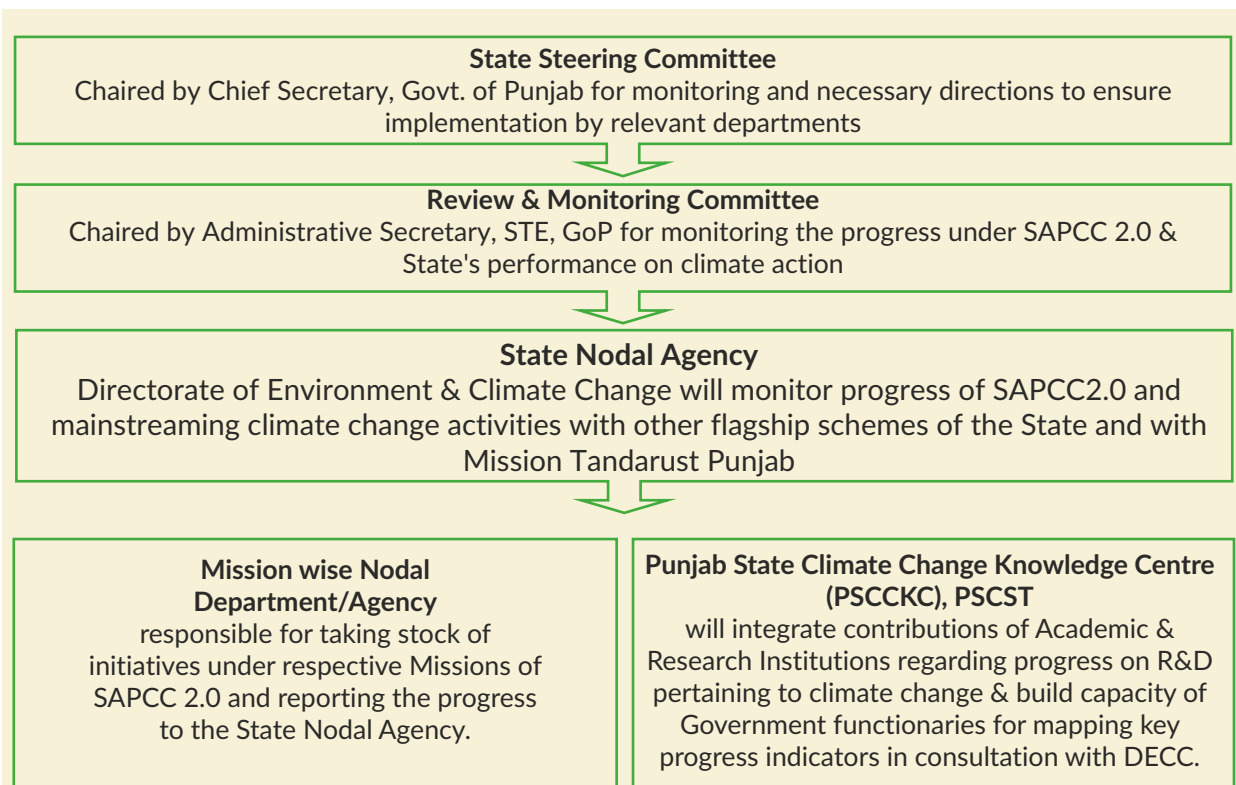


Figure 8.1: Implementation framework of SAPCC

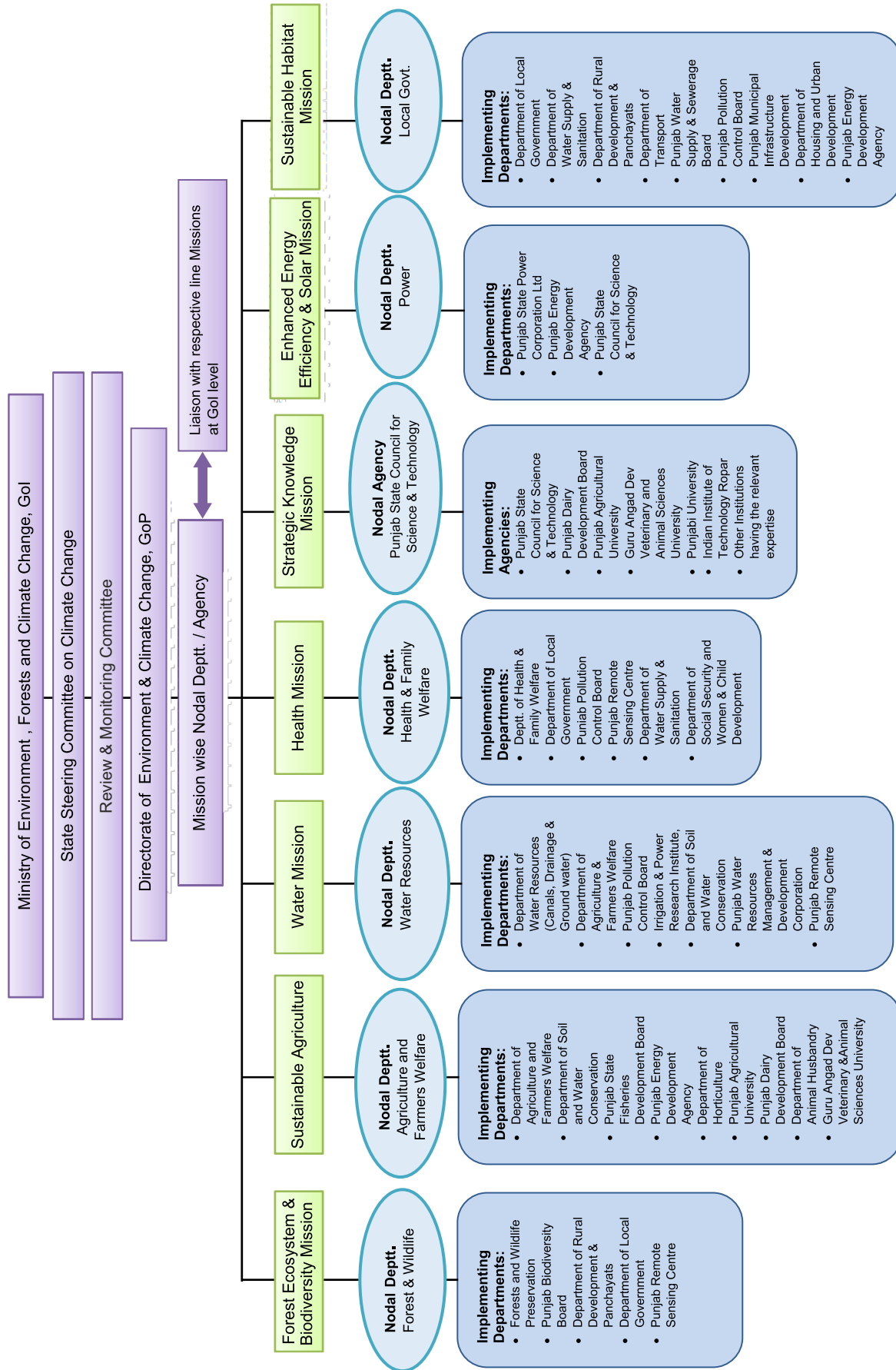


Figure 8.2: Implementation, Monitoring & Evaluation Framework of SAPCC2.0

## 8.2 Implementation of SAPCC 2.0 : Mission-wise Strategies and Implementing Agencies

A close inter departmental coordination is required for successful implementation of strategies. The principal responsibility of various departments and institutions/organisations for execution of strategies under various missions of SAPCC 2.0 have been mentioned in the **Tables 8.1 to 8.7**. The strategies coded with \*/N/\* depict newly introduced strategies in SAPCC 2.0 whereas the remaining strategies are continuing from SAPCC 1.0. For example in code FR/N/7, 'FR' represent mission forest, ecosystem & biodiversity; 'N' represent new strategy and '7' depict the strategy number.

**Table 8.1: Implementing Agencies for State Mission on Forest, Ecosystem & Biodiversity**

Code	Strategy	Implementing Agency
FR/1	Improving the stock of existing forests and bringing them from degraded (canopy density<0.4) category to medium dense forest (0.4 to 0.7) category by carrying out plantations.	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> </ul>
FR/2	Afforestation in public areas, industrial sites, settlement areas, along the rivers, roadside plantation and shelterbelt plantation	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> <li>Department of Local Government</li> </ul>
FR/3	Increasing tree cover outside forest area by promoting agro-forestry and house hold forestry in the State.	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> <li>Department of Rural Development &amp; Panchayats</li> <li>Department of Local Government</li> </ul>
FR/4	Conservation and protection of biodiversity in the State	<ul style="list-style-type: none"> <li>Department of Forests &amp; Wildlife Preservation</li> <li>Punjab Biodiversity Board</li> </ul>
FR/5	Forest Fire Management	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> <li>Punjab Remote Sensing Center</li> </ul>
FR/N/6	Strengthening capacities and extension services of the forest department for sustainable management of forests	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> </ul>
FR/N/7	Development of PES (Payment for Ecosystem Services)	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> </ul>
FR/N/8	Facilitation of better market opportunities for major and minor forest produce	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> </ul>
FR/N/9	Ecosystem improvement and habitat protection for wildlife and dependent biodiversity conservation	<ul style="list-style-type: none"> <li>Department of Forests and Wildlife Preservation</li> <li>Punjab Biodiversity Board</li> </ul>

**Table 8.2: Implementing Agencies for State Mission on Sustainable Agriculture**

Code	Strategy	Implementing Agency
AG/N/1	Optimum use of water resources and promoting high density aquaculture system	<ul style="list-style-type: none"> <li>Department of Soil &amp; Water Conservation</li> <li>Punjab State Fisheries Development Board</li> </ul>
AG/2	Promote crop diversification including enhancing area under horticulture and fishery	<ul style="list-style-type: none"> <li>Department of Agriculture &amp; Farmers Welfare</li> <li>Department of Horticulture</li> <li>Punjab State Fisheries Development Board</li> </ul>
AG/3	Promotion of integrated nutrient management in soils and declining the use of pesticides and fertilizers use and promoting organic farming	<ul style="list-style-type: none"> <li>Department of Agriculture and Farmers Welfare</li> <li>Department of Horticulture</li> </ul>
AG/4	Proper management of agricultural crop residue.	<ul style="list-style-type: none"> <li>Department of Agriculture and Farmers Welfare</li> <li>Punjab Energy Development Agency</li> <li>Punjab Pollution Control Board</li> </ul>
AG/5	Research for developing suitable crop cultivars, short duration and climate resilient varieties of crops, vegetables and fruits	<ul style="list-style-type: none"> <li>Punjab Agricultural University</li> </ul>
AG/N/6	Efficient utilization of livestock manure for energy	<ul style="list-style-type: none"> <li>Department of Animal Husbandry, Punjab</li> <li>Punjab Energy Development Agency</li> </ul>
AG/N/7	Manage livestock health in the emerging pests and disease scenario.	<ul style="list-style-type: none"> <li>Department of Animal Husbandry</li> </ul>
AG/N/8	Development and Management of Climate resilient sheds	<ul style="list-style-type: none"> <li>Punjab Dairy Development Board</li> <li>Guru Angad Dev Veterinary and Animal Sciences University</li> </ul>
AG/N/9	Conservation and propagation of indigenous breeds of livestock	<ul style="list-style-type: none"> <li>Department of Animal Husbandry Punjab</li> <li>Guru Angad Dev Veterinary and Animal Sciences University</li> </ul>
AG/N/10	Promote shrimp culture and other suitable species in saline and water-logged area to generating livelihood opportunity	<ul style="list-style-type: none"> <li>Punjab State Fisheries Development Board</li> </ul>
AG/N/11	Smart and resource efficient dairy farming	<ul style="list-style-type: none"> <li>Punjab Dairy Development Board</li> </ul>
AG/N/12	Research for enhancing resilience of livestock sector	<ul style="list-style-type: none"> <li>Guru Angad Dev Veterinary and Animal Sciences University</li> <li>Department of Animal Husbandry</li> <li>Punjab Dairy Development Board</li> </ul>



**Table 8.3: Implementing Agencies for State Mission on Water**

Code	Strategy	Implementing Agency
WR/N/1	Water resource (including river courses, tributaries, canals) mapping through GIS and Remote sensing technology	<ul style="list-style-type: none"> <li>Department of Water Resources (Canals and Drainage)</li> <li>Punjab Remote Sensing Centre</li> </ul>
WR/2	Manage floods in a future erratic and excess extreme rainfall scenario	<ul style="list-style-type: none"> <li>Department of Water Resources (Canals and Drainage)</li> </ul>
WR/3	Contain the likely enhanced water logging situation in the south west districts of Punjab due to the projected increase in rainfall in the region	<ul style="list-style-type: none"> <li>Department of Water Resources (Drainage &amp; Ground water)</li> <li>Department of Agriculture &amp; Farmers Welfare</li> </ul>
WR/4	Suggested Research and monitoring activities for effective decision making	<ul style="list-style-type: none"> <li>Irrigation &amp; Power Research Institute, Punjab (IPRI)</li> </ul>
WR/N/5	Undertake a focused approach to augment groundwater especially in problematic/ overexploited areas	<ul style="list-style-type: none"> <li>Department of Water Resources (Ground water)</li> </ul>
WR/6	Enhance water use efficiency by 20%	<ul style="list-style-type: none"> <li>Department of Soil &amp; Water Conservation</li> <li>Department of Water Resources (Canals and Drainage)</li> <li>Punjab Water Resources Management &amp; Development Corporation</li> </ul>
WR/7	Abate continued water pollution of underground and surface water sources	<ul style="list-style-type: none"> <li>Punjab Pollution Control Board</li> <li>Department of Water Resources</li> </ul>



**Table 8.4: Implementing Agencies for State Mission on Health**

Code	Strategy	Implementing Agency
HEL/N/1	Developing an early warning and alert systems in specific areas for heat waves and AQI.	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> <li>• Department of Local Government</li> <li>• Punjab Pollution Control Board</li> <li>• Punjab Remote Sensing Centre</li> </ul>
HEL/N/2	Developing Mechanism for climate sensitive disease tagging	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> </ul>
HEL/N/3	Create awareness among general population (vulnerable community), health-care providers and Policy makers regarding impacts of climate change on human health	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> </ul>
HEL/N/4	Strengthen/develop mechanism for management of vector borne disease through surveillance and establishment of sentinel sites	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> <li>• Department of Local Government</li> <li>• Department of Rural Development &amp; Panchayats</li> </ul>
HEL/N/5	Strengthening/ developing management strategies for water borne illness	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> <li>• Department of Water Supply and Sanitation</li> </ul>
HEL/N/6	Improving nutritional status of young children, adolescent girls, pregnant women as well as reducing mortality and morbidity among young children due to low birth weight, malnutrition, etc	<ul style="list-style-type: none"> <li>• Department of Social Security and Women &amp; Child Development</li> <li>• Department of Health and Family Welfare</li> </ul>
HEL/N/7	Reducing the maternal mortality rate by improving quality of MCH care at the rural community level	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> </ul>
HEL/N/8	Greening of health sector and enhancing the energy efficiency of the healthcare buildings.	<ul style="list-style-type: none"> <li>• Department of Health and Family Welfare</li> <li>• Punjab Energy Development Agency</li> </ul>

**Table 8.5: Implementing Agencies for State Mission on Strategic Knowledge**

Code	Strategy	Implementing Agency
SK/1	Manage, Interpret, Disseminate data & Information	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Relevant Universities/R&amp;D institutions in the State</li> </ul>
SK/N/2	Strengthening Knowledge Networks in the domain of Environment & Climate Change to address research issues and promote technology development for enhancing State's resilience	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Relevant Universities/R&amp;D institutions in the State</li> </ul>
SK/N/3	Capacity building of Govt. functionaries for effective implementation of SAPCC 2.0 involving training/ extension centres of state institutions	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Training institutes/wings of State Development Departments</li> </ul>
SK/N/4	Trainings for upcoming researchers in climate change domain for better aligning research & promote start-ups to address sectoral challenges	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Relevant Universities/R&amp;D institutions in the State</li> </ul>
SK/N/5	Mainstreaming climate change concerns in ongoing programs & schemes through evidence based planning of adaptation actions.	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>State Development Departments</li> </ul>
SK/N/6	Specialized certificate trainings for dairy farmers/youth entrepreneurs for sustained milk productivity in climate change scenario & minimizing methane emissions from dairy	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Punjab Dairy Development Board</li> <li>Guru Angad Dev Veterinary &amp; Animal Sciences University</li> </ul>
SK/N/7	Awareness & Outreach Activities for School Students, Women, Industrial workers building an informed and resilient society.	<ul style="list-style-type: none"> <li>Punjab State Council for Science &amp; Technology</li> <li>Punjab State Climate Change Knowledge Centre</li> <li>Punjabi University, Patiala</li> <li>State Institute of Rural Development, DRDP</li> <li>Department of Education</li> </ul>



**Table 8.6: Implementing Agencies for State Mission on Enhanced Energy Efficiency & Solar Mission**

Code	Strategy	Implementing Agency
EN/N/1	Addressing climate change through development of solar and other clean energy technologies to power a clean and sustainable future.	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Council for Science &amp; Technology</li> <li>• Research Institutions</li> </ul>
EN/N/2	Promote energy efficiency in residential, Commercial & Institutional buildings such as Hotels, Malls, and Govt. buildings	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Power Corporation Ltd.</li> </ul>
EN/3	Increased coverage & utilization of solar as well as other renewable energy sources in urban and rural areas	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Department of Local Government</li> <li>• Department of Rural Development &amp; Panchayats</li> </ul>
EN/N/4	Develop small and micro hydro project	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Power Corporation Limited</li> </ul>
EN/5	Introduction of farm-level solar power generation to reduce energy demand from irrigation	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Power Corporation Limited</li> </ul>
EN/N/6	Enhancing the private sector involvement in the renewable energy sector	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Power Corporation Limited</li> </ul>
EN/7	Enhancing energy efficiency & conservation in MSMEs	<ul style="list-style-type: none"> <li>• Punjab Energy Development Agency</li> <li>• Punjab State Council for Science and Technology</li> </ul>



