State Action Plan on Climate Change for Chandigarh

Department of Environment (DoE)
Chandigarh Administration

Suggested format for citation

T E R I. 2024
State Action Plan on Climate Change (SAPCC) for Chandigarh
New Delhi: The Energy and Resources Institute. 200 pp.
[Project Report No.]

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Executive Summary

1. Successive scientific assessment reports by the Intergovernmental Panel on Climate Change (IPCC) have demonstrated that addressing climate change and preparing to adapt to the risks that it poses to population and ecosystems is critical for ensuring sustainable development. Scientific findings on climate change have consistently shown that human activities, particularly the burning of fossil fuels and deforestation, are driving a rapid increase in greenhouse gas emissions. This has led to a significant rise in global temperatures, with the IPCC reporting that human-induced global warming has already reached 1.1°C above pre-industrial levels. The consequences of this warming are evident in more frequent and severe weather events, rising sea levels, and the loss of biodiversity.
2. These alarming trends underscore the urgent need for global collaboration to mitigate climate change. The Paris Agreement, adopted in 2015, represents a landmark effort in this regard. It aims to limit global temperature rise to well below 2°C, with efforts to keep it to 1.5°C. The agreement emphasizes the importance of nationally determined contributions (NDCs), where countries commit to specific actions to reduce emissions and adapt to climate impacts.
3. Given the size of its population and level of development, India is among the most vulnerable countries. While India's contribution to the global historical emissions of the greenhouse gases (GHGs) is marginal, India has taken a bold and ambitious path to dealing with climate change. At the national level, India's climate policy is defined by its long-term target of becoming a net-zero economy by 2070. To Achieve this goal India announced in 2022 the Long-Term Low-Carbon Development Pathways (LT-LCDS) outlining 7 pillars focusing on power, transport, cities, industris, forestry, negative emission technologies, and mobilization of finance from domestic and international sources. The National Action Plan on Climate Change (NAPCC) launched in 2008 comprising of nine missions provides overall direction to India's climate policy. The 9 missions cover solar power, energy efficiency, sustainable habitat, Himalayan ecosystem, forestry, sustainable agriculture, water, strategic knowledge, and health.
4. At COP 26 in Gasgow, India also announced it's philosophy for climate action, the Mission LiFE (Lifestyle for Environment), a pioneering initiative aimed at promoting sustainable living and environmental consciousness. The mission seeks to transform individual and community behaviors towards more eco-friendly practices. Mission LiFE operates on three key phases: Change in Demand, Change in Supply, and Change in Policy. The first phase encourages individuals to adopt simple, sustainable actions in their daily lives, such as conserving water and energy, reducing waste, and minimizing the use of single-use plastics. The second phase aims to influence industries to align their supply chains with these sustainable demands. Finally, the third phase focuses on shaping policies that support sustainable consumption and production.
5. India updated its NDCs in 2022 setting the target of reducing GHG emission intensity of GDP by 45% by 2030 from 2005 levels supported by increasing non-fossil based power installed capacity to 50% and enhancing forestry based cumulative sequestration by 2.5 to 3 billion tonnes of CO_2e. India is also committed to the Agenda 2030 focusing on the 17 Sustainable Development Goals (SDGs) which need to be synergized with all developmental policies including mainstreaming of climate change into development

planning. These policy documents, along with sectoral policy commitments an international and national level define the context and scope of climate action in India.

6. At the sub-national level, the State Action Plans on Climate Change (SAPCC) are the instruments of mainstreaming climate change into state/Union Territory level development planning. In 2009, the Ministry of Environment, Forest, and Climate Change (MOEF&CC) asked all the states and UTs to prepare their SAPCCs for a period covering 2010-2020 in line with the various relevant missions under the NAPCC. In 2019, the MOEF&CC provided a framework for revising the SAPCC 2.0 for a period covering 2020-2030. The UT of Chandigarh prepared its first Climate Action Plan on Climate Change in 2015. The SAPCC 2.0 for the UT has been revised according to framework provided by the MOEF&CC and in alignment with the broader climate policy framework at the national level as outlines in the above paragraph.