**Table 8.7: Implementing Agencies for State Mission on Sustainable Habitat**

Code	Strategy	Implementing Agency
SH/N/1	Upscaling of Liquid and Solid waste treatment and its compliance	<ul style="list-style-type: none"> <li>Punjab Water Supply &amp; Sewerage Board</li> <li>Department of Water Supply &amp; Sanitation</li> <li>Punjab Pollution Control Board</li> <li>Punjab Municipal Infrastructure Development Company</li> <li>Department of Rural Development &amp; Panchayats</li> </ul>
SH/N/2	Developing sustainable street lightning system in rural areas	<ul style="list-style-type: none"> <li>Punjab Energy Development Agency</li> <li>Department of Rural Development &amp; Panchayats</li> <li>Department of Local Government</li> </ul>
SH/N/3	Development of green community space	<ul style="list-style-type: none"> <li>Department of Local Government</li> <li>Department of Rural Development &amp; Panchayats</li> </ul>
SH/N/4	Rejuvenation/rehabilitation of village ponds	<ul style="list-style-type: none"> <li>Department of Rural Development &amp; Panchayats</li> <li>Department of Water Supply &amp; Sanitation</li> <li>Punjab Pollution Control Board</li> </ul>
SH/N/5	Undertake natural resource conservation measures in/around habitations	<ul style="list-style-type: none"> <li>Department of Local Government</li> <li>Department of Rural Development &amp; Panchayats</li> </ul>
SH/N/6	Strengthen the livelihood generation through MGNREGA	<ul style="list-style-type: none"> <li>Department of Rural Development &amp; Panchayats</li> <li>Department of Water Supply &amp; Sanitation</li> </ul>
SH/N/7	Promoting affordable housing in rural areas	<ul style="list-style-type: none"> <li>Department of Rural Development &amp; Panchayats</li> <li>Department of Housing &amp; Urban Development</li> </ul>
SH/N/8	Strengthening sanitation facilities in rural schools and create herbal/kitchen gardens for promoting healthier lifestyle	Department of Rural Development & Panchayats
SH/N/9	Develop a Smart urban mobility	<ul style="list-style-type: none"> <li>Transport Department of Punjab</li> <li>Punjab Energy Development Agency</li> <li>Department of Housing &amp; Urban Development</li> <li>Department of Local Government</li> </ul>
SH/10	Promote a sustainable integrated transport system	<ul style="list-style-type: none"> <li>Transport Department of Punjab</li> <li>Department of Local Government</li> </ul>
SH/N/11	Bioremediation of landfill site for legacy waste management and setting up of sanitary landfills for inert waste	<ul style="list-style-type: none"> <li>Department of Local Government</li> <li>Department of Water Supply &amp; Sanitation</li> <li>Department of Rural Development &amp; Panchayats</li> </ul>
SH/12	Enhance drainage capacity of existing storm water drainage system in towns to address issue of excessive runoff	<ul style="list-style-type: none"> <li>Punjab Water Supply &amp; Sewerage Board</li> <li>Department of Local Government</li> </ul>
SH/13	Development of Green Buildings official spaces/institutions	<ul style="list-style-type: none"> <li>Department of Housing &amp; Urban Development</li> <li>Department of Local Government</li> </ul>

### 8.3. Monitoring & Evaluation

Defining an appropriate institutional arrangement is the key to effective Monitoring and Evaluation (M&E) system. M&E mechanism for SAPCC2.0 will be operationalized taking into account the existing institutional framework driven by the departments/agencies as discussed under implementation framework. Each implementing department will constitute a small working group with at least 2 members well versed with the departmental activities & finance and one Nodal officer. Nodal officer will be the interface for data updation. They being the technical point of contact and interface with executing departments for data collection, will be trained on priority. The State Nodal Agency and Punjab State Climate Change Knowledge Centre will plan and facilitate training on aspects of data requirement, data reporting, frequency, etc. In addition, line department officials, officials from department of Finance & Planning shall also be part of the training process.

The Monitoring and Evaluation for SAPCC 2.0 envisages assessment of the State's overall progress towards climate resilience and also to evaluate State's contribution towards country's NDCs and SDGs. Key Progress indicators of each strategy have been identified to monitor and review the progress of SAPCC 2.0 (**Annexure XIV**). The approach indicated in **Figure 8.3** below is envisaged to be adopted by Mission Nodal Departments/Agencies for monitoring & evaluating the Action Plan:

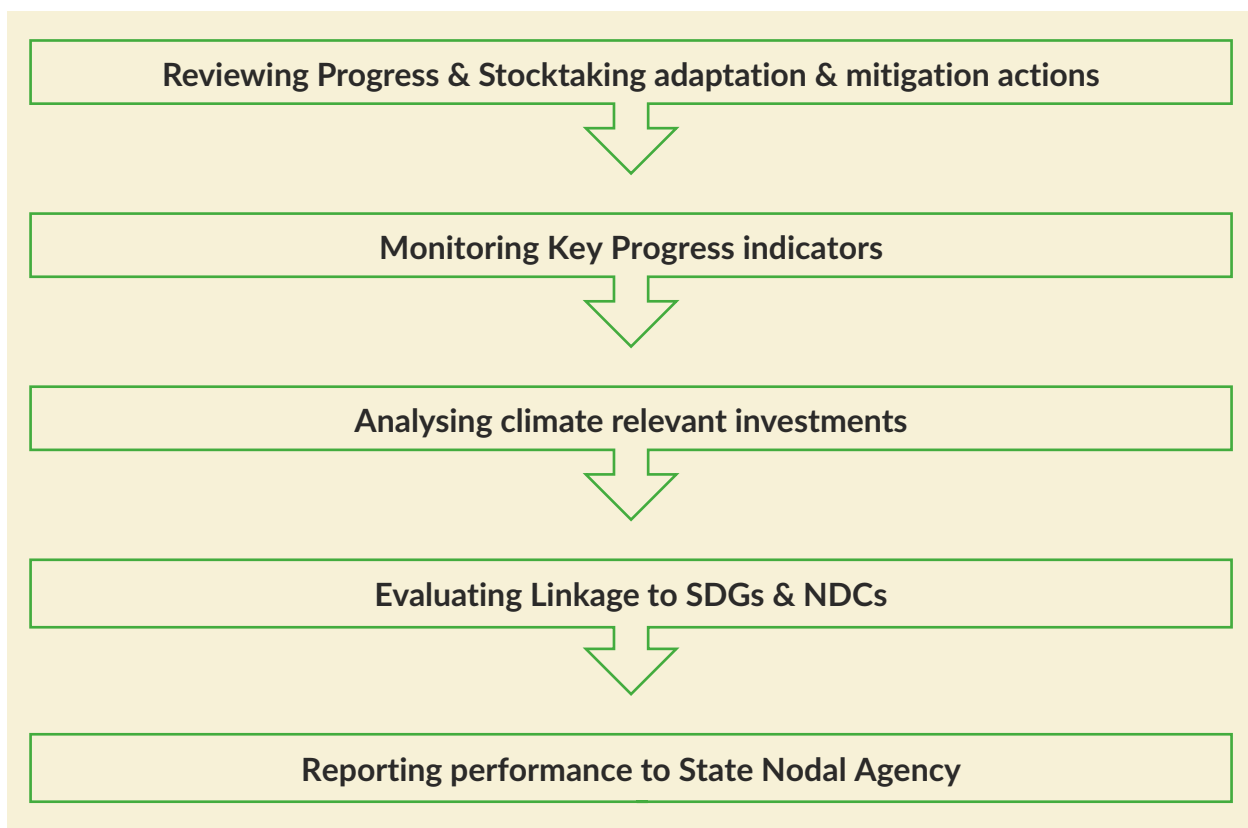


Figure 8.3: Monitoring & Evaluation structure of Punjab SAPCC 2.0

### 8.3.1. Monitoring and evaluation mechanism adopted by Punjab

Key Progress Indicators (KPIs) under each mission have been developed in consultation with stakeholder departments to capture progress viz a viz the strategies for measuring contribution towards enhancing climate resilience (**Annexure-XIV**). However, State Nodal Agency may develop more indicators in consultation with stakeholder departments during implementation phase of SAPCC as per State's requirement. Key Progress Indicators (KPIs) are also categorised under output, outcome and process categories for effective evaluation (**Table 8.8**)

**Table 8.8: Category of Indicators for evaluation**

Category of Indicators	Explanation
Output	Such indicators often represent countable immediate results of an action e.g. no. of people receiving a training
Outcome	These indicators represent long-term outcome of a measure/ process
Process	Actions indicating steps or processes undertaken to generate output

The M&E protocol is suggested to be activity/strategy based and a suggestive dashboard is illustrated in **Table 8.9**, which may further be modified as per the State's evolving frameworks. Each Mission Nodal Agency should also prepare yearly targets/milestones in consultation with stakeholder departments and State Nodal Agency for effective monitoring of progress vis a vis the strategies of SAPCC 2.0.

**Table 8.9: Illustrative depiction of the M&E dashboard for implementation of SAPCC**

	Strategy Code	Strategy	Key Progress Indicator	Progress	Category of action	Linked to SDG/NDC (target)	Allocated Funding	Source of Funding
1.	FR/1.0	Extend Forest and tree cover	Area added under forest cover in the state annually	XX (in ha)	Adaptation	15.1.1 - Forest area as a proportion of total land area	XX million	<<To be added>>
2.	.....	.....	.....	.....	.....	.....	.....	.....
3.	.....	.....	.....	.....	.....	.....	.....	.....
4.	.....	.....	.....	.....	.....	.....	.....	.....
5.	.....	.....	.....	.....	.....	.....	.....	.....

An indicator-based dashboard as illustrated above can be developed by each Mission Nodal Department/Agency in consultation with stakeholder departments and State Nodal Agency to monitor the progress made on each strategy.

Further, aggregate indicators have been developed and represented at Annexure -XV in order to measure SAPCC's contribution towards India's climate change mitigation goals including long-term goal of reaching net-zero by 2070. Furthermore, the implementing agencies could also plan to indicate social economical and environmental contribution of each intervention and depict the same by enhancing the illustrative M&E dashboard tabulated above.

## 8.4 Tools and methods for harmonization

The State intends to ensure the synergistic functioning of existing mechanisms for effective reporting of State's efforts towards climate change across various sectors & domains.

### 8.4.1 Highlighting State's Climate Action in the budget document

Extensive exercise has been carried out to include strategies in SAPCC2.0, keeping in view the existing programs of various State Departments/ Organizations. This effort needs to be reflected in State's budget document as it will highlight the State's contribution towards climate action at National level. For this, the Department of Planning and Finance may code the existing schemes identified in current SAPCC 2.0 document indicating their contribution towards climate change adaptation and mitigation. This would also help the State for prioritizing the budget for climate action in times to come.

### 8.4.2 Data management System

- Data for each Key Progress Indicator (KPI) under each mission will be collected by respective Nodal Officers of the Implementing Agencies and will be evaluated by respective Mission Nodal Departments/ Agencies before reporting to the State Nodal Agency.
- State Nodal Agency i.e Directorate of Environment & Climate Change, Department of Science, Technology & Environment, Govt. of Punjab will periodically review and monitor the progress of SAPCC 2.0 atleast once annually or as per the State's requirement.
- The dashboard for key progress indicators will be dynamic and updated on regular basis by Mission Nodal Departments / Agencies in consultation with State Nodal Agency in order to align the outcomes with goals, besides regular monitoring and stocktaking of results and achievements under the State Missions, mid-term review of climate relevant strategies will also be undertaken.

### 8.4.3 Capacity Building

Need based capacity building of Mission Nodal Departments/Agencies will be carried out by Punjab State Climate Change Knowledge Centre, PSCST in consultation with DECC for better comprehension of climate change strategies & key progress indicators by them.





# ANNEXURES





## ANNEXURE - I

## Progress Mapping for Forest and Biodiversity related strategies of SAPCC 1.0

Code	Strategy	Physical Progress	Expenditure (in INR million)
<b>Strategy 1</b>			
FR/1.0	Extend forest and tree cover	<ul style="list-style-type: none"> <li>State has increased tree cover and improved quality of forest by planting more than 22.6 million trees covering an area of 25,179 ha under important schemes Green India Mission (GIM) &amp; Punjab Compensatory Afforestation Fund Management &amp; Planning Authority (PUNCAMPA)</li> <li>Under green highway project, 0.12 million plants have been planted on NH-54 section between Amritsar and Pathankot</li> </ul>	143.28
FR/1.1	Extend forest and tree cover in a saline-alkaline area	<ul style="list-style-type: none"> <li>Compensatory afforestation was undertaken in 482.29 ha saline-alkaline area with 4,82,298 number of suitable plants.</li> </ul>	97.07
FR/1.2	Extend forest and tree cover in the water logged area- Willow, Eucalyptus, Arjun	<ul style="list-style-type: none"> <li>Compensatory afforestation was undertaken in 39.342 ha waterlogged area through more than 39,000 plantations</li> </ul>	1.67
FR/1.3	Undertake extensive agro forestry	<ul style="list-style-type: none"> <li>More than 14.98 million trees were planted under "Sub-mission on Agro-forestry (SMAF)" covering an area of 17,560.13 ha.</li> <li>About 8.39 million plants were supplied free of cost for purpose of the agroforestry under the State's initiative of "Ghar Ghar Hariyali".</li> </ul>	144.85
FR/1.4	Plant trees in institutional areas	<ul style="list-style-type: none"> <li>Under Green Punjab Mission a total of 1.00 million trees have been planted covering 1,340 ha of institutional area.</li> </ul>	0.19
FR/1.5	Restore and rehabilitate <i>Dalbergia sissoo</i> & <i>Acacia nilotica</i>	<ul style="list-style-type: none"> <li>More than 4.3 million trees of <i>Dalbergia sissoo</i> &amp; 1.1 million <i>Acacia nilotica</i> species have been planted</li> </ul>	Not available
FR/1.6	Develop forest fire management strategies and prevention of encroachment into forests	<ul style="list-style-type: none"> <li>State has prepared Crisis Management Plan and also identified fire prone zones for effective management.</li> <li>Under Rashtriya Krishi Vikas Yojana (RKVY) 1,292 farmers from 6 Kandi Forest divisions i.e., Ropar, SAS Nagar, SBS Nagar, Hoshiarpur, Dasuya and Pathankot availed the subsidy of INR 81.3 million for erecting 471 km fence in agriculture fields.</li> </ul>	96.50

Code	Strategy	Physical Progress	Expenditure (in INR million)
		<ul style="list-style-type: none"> <li>• Around 0.5 million plants of <i>Dalbergia sissoo</i> and other local trees have been planted along Satluj and Beas rivers, after removal of encroachment.</li> <li>• In Dalhousie road forest in Pathankot, two natural parks with walking trails and open gyms have been established by recovering encroached land</li> </ul>	
FR/1.7	Estimate current carbon from all pools of carbon in the state	<ul style="list-style-type: none"> <li>• According to ISFR 2021, Punjab's forests have 13.56 million tonne of carbon stock which is 49.72 million tonne of CO<sub>2</sub> equivalent.</li> </ul>	Not available
<b>Strategy 2</b>			
FR/2.1	Reduce fragmentation of forests. This can be done by providing corridors for species migration; both fauna and flora.	<ul style="list-style-type: none"> <li>• Removed encroachments from around 7,667 ha area</li> <li>• Indigenous plants such as, <i>Dalbergia sissoo</i>, <i>Terminalia arjuna</i> etc planted under PUNCAMPA.</li> </ul>	136.14
FR/2.2	Undertake enrichment plantation in Non-PLPA (Punjab Land Preservation Act) land	<ul style="list-style-type: none"> <li>• Enrichment plantation undertaken in 115 ha area through more than 0.55 million plantations.</li> </ul>	3.13
FR/2.3	Encourage aided natural regeneration in degraded and open forest areas	<ul style="list-style-type: none"> <li>• Compensatory afforestation undertaken in 7,565 ha degraded forest area through 7.56 million plants to regenerate the degraded area and open forest area.</li> </ul>	385.26
FR/2.4	Establish sacred groves, panchwatis (green clusters), and other community utility sites (parks, green belts, etc.)	<ul style="list-style-type: none"> <li>• Developed more than 140 sacred groves (400 plants per ha)</li> <li>• Under the two-plantation schemes- 550<sup>th</sup> &amp; 400<sup>th</sup> birth anniversaries of Gurus, 13.7 million trees planted in around 12,900 villages.</li> <li>• 125 micro forests (Oxy parks) developed in urban areas</li> <li>• 12 environmental and forest awareness parks developed</li> <li>• Government has announced to set up biodiversity parks at Sangrur, Giddherbaha and Bathinda.</li> </ul>	33.06
FR/2.5	Undertake soil conservation measures in degraded forest areas in Shivalik hills	<ul style="list-style-type: none"> <li>• Department of Soil and Water Conservation, Punjab, constructed 726 small rainwater harvesting-cum- recharging structures in Kandi area (Shivalik hills) at a cost of INR 446 million, thereby benefiting 20,162 ha area</li> <li>• IIT Ropar conducted a study for determination/ delineation of soil erosion hotspots &amp; assessment of sediment transfer through magnitude frequency analysis in catchment of Bhakra Dam Reservoir.</li> </ul>	393.10



Code	Strategy	Physical Progress	Expenditure (in INR million)
FR/2.6	Revitalize upscale community initiatives through JFM mechanism to conserve forests and design models to ensure payment for ecosystem services	<ul style="list-style-type: none"> <li>Punjab records 58.32% of forest covered under Joint Forest Management (JFM) with a total area of 0.19 million ha of forest land.</li> <li>Around 91,850 families involved in JFM committees generated annual employment of 0.8 million man-days for utilization of locally available bioresources of Shivalik belt for value addition through technological empowerment with the financial support of INR 40.48 million.</li> </ul>	40.48
FR/2.7	Create infrastructure in villages such as water harvesting structures, green walkways, etc. as per the requirement articulated in micro-plans.	<ul style="list-style-type: none"> <li>Under Watershed Management Program scheme, treatment area of 20,286 ha covered.</li> <li>Ground water recharge through rainwater harvesting structure/low dams created in area of 12,276 ha.</li> </ul>	Not available
FR/2.8	Promote micro- credit and undertake skill up-gradation on bee keeping and other agro forestry activities	<ul style="list-style-type: none"> <li>Expenditure of INR 14.50 million incurred for providing alternate livelihood and improving the quality of life of 2,136 beneficiaries in the forested area by utilising locally available bio-resources such as medicinal plants.</li> <li>25 Ayurveda herbs collection centres also set up</li> <li>70 herbal gardens developed with plantation of 9,800 plants</li> </ul>	48.23
FR/2.9	Control damage to crops by extensive habitat improvement away from the crops and fencing wherever necessary	<ul style="list-style-type: none"> <li>Under the RKVY project, farmers encouraged to go for chain link fencing to minimize losses by animal damage to crops.</li> </ul>	81.30
FR/2.10	Avoid unstable agriculture through diversification	<ul style="list-style-type: none"> <li>Under Agro-forestry Programme, more than 14.98 million trees planted under "Sub-mission on Agro-forestry (SMAF)" covering an area of 17,560 ha.</li> </ul>	144.85
FR/2.11	Take need-based steps for community empowerment and capacity building for income generation activities	<ul style="list-style-type: none"> <li>25 Storage godown &amp; drying sheds at panchayat/common land constructed for community use</li> <li>6 shredding machines &amp; 5 drying units also set up.</li> <li>Regular training cum capacity building programmes for JFMCs for income generation activities.</li> </ul>	15.51

Code	Strategy	Physical Progress	Expenditure (in INR million)
<b>Strategy 3</b>			
FR/3.1	Strengthen extension wing of the Forest Department	<ul style="list-style-type: none"> <li>Capacity building programs conducted for strengthening of extension wing through e-governance</li> </ul>	1.85
FR/3.2	Undertake training and dissemination activities for policy makers and other key stakeholders	<ul style="list-style-type: none"> <li>58 capacity building and training programs for JFMCs conducted</li> <li>Celebration of International Day for Biological Diversity (IDB) annually by organizing seminars, webinars, exhibitions, competitions, field visits etc. jointly with District Administration, BMCs, academic institutions, proactive NGOs etc.</li> </ul>	0.89
<b>Strategy 4</b>			
FR/4.1	Undertake production of planting material of different tree species	<ul style="list-style-type: none"> <li>3.99 million clonal stock of <i>Eucalyptus</i>, <i>Dalbergia sissoo</i> and <i>Populus</i> raised in nurseries for enhancing the wood availability</li> </ul>	54.35
FR/4.2	Identify and develop drought- tolerant clones of fast-growing tree species for matching tree species clones for different sites	<ul style="list-style-type: none"> <li>Transplantation of tall plants of Desi Khajoor/ Indian Date (<i>Phoenix dactylifera</i>) carried out at Bathinda, Punjab.</li> </ul>	Not available
FR/4.3	Enhance productivity from agro forestry plantation through development of production technologies for various climate hardy species to increase income of the farmers	<ul style="list-style-type: none"> <li>More than 4.3 million Sheesham (<i>Dalbergia sissoo</i>) and 1.1 million Kikar (<i>Acacia nilotica</i>) trees planted</li> <li>PAU conducted trials on raising Poplar (<i>Populus</i>) through drip irrigation for efficient utilization of water</li> </ul>	1.65
<b>Biodiversity related strategies</b>			
<b>Strategy 1</b>			
BIO/1	Understand the response of Himalayan glaciers to climate change	<ul style="list-style-type: none"> <li>Central University Bathinda studied impact of invasive Species on Himalayan biodiversity and established co-relation between climate change and genetic diversity of <i>Taxus wallichiana</i> and <i>Ulmus wallichiana</i> in Himalayan region by DNA markers and geospatial technology</li> </ul>	3.49



Code	Strategy	Physical Progress	Expenditure (in INR million)
BIO/2	Protect, Preserve and Conserve Shivalik biodiversity of forests. Launch a strong initiative to conserve Shivalik biodiversity to facilitate protection of species	<ul style="list-style-type: none"> <li>• 100% setting up of BMCs &amp; preparation of PBRs for all the districts of Shivalik region namely Patankot, Gurdaspur, Rupnagar, SBS Nagar &amp; SAS Nagar.</li> <li>• Prepared 31 Model PBRs to document biodiversity &amp; associated traditional knowledge of biodiversity rich villages of Districts Gurdaspur, Pathankot &amp; Hoshiarpur</li> <li>• Conducted following special projects/studies with the financial support of National Biodiversity Authority, UNESCO and Govt. of Punjab: <ul style="list-style-type: none"> <li>o Promoting environment sustainability through Biodiversity Conservation in districts Gurdaspur, Pathankot &amp; Hoshiarpur</li> <li>o Study of natural occurring elite varieties of sucking mango in district Hoshiarpur</li> </ul> </li> </ul>	4.76
BIO/3	Rehabilitate natural wetlands to enhance their capacity to withstand the impacts of climate change by involving the community	<ul style="list-style-type: none"> <li>• Identification and documentation of key species carried out for conservation and management of wetland ecosystems.</li> <li>• Biodiversity assessment studies undertaken in all major wetlands</li> <li>• Initiation of Bird Census &amp; Bird Ringing at various wetlands in collaboration with Bombay Natural History Society</li> <li>• Setting up of wetland interpretation centres highlighting biodiversity at Harike, Kanjli, Ropar and Nangal</li> <li>• Punjabi University Patiala, carried out ecological studies of Ranjit Sagar Wetland with special reference to fish communities Structure and Biodiversity Assessment on Keshopur Miani and Shalla Pattan Wetlands.</li> </ul>	2.36
BIO/4	Promote cropping of indigenous varieties	<ul style="list-style-type: none"> <li>• Punjab Biodiversity Board (PBB) has implemented FAO- Technical Cooperation Programme project on promoting conservation and mainstreaming of agro-biodiversity in collaboration with Punjab Agricultural Management &amp; Extension Training Institute (PAMETI), PAU and Centre of Research in Rural and Industrial Development (CRRID).</li> </ul>	0.10
<b>Total Expenditure</b>			<b>1834.07</b>



## ANNEXURE - II

## Progress Mapping for Sustainable Agriculture related strategies of SAPCC 1.0

Code	Strategy	Physical Progress	Expenditure (in INR million)
AG/1	Promote crop diversification in the state as per the suitability of production in its different agro- climatic zones and take advantage of the efficiency of C3 vs C4 crops in the enhanced CO <sub>2</sub> environment.	<ul style="list-style-type: none"> <li>About 26.3 ha area shifted from paddy to other crops like basmati, cotton, maize, and other Kharif pulses.</li> <li>About 5058.57 ha area covered under organic farming</li> </ul>	Not available
AG/2	Assess the suitability of different types of crops to climate change in the 6 agro- climatic zones of Punjab to design crop diversification packages in a changing climate scenario	<ul style="list-style-type: none"> <li>Punjab Agricultural University (PAU) developed 25 varieties of different crops (13 of field crops, 4 of fruits, 6 of vegetables, and 2 of ornamental crops) and assessed their productivity.</li> </ul>	442.95
AG/3	Start crop diversification process now, by the increasing area under crops such as maize, guar, pearl millet, oil seeds, pulses, cotton, sugarcane, forages etc. These crops have been side-lined due to mono cropping of rice. They have to be selected keeping in view their productivity potential in each agro-climatic zone and their CO <sub>2</sub> utilization efficiency without compromising Punjab's target of contribution of grain to the central pool.	<ul style="list-style-type: none"> <li>Under the Contract Farming Programme, quality and marketable produce has been cultivated in the State, including crops like Hyola (Hybrid Rapeseeds Mustard), sunflower, durum wheat, malting barley, moong, basmati (pure, hybrid, evolved), maize, etc.</li> <li>Vegetable crop varieties developed by PAU are PAU Pumpkin (Magaz Kadoo- 1 &amp; Punjab Nawab), Cucumber (Punjab Kheera-1), Tomato (Punjab Tinda-1 &amp; Punjab Swarna), Potato (Kufri Ganga) and Brinjal (Punjab Raunak &amp; Punjab Bharpoor) Tomato (PTH), Capsicum (PSM 1), Onion (PRO 7, PWO 2, PYO 1 &amp; POH 1), Carrot (PC 161), Bitter gourd (Punjab Karela 15), Sponge gourd (Punjab Nikhar)</li> </ul>	88.60