Climate Profile of Chandigarh

7. The UT of Chandigarh is likely to experience noticeable shifts in its climate. The climate is projected to be wetter and warmer and prone to increased instances of heavy rainfall as well very hot days. The historical data (1951-2017) suggests that the annual rainfall shows no significant pattern but the consequetive wet days spells along with number of dry days have been increasing. The climate modelling projections for 2020-2050 period suggest that there will be the annual rainfall will increase (by 6.46% to 7.01%) including the number of heavy and very heavy rainfall days (by 34.4% to 33.7%).
8. The temperature conditions in the UT will also see an acceleration of the historical trend of growing annual average temperature as well as increase in the annual average of minimum temperatures. The historical data (1969-2016) shows that the annual average maximum as well as annual average minimum temperatures have been increasing. The climate modelling projections for 2020-2050 period suggest an increase in annual average maximum temperatures (by 1.47^{0}C to 1.70^{0}C) as well as annual average minimum temperatures (by 1.49^{0}C to 1.76^{0}C). In the context of Chandigarh, this would imply overshooting the global goal of limiting the temperature rise to 1.5^{0}C from the pre-industrial revolution levels This trend is likely to intensify the observed urban heat island effect in the UT.

Climate change vulnerabilities

9. Composite vulnerability profile was developed for the UT and climate change vulnerabilities were assessed for the year 2010 and 2020 to measure systemic preparedness. The UT of Chandigarh has become more vulnerable in 2020 compared to 2010, despite its significant progress on building adaptive capacities. The increase in vulnerability is primarily driven by a rapid increase in the population, number of climate related hazards, and energy consumption. The UT also exhibit a significant urban heat island effect where the urban centre experiences higher temperatures compared to its peripheral rural areas covered with higher vegetation density. From the climate vulnerability perspective, the key areas of concern for the UT are identified in the water and health sectors. In particular, water logging during the monsoon season and depleting availability of fresh water driven by higher demand and excessive ground water extraction, along with health issues related to surface urban heat island effect, heat waves, and water- and vector-borne diseases would require specific attention.

Adaptation Strategies

10. Based on the vulnerability analysis, three sectors – water, forest and biodiversity, and health—have been identified as focus areas for adaptation strategies.

10.1. *Water sector*: The UT's vulnerability in terms of water resources has increased due to poor drainage density, water logging, groundwater decline and lack of efficient wastewater treatment. With the rising high population density it may exacerbates water stress in the UT and thus interventions focus at improving resilience of water sector, including enhancing the water use efficiency though reducing leakage losses, development of sustainable drainage systems, mandating and enforcing water meters in high consumption segments/sectors; groundwater conservation by restriction on new borewells, metering of its usage by industries and taxation on overextraction; reuse and recycling of water to reduce consumption; mandating rainwater harvesting in public establishments. Increasing the STP capacity is central to adaptation in water sector. These interventions are suitably aligned with the Mission LiFE, SDGs, LT-LCDS, National Water Mission, and NDCs.

10.2. *Forest and biodiversity*: Improving the green cover and forest biodiversity, controlling invasive species, and managing forest fires are essential to build adaptive capacity in the sector. In line with the Green India Mission, National Biodiversity Strategies and Action Plans, Kunming-Montreal Global Biodiversity Framework (GBF), LT-LCDS, NDCs, SDGs, Mission LiFE, and Ek Ped Ma Ke Naam campaign, the interventions in the forest and biodiversity sector focus on increasing public participation in the various plantation drives with a clear emphasis on replacing invasive plant species with native species, developing a Citizen's Biodiversity Register, restoration of water bodies, and avoidance of forest fires.

10.3. *Health sector*: Extreme temperature coupled with increased variability in rainfall in future provides favourable conditions for pathogens and vectors such as mosquitos, thus increasing the risk of water and vector-borne diseases. The UT already has a well-developed health infrastructure, therefore till 2030, main adaptation strategy relies of making the citizens more aware and alert about the risks and best practices. The interventions in the water sector and forestry and biodiversity sectors are likely to moderate the vulnerabilities. These interventions are suitably aligned with the Mission LiFE, SDGs, LT-LCDS, National Water Mission, and NDCs.

11. Mitigation Strategies

The UT's contribution to country's GHG emissions is marginal. Yet, the UT is aware of the impact on GHG emissions from the rapid increase in energy demand in power and transport sectors. In line with the national mitigation goals as outlined in the NDCs, LT-LCDS, and NAPCC missions along with the imperatives of SDGs, the UT is making all efforts to minimize its GHG footprint. Accordingly strategies have been identified in the power, transport, energy efficiency and buildings, and waste sectors.