	Increase area under horticulture plants such as potato and fruits, as their yields in Punjab is likely to increase with climate	<ul style="list-style-type: none"> <li>Horticulture includes 93,766 ha area under fruits and 3,06,000 ha under vegetables.</li> <li>Area under horticulture has expanded to 0.4 million ha in 2020-21 compared to 0.29 million ha in 2014-15.</li> <li>Production has increased to 8.21 million MT in 2021, with about 40% growth from 2014-15.</li> <li>For the promotion of fruits and vegetable cultivation at-home scale, department provided summer and winter season vegetable mini-kits to growers, also promoting plantation of fruit plants at tube wells.</li> </ul>	
Code	Strategy	Physical Progress	Expenditure (in INR million)
AG/4	<b>Support the increase in horticulture diversification through research</b>		17.90
4.1	Raise nursery plantations in screen houses to protect from adverse soil and climate conditions	<ul style="list-style-type: none"> <li>Horticulture department has developed 3 Government gardens and nurseries at Chhauni Kalan, Bhunga and Khiala Bulanda to provide good quality plants. The nurseries provide about 70,000 fruit plants per year.</li> <li>Approximately 17.2 million seedlings been supplied to the farmers, benefitting nearly 6000 farmers, by the Centre of Excellence for Vegetables, Kartarpur, Distt. Jalandhar.</li> <li>About 95,000 quality disease-free citrus plants supplied to growers by Centre of Excellence for Fruits, Hoshiarpur.</li> <li>2 screen houses established for the maintenance of mother plant varieties</li> <li>90% subsidy provided to small farmers for installing poly house units</li> </ul>	
4.2	Identify and introduce low chill varieties of temperate fruits grown under sub-tropical area	<ul style="list-style-type: none"> <li>Several varieties namely Peach (Shan-e-Punjab), Pear (Patharnakh, Punjab Nakh, Punjab Gold, Punjab Nectar, Punjab Beauty, Le conte, Nigisiki and Punjab Soft), Plum (Sutlej Purple, Kala Amritsari, Katruchak) developed to cultivate in subtropical areas.</li> <li>Introduced 35 varieties of low chill temperate fruits (pear, peach, plum, apricot, walnut, pecan nut). New training systems for canopy management of temperate fruit plants being evaluated for high-density planting under sub-tropical conditions.</li> </ul>	
4.3	Refine existing production and post-harvest technologies in commercial fruit of Punjab	<ul style="list-style-type: none"> <li>Horticulture department developed 54 cold rooms, 17 pack houses, 4 cold stores, 1 minimal processing units.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
4.4	Undertake research under protected conditions using conventional and biotechnological approaches to understand the impacts of climate change on appearance, change of host plant, build-up of insect and mite population, and disease build up in fruits such as guava, mango, grapes, papaya, banana etc. and devise remedies for the same.	<p>Following advanced varieties developed after R&amp;D:</p> <ul style="list-style-type: none"> <li>• Tomato: Punjab Red Cherry, Punjab Varkha Bahar-4, Punjab Gaurav, Punjab Sartaj, Punjab Sona Cherry, Punjab Kesar Cherry, Punjab Swarna, PBH-4, PBH-5, PBHR-41, PBHR-42, Punjab Raunak and PTH 2.</li> <li>• Chilli: CH-27; Muskmelon: MH-27 &amp; MH-51; Pea: Matar Ageta, AP-3; Bottle Gourd: Punjab Barkat &amp; Punjab Bahar</li> <li>• Pumpkin: PPH-1, PPH-2, PAU Magaz Kadoo-1 &amp; Punjab Nawab</li> <li>• Bitter Gourd: Punjab Jhaar Karela-1 &amp; Punjab Karela 15</li> <li>• Chinese Cabbage: Saag Sarson</li> <li>• Radish: Punjab Moti No 2</li> <li>• Tinda: Punjab Tinda-1</li> <li>• Cucumber: Punjab Kheera-1</li> <li>• Broccoli: Palam Samridhi</li> <li>• Methi: Kasuri Supreme</li> <li>• Garlic: PG-18</li> <li>• Capsicum: PSM 1</li> <li>• Onion: PRO7, PWO 2, PYO 1, POH 1</li> <li>• Carrot: PC 161</li> <li>• Brinjal: Punjab Bharpoor</li> <li>• Sponge gourd: Punjab Nikhar</li> </ul>	
4.5	<p>Promote plantation of horticulture crops resistant to water logging in addition to Eucalyptus, that would include:</p> <ul style="list-style-type: none"> <li>- Identifying the horticulture plants resistant to water logging</li> <li>- Conducting Pilot programmes</li> <li>- Through extension activities reach out to farmers.</li> </ul> <p>(Some of the other trees/crops that can be planted and harvested include Willow, Arjun, Jamun, deep water rice amongst others)</p>	<ul style="list-style-type: none"> <li>• On basis of species trial at Ratta Khera, <i>Eucalyptus tereticornis</i> and <i>Casuarina equisetifolia</i> found relatively more successful with respective survival values as 84.8% and 78.8%, respectively.</li> <li>• Pilot programmes conducted for another set of two species i.e., <i>Syzygium cuminii</i> and <i>Terminalia arjuna</i> and survival values as 57.6 and 48%, respectively observed.</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
AG/5	Provide minimum support prices for the non-rice and wheat crops as per the recommendation of the Farmers Commission without taking into account price of subsidised power.	<ul style="list-style-type: none"> <li>Govt of Punjab announced Minimum Support Price (MSP) of Rs 7275/quintal on moong for FY 2021-22 to encourage farmers to adopt non-rice cultivation in the State</li> </ul>	Not available
AG/6	<b>Sustainably manage agriculture crop residue to avoid the ill effects of on-farm burning of crop residue in Punjab and also benefit from management of the same.</b>		822.32
6.1	Raise awareness amongst farmers to urge them to go for diversification of cropping to generate less rice and wheat straw	<ul style="list-style-type: none"> <li>Interactions carried out by various farmer groups on crop burning issues, with experts from ICAR, PAU, Co-operative &amp; FPOs for crop diversification</li> <li>IEC activities conducted and implemented by ICAR through 22 KVKs in Punjab. 4059 awareness programmes (camp/kisan mela) conducted at village panchayat, block, district, and state level under IEC activities of the programme and around 12,500 farmers trained under various programmes.</li> <li>Special awareness camps by PPCB to curb paddy straw burning issues.</li> </ul>	
6.2	Promote straw mulching through reincorporation in soil for improvement in soil health in areas where soil is degraded due to residue burning	<ul style="list-style-type: none"> <li>More than 4500 villages declared zero stubble burning in the year 2019 as compared to 76 villages in 2018.</li> <li>Paddy straw burning incidences came down by 50.4% in 2019 as compared to reported incidents during 2016.</li> </ul>	
6.3	Undertake frontline demonstration and distribution at subsidized cost of rotavators, happy seeders, zero tillage machines to support soil conservation in areas where soil has been degraded due to residue burning	<ul style="list-style-type: none"> <li>A total of 76,626 machines distributed in Punjab during the last three years, which include 13,316 happy seeders, 17,697 super seeder, 6,939 paddy straw chopper, 5,682 mulcher, 7,538 R.M.B plougher, 13,546 zero till drill, 5,930 super SMS, 661 rotary slasher, 83 shrub master, 970 cutters cum spreader, 3,835 rotavator, 224 baler and 205 rakes.</li> <li>Dept. of Agriculture provisioned subsidy for purchase of agriculture machinery for paddy straw.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
6.4	Set up of agriculture machinery service centres	<ul style="list-style-type: none"> <li>Subsidy to the tune of INR 5452.30 million provided through Custom Hiring Centres (CHCs) and INR 1962.50 million has been disbursed to individual farmers as subsidy.</li> </ul>	
6.5	Organise awareness programmes on ill effects of residue burning	<ul style="list-style-type: none"> <li>For promotion of agriculture mechanization for in situ management of crop residue, INR 243.90 million has been spent in last 3 years</li> <li>5,000 farmer camps organized in the villages for demonstration of machines under the Action Plan on crop burning</li> </ul>	
6.6	Promote biomass power plants to use the excess residue and also to enhance share of renewables in Punjab	<ul style="list-style-type: none"> <li>Punjab utilizes about 4.30 million tonnes of paddy straw collected through various stakeholders.</li> <li>Paddy straw is being used in 11 biomass-based projects of capacity 97.5 MW, which consumes 1 million tonne paddy straw per year.</li> </ul>	
6.7	Utilise rice straw in cattle feed for protein augmentation and for hay bedding	<ul style="list-style-type: none"> <li>4 gaushalas in Sangrur, Ahmedgarh, Dhuri and Barnala taken up initiative to use paddy straw as fodder for cattle.</li> <li>Initiatives taken up by GADVASU for nutrient enriched rice straw based fodder.</li> </ul>	
<b>AG/7</b>	<b>Promote resource conservation of soil, water, and energy</b>		<b>11,807.33</b>
7.1	Promote integrated nutrient management in soils to auger for the degrading soil health status in the state and avoid further degradation due to climate change	<ul style="list-style-type: none"> <li>Integrated Nutrient Management (INM) is carried out under the Central sponsored Soil Health Card Scheme.</li> <li>Farmers' awareness camps on adoption of INM farming techniques for balanced and judicious use of fertilisers.</li> <li>Soil testing programs under National Mission on Sustainable Agriculture (NMSA) and Rashtriya Krishi Vikas Yojana (RKVY). More than 2.43 million soil health cards issued to farmers. 58 soil testing laboratories set up in Punjab out of which, 55 are stationery and 3 are mobile laboratories.</li> </ul>	
7.2	Identify and initiate measures to enhance carbon sequestration in soils	<ul style="list-style-type: none"> <li>Various agricultural practices for re- incorporation of agro-residues in the soil promoted to enhance soil organic carbon, thereby improving soil health.</li> </ul>	
7.3	Stabilize sequestered carbon in soils	<ul style="list-style-type: none"> <li>Research and training on assessment methods for soil carbon and GHGs emission in agriculture undertaken by PAU under The World Bank sponsored ICAR NAHEP-CAAST Project.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
7.4	Undertake regular and compulsory soil testing, water testing, etc.	<ul style="list-style-type: none"> <li>Regular soil testing is being carried out for both Kharif and Rabi seasons by PAU</li> </ul>	
7.5	Promote green manure forage on soils for soil nutrient conservation forage to be grown after harvesting of wheat crop in stubbles left on fields in April-July. Minimum tillage requirement thereby avoiding input costs	<ul style="list-style-type: none"> <li>Promoted Kharif fodder crops like sorghum, bajra, maize, cowpea, guara and makchari with minimum tillage practices.</li> </ul>	
7.6	Promote use of laser levellers, ridge planting, straw and bio mulching and micro irrigation	<ul style="list-style-type: none"> <li>Provided subsidy of INR 0.15 million/unit or 50% of cost whichever less for Laser land leveller under the Resource Conservation Machineries/Energy Management of National Food Security Mission (NFSM).</li> <li>Promotion of micro irrigation (NABARD-RIDF), with 80% subsidy amounting to Rs. INR 666.3 million on Drip &amp; Sprinklers to increase water use efficiency on 7,018 ha of 4,956 farmers during 2014-20.</li> <li>Promoted underground pipeline system (UGPS) for on-farm water conservation on 0.14 million hectares of canal and tube well commands during 2014-20.</li> </ul>	
7.7	Undertake micronutrients demonstration for farmers	<ul style="list-style-type: none"> <li>Department of Agriculture organised demonstrations and trainings on micronutrients for farmers.</li> <li>Soil/leaf testing in different horticulture estates undertaken for recommending optimal use of fertilizers by the Department of Horticulture</li> <li>Soil and micronutrient management under NFSM with a provision of subsidy of INR 500/ha or 50% of the cost, whichever less.</li> </ul>	
7.8	Install Automatic weather stations all across at 25 x 25 km grid Punjab to develop agro-climate wise cropping plan and adequate deployment of farm inputs	<ul style="list-style-type: none"> <li>2 Automated weather stations installed under DST project in Hoshiarpur and SBS Nagar.</li> <li>4 automated weather stations installed under NHM project in Bathinda, Jalandhar, Rupnagar and Kapurthala.</li> <li>25 stations installed in different districts of Punjab, out of which 5 are Agro AWS (Automatic Weather Stations), located at Balachaur, Bathinda, Faridkot, Gurdaspur and Ludhiana</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
		<ul style="list-style-type: none"> <li>Development of weather and climate change data archive and retrieval system taken up by PAU</li> <li>PAU conducted targeted research on crop-weather &amp; crop-weather- pest relationship studies.</li> </ul>	
7.9	Policy for preservation of subsoil water	<ul style="list-style-type: none"> <li>Under Punjab Preservation of Subsoil Water Act, 2009, the date for paddy transplantation is notified annually to coincide with onset of monsoon.</li> <li>Direct seeded rice (DSR) method being promoted by PAU in suitable areas to reduce stress on under ground water.</li> <li>Implementation of Paani Bachao Paise Kamao pilot scheme for incentivising water and energy efficiency for agriculture consumers in 6 agriculture feeder areas.</li> </ul>	
7.10	Promote direct seeding in moist soils and follow SRI based water application in rice- set of practices that lead to less water usage right from seedling preparation to planting	<ul style="list-style-type: none"> <li>Cropping system-based demonstration (100 ha) for wheat- rice through SRI covered under the National Food Security Mission, with a subsidy of Rs 12,500 per ha.</li> <li>Department of Agriculture has promoted and adopted the DSR method for sowing of crops using laser land levellers in fields, in different parts of Punjab</li> </ul>	
7.11	Promote Alternate Wetting and Drying (AWD) method for irrigation of rice fields instead of continuously flooding to save on water as well as electricity for drawing water from tube wells	<ul style="list-style-type: none"> <li>Irrigation schedules developed by PAU for wheat, sugarcane and other rabi crops based on a simple evaporative demand.</li> </ul>	
7.12	Develop schedule of irrigation based on crop simulation modelling that consider the on farm tensiometer readings and weather data	<ul style="list-style-type: none"> <li>Work initiated on irrigation scheduling in wheat through simulation and field studies based on soil moisture depletion and irrigation at critical growth stages</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
AG/8	<b>Formulate Agriculture Market Intelligence Cell within the Department of Agriculture in order to adjust the production systems each year which have to be aligned according to the variable climate as well as to the demands of the markets after meeting the basic demand of food security of the state</b>		Not available
8.1	Take necessary actions to formulate the Marketing intelligence cell	<ul style="list-style-type: none"> <li>Punjab Mandi Board has developed "Market Intelligence System" that monitors prevailing prices, market arrivals, available varieties, and seasonal variations</li> <li>"Market Intelligence Cell" is also proposed to guide farmers about ongoing global trends besides Agriculture Livelihood Policy</li> </ul>	
AG/9	<b>Develop cultivars and enhance germ plasm base that are (a) thermal resistant, (b) can withstand water stress, (c) can grow in waterlogged areas, (d) withstand emerging pests and diseases, and (e) withstand enhanced levels of CO<sub>2</sub></b>		71.85
9.1	Development of early maturing and heat tolerant varieties of wheat	<ul style="list-style-type: none"> <li>PAU developed wheat varieties namely, Unnat PBW 550 (short duration) and PBW 752 &amp; PBW 757 (early maturity, heat tolerant and resistant to yellow and brown rust)</li> </ul>	
9.2	Popularize basmati rice cultivation, develop varieties with basmati quality in productive backgrounds, develop basmati rice varieties resistant to insect pests by introduction of resistance from cultivated and wild rice varieties	<ul style="list-style-type: none"> <li>Three varieties of basmati recommended for cultivation in Punjab.</li> <li>Breeding program for the introduction of desirable traits is underway which includes resistance to emerging biotic (Neck blast, BPH) and abiotic stresses (salinity).</li> <li>Farmers regularly made aware of new varieties &amp; recent developments in basmati cultivation.</li> </ul>	
9.3	Develop climate resilient high yielding maize hybrids and enhance production of hybrid seeds	<ul style="list-style-type: none"> <li>Climate resilient &amp; high yielding varieties of maize namely, PMH 6, PMH 7 (short duration), PMH 8, PMH 9 (cold tolerant), PMH 10 (for spring season), DKC 9108 and PMH 12 developed and PAU regularly provide recommendations to enhance production from hybrid seeds.</li> <li>The component traits of heat stress tolerance being mapped for development of heat stress tolerant maize hybrids.</li> </ul>	
9.4	Develop short duration moong and mash varieties for growing as cash crop during summer	<ul style="list-style-type: none"> <li>Developed a new spring/summer moong bean variety TMB 37 maturing in 60 days.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
9.5	Development of arhar varieties tolerant to heat stress at seedling stage	<ul style="list-style-type: none"> <li>Developed Arhar varieties (AL-15, AL 201, PAU 881, PPH 4, AL 882, UPAS-120)</li> </ul>	
9.6	Develop soyabean varieties resistant to yellow mosaic virus and develop determinate types to serve as short duration additional crop	<ul style="list-style-type: none"> <li>Developed advance soyabean varieties (SL 958, SL 525 and SL 744)</li> </ul>	
9.7	Develop sugarcane varieties with better frost tolerance under low temperature conditions and varieties with high germination percentage under high temperature.	<ul style="list-style-type: none"> <li>Developed Sugarcane varieties including CoPb 92, CoPb 93 and CoPb 94</li> </ul>	
9.8	Develop multi-cut berseem varieties with better frost tolerance/winter hardiness and varieties with inbuilt tolerance to terminal heat stress for high seed yielding ability	<ul style="list-style-type: none"> <li>Variety (BL 43) of berseem has been developed</li> </ul>	
9.9	Develop pearl millet and sorghum multi-cut hybrids with tolerance to high temperature and drought. Identify and develop new varieties of pearl millet suitable for good quality silage.	<ul style="list-style-type: none"> <li>Developed sorghum variety PSC 4 and Pearl millet hybrid PHB-2168 &amp; PCB 165</li> </ul>	
9.10	Develop heat tolerant cotton cultivars. Identify chemicals for exogenous application that provide heat tolerance at seedling stage Revive cotton cultivation in South-Western districts	<ul style="list-style-type: none"> <li>Varieties developed include: <ul style="list-style-type: none"> <li>American cotton: PAU Bt-1, LH 2118, LH 2228, LH 2256, F 2383, F2276 and F2381</li> <li>Desi cotton: LD 949 and LD 1019</li> </ul> </li> <li>Application of certain chemicals like Ethereal, Drop Ultra, MgSo<sub>4</sub>, Mepiquat chloride and Boron recommended for enhancing productivity under adverse conditions</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
9.11	Oilseeds: Develop high temperature tolerant varieties, Drought tolerant varieties, develop cost effective production and protection technology, develop dual purpose canola (fodder and seeds)	<ul style="list-style-type: none"> <li>• Germplasm stocks of Indian mustard (Brassica juncea) tolerant to heat were identified (PML4 and PLM 2) as tolerant and being used in the cross-breeding programmes to develop drought tolerant varieties.</li> <li>• Foliar applications of salicylic acid and brassinolide improved seed yield under rainfed conditions</li> </ul>	
<b>AG/10</b>	<b>Manage new and emerging pests, diseases and weeds in crops.</b>		10.61
10.1	Map the existing pest and disease profiles of important crops in Punjab and link it to climate important parameters triggering them	<ul style="list-style-type: none"> <li>• Pest populations of important fungal and bacterial phytopathogens of rice, wheat and maize are being characterized and mapped on regular basis.</li> <li>• Correlation between the onset and spread of yellow rust disease and weather parameters being established.</li> </ul>	
10.2	Develop models for forecasting emerging as well as existing crop pests and diseases	<ul style="list-style-type: none"> <li>• Web-based decision support system for late blight disease of Potato' developed by PAU.</li> <li>• Weather based prediction model, JHULSACAST being used for late blight of potato.</li> <li>• Prediction model for yellow rust of wheat weather based prediction for leaf curl of cotton has been developed.</li> <li>• Research activities on disease related simulation models are being carried out.</li> </ul>	
10.3	Develop improved integrated pest and disease management system for important agricultural crops in Punjab. It will involve (a) Monitoring of quantitative as plan, (b) Advance warning system incorporating climate factors, preventive measures, remedial measures etc. in case of attack	<ul style="list-style-type: none"> <li>• Integrated management of mites on capsicum, brinjal, cucumber and pole beans.</li> <li>• Integrated management for important diseases of rice, wheat, potato, maize, citrus and tomato developed.</li> <li>• Advance forewarnings and preventive measures are being recommended for late blight disease of potato and yellow rust of wheat through a web-based decision support system.</li> <li>• Relationship of insect-pests of important crops with changing weather parameters were investigated. Mobile based 'COTFLY' app for the management of cotton crop from white fly has been developed.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
10.4	Undertake studies on dynamics / epidemiology with climate factors important pollinators and natural enemies of crop pests and phytopathogens in agricultural crops to link their population	<ul style="list-style-type: none"> <li>Effect of weather parameter on nectar secretion in sunflower blooms and foraging intensity of <i>Apis mellifera</i> investigated. It was found that with the rise in temperature nectar secretion decreased along with the foraging intensity of <i>Apis mellifera</i>.</li> </ul>	
10.5	Develop integrated weed management approaches for conservation agriculture	<ul style="list-style-type: none"> <li>Integrated management of weeds of wheat, rice, maize and pulses undertaken.</li> </ul>	
10.6	Undertake management of herbicide resistance in <i>Phalaris minor</i> in wheat	<ul style="list-style-type: none"> <li>Metribuzin+Clodinafop, Pendimethalin+Pyroxasulfone caused 100% mortality of resistant <i>Phalaris minor</i> populations</li> </ul>	
10.7	Monitor herbicide residue in crop residue and ground water	<ul style="list-style-type: none"> <li>Residues of butachlor, pretilachlor, anilophos in rice; clodinafop, sulfosulfuron, metsulfuron-methyl and pendimethalin in wheat, crop samples and soil &amp; water collected from farmer's field during harvesting analysed and found within the permissible limits.</li> </ul>	
10.8	Monitor changing weed behaviour and their competitive ability due to climate change	<ul style="list-style-type: none"> <li>Weed management initiatives taken under Integrated Pest Management.</li> <li>Weedicides made available to farmers and growers with a subsidy of Rs 500/ha or 50% of cost, whichever less.</li> <li>Weed monitoring and management also taken up under National Mission on Oilseeds and Oil Palm (NMOOP)</li> </ul>	
<b>AG/11</b>	<b>Diversify into value addition activities to avoid waste of agriculture produce and increase storage capacity of grains to ensure farmer incomes in a changing climate scenario.</b>		<b>338.90</b>
11.1	Enhance storage capacity to accommodate excess grain produced each year	<ul style="list-style-type: none"> <li>State has 578 units available for storage of food grains, out of which 575 are godowns and 3 are silos, under the Food Corporation of India.</li> <li>Punjab State Warehousing Corporation (PSWC) has registered 8 owned godowns of total 18,150 MT capacity in the districts of Kapurthala, SBS nagar and Jalandhar.</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
		<ul style="list-style-type: none"> <li>PAU designed improved grain storage structures for small scale storage.</li> <li>The state added enormous, covered storage capacity under Private Entrepreneurs Guarantee (PEG) Scheme.</li> </ul>	
11.2	Improvement in PDS System	<ul style="list-style-type: none"> <li>Aadhaar enabled Public Distribution System (AePDS) developed and made operational through Food, Civil Supplies and Consumer Affairs Department, Punjab.</li> <li>Total 4.00 million cards issued and 18,244 shops enrolled under the computerised PDS system.</li> </ul>	
11.3	Undertake value addition activities to convert excess grain to other processed food such as biscuits, paper, chips etc. through tie ups with established processing industries to sell these value-added products in a pan India market.	<ul style="list-style-type: none"> <li>Department of Food, Civil Supplies and Consumer Affairs, Punjab initiated work on setting up food processing units to help farmers.</li> <li>End-to-end computerisation by creation of a large database of all Arhtiyas, Mills, Mandis, Ration card holders and Fair Price Shops under development.</li> <li>Agri Infrastructure in the State is under development, major clusters developed are ITC Food Park at Kapurthala, Corn based mega Food Park at Phagwara, Multi-dimensional mega Food Park at Fazilka, Modern Food processing facilities Food Park at Ladhawal, Ludhiana and Punjab Agri Food Parks Ltd and Punjab Agro Ventures Ltd at Sirhind.</li> </ul>	
AG/12	<b>Promote cooperative farming amongst marginal, small, and medium farm land owners to reduce input costs, and maximize productivity and farm incomes and hence ensure livelihood security and income for farmers</b>		Not available
12.1-12.2	Generation of awareness amongst farmers on benefits of cooperative farming and happy seeders etc. towards maximization of output and reduction in input costs thereby ensuring livelihood security	<ul style="list-style-type: none"> <li>INR 5000 per group subsidy is provided for capacity building, skill development and to support services to farmers</li> </ul>	
12.3	Review and/or introduce policies suitable for successful operation of farm cooperatives.	<ul style="list-style-type: none"> <li>Drafting of Punjab State Farmers' Policy by Punjab State Farmers' and Farm Workers' Commission (PSFC) is under process</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
AG/13	<b>Manage climate risk through crop insurance and by assessing the socio-economic impacts of climate change on agriculture.</b>		Not available
13.1	Develop weather indexed crop insurance to support farmers in case of crop failure and overcome loss in earning due to deficit in production w.r.t normal for each year such an event occurs- to be subsidised by the Govt.	<ul style="list-style-type: none"> <li>Punjab planned to set up an agriculture insurance corporation. Restructuring of Weather-Based Crop Insurance Scheme (RWBCIS) is under process to tackle climate change related impacts and loss in agriculture</li> </ul>	
13.2	Assess the socio-economic impacts of climate change on agriculture, its value chain and communities	<ul style="list-style-type: none"> <li>Socio economic assessment and research on impacts of climate change on agriculture being conducted.</li> </ul>	
<b>Livestock Sector</b>			
LIV/1	<b>To manage heat stress and ensure high productivity of livestock in a climate change scenario.</b>		54.60
1.1	Special thrust on preservation, development and popularization of superior indigenous germplasm – large and small ruminant and poultry. This would help to harness the gene pool of indigenous varieties of livestock (Sahiwal cow, Nili Ravi Buffalo and Beetal goat, and Punjab Brown poultry) that can withstand heat.	<ul style="list-style-type: none"> <li>Production/ Procurement of HGM (High Genetic Merit) bulls of Murrah (216), Nili-Ravi (19) and Sahiwal (38) under P.T. Murrah, P.S. Nili-Ravi &amp; P.T. Sahiwal projects being done at the cost of INR 234.90 million, INR 52.4 million &amp; INR 130.20 million, respectively, under RGM (Rashtriya Gokul Mission).</li> <li>A State of Art Indigenous Cattle Breeding Farm, Gokul Gram at Bir Dosanjh, Nabha established at a cost of INR 128.40 million to house elite indigenous breeds of cattle (Sahiwal &amp; Gir) with the objective of their conservation, development and propagation.</li> </ul>	
1.2	Develop climate resilient crossbred high milk yielding cows/buffalos with indigenous livestock and that of poultry as well	<ul style="list-style-type: none"> <li>Pilot NAFCC project on sustainable interventions to achieve sustainable milk production through climate resilient bovine management under implementation in 3 districts Tarn Taran, Bathinda and Ludhiana at cost of INR 173.90 million.</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
1.3	Ensure adequate housing to avoid exposure to extreme heat to all livestock that are held by small and marginal farmers.	<ul style="list-style-type: none"> <li>Rashtriya Gokul Mission and Gokul Gram Initiatives taken up in creating Bull Mother Farm at village Rauni with a capacity of 300 animals. This is conducted under the National Project for Bovine Breeding.</li> </ul>	
<b>LIV/2</b>	<b>Recover energy from livestock Manure</b>		2.50
2.1	Promote biogas plants in commercial dairies in Punjab using dairy farm waste including dung and urine for electricity generation which will be utilized for dairy operations and excess supplied to the grids. Co-benefits, avoid CH <sub>4</sub> emission.	<ul style="list-style-type: none"> <li>Rural based biogas plants are being set up</li> <li>Biogas digester being installed in model Gaushala to generate energy under NAFCC bovine management project.</li> <li>1 MW capacity biogas plant set up at Haibowal, dairy complex at District Ludhiana.</li> </ul>	
2.2	Make mandatory installation of biogas plants for farmers holding land more than 4 ha or having more than 5 mulching animals.	<ul style="list-style-type: none"> <li>Installation of domestic biogas plants at farmer fields is promoted and implemented by PAU</li> <li>Implementation of National Biogas and Manure Management programme by PEDDA</li> <li>Development of new modified PAU Janta Model biogas plant</li> </ul>	
<b>LIV/3</b>	<b>Manage livestock health in the emerging pest and disease scenario</b>		171.17
3.1	Map the existing pest and disease profile of various livestock in Punjab and link it to climate parameters triggering them	<ul style="list-style-type: none"> <li>Animal Husbandry Department developed a unit "Punjab Veterinary Vaccine institute" at Ludhiana for research and production of bacterial and viral vaccines for prevention and control of contagious diseases in livestock and poultry.</li> <li>Vaccination for prevention and control of livestock diseases like Foot and Mouth Diseases (FMD), Haemorrhagic Septicaemic, Entero- Toxaemia, Swine fever developed.</li> </ul>	
3.2	Developing advance warning systems about emerging pests and disease attack through modelling.	<ul style="list-style-type: none"> <li>Initiated development of Disease forecasting system under the NAFCC project in line with National Animal Diseases Referral Expert System (NADRES)</li> </ul>	
3.3	Develop integrated Pest and Disease management for each commercially important livestock in Punjab.	<ul style="list-style-type: none"> <li>North Regional Disease Diagnostic Lab, NRDDL Jalandhar developed with specialised facilities for Anthrax &amp; Glander's testing, Sero- Monitoring of pre and post Foot &amp; Mouth Disease (FMD) vaccination sera samples, surveillance of diseases like Tuberculosis (TB), Johne's disease (JD), Brucellosis, Campylobacteriosis, Rinderpest Trichomoniasis, etc.</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
<b>LIV/4</b>	<b>Ensure adequate feed for livestock – green fodder</b>		<b>27.59</b>
4.1	Estimate additional requirement of green fodder in the future based on outlook of livestock management	<ul style="list-style-type: none"> <li>Estimated green fodder availability @ 42 kg per animal/day by 2019-30. Planning underway for preservation of green fodder for making silage and hay to be used in scarcity period and to be supplied to fodder deficit areas of the country.</li> </ul>	
4.2	Ensure adequate green- feed for livestock. Currently there is an availability of 28 kg green fodder/animal/day. The deficit is to be met by increasing the productivity of green fodder	<ul style="list-style-type: none"> <li>The Punjab Regulation of Compounded Cattle-feed, concentrates &amp; Mineral mixtures Act, 2018, ensures quality feed used in dairy sector.</li> <li>The Animal Husbandry Department ensures provision of improved feeding and management practices.</li> <li>Green fodder availability in the State has increased from 30 kg (per animal/day) to 35 kg (per animal/day) in 2019-20.</li> </ul>	
4.3	Developing new varieties of fodder seeds	<ul style="list-style-type: none"> <li>Research studies conducted on economics of production, processing and marketing of fodder crops in Punjab by Agro Economic Research Centre, Ludhiana.</li> <li>SL 44 and Punjab Sudax varieties of Sorghum being used for fodder.</li> </ul>	
4.4	Promotion of mechanization in fodder cultivation to lower the cost of fodder production	<ul style="list-style-type: none"> <li>A subsidy at 25% subject to the maximum of INR 50,000 on fodder harvester and self propelled forage cutter is provided by Department of Dairy Development, Punjab under Purchase of Machinery at Dairy Farm scheme. Around 3,03,176 single row fodder harvesters &amp; 127 forage cutters have been subsidised under the scheme.</li> </ul>	
4.5	Mitigation strategies- measuring and devising mitigation strategies for methane production in ruminants	<ul style="list-style-type: none"> <li>Different feed ingredients screened for methane production potential. Farmers/feed industry can use the feed ingredients with low methane production potential in formulation of compounded concentrate mixture. Feeding such feeds will result in improved productivity and reduce methane production in animals.</li> </ul>	
<b>LIV/5</b>	<b>Ensure cover for climate risk to livestock</b>		<b>112.50</b>
5.1	Encouraging small, marginal farmers and nomads to have a mix of small ruminants to ensure protection from climate risk (having a mix of poultry, sheep/goat, pigs and rabbits)	<ul style="list-style-type: none"> <li>Promotional activities and trainings being conducted by Animal Husbandry Department and Dairy Development Board, Punjab</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
5.2	Development of early warning systems for disease and pest outbreak forecast, and information on dispensaries available that can provide cure in each area/region of the state. Information to be provided through modern tools of IT	<ul style="list-style-type: none"> <li>GADVASU initiated efforts for development of Disease forecasting system in line with National Animal Diseases Referral Expert System (NADRES)</li> </ul>	
5.3	Develop climate index-based livestock insurance and market the same	<ul style="list-style-type: none"> <li>Insurance of cows and buffaloes under Pashu Dhan Bima Yojana by Punjab Livestock Development Board</li> <li>Pilot launch of weather linked insurance system under NAFCC project.</li> </ul>	
<b>Total expenditure</b>			<b>13,968.82</b>

## ANNEXURE - III

## Progress Mapping for Water related strategies of SAPCC1.0

Code	Strategy	Physical Progress	Expenditure (in INR million)
WR/1	Draft a State Water Policy to undertake an integrated water resource management at a basin level within the state to conserve water, minimize wastage and ensure equitable distribution.	<ul style="list-style-type: none"> <li>Notified Punjab Water Resources (Management and Regulation) Act, 2020 to provide guidance for the management and regulation of water resources of the state for ensuring the judicious, equitable and sustainable utilization and management.</li> <li>Notified Punjab State Rural Water Supply &amp; Sanitation Policy 2014.</li> <li>Preparation of State Specific Action Plan (SSAP) on Water Sector by IIT Ropar is underway.</li> </ul>	Not available
WR/2	Undertake a focused approach to augment groundwater especially in problematic/over exploited areas taking advantage of continued projection of excess rainfall with respect to baseline scenario.	<ul style="list-style-type: none"> <li>Set up 1,133 ground water level monitoring stations.</li> <li>Initiated 30 Artificial Recharge Schemes under which, installed 208 injection wells and 9 piezometers installed to monitor ground water recharging.</li> <li>IIT Ropar conducted a feasibility study on aquifer storage of water by artificial recharge in and around Punjab region.</li> <li>Central University, Bathinda studied the ground water quality of different districts and reported its quality for drinking and agriculture purpose.</li> </ul>	Not available
WR/3	Enhance water use efficiency by 20%	<ul style="list-style-type: none"> <li>Promoted Micro Irrigation (MI) (Drip &amp; Sprinklers) on 7,018 ha for efficient use of irrigation water.</li> <li>Promoted Underground Pipeline System (UGPS) for on-farm water conservation on 0.14 million ha to reduce seepage losses.</li> <li>Conducted 47 Innovative irrigation projects for utilization of treated water from Sewage Treatment Plants (STPs) of cities/ towns and irrigated 6386 ha land.</li> </ul>	5,662.80
WR/4	Augment surface water resources to accommodate excess rainfall and runoff projected for mid century.	<ul style="list-style-type: none"> <li>Roof top water harvesting made mandatory in all buildings above 200 sq. yard by amendment of building byelaws. Watershed Management works carried out at &gt;0.13 million ha of wastelands &amp; degraded lands. 183 Water Harvesting &amp; recharging structures (WHS) constructed for storage, irrigation and natural recharge benefiting 3,903 ha of sub-mountainous Kandi area.</li> <li>Carried out remodelling &amp; cleaning of 730 ponds and work underway for 589 ponds.</li> </ul>	

Code	Strategy	Physical Progress	Expenditure (in INR million)
WR/5	Manage floods in a future erratic and excess extreme rainfall scenario.	<ul style="list-style-type: none"> <li>Embankment strengthening of 1800 km undertaken for flood protection by irrigation Department along rivers Beas &amp; Sutlej in district Hoshiarpur, Jalandhar and SBS Nagar and Mehangerwal choe &amp; Rahon Creek in Hoshiarpur. Some of the projects are as under: <ul style="list-style-type: none"> <li>Flood protection &amp; Drainage works on Ghaggar River and its tributaries &amp; Tangri Nadi under NABARD RIDF XI.</li> <li>Flood protection projects in Gurdaspur and Amritsar districts under NABARD RIDFX.</li> </ul> </li> <li>Around 70 numbers of digital rain gauges installed for instant measurement and online transmission of rainfall data under World Bank assisted Hydrology Project Phase-II.</li> </ul>	369.90
WR/6	Contain the likely enhanced water logging situation in the south west districts of Punjab.	<ul style="list-style-type: none"> <li>7,200 km drainage network developed/ maintained to save agriculture from flood hazards and regulate water logging in south western region.</li> <li>Important initiatives are as under: <ul style="list-style-type: none"> <li>36 projects undertaken in District Sri Muktsar Sahib under NABARD RIDF XIV.</li> <li>Installation of 387 shallow piezometers is underway in the south western portion of Punjab State for monitoring of water quality and water logging.</li> </ul> </li> <li>Department of Fisheries has initiated shrimp culture in salt affected and water logged areas</li> </ul>	5,850.00
WR/7	Abate continued water pollution of underground and surface water sources which is likely to increase due to increase in industries and population	<ul style="list-style-type: none"> <li>130 STPs (1759.5 MLD) constructed and 55 STPs (625.5 MLD) under construction in urban towns.</li> <li>93,000 new sewerage connections given under Atal Mission for Rejuvenation and Urban Transformation (AMRUT).</li> <li>Under Swachh Bharat Mission (SBM), 1,00,609 nos. of Individual Household Toilets constructed &amp; 11,388 nos. of Community/ public toilets constructed</li> </ul>	Not available
WR/8	Establish adequate institutional support for efficient water resource augmentation, conservation, distribution and governance through development of basin level Integrated Water Management plans	<ul style="list-style-type: none"> <li>Water Resources wing of Irrigation Department strengthened for channelizing, processing and validating data to the users.</li> <li>Strengthening of Irrigation &amp; Power Research Institute (IPRI), Punjab.</li> <li>Strengthening of Punjab Irrigation Management &amp; Training Institute (PIMTI), Amritsar.</li> </ul>	412.60

Code	Strategy	Physical Progress	Expenditure (in INR million)
WR/9	Suggested research and monitoring activities for effective decision making	<ul style="list-style-type: none"><li>Irrigation &amp; Power Research Institute (IPRI) is conducting regular research on Hydraulics Modelling , Groundwater Hydrology and providing analytical facilities to various Government, semi-Government, private organization in Punjab.</li></ul>	11,847.60
	<b>Total Expenditure</b>		<b>24,142.90</b>



## ANNEXURE - IV

## Progress Mapping for Strategic Knowledge Mission related strategies of SAPCC 1.0

Code	Strategy	Physical Progress	Expenditure (in INR million)
SK/1	Develop a Centre for Excellence in existing R&D body to address all research issues and technology development and demonstration issues related to climate change	<ul style="list-style-type: none"> <li>Set up a separate Directorate of Environment &amp; Climate Change as core State Department to drive climate change actions &amp; monitor State Action Plan on Climate Change.</li> <li>Established Punjab Climate Change Knowledge Centre (PSCCKC) in Punjab State Council for Science &amp; Technology (PSCST), Department of Science, Technology &amp; Environment (DSTE), GoP with the support from DST, Gol.</li> <li>PSCCKC has developed projects and mobilized additional finance of INR 877 million to address regional concerns involving relevant line departments with support from Government of India.</li> <li>Punjab Remote Sensing Centre (PRSC) has been catering to the geospatial needs of the State as the centralized hub for the geo-spatial data for mapping, monitoring and modelling of hazards and risk analysis pertaining to impacts of climate change on agro- ecosystems, water resources, Soil fertility and quality, crop growth and production, changing land use and soil patterns, environment, forest resources, and crop disease surveillance.</li> <li>Established First Global Centre of Excellence (GCE) at IIT Ropar in collaboration with IIT Alumni Council for the development of 'Agritech and Water'.</li> <li>PBTI-PPCB Joint Environment Resource Centre set up to facilitate environment related research, advisory and skill up-gradation needs of industry, government departments &amp; other stakeholders of Punjab/ adjoining states.</li> <li>Centre of Innovative and Applied Bioprocessing (CIAB) set up with the support of Department of Biotechnology which focuses on secondary agriculture and development of value added products from different types of bio resources.</li> <li>GNDU set up centre for Sustainable Habitat (CSH), Centre for Agriculture Research and Innovation (CARI) and Drug and Pollution Testing as well as Solid &amp; Liquid resource management facilities.</li> <li>Centre for Eco-system Restoration set up at Punjabi University, Patiala.</li> <li>Central University of Punjab, Bathinda, established laboratory for environmental (air, water and soil) analysis.</li> <li>Initiated M.Tech course with specialization in Water Resources &amp; Environment at IIT Ropar.</li> </ul>	66.98

Code	Strategy	Physical Progress	Expenditure (in INR million)
SK/2	Develop a deeper understanding of climate change issues	<p>Several research studies have been undertaken by the premier institutions of the State including IIT-Ropar, Punjab Agricultural University (PAU), Ludhiana, Central University, Bathinda, Punjabi University, Patiala, Guru Nanak Dev University (GNDU), Amritsar, etc. List of notable outcomes are as under:</p> <ul style="list-style-type: none"> <li>• Assessment of hydro-climatic extremes and related environmental consequences under ISIRD project.</li> <li>• Hydro-climatic prediction for catchment of Bhakhra dam under climate change scenarios</li> <li>• Designed sustainable storm water drainage system for Patiala city.</li> <li>• Assessment of impact of rainwater harvesting on groundwater quality in India with specific reference to fluoride &amp; micro-pollutants.</li> <li>• Fluorimetric estimation of uranium and its source apportionment in groundwater as well as assessment of organochlorine pesticide residues has been carried out for district Bathinda.</li> <li>• Extensively studied the spatial distribution of Uranium and associated water quality parameters in ground water/drinking water in 10 districts (Fatehgarh Sahib, Ludhiana, Barnala, Nawanshar, Rupnagar, Fazilka, Muktsar, Mohali, Sangrur and Patiala) of Punjab.</li> <li>• Investigated the potential of agro- wastes for production of eco-friendly products. Explored practice of converting cellulose and other wastes to bioplastics and bio-butanol.</li> <li>• Studies on accumulation of heavy metals in rice grains and the possible health impact on rice consumers in the Malwa region of Punjab is under progress.</li> <li>• Carried out the biodiversity assessment &amp; ecological studies of Ranjit Sagar Keshopur Miani and Shalla Pattan Wetlands.</li> <li>• Prepared Peoples' Biodiversity Registers (District, Block and village) at each local body level.</li> <li>• Conducted studies on utilization of agro-residues for production of lignocellulolytic enzymes, xylo-oligosaccharides and ethanol using novel approaches.</li> <li>• Monitoring of Pollution load of pond ecosystems of villages of Punjab and their restoration measures</li> <li>• Studies undertaken for Trace Level Detection of Heavy Metals/Metalloids in varied systems.</li> </ul>	33.00