11.1. *Power sector*: The UT aims to decarbonize its power consumption by 2030. The main strategies include making all efforts to making the city a Model Solar City by 2030 by implementing various solar rooftop programmes including PM Suryaghar

Muft Bijli Yojna, and sourcing the balance power needs from the non-fossil energy sources-hydro, solar, wind, and nuclear. Installation of 224 MW through various solar rooftop programmes is planned including a total of 6,247 government residential houses identified as feasible for solar installation. Under the PM Surya Ghar Muft Bijli Yojna a total of 5,366 registrations have been received. An annual emission reduction of about 2,68,000 tCO_2e by 2030 is estimated.

11.2. *Transport sector*: The Chandigarh Electric Vehicle Policy 2022, sets the targets and direction for shifting the energy consumption from non-fossils to electricity. The UT has plans to convert its entire bus fleet to electric buses with the SAPCC plan period. It also aims at achieving the highest penetration of Zero Emission Vehicles amongst all Indian cities, by the end of policy period by providing incentives, promoting environment-friendly commute systems (including converting all buses to electric buses), building EV charging infrastructure, introducing integrated transport management system (ITMS), and creating public awareness. In 2024, EVs accounted for 15.26% of total vehicle registration which is targeted to be increased to 70%.

11.3. *Energy efficiency and buildings*: Towards creating the opportunities of energy efficient options, Chandigarh has made progress in proposing strategies in retrofitting of existing buildings. The UT has introduced the Energy Conservation Building Code (ECBC) in 2024 and promoting energy efficient appliances and cost-effective solutions that help in reducing the overall energy consumption and carbon emissions. The need of mandating energy and green certifications for buildings are also being done for creating energy efficiency in the building sector.

11.4. *Waste sector*: Chandigarh has a 100% collection efficiency for Municipal Solid Waste. With a view on processing and managing the waste, Chandigarh has already established waste management plants for managing construction waste, biomedical waste and sewage. More focus is being given towards implementing various systems to consolidate the existing operations and deriving energy from solid waste in terms of overall energy generation. City also plans to establish Integrated Solid Waste Management (ISWM) system.

Financial estimates

12. The implementation of various mitigation and adaptation strategies is estimated to have a financial burden of about INR nine thousand two hundered crore (9200 Cr.) for 2020-2030 period. A substantial part of this estimate goes to power, transport, and water sectors. In terms of sources of finance, the interventions are already budgeted through various financial streams under the UT's annual budget, central schemes (PM Surya Ghar Muft Bijli Yojan, AMRUT, SMART CITIES), and projects funded by international agencies and private sector participation.

Institutional Mechanism:

13. To ensure smooth implementation of the SAPCC 2.0 a three-tier institutional mechanism has been proposed building on the mechanism created under the earlier action plan. The State Level Steering Committee (SLSC), headed by the Chief Secretary of the UT of Chandigarh oversees the overall implementation. The Climate Change Monitoring Committee (CCMC), headed by the Director, Department of Environment. The CCMC is supported by a Programme Cell with a dedicated team of technical staff for coordination, monitoring, data collection, analysis, report preparation and analysis, and management of dashboard. Five Climate Change Working Groups aligned with the missions under the NAPCC will ensure that the interventions and activities identified under the different missions for the various departments are carried out in an efficient manner and report to CCMC.

Monitoring, Evaluation, and Reporting

14. Aligned with the institutional mechanism, an IT enabled dashboard-based approach for data collection, verification, integration, analysis, and feedback has been established. About 50 indicators under 11 sectoral themes have been identified for tracking progress. All concerned departments will depute nodal persons for ensuring continuous monitoring and updating of data. It will be coordinated by the Program Cell housed under the Department of Environment, reporting to the CCMC.

Overall, SAPCC is crucial for integrating climate change into state and Union Territory (UT) development planning. Chandigarh's SAPCC 2.0 aligns with national climate policies and addresses its unique climate challenges, including increased rainfall and rising temperatures. Chandigarh's climate is projected to become wetter and warmer, with more heavy rainfall and hotter days. Historical data shows increasing trends in both maximum and minimum temperatures. Climate models predict further increases, exacerbating the urban heat island effect. The UT's vulnerability has grown due to population increase, climate hazards, and energy consumption. Key concerns include water logging, fresh water scarcity, and health issues related to heat and water-borne diseases. Adaptation strategies focus on water, forest and biodiversity, and health sectors. Mitigation efforts aim to reduce greenhouse gas emissions through initiatives in power, transport, energy efficiency, and waste management. Financial estimates for these strategies total INR 9200 crore for 2020-2030, supported by various funding sources. A three-tier institutional mechanism ensures effective implementation and monitoring of the SAPCC 2.0.