Code	Strategy	Physical Progress	Expenditure (in INR million)
		<ul style="list-style-type: none"> <li>• Developed rhizo-remediation based waste water treatment protocols to improve the treatment efficiency of waste water treatment plant.</li> <li>• Evaluated studies for prevalence of radium, its distribution, source determination &amp; risk assessment in groundwater of SW-Punjab.</li> </ul> <p>In addition, extensive capacity building activities have been carried out for knowledge dissemination and strengthening of capacities of human resource in the climate change domain. Key programs conducted are as under:</p> <ul style="list-style-type: none"> <li>• A knowledge network has been created with 14 Universities/Institutions and 4 Industrial Associations to promote research on climate change issues in the State.</li> <li>• PSCCKC organized 98 capacity building programs including webinars, expert lectures, trainings for Government officers, academicians, students, NGOs, farmers etc. with total Outreach &gt; 6000</li> <li>• PHDCCI organized several workshops, conferences, seminars &amp; training programs on Green Buildings &amp; Building rating system, innovative technologies, Green hydrogen, etc. with the support from MNRE &amp; MoEF&amp;CC, Gol</li> <li>• PBB has undertaken capacity building activities under Food Agriculture Organization-Technical Cooperation Programme (FAO-TCP) project on mainstreaming of agro biodiversity in collaboration with Punjab Agriculture Management &amp; Extension Training Institute (PAMETI) and Centre for Research in Rural and Industrial Development (CRRID), Chandigarh</li> <li>• Built understanding on climate change concerns among school students benefitting &gt; 5 lakh children through multifarious activities under NGC Network.</li> <li>• More than 4500 persons trained in environment &amp; climate change domain by research institutions of the State</li> <li>• Conducted skill up-gradation and training programs for industrial workers and farmers on climate resilient technologies &amp; practices.</li> </ul>	



Code	Strategy	Physical Progress	Expenditure (in INR million)
SK/3	Undertake research and development of new and innovative climate friendly technologies	<p>Various Academic/ R&amp;D Institutes and departments in the State including PAU, Central University, Punjabi University, Guru Nanak Dev University (GNDU), IISER, Panjab University, PGIMER, IIT-Ropar, Central Ground Water Board etc. are working on Environment and Climate Change domains. Innovative processes/ technologies developed to address emerging environment and climate changes challenges are as under:</p> <ul style="list-style-type: none"> <li>• Developed an instrument for quantifying atmospheric OH reactivity.</li> <li>• Integrated biological and bio-electro- chemical process developed for wastewater treatment and resource recovery.</li> <li>• Real-time monitoring of air pollutants in seven cities of North India conducted during crop residue burning to establish relationship with meteorology and trans-boundary movement of air.</li> <li>• Undertaking focused research on weather driven dynamic crop growth &amp; yield simulation models, crop weather relationship models, weather-crop-insects/diseases interactions support adaptation planning of agriculture sector in climate change scenario.</li> <li>• Developed a technology for utilization of rice straw biomass as biocoal through torrefaction. In addition, novel enzyme variants have been identified for conversion of cellulose and xylan.</li> <li>• Developed bio-electro chemical technologies for CO<sub>2</sub> utilization and waste water management at the point sources with the objective to transition existing linear resource utilization to circular utilization.</li> <li>• Developed Microbial Electrolysis Cell for integrated landfill leachate treatment and biohydrogen production. Further studies are underway to increase its production and efficiency.</li> <li>• Bio-herbicides using modern techniques of encapsulation are under development. The essential oil components can be used successfully as bio herbicides in wheat and paddy crops.</li> <li>• Developed protein based biosensor for monitoring of arsenic and cadmium in water &amp; soil. In addition, different analytical methods developed for testing various phyto-constituents.</li> </ul>	92.47



Code	Strategy	Physical Progress	Expenditure (in INR million)
SK/4	Undertake Technology Demonstration, Field Implementation & Extension	<p>Developed &amp; demonstrated cleaner technologies benefiting 1300 Industries and brought in private sector investment of INR 3000 million in the State towards cleaner technologies, which led to particulate matter reduction of 52,000 Tonnes/annum leading to improved work zone environment of ~25,000 industrial workers.</p> <p>Following key technologies demonstrated for agricultural &amp; industrial sectors:</p> <ul style="list-style-type: none"> <li>• Novel Climate Resilient Livestock sheds</li> <li>• Piloted Weather Linked Insurance System</li> <li>• Paddy straw based briquetting units</li> <li>• Converted Coal based Re-rolling mills to PNG</li> <li>• Establishing use of paddy straw briquettes in industrial boilers and brick kilns. Rice straw torrefaction to biocoal for energy generation.</li> <li>• PAU has been actively disseminating agriculture/livestock advisories to &gt;0.65 million farmers to face aberrant weather conditions and efficient farm/livestock management practices. In addition, PAU has developed &amp; demonstrated improved agricultural package &amp; practices.</li> <li>• Farmer level trainings &amp; awareness programs being taken up across the State by Dairy Development Board.</li> </ul>	125.06
SK/5	Address IPR Issues	<ul style="list-style-type: none"> <li>• Technology Innovations &amp; Support Centre (TISC) and Patent Information Cell (PIC) are functioning in PSCST to provide technical support and facilitate patent search and filing process. Total 74 patent searches in Environment/Climate Change domain facilitated through PIC in the State.</li> <li>• Patent on Zig-zag technology in Brick Kiln sector filed by PSCST</li> </ul>	1.20
SK/6	Manage, Interpret & Disseminate Data and Information	<ul style="list-style-type: none"> <li>• District level vulnerability assessment undertaken by PSCCKC as per Uniform National Framework of DST, GoI. Assessment outcome has been made part of National publication on District level Vulnerability Assessment.</li> <li>• IISER Mohali investigated spatio- temporal variability of Extreme Rainfall Events over Northwest India for the period 1979-2018 using India's first highest resolution regional atmospheric reanalysis.</li> </ul>	Not available



Code	Strategy	Physical Progress	Expenditure (in INR million)
		<ul style="list-style-type: none"> <li>• Analysis of Heat Stress conditions &amp; associated physical mechanisms, aerosol burden (Natural Dust, Sulfate, Black Carbon and Organic Carbon) across Indo-gangetic plain specially Punjab and adjoining States, the isoprene emissions impacting ozone formations and having influence on regional air quality, etc. studied for modulation of air pollution over indo- gangetic plains for accurate air quality forecasting.</li> <li>• Various studies conducted by IISER suggest that trees over croplands could mitigate the peak time day temperature and ozone. Expanding agro forestry to 50% could improve regional rice yields by upto 40% and may have great economic values.</li> <li>• Agro-climatic Atlas and technical reports on Climate Change Facts/Projections for Punjab during 21st Century published by Department of Climate Change and Agricultural Meteorology, PAU</li> <li>• Analysis and interpretation of trends of past weather parameters viz temperature (mean/max), precipitation, relative humidity, etc.</li> <li>• Developed target specific resource material to promote understanding on climate change among masses through brochures, newsletters, guidebooks, etc.</li> <li>• PGIMER has undertaken COVID response study for dissemination of knowledge for management of COVID spread.</li> </ul>	
<b>Total Expenditure</b>			<b>318.71</b>



## ANNEXURE - V

## Progress Mapping for Energy Enhanced efficiency &amp; Solar Mission-related strategies of SAPCC 1.0

Code	Strategy	Physical Progress	Expenditure (in INR million)
EN/1	Increase the share of solar power in the grid electricity. Target: At least 4% of GOI target of 20,000 MW i.e., 800 MW through Private Participation	<ul style="list-style-type: none"> <li>Ground Mounted Solar Plants of 815.5 MW capacity and Solar Rooftop Power Plants of cumulative capacity 60.5 MW installed in the State.</li> <li>Realized Solar Net-metering of 88.5 MW.</li> <li>Setup 20 MW capacity Canal Top Solar power plants</li> </ul>	Not available
EN/2	Use unproductive land in the state in line with the Charnaka model of Gujarat to generate 300 MW of electricity using SPV through Private Participation	<ul style="list-style-type: none"> <li>Installed 7,578 Solar PV pumps under the off-grid Solar photovoltaic (SPV) program in the State.</li> </ul>	Not available
EN/4	Promote roof-top solar PV power. The target for 100 MW within 12 <sup>th</sup> plan & 13 <sup>th</sup> Plan	<ul style="list-style-type: none"> <li>Installed Solar Rooftop Power Plants of cumulative capacity 60.5 MW</li> </ul>	5236
EN/5	Development of solar cities	<ul style="list-style-type: none"> <li>Initiated development of Mohali, Amritsar, Ludhiana and Sultanpur Lodhi as solar cities.</li> </ul>	0.22
EN/6	Increase coverage of solar lighting by putting 1000 solar lighting systems during the 12 <sup>th</sup> and 13 <sup>th</sup> five-year plan	<ul style="list-style-type: none"> <li>State has installed significant number of 91,976 Solar Street Lighting Systems in 4,077 villages</li> </ul>	123.15
EN/7	Provide an incentive for solar thermal water heating systems in Urban/Rural residences	<ul style="list-style-type: none"> <li>Solar/thermal water heaters of 0.37 million litres per day (LPD) capacity installed in the State for which 30% subsidy is provided under the scheme of Ministry of New and Renewable Energy, Gol.</li> </ul>	69.29
EN/8	Achieve 15-20% energy efficiency in small and medium enterprises (SMEs).	<ul style="list-style-type: none"> <li>Punjab Energy Development Agency (PEDA) initiated work on Waste Heat Recovery for 20 identified Industries including SMEs and large industries in Punjab in collaboration with Energy Efficiency Services Limited (EESL).</li> <li>Demonstrated Waste Heat Recovery Systems in the Five Steel Re-rolling mills at Mandi Gobindgarh in collaboration with Punjab State Council for Science &amp; Technology (PSCST). The initiative led to saving of 482.5 tonne annual coal costing INR 62.73 million. The specific coal consumption in these units has been reduced by 8-12% and annual GHG emission reduction envisaged as 1,061 tonne CO<sub>2</sub></li> </ul>	Not available

Code	Strategy	Physical Progress	Expenditure (in INR million)
EN/9	Achieve energy efficiency of the order of 15-35% in buildings (Commercial & Institutional buildings such as Hotels, Malls, and Govt. buildings based on ECBC/GRIHA norms).	<ul style="list-style-type: none"> <li>State has provisioned 15% rebate in property tax for ECBC Compliance and up to 10% extra FAR for GRIHA, IGBC &amp; LEED. More than 340 building have been ECBC compliant and 30-40% energy savings have been achieved.</li> <li>ECBC norms made mandatory for buildings having connected load of 100 KW and above or contract demand of 120 KVA &amp; above. Constructions including Bus Stands (Patiala &amp; Gurdaspur), Hospitals (Mankind &amp; Mehar) and Borlaug Institute for South Asia (BISA) Ludhiana are underway in compliance of ECBC norms.</li> <li>Various Energy Efficiency measures implemented in 117 Govt Schools, KVs &amp; JNVs &amp; 65 Primary &amp; Middle Govt. Schools.</li> <li>PEDA sensitized &gt;6500 officials and builders for construction of Punjab ECBC compliant buildings, suitable building materials &amp; energy efficient appliances such as AAC (Autoclaved Aerated Concrete) blocks; Heating, Ventilation &amp; Air Conditioning (HVAC), Solar PV and hot water, electrical systems etc.</li> </ul>	Not available
EN/10	Achieve energy efficiency in street lighting by replacing conventional street lights with LEDs	<ul style="list-style-type: none"> <li>Replaced conventional street lights with 390 LED lights at M.C Mohali and Grain market, Sirhind Mandi and 489 LED tubes/lamps in villages</li> </ul>	10.30
EN/11	Promote energy efficiency in consumer appliances	<ul style="list-style-type: none"> <li>Installed 35 energy efficient motor pumps for drinking water supply at Mohali, Rajpura, Pathankot</li> <li>Installed 14,814 LED lights under LED Village Campaign Scheme and installed 1626 Energy efficient Fans, 31 BEE Star rated ACs &amp; 500 LED street lights in villages</li> </ul>	Not Available
EN/12	Achieve 3-7% improvement in energy efficiency in large energy consumers not designated by BEE under PAT schemes such as food processing, Chemicals, and Ceramics	<ul style="list-style-type: none"> <li>Under "Perform, Achieve and Trade (PAT)" scheme of Ministry of Power, energy savings of 5,169 Million Units (MUs) achieved in large energy consuming industrial units notified as Designated Consumers under the Energy Conservation Act-2001 for 3 year period of PAT Cycle-I (2012-15).</li> </ul>	4.24



Code	Strategy	Physical Progress	Expenditure (in INR million)
EN/13	Create demand for energy- efficient appliances, technologies, and programs by educating the public and private sector on their options	<ul style="list-style-type: none"> <li>Undertaken regular sensitization through expert lectures, radio jingles, social media platforms and outreach programmes for commemorating energy conservation day annually.</li> <li>Published resource material (booklets/ brochures, pamphlets, etc., in vernacular Language) for mass awareness on Energy conservation and Energy Efficiency.</li> </ul>	3.53
EN/14	Conduct education and training of key stakeholders – energy managers and energy auditors on implementation of EC measures, e-filing on annual reporting energy data and e-learning in consonance with BEE's mission on the EC Act and for monitoring and evaluation	<ul style="list-style-type: none"> <li>Conducted regular workshops/ training programs for designated consumers by CEA, CEM, AEAs, ESCOs.</li> <li>Trained more than 2000 Surya- mitras and 80 rooftop solar grid engineers under Skill Development program.</li> </ul>	Not available
<b>Total expenditure</b>			<b>5,446.73</b>



## ANNEXURE - VI

## Progress Mapping for Sustainable Habitat related strategies of SAPCC1.0

Code	Action	Physical Progress	Expenditure (in INR million)
<b>Strategy 1: Avert enhanced heat island effect and promote self- sustainability in cities</b>			
SH/1	Adopt and implement ECBC/GRIHA norms for climate-proofing building envelopes of both old and new commercial public and residential buildings in cities	<ul style="list-style-type: none"> <li>ECBC compliance made mandatory in the State for building complexes that are not for industrial use with a connected load of more than 100 KW or air conditioned area of 500 sqm or more. Provisioned 15% rebate in property tax to ECBC complaint buildings.</li> <li>Additional incentive of 5% FAR (Floor Area Ratio) to buildings on submission of certification of 'Green Building' from GRIHA (4 or 5 stars), LEED (gold or platinum), and IGBC (gold or platinum)</li> </ul>	Not available
SH/2	All housing programs/ schemes of the Government for the EWS's to make provision for inclusion of building designs with ECBC/GRIHA norms to protect this section from extreme heat and to introduce energy efficiency.	<ul style="list-style-type: none"> <li>Introduced Punjab Municipal Green Buildings Incentives Policy for ensuring energy efficiency</li> <li>Affordable Housing projects undertaken for provisioning housing to EWSs with basic amenities.</li> <li>Development of Eco-city 1, Eco-city 2, and Medicity phase 1 and 2 under Greater Mohali Area Development Authority (GMADA)</li> </ul>	12,002.06
SH/3	Capacity building/ training activities for architects, builders, residence owners, and other stakeholders about the use of materials reducing energy absorption capacities of the envelope of buildings.	<ul style="list-style-type: none"> <li>Capacity building and training programmes organized for infrastructure consultants of all urban local bodies, Department of Architecture and Town Planning, improvement trusts, builders and developers on "Energy simulation Energy Management Information System (EMIS) tool" and green buildings.</li> <li>Conducted awareness programs &amp; trainings for various stakeholders involving real estate professionals on EcoNiwas Samhita Implementation and Star Labelling for Residential buildings with National Real Estate Development Council (NAREDCO) in collaboration with PEDDA, Bureau of Energy Efficiency (BEE) and GIZ</li> <li>Imparted trainings in green jobs like Solar system installation, food processing, e-vehicles, etc. under Punjab Skill Development Mission.</li> <li>More than 48 capacity-building training programs conducted for Municipal Functionaries on sustainable habitat related matters.</li> </ul>	Not available

Code	Action	Physical Progress	Expenditure (in INR million)
SH/4	Promote a higher share of renewables in total energy consumed (e.g., solar, recycled waste, wind) in cities in its residential, commercial areas, and public utilities.	<ul style="list-style-type: none"> <li>• 500 MW of biofuel projects developed to increase share of renewable.</li> <li>• Notified Punjab Municipal Building Byelaws, 2018 wherein installation of rooftop solar PV Installation &amp; Solar water heaters in Residential/Non- residential plots of selected size made mandatory.</li> <li>• LED/solar lights mandatory for buildings of all categories.</li> <li>• Mandatory use of flash bricks as building materials in multistorey residential/ institutional projects.</li> <li>• Installation of 25 intelligent traffic light management systems.</li> <li>• Provisioned parking area of &gt;60,000 sqm along road side to prevent traffic hazard.</li> <li>• Development of 982 Street/ Solar Lights installed in the various districts of the state.</li> </ul>	39.21
<b>Strategy 2 Address challenges associated with projected excess rainfall scenarios</b>			
SH/5	Study to analyze the likelihood of recurrence of extreme events and their intensities.	<ul style="list-style-type: none"> <li>• Study on heat island effect and heatwaves in major urban hotspots in Punjab.</li> </ul>	Not available
SH/6	Reduce surface runoff in urban areas by increasing infiltration-maximize area under rainwater harvesting.	<ul style="list-style-type: none"> <li>• Rainwater harvesting mechanism is being adopted in all residential and commercial buildings under the Building Byelaws.</li> <li>• Green buffers developed along road sides to facilitate infiltration.</li> </ul>	Not available
SH/7	Assess deficit in drainage including pumping capacities and hydraulic capacities.	<ul style="list-style-type: none"> <li>• Drainage capacity needs upgradation in the wake of intense rainfall.</li> </ul>	Not available
SH/8	Enhance drainage capacities of existing stormwater drainage systems in towns in the flood plains.	<ul style="list-style-type: none"> <li>• Stormwater drainage system mandatory for all housing Projects.</li> <li>• Repair and maintenance of roads to avoid water logging.</li> <li>• Stormwater drainage collection system provided along main roads.</li> </ul>	Not available



Code	Action	Physical Progress	Expenditure (in INR million)
SH/9	Develop mechanisms to separate sewer and stormwater drainage.	<ul style="list-style-type: none"> <li>State Treated Waste Water Policy 2017 notified</li> <li>Study on design of Sustainable Storm Water Drainage (SWD) System for Patiala City conducted by IIT Ropar.</li> <li>At present, 68% sewage is treated in Punjab which is highest in any state of India.</li> <li>130 STPs (1759.5 MLD) constructed and 55 STPs (624 MLD) are under construction in urban towns.</li> </ul>	Not available
<b>Strategy 3: Contain pollution in river water and air pollution in urban areas in a warming scenario.</b>			
SH/10	Ensure enough water flows at various checkpoints to reduce the enhanced pollutant loadings with warming of river water in the river systems.	<ul style="list-style-type: none"> <li>Water quality monitoring of all 4 rivers (Sutlej, Beas, Ravi, and Ghaggar) at 37 monitoring stations under National Water Quality Monitoring Programme (NWMP).</li> <li>Released 200 cusec water into Budha Nallah from Sirhind Canal.</li> </ul>	31.05
SH/11	Revise standard levels of pollutants that can be released from the industrial and domestic wastewater discharges to make rivers less polluted in a climate change scenario.	<ul style="list-style-type: none"> <li>Monitoring of discharge of liquid effluents on land and effects on soil due to the leaching</li> <li>11 real time water quality monitoring stations have been installed in rivers.</li> <li>New guidelines of management of septage and fecal sludge are being prepared in consultation with stakeholder departments.</li> <li>Online treated effluent quality monitoring systems installed at the outlet of STPs/ETPs.</li> <li>Parameters of water quality of treated waste water have been notified by Punjab Pollution Control Board (PPCB).</li> </ul>	Not available
SH/12	Ensure cleaner air in a climate change scenario	<ul style="list-style-type: none"> <li>Under National Air Quality Monitoring Programme (NAMP), ambient air quality monitoring carried out in 9 critically polluted towns through 24 continuous ambient air quality monitoring systems.</li> <li>10 additional Continuous Ambient Air Quality Monitoring Stations (CAAQMS) under installation.</li> <li>&gt;200 induction furnaces have been converted to side hood suction technology, &gt;2000 brick kilns adopted energy efficient induced draft technology and 73 industries have been converted from coal to PNG use.</li> <li>Air quality management division setup at PPCB</li> <li>Implementing actions/activities for air pollution control under National Clean Air Programme (NCAP).</li> </ul>	Not available



Code	Action	Physical Progress	Expenditure (in INR million)
<b>Strategy 4: Develop a sustainable integrated transport system in Punjab</b>			
SH/13	Policy shift to integrated public transport system as per the National Transport Policy, 2006	<ul style="list-style-type: none"> <li>Ludhiana and Amritsar have received central assistance for increasing their bus services. The numbers of buses allocated are 200 and 150 respectively of various capacities.</li> <li>Designated parking sites of &gt;48000 sqm created</li> <li>Developed additional road side parking of &gt;18000 sqm earmarked to prevent vehicle parking on non-designated areas</li> <li>Designated cycle tracks and pedestrian path of &gt;190 km developed</li> </ul>	Not available
SH/14	Reduce congestion, improve operational efficiency, reduce noise and air pollution by introducing intelligent traffic management systems	<ul style="list-style-type: none"> <li>Intelligent traffic management system installed at 25 locations.</li> <li>Initiated installation of Charging Stations for E-Vehicles.</li> <li>Imposed ban on diesel operated three-wheelers in Jalandhar, Ludhiana and Amritsar.</li> <li>Regular checking for overloading / polluting vehicles and issuance of challans.</li> <li>Policy for phasing out old transport vehicles under consideration.</li> <li>Mass media campaign for road safety on social media taken up.</li> </ul>	Not available
SH/15	Promote low carbon transport System	<ul style="list-style-type: none"> <li>4/6 lane of State Highways for better connectivity with minimal congestion</li> <li>Introduced E-vehicles under SMART city Mission in the State</li> <li>Prepared policy on E-vehicles prepared and introduced 842 Euro-6 compliant buses along with phasing out of Euro-3/ Euro-4 buses.</li> <li>271 remote sensor-based PUC systems have been linked with VAHAN/SAARTHI.</li> </ul>	Not available
SH/16	Enhance fuel efficiency and reduce emissions from the transport sector	<ul style="list-style-type: none"> <li>Training centers set up for heavy vehicles driving for raising awareness on driving and maintenance of vehicles.</li> <li>Implementation of policy for phasing out old transport vehicles at the initial stages.</li> <li>Organized 356 public awareness campaigns for control of vehicular emissions</li> </ul>	Not available
<b>Strategy 5: Avail waste to energy in major cities in Punjab</b>			
SH/17	Use of municipal solid waste to generate electricity	<ul style="list-style-type: none"> <li>Waste-to-energy plants of capacity 1.5 MW being installed.</li> </ul>	Not available



Code	Action	Physical Progress	Expenditure (in INR million)
<b>Strategy 6: Ensure human health security vis a vis impacts of climate change</b>			
HEL/1	<p>Punjab IDSP to cover all medical health units including rural health centres, Govt. and private hospitals &amp; clinics in all urban centres</p> <p>All doctors from every type of health facility in the state will need to key in directly on to the IDSP portal – all required parameters established by IDSP. A copy of the same also to be maintained by health facility from which it is generated. This is to be done as soon as a patient is diagnosed with identified climate related health issues – namely heat stress, respiratory diseases, water borne diseases, etc.</p>	<ul style="list-style-type: none"> <li>Regular monitoring &amp; reporting under Integrated Disease Surveillance Program (IDSP) in coordination with Rapid Response Teams (RRTs), State Public Health Laboratories, medical colleges &amp; State level Medical Institutions in Punjab.</li> <li>Provided free Medical camps to marginalized community in urban slums and rural areas of the State.</li> <li>Conducted Health awareness camps and check-up sessions in schools and colleges of the State</li> <li>Capacity Building &amp; training of health workers under IDSP at district and block levels for primary health care in Punjab.</li> </ul>	Not available
HEL/2	<p>Create a state programme on heat and cold stress management in line with National programmes such as the National Vector borne disease Programme, Revised National TB Programme etc.</p>	<ul style="list-style-type: none"> <li>Initiated State programme on Climate Change and Human Health in line with National Mission.</li> </ul>	Not available
HEL/3	<p>Develop capacities to generate short, medium and long-term climate forecasts and different diseases occurrence probabilities keeping in view the topography and land use to alert citizens and institutions to prepare &amp; act to avert diseases outbreaks</p>	<ul style="list-style-type: none"> <li>Outbreak reporting from each village through ASHA workers.</li> <li>Capacity building &amp; Operation Research for Efficient Health Information System (HIS), International Classification of Diseases (ICD-10) &amp; Family of International Classification (ICF) in collaboration with Regional Health Statistics Training Centre (RHSTC), Punjab.</li> <li>Medical camps, health awareness sessions and check-ups in schools and colleges by Punjab Institute of Medical Sciences (PIMS).</li> </ul>	Not available
<b>Total expenditure</b>			<b>12,072.32</b>



## Annexure-VII

## Strategies and Financial requirement for Forest, Ecosystem &amp; Biodiversity sector

Code	Strategy	Name of Scheme/programme from which fund can be assessed	Type (AD/MI/Both)	Nature
FR/N/1	Improving the stock of existing forests and bringing them from degraded (canopy density<0.4) category to medium dense forest (0.4 to 0.7) category by carrying out plantations.	GIM, CAMPA	MI	Policy
FR/2	Afforestation in public areas, industrial sites, settlement areas, along the rivers, roadside plantation and shelterbelt plantation.	Ghar Ghar Hariyali, GIM, CAMPA, Green highway project	MI	Policy
FR/3	Increasing tree cover outside forest area by promoting agroforestry and urban/house hold forestry in the State.	Green Punjab Mission, Submission on agro forestry, Green Punjab Mission	MI	Policy
FR/N/4	Conservation and protection of biodiversity in the State	FT-14 Conservation, Management & Development of wildlife in the State Ft-02 Assistance for Development of selected Zoos	MI	Policy
FR/5	Forest Fire Management	Green Punjab Mission, RKVY	AD	Policy
FR/N/6	Strengthening capacities and extension services of the forest department for sustainable management of forests	Green Punjab Mission FT-7 Intensification of Forest Management (Integrated Forest Protection Scheme (60:40)	Both	CB
FR/N/7	Development of PES (Payment for Ecosystem Services)	State funding	AD	Investment
FR/N/8	Facilitation of better market opportunities for major and minor forest produce	State Funding	AD	Investment
FR/N/9	Ecosystem improvement and habitat protection for wildlife and biodiversity conservation.	FT-14 Conservation management & Development of Wildlife in the State FT-3 Assistance of the development of selected Zoos	Both	Policy

### Financial Requirement under Forest, Ecosystem & Biodiversity sector

Major schemes	Proposed Budget (2021-2030) in INR Million
FT-23 Punjab Forestry Watershed Development Project	1690
PUNCAMPA	16050
Green Punjab Mission	5920
FT-32 Grant in Aid to State Forest Development Agency for implementation of Sub mission on Agro-Forestry	920
Ghar-Ghar Hariyali	590
FT-14 Conservation, Management & Development of wildlife in the State	1760
FT-7 Intensification of Forest Management (Integrated Forest Protection Scheme (60:40)	200
FT-2 Integrated Development of Wildlife Habitats	100
FT-3 Assistance for Development of selected Zoos	1910
<b>Total proposed budget</b>	<b>29,140</b>



## Annexure-VIII

## Strategies and Financial requirement for Sustainable Agriculture Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
AG/N/1	Optimum use of water resource and promoting high density aquaculture system	Pradhan Mantri Matsya Sampada Yojana (PMMSY)	AD	140.00	Policy
AG/N/2	Promote crop diversification including enhancing area under horticulture and fishery	Pradhan Mantri Matsya Sampada Yojana (PMMSY) National Horticulture Mission (NHM)	AD	5,238.00	Policy
AG/N/3	Promotion of integrated nutrient management in soils and declining the use of pesticide, fertilizer and promoting organic farming	PMKSY, NMSA, RKVY, NHM	AD	22,711.14	Policy
AG/N/4	Proper management of agricultural crop residue.	SMAF	Both	1,233.48	Investment
AG/N/5	Research for developing suitable crop cultivars, short duration and climate resilient varieties of crops, vegetables and fruits	State scheme	AD	1,317.00	Research
AG/N/6	Efficient utilization of livestock manure for energy	GOBAR-DHAN (Galvanizing Organic Bio-Agro Resources Dhan) SCHEME of Swachh Bharat Mission- Grameen (SBM-G), Govt. of India	MI	110.00	Policy
AG/N/7	Manage livestock health in the emerging pest and disease scenario.	NADCP (100% GOI) Free vaccination to all livestock against FMD & Brucellosis	AD	725.85	Investment
AG/N/8	Climate resilient shed	Distribution of climate resilient cattle sheds, milk producer awareness camps.	Both	202.50	Investment

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
AG/N/9	Conservation and propagation of indigenous breed of livestock	100% GoI PROJECT under NDP-1(2014- 19) & RGM (2019-20)	Both	234.92	Policy
AG/N/10	Promote shrimp culture and other suitable species in saline and water logged area for generating livelihood opportunity	Pradhan Mantri Matsya Sampada Yojana (PMMSY)	AD	560.00	Pilot
AG/N/11	Smart and resource efficient dairy farming	<ul style="list-style-type: none"> <li>Two weeks dairy training</li> <li>Promotion of bale silage and TMR</li> </ul>	Both	364.00	Research
AG/N/12	Research for enhancing resilience of livestock sector	NAFCC	AD	621.40	Research
<b>Total Proposed Budget</b>				<b>33,458.29</b>	

## Annexure-IX

## Strategies and Financial requirement for Water Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
WR/N/1	Water resource (including river sources, tributaries, canals) mapping through GIS and Remote sensing technology	Department of Planning	AD	40,000.00	Investment
WR/2	Manage floods in a future erratic and excess extreme rainfall scenario	State schemes	MI	12,000.00	Policy
WR/3	Contain the likely enhanced water logging situation in the south west districts of Punjab due to the projected increase in rainfall in the region.	Centrally Sponsored Schemes (CSS) (75:25::CS:SS)	MI	38,200.00	Policy
WR/4	Suggested research and monitoring activities for effective decision making	State schemes	AD	90.00	Research
WR/N/5	Undertake a focused approach to augment groundwater especially in problematic/ overexploited areas	State schemes	MI	4,500.00	Research
WR/6	Enhance water use efficiency by 20%	National Water Mission and state schemes	AD	15,942.70	Policy
WR/7	Abate continued water pollution of underground and surface water sources	National Water Mission and state schemes	Both	15,830.00	Policy
<b>Total Proposed Budget</b>				<b>1,26,562.70</b>	

## Annexure-X

## Strategies and Financial requirement for Health Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
HEL/N/1	Developing an early warning and alert systems in specific areas for heat waves and AQL.	National Programme for Climate Change and Human Health	AD	No separate budget is required.	Policy
HEL/N/2	Developing mechanism for climate sensitive disease tagging	National Programme for Climate Change and Human Health Integrated Disease Surveillance Project (IDSP) National Vector-Borne Disease Control Programme	AD	No Additional Infrastructure, Human resource will be needed as already established infrastructure under IDSP	Pilot
HEL/N/3	To create awareness among general population (vulnerable community), health-care providers and Policy makers regarding impacts of climate change on human health	National Programme for Climate Change and Human Health	AD	31.00	Policy
HEL/N/4	Strengthen/develop mechanism for management of vector borne disease through surveillance and establishment of sentinel sites	National Vector Borne Disease Control Programme	AD	426.30	CB
HEL/N/5	Strengthening/developing management strategies for water borne illness	Integrated Disease Surveillance Project	AD	84.00	CB
HEL/N/6	Improving nutritional status of young children, adolescent girls, pregnant women as well as reducing mortality and morbidity among young children due to low birth weight, malnutrition, etc	Rashtriya Bal Swasthya Karyakram (RBSK) Rajiv Gandhi Schemes for Empowerment of Adolescent Girls (SABLA)	AD	30.00	Policy

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
HEL/N/7	Reducing the maternal mortality rate by improving quality of MCH care at the rural community level	Mother and Child Health Programme	AD	640.00	Policy
HEL/N/8	Greening of health sector and enhancing the energy efficiency of the healthcare buildings.	National Programme for Climate Change and Human Health	Both	99.49	Pilot
<b>Total Proposed Budget</b>				<b>1,310.79</b>	

## Annexure-XI

## Strategies and Financial requirement for Strategic Knowledge Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
SK/1	Manage, interpret, disseminate data & information	State/central Programme	AD	Not available	Research
SK/N/2	Strengthening Knowledge Networks in the domain of Environment & Climate Change to address research issues and promote technology development for enhancing State's resilience	NMSKCC, DST, GoI  SPIPA GiZ-India,  MoEFCC, GoI	AD	190.10	CB
SK/N/3	Capacity building of Govt. functionaries/ for effective implementation of SAPCC 2.0 involving training/ extension centres of state institutions	NAPCC, SAPCC MoEFCC, GoI  Capacity Building on CC, MoEFCC, GoI	AD	3.50	CB
SK/N/4	Trainings for upcoming researchers in climate change domain for better aligning research & promote start-ups to address sectoral challenges	NMSKCC, DST, GoI  Capacity Building on CC, MoEFCC, GoI	AD	Not Available	CB
SK/N/5	Mainstreaming climate change concerns in ongoing programs & schemes through evidence based planning of adaptation actions.	NAPCC, SAPCC MoEFCC, GoI, DST, GoI	AD	Not Available	CB
SK/N/6	Specialized certificate trainings for dairy farmers/youth entrepreneurs for sustained milk productivity in climate change scenario & minimizing methane emissions from dairy	Dairy Entrepreneurship Development Scheme and Micro Enterprise Development Programme (MEDPs), NABARD, NDDB Green Skill Development Programme, MoEFCC, GoI.	Both	120.00	CB

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
SK/N/7	Awareness & outreach activities for school students, women, industrial workers building an informed and resilient society.	EEAT, NGC, MoEFCC, GoI Livelihood and Enterprise Development Programmes, NABARD, CCA-RAI, DST, GoI	Both	Not available	CB
<b>Total Proposed Budget</b>				313.60	



## Annexure-XII

## Strategies and Financial requirement for Energy Efficiency and Solar Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
EN/N/1	Addressing climate change through development of solar and other clean energy technologies to power a clean and sustainable future.	State Scheme (Grid Connected Rooftop Solar Plants on Govt. Buildings), state scheme 1500MU	MI	42,000.00	Policy
EN/N/2	Promote energy efficiency in residential, commercial & institutional buildings such as Hotels, Malls, and Govt. buildings	Centre scheme Strengthening of State Designated Agency (SDAs)	MI	140.00	Policy
EN/N/3	Increased coverage & utilization of solar as well as other renewable energy sources in urban and rural areas	Supply installation & commissioning of LED based solar lights, Multiple Centre and State Scheme	MI	7.05	Investment
EN/N/4	Develop small and micro hydro project	BOO Basis	MI	4,500.00	Investment
EN/5	Introduction of farm-level solar power generation to reduce energy demand from irrigation	Centre scheme, Installation of solar pumps	MI	16,670.00	Policy
EN/N/6	Enhancing the private sector involvement in the renewable energy sector	BOO basis	MI	NA	Investment
EN/7	Enhancing energy efficiency & conservation in MSMEs	Multiple Centre and State Schemes	MI	NA	Investment
<b>Total Proposed Budget</b>				<b>63,317.05</b>	