1. Introduction

The effects of climate change are being felt across the world, with impacts ranging from threat to food production to rising sea levels, to intensifying droughts and floods, increased vulnerability to disasters, and subsequent displacement. The United Nations (UN) Intergovernmental Panel on Climate Change (IPCC), through its *Fifth and Sixth Assessment Report* in 2014 and 2021 respectively, have categorically stated that human activities are predominantly responsible for causing climate change. The IPCC 2014 Assessment report concluded that there was a 95% probability that human activities have warmed the planet's surface over the last 50 years. The IPCC 2021 Assessment report reiterated human-induced climate change and highlights how this confidence has increased with the release of each successive report since the second assessment report in 1995[1]. The World Meteorological Organisation (WMO) had highlighted 2000–2020 as the decades of 'exceptional global heat'[2]. The issue of addressing climate change has become widely recognised, and over the years, the United Nations Framework Convention on Climate Change's (UNFCCC) subsequent Conference of Parties (COP) have resulted in landmark agreements, targeting different aspects to combat climate change, with the Paris Agreement in 2015 being a significant international treaty marking the landmark moment where a global consensus was reached (Figure 1.1). The Paris Agreement aims to align global action and response to climate change towards keeping global temperatures below 2˚C rise since pre-industrial levels. Since then, climate change has become a critical aspect of global negotiations and development plans. The climate actions under the Paris Agreement, find further support from the UN's 2030 Agenda with the 17 Sustainable Development Goals (SDGs), which are designed as a 'blueprint to achieve a better and more sustainable future' (Figure 1.2)[3].

[1] IPCC, 2021. Climate change widespread, rapid, and intensifying – IPCC. (Press Release). Details available at <https://www.ipcc.ch/site/assets/uploads/2021/08/IPCC_WGI-AR6-Press-Release_en.pdf>

[2] World Meteorological Organisation, 2019. 2019 concludes a decade of exceptional global heat and high-impact weather. (Press Release). Details available at <https://public.wmo.int/en/media/press-release/2019-concludes-decade-of-exceptional-global-heat-and-high-impact-weathe>

[3] United Nations. Sustainable Development Goals. 2016. Details available at <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

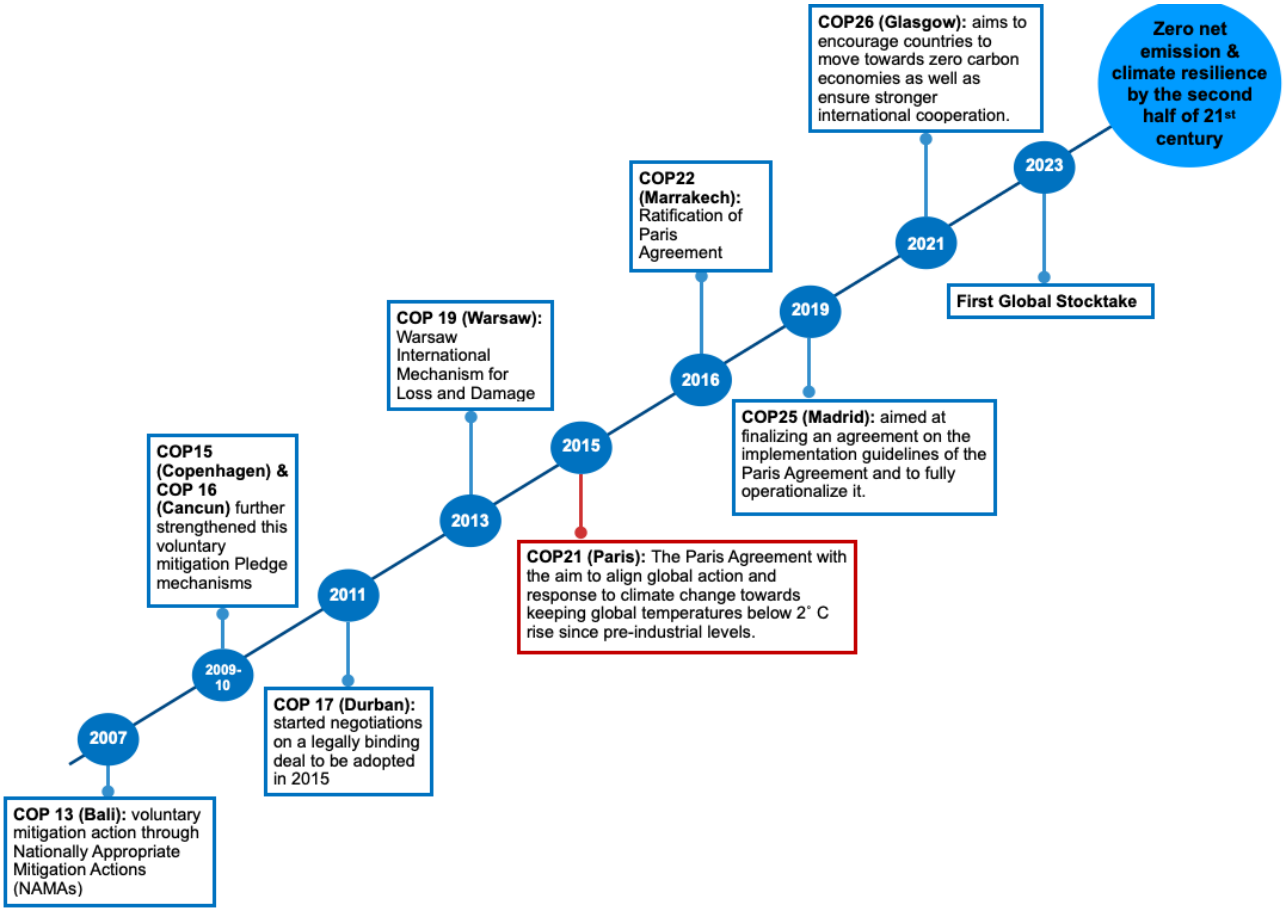


Figure 1.1: Progressive strengthening of climate actions through the UNFCCC-led COPs

Figure 1.2: Sustainable Development Goals of the UN

The COP 26 held in Glasgow under the Presidency of the United Kingdom in 2021, saw many countries moving towards zero-carbon economy and enabling stronger international cooperation for its effective realization. The overarching aim was to also initiate significant

emission cuts by 2030, and to encourage better support for vulnerable economies to adapt to climate change.

1.1 India's Climate Initiatives

India's ambitious climate commitments come in the context of adverse climate impacts fast becoming a reality across the country. India has been at the brunt of the fast-changing climate over the past few decades. As per the Global Climate Risk Index 2021, India ranks seventh in the Climate Risk Index for 2019, which indicates a very high level of exposure and vulnerability to extreme weather events[4]. India already has seen an increase in average temperature by ~0.7°C over the last century, from 1901–2018, and the worst-case scenario, put forth by a report by the Ministry of Earth Sciences (MoES) (2020),[5] projects the temperature increase at 4.4°C by the end of 2100 (as per 1976–2005 average). This changing climate puts India at high vulnerability, with impacts in the form of water depletion and freshwater insecurity, increasing food insecurity, stressed natural ecosystems, and increased exposure to extreme weather events. India's high dependence on climate-sensitive primary sectors such as agriculture will also bear the brunt of the impact, directly impacting the economy of the country due to reduced agricultural productivity. Increased intensity and frequency of disasters has also been observed in India, with a rise in extreme rainfall events, increasing incidents of forest fires and a rise in extreme disasters in form of cyclones. Looking at this, onset of climate change effects, about 68% of the cultivated land is estimated to be vulnerable to drought, 58.6% landmass is prone to earthquakes, 12% to floods, 5700 km of the coastline is prone to cyclones and 15% of the area is susceptible to landslides[6]. This establishes the need for urgent climate action across the country and to put climate mitigation and adaptation actions at the centre of the development process.

With this context, under the Paris Agreement, India submitted its Nationally Determined Contributions (NDCs),[7] with three quantifiable commitments and other overarching pledges for 2021–30, to set forth a comprehensive framework for its climate actions. These are depicted in the Figure 1.3.