## Annexure-XIII

## Strategies and Financial requirement for Sustainable Habitat Mission

Code	Strategy	Name of Scheme/ programme from which fund can be assessed	Type (AD/MI/ Both)	Proposed Budget (2021-2030) in INR million	Nature
SH/N/1	Upscaling of liquid and solid waste treatment and its compliance	Swachh Bharat Mission	MI	28,370	Policy
SH/N/2	Developing sustainable street lightning system	Smart Village Campaign & related State/Centre Schemes	MI	14,88.63	Policy
SH/N/3	Development of green community space	AMRUT	Both	27,670	Policy
SH/N/4	Rejuvenation/ rehabilitation of village ponds	MGNREGA & Other Sources	MI	50,000	Policy
SH/N/5	Undertake natural resource conservation measures in/around habitations	Multiple state and centre scheme	Both	Not available	Policy
SH/N/6	Strengthen the livelihood generation through MGNREGA	MGNREGA scheme	AD	33,000	Policy
SH/N/7	Promoting affordable housing in rural areas	Pradhan Mantri Awaas Yojana (PMAY)	AD	6,133.60	Policy
SH/N/8	Strengthening sanitation facilities in rural schools and create herbal/ kitchen gardens for promoting healthier lifestyle	Smart Village Campaign & related State/Centre Scheme	AD	2,794.60	Policy
SH/N/9	Develop a Smart urban mobility	Smart City Mission	MI	6,585.90	Policy
SH/N/10	Promote a sustainable integrated transport system	Multiple Centre Schemes	MI	Not Available	Investment
SH/N/11	Bioremediation of landfill sites for legacy waste management and setting up of sanitary landfills for inert waste	Swachh Bharat Mission Urban 2.0	MI	Not Available	Investment
SH/12	Enhance drainage capacity of existing storm water drainage system in towns to address issue of excessive runoff	Multiple state and Centre scheme	AD	75,000.00	Policy
SH/N/13	Development of Green Buildings official spaces/institutions	Smart City Mission	MI	601.40	Policy
<b>Total Proposed Budget</b>				<b>2,31,644.13</b>	

## Annexure-XIV

## Key Progress indicators (KPIs) for Adaptation Strategies

Strategy	Key Progress Indicators	Category
<b>Forest, Ecosystem &amp; Biodiversity</b>		
<b>FR/1</b> Improving the stocking of existing forests and bringing them from degraded (canopy density<0.4) category to medium dense forest (0.4 to 0.7) category by carrying out plantations.	Number of saplings/trees planted	Output
	% survival of planted saplings	Outcome
	Degraded area reclaimed/rehabilitated through plantation (ha)	Outcome
<b>FR/2</b> Afforestation in public areas, industrial sites, settlement areas, along the rivers, roadside plantation, and shelterbelt plantation	Number of trees planted	Output
	% increase in green space	Outcome
<b>FR/3</b> Increasing tree cover outside forest area by promoting agro-forestry and household forestry in the State.	% increase in Trees Outside Forest (TOF)	Outcome
	Trees planted under 'Ghar Ghar Hariyali' and schemes like 550 <sup>th</sup> anniversary plantation, etc.	Output
	Financial incentive provided to farmers	Process
<b>FR/4</b> Conservation and Protection of Biodiversity in the State	Setting up of Biodiversity Parks in rural & urban areas.	Output
	Rehabilitation & propagation of threatened species	Outcome
	Conservation initiatives taken with the active involvement of Biodiversity Management Committees (BMCs)	Process
<b>FR/5</b> Forest Fire Management	Length of fire lines created to avoid spread of forest fire	Outcome/ Output
	Number of watch towers constructed	Output
	Number of man hours generated and income opportunity provided to local people	Process
<b>FR/N/6</b> Strengthening capacities and extension services of the forest department for sustainable management of forests	E-governance initiative undertaken	Process
	Updating and digitization of process/ documents such as People's Biodiversity Registers (PBRs)	Process
	Preparation of check list of indigenous flora/fauna & migratory birds of Punjab	Process
	Customized awareness activities for all the stakeholders including BMCs, industry, etc.	Process

Strategy	Key Progress Indicators	Category
<b>FR/N/7</b> Development of PES (Payment for Ecosystem Services)	Number of beneficiaries covered	Outcome
	Financial assistance provided	Process
<b>FR/N/8</b> Facilitation of better market opportunities for major and minor forest produce	No. of certificates issued to local people for sustainable procurement of wood and GI tagging	Process
	Development of sustainable value chain market for major/minor forest produce	Process
<b>FR/N/9</b> Ecosystem improvement and habitat protection for wildlife and dependent biodiversity conservation	Identification & GIS mapping of small wetlands in the State. Initiatives taken for wetland conservation	Process
	Species specific In-situ conservation measures undertaken	Outcome
<b>Sustainable Agriculture</b>		
<b>AG/N/1:</b> Optimum use of water resource and promoting high density aquaculture system	Area benefited with the use of treated water of irrigation (in ha)	Output
	Area covered under underground pipeline for on- farm water conservation (in ha)	Output
	Area covered under micro-irrigation (in ha)	Output
	Area brought under Fishery- Re-circulatory Aquaculture System (RAS) and Bio-floc Technology	Output
<b>AG/2:</b> Promote crop diversification including enhancing area under horticulture and fishery	Area (ha) covered under crop diversification	Output
	Area (ha) brought under aquaculture	Outcome
<b>AG/3:</b> Promotion of integrated nutrient management in soils and declining the use of pesticides and fertilizers and promoting organic farming	% reduction in the consumption of chemical fertilizers	Outcome
	% area included under organic farming	Outcome
	Number of soil health cards issued	Output
	Number of soil testing/leaf analysis facilities set up	Output
	Quantity of nitrogen rich water from aquaculture supplied to farms	Output
<b>AG/4:</b> Proper management of agricultural crop residue.	Number of machineries provided	Output
	Total biomass power generated	Output
<b>AG/5:</b> Research for developing suitable crop cultivars, short duration and climate resilient varieties of crops, vegetables and fruits	Climate resilient /drought resistant varieties developed	Output
	Improved practices/ packages introduced	Process



Strategy	Key Progress Indicators	Category
<b>AG/N/6:</b> Efficient utilization of livestock manure for energy	Total energy generated	Output
	Indirect revenue generated	Outcome
<b>AG/N/7:</b> Manage livestock health in the emerging pests and disease scenario.	Total vaccination conducted	Process
	Nutrient kits distributed	Process
<b>AG/N/8:</b> Development and Management of climate resilient sheds	Number of climate resilient sheds developed /replicated	Output
<b>AG/N/9:</b> Conservation and propagation of indigenous breeds of livestock	Number of Artificial Insemination done for breed improvement	Process
<b>AG/N/10:</b> Promote shrimp culture and other suitable species in saline and water-logged area for generating livelihood opportunity	Area of land (ha) brought under shrimp culture	Output
	Beneficiaries covered and income generated	Outcome
<b>AG/N/11:</b> Smart and resource efficient dairy farming	Total Mixed Ration (TMR) distributed per animal	Process
	Number of dairy farms covered	Process
	Maize based silage distributed	Process
<b>AG/N/12:</b> Research for enhancing resilience of livestock sector	Weather linked insurance product developed	Process
	Disease forecasting model introduced	Process
	Other research initiatives taken	Process
<b>Water Mission</b>		
<b>WR/N/1:</b> Water resources (including river courses, tributaries, canals) mapping through GIS and remote sensing technology	Length of canal/ drainage mapped through GIS	Output
	% of water resources covered under mapping	Output
	Mapping of appurtenant structures such as Head Regulators, Cross Regulators, Bridges, Cross Drainage Works, Outlets, Stud, Spurs, etc.	Output
<b>WR/2:</b> Manage floods in a future erratic and excess extreme rainfall scenario.	Number of check dams constructed	Output
	Cleaning of drainage (km) lines/system	Output
	Number of flood protection structures created	Output
	Reassessment of Capacity of all existing structures based on latest statical models available	Output
<b>WR/3:</b> Contain the likely enhanced water logging situation in the south west districts of Punjab due to the projected increase in rainfall in the region.	Area reclaimed in ha	Outcome
	Area brought under agriculture in ha	Outcome
	No. of shallow piezometers installed	Process

Strategy	Key Progress Indicators	Category
<b>WR/4:</b> Suggested research and monitoring activities for effective decision making	Number of hydrological/modeling studies conducted	Output
	Important research outcomes	Outcome
	Alternatives for flood protection and lining works, identification of innovative cost effective techniques and No. of such works executed.	Output
<b>WR/N/5:</b> Undertake a focused approach to augment groundwater especially in problematic/ overexploited areas	Number of artificial recharge structures	Output
	Groundwater table assessment & monitoring	Process
	Quantity of ground water recharge	Output
	Any policy level initiative taken	Process
<b>WR/6:</b> Enhance water use efficiency by 20%	Length of lining/relining of canals (km)	Output
	Area benefited with the use of treated wastewater for irrigation (in ha.)	Output
	Area covered under underground pipeline for on-form water conservation (in ha.)	Output
	Area covered under micro irrigation (in ha)	Output
	Stabilization of irrigation in command area (ha)	Outcome
	Length of canal cleaned (km)	Output
	Number of Public Awareness events organised.	Output
<b>WR/7:</b> Abate continued water pollution of underground and surface water sources which is likely to increase due to increase in industries and population	Improvement in BOD/COD of river water	Output
	Installation of water quality monitoring systems	Process
	Any specific initiatives taken	-
<b>Health Mission</b>		
<b>HEL/N/1</b> – Developing an early warning and alert systems in specific areas for heat waves and AQI.	Number of monitoring stations set up for AQI	Output
	AQI alerts generated through different mediums	Output
	Number of tele-assistance services provided	Process
	Number of displays installed for temperature and weather forecast at public places	Output
<b>HEL/N/2</b> –Developing mechanism for climate sensitive disease tagging	% of climate sensitive cases reported Vs total OPD patients	Output
	Categorization of reported climate sensitive cases wrt gender, age and occupation	Output
<b>HEL/N/3</b> – To create awareness among general population (vulnerable community), health-care providers and Policy makers regarding impacts of climate change on human health	Number of trainings conducted for public awareness	Output
	Health work force (Asha workers, para- medical staff) trained for prevention, mitigation and risk management on climate sensitive illness	Outcome

Strategy	Key Progress Indicators	Category
<b>HEL/N/4</b> – Strengthen/develop mechanism for management of vector borne disease through surveillance and establishment of sentinel sites	Number of breeding sites treated and eliminated	Output
	Number of vector borne cases reported and treated each year	Process
<b>HEL/N/5</b> – Strengthening/ developing management strategies for water borne illness	Number of cases reported and treated for water borne illness	Process
	Outbreak incidences reported	Process
	Households covered with tap water supply	Outcome
<b>HEL/N/6</b> – Improving nutritional status of young children, adolescent girls, pregnant women as well as reducing mortality and morbidity among young children due to low birth weight, malnutrition, etc.	Improved nutrition status of mid-day meal	Outcome
	Beneficiaries covered under nutrition program	Outcome
<b>HEL/N/7</b> – Reducing the maternal mortality rate by improving quality of MCH care at the rural community level	% of institutional deliveries against total reported pregnancies in rural areas	Process
<b>HEL/N/8</b> – Greening of health sector and enhancing the energy efficiency of the healthcare buildings.	Energy audits conducted	Process
	Number of equipment replaced with energy efficient ones	Output
	Number of green teams formed in health centres for environment related activities	Process
<b>Strategic Knowledge Mission</b>		
<b>SK/1</b> - Manage, interpret, disseminate data & information	Knowledge products developed and disseminated	Output
<b>SK/N/2</b> - Strengthening knowledge networks in the domain of environment & climate change to address research issues and promote technology development for enhancing state's resilience	Decentralized resource centres set up in academic/research institutes	Process
	Research papers collated on climate change issues	Process
	Repository of climate resilient practices/ technologies developed	Process
	Climate resilient practices/technologies demonstrated	Output
<b>SK/N/3</b> -Capacity building of Govt. functionaries/ for effective implementation of SAPCC 2.0 involving training/ extension centres of state institutions	Number of capacity building programmes undertaken for varied set of stakeholders	Output

Strategy	Key Progress Indicators	Category
<b>SK/N/4</b> – Trainings for upcoming researchers in climate change domain for better aligning of research & promote start-ups to address sectoral challenges	Sectoral database developed on climate relevant aspects	Output
	No. of startups identified working in the area of climate change	Process
	No. of cost effective/ tech-based solutions to environmental challenges demonstrated/ promoted	Output
	No. of pilot scale field demonstration carried out through relevant stakeholder departments.	Output
<b>SK/N/5</b> – Mainstreaming climate change concerns in ongoing programs & schemes through evidence based planning of adaptation actions.	No. of sensitization programmes conducted for relevant sectors and departments	Process
	Block level vulnerability assessment based on uniform national framework	Process
<b>SK/N/6</b> – Specialized trainings for dairy farmers/youth entrepreneurs for sustained milk productivity in climate change scenario & minimizing methane emissions from dairy	No. of camps organized on climate resilient livestock practices	Output
	Specialized trainings conducted for new entrepreneurs	Output
<b>SK/N/7</b> – Awareness & outreach activities for school students, women, industrial workers for building an informed and resilient society.	No. of skill development programmes for industry workers on cleaner technologies and practices	Output
	No. of women training programs for alternate livelihood	Output
	No. of specific resource material developed	Output
	No. of outreach programmes for students	Output

## Annexure-XV

## Key Progress indicators (KPIs) for Mitigation Strategies

Strategy	Key Progress Indicators	Category
<b>Energy</b>		
EN/N/1: Addressing climate change through development of solar and other clean energy technologies to power a clean and sustainable future.	Number of solar parks developed	Output
	Total generation of solar energy (MW)	Output
	Number of rooftop solar system installed	Output
EN/N/2: Promote energy efficiency in residential, commercial & institutional buildings such as hotels, malls, and govt. buildings	Number of LED lights installed	Output
	Number of energy audits conducted	Process
	Number of appliances replaced with an energy efficient appliance	Output
EN/N/3: Increased coverage & utilization of solar as well as other renewable energy sources in urban and rural areas	Installation of solar lights	Output
	Rooftop solar panels installed on private and public buildings	Output
	Installation of solar water pumps	Output
	Setting up of biogas energy projects	Output
EN/N/4: Develop small and micro hydro project	Number of small/micro hydro projects initiated	Output
	Total energy generated	Output
EN/5: Introduction of farm-level solar power generation to reduce energy demand of irrigation	Number of solar pumps installed for irrigation	Output
EN/N/6: Enhancing the private sector involvement in the renewable energy sector	Projects installed under PPP mode	Output
	Energy generated by private sector projects	Output
EN/N/7 : Enhancing energy efficiency & conservation in MSMEs	Energy efficient technologies demonstrated (in nos.)	Output
	Energy saving in industries (Mtoe)	Outcome
<b>Sustainable Habitat</b>		
SH/1: Upscaling of liquid and solid waste treatment and its compliance	Number of sewage treatment plants (STPs) installed	Output
	Number of compost pits & Material Recovery Facilities (MRFs) constructed	Output
	Number of industries complying with pollution standards	Outcome

Strategy	Key Progress Indicators	Category
<b>SH/2:</b> Developing sustainable street lightning system in rural areas	Number of solar lights installed	Output
	Number of LED lights installed	Output
<b>SH/3:</b> Development of green community space	Number of green belts/community spaces added	Outcome
	Area covered (in ha) under plantation	Output
<b>SH/4:</b> Rejuvenation/ rehabilitation of village ponds	Number of ponds rejuvenated/ rehabilitated	Output
<b>SH/5:</b> Undertake natural resource conservation measures in/around habitations	Area brought under soil conservation practices (in Ha)	Outcome
	Number of ponds managed & conserved	Output
<b>SH/6:</b> Strengthen the livelihood generation through MGNREGA	Number of workers involved/workdays generated	Output
	No. of households covered under MGNREGA	Outcome
	No of members covered under insurance: Janashree Bima Yojana (JBY), Rashtriya Swasthya Bima Yojana (RSBY), others	Outcome
	Monthly enhancement of income of SHGs	Outcome
	Number of new enterprises started under Start-up Village Entrepreneurship Programme (SVEP) & Income generated through SVEP	Outcome
<b>SH/7:</b> Promoting affordable housing in rural areas	Number of affordable houses constructed	Output
<b>SH/8</b> Strengthening sanitation facilities in rural schools and create herbal/kitchen gardens for promoting healthier lifestyle	Number of Schools covered, and projects completed.	Output
	Number of vegetable gardening kits distributed in rural areas	Output
<b>SH/9:</b> Develop a Smart urban mobility	Intelligent traffic management systems developed	Process
	Low carbon transportation initiatives	Process
	EV charging sub stations developed	Output
	Smart parking spaces established	Output
<b>SH/10:</b> Promote a sustainable integrated transport system	Number of fast-moving fleet corridors constructed	Output
	Increase in public transport vehicles	Outcome
	New parking areas added to manage congestion	Outcome



Strategy	Key Progress Indicators	Category
<b>SH/11:</b> Bioremediation of landfill site for legacy waste management and setting up of sanitary landfills for inert waste	Number of sites remediated	Output
	Area of land cleared (Ha)	Outcome
<b>SH/12:</b> Enhance drainage capacity of existing storm water drainage system in towns to address issue of excessive runoff	Initiatives for storm water management	Process
	Maintenance of storm water drainage system	Process
<b>SH/13:</b> Development of green buildings official spaces/institutions	Number of buildings rated as 'green buildings'	Process
	Rainwater harvesting units installed	Output
	Composting units set up in institutions for waste management	Output
	Wastewater treatment facilities installed	Output

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