In Glasgow, Mr Narendra Modi, Prime Minister of India announced five elements—'Panchamrit'—to deal with the challenge of climate change. These elements are:

1. India will take its non-fossil energy capacity to 500 GW by 2030.
2. India will meet 50% of its energy requirements from renewable energy by 2030.
3. India will reduce the total projected carbon emissions by one billion tonnes from now till 2030.
4. By 2030, India will reduce the carbon intensity of its economy by less than 45%.

[4] Eckstein, David., Kunzel, Vera, and Schafer, Laura. 2021. Global Climate Risk Index 2021. Who suffers most from extreme whether events? Weather-related Loss Events in 2019 and 2000 to 2019 (Briefing Paper). Germanwatch. Details available at <https://www.germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf>

[5] Ministry of Earth Sciences (MoES). 2020. Assessment of Climate Change over the Indian Region (Report). Springer. Details available at <https://doi.org/10.1007/978-981-15-4327-2>

[6] IANS. 2020. Climate change displaced more people in 2018 than violent conflicts: environment annual (article). The Weather Channel. *The Times of India*. Details available at <https://weather.com/en-IN/india/news/news/2020-02-10-climate-change-displaced-people-2018-conflicts-environment-annual>

[7] Ministry of Environment, Forest and Climate Change. 2015. India's Intended Nationally Determined Contributions: working towards climate justice. Government of India. Details available at <https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf>

5. By the year 2070, India will achieve the target of Net Zero.

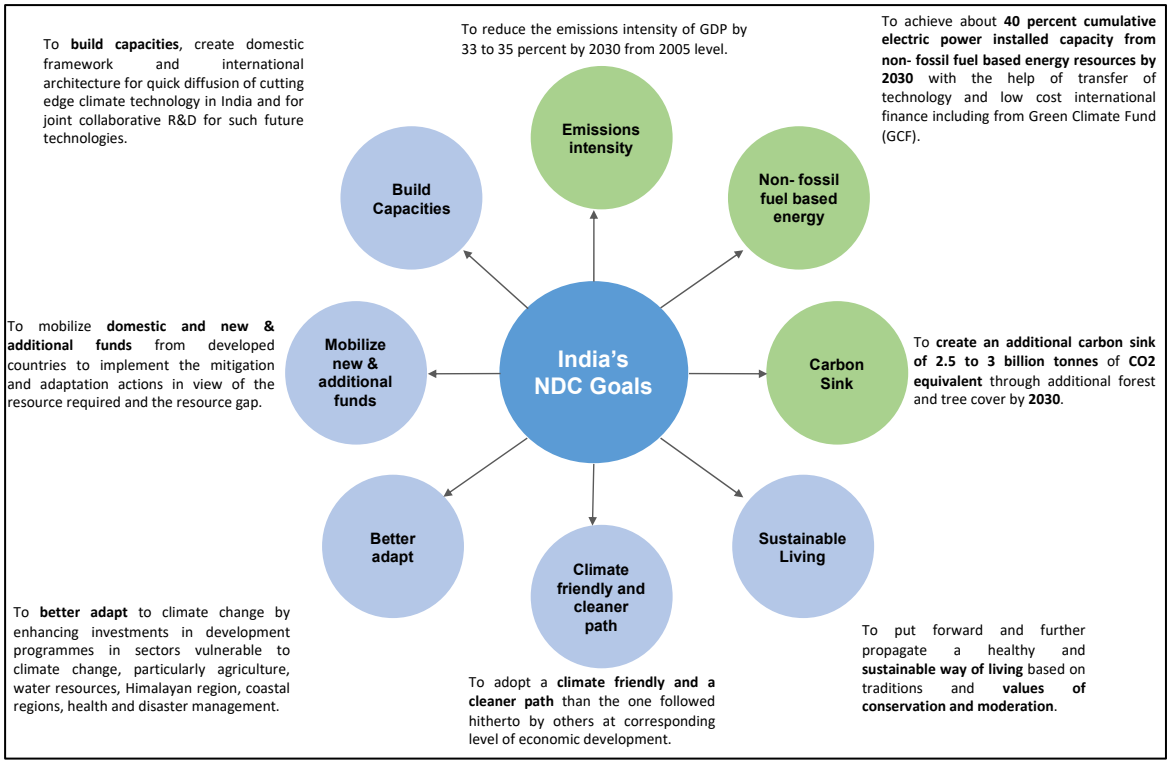


Figure 1.3: India's NDC Goals till 2030

To achieve its global commitments, the Government of India has launched several national level policies and schemes, across a range of sectors, to align national developmental goals with NDC targets. Some of these include:

1. FAME Scheme for promoting cleaner transportation through E-mobility solutions
2. Atal Mission for Rejuvenation and Urban Transformation (AMRUT) for smart cities
3. Pradhan Mantri Ujjwala Yojana for access to clear cooking fuel
4. PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme
5. UJALA scheme aimed at initiating use of energy-efficient LED bulbs
6. PM Surya Ghar Muft Bijli Yojna (PMSGMBY)
7. Swachh Bharat Mission
8. LiFE: Lifestyle for Environment Mission announced in COP26 in 2021

To meet the NDC goals as well as the long-term goal of becoming a net-zero economy by 2070, India has developed a Long-Term Low Carbon Development Strategy (LT-LCDS) which was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2022. The LT-LCDS focuses on 7 key pillars as part of India's strategy:

1. Low Carbon Development of Electricity Systems Consistent with Enhanced Development Benefits
2. Develop an Integrated, Efficient, Inclusive Low-Carbon Transport System
3. Promoting Adaptation in Urban Design, Energy and Material-Efficiency in Buildings, and Sustainable Urbanisation
4. Promote Economy-Wide Decoupling of Growth from Emissions and Development of an Efficient, Innovative Low-Emission Industrial System

5. CO_2 Removal and Related Engineering Solutions
6. Enhancement of Forest and Vegetative Cover Consistent with Socio-Economic and Ecological Considerations.
7. Economic and Financial Aspects of Low-Carbon Development

The LT-LCDS also place the Mission LiFE – Lifestyle for Environment at the centre of India's philosophy in addressing climate change and pursuing sustainable development. The mission encourages individuals to adopt behaviors that result in energy savings, water efficiency and conservation, reduction in single use plastic, adoption of sustainable food systems, waste reduction and management, adoption of health life-style, and reduction in e-waste. About 75 actions have been identified for individuals to adopt in their behavior.[8]

Reiterating its commitment to global climate action, India has taken steps to join various international climate pacts and lead international coalitions. For instance, India launched the initiative on efficient consumption of solar energy, by leading the International Solar Alliance (ISA), with its primary objective of promoting solar power utilization. Following this, in 2019, India also launched the Coalition for Disaster Resilient Infrastructure (CDRI), with its mission of rapidly expanding the development of resilient infrastructure and retrofitting existing infrastructure for resilience. India also joined the Climate and Clean Air Coalition (CCAC), to promote clean air by targeting energy and resource intensive sectors like transport, agriculture, industry, and waste management.

From an institutional perspective, India has taken steps beyond global commitments by incorporating climate action plans into the governance structure. Further, at the national level, the key developmental policies, and programmes, including those for climate-relevant actions, are aligned with the SDGs. The Ministry of Environment, Forest, and Climate Change (MoEFCC) has been developed as the nodal agency to oversee climate action at both national and international levels. Additionally, executive bodies like PMs Council on Climate Change, Executive Committee on Climate Change, and Steering Committee on Climate Change have been established at different governance levels to monitor, implement, and approve projects aimed at climate action.

India's climate actions started much earlier than the Paris Agreement, when in 2008 India released its National Action Plan on Climate Change (NAPCC) that acts as a blueprint for the country's actions on climate change mitigation as well as adaptation strategies. The aim of the NAPCC is to recognise the challenges posed by climate inaction and address them. Since India is a developing country, economic growth is still at the centre of its growth strategy, and hence the NAPCC has been designed keeping this in mind, from a sustainable development perspective. The nine national missions were drawn out that form the basis of this plan (Table 1.1).

[8] https://www.niti.gov.in/sites/default/files/2022-11/Mission_LiFE_Brochure.pdf

Table 1.1: National missions under NAPCC

Mission and Nodal Department	Key Objective
National Solar Mission (NSM) *Nodal Department: Ministry of New and Renewable Energy (MNRE)*	Increasing the share of solar energy mix through development of new solar technologies, while attempting to expand the scope of other renewable and non-fossil options such as nuclear energy, wind energy, and biomass.
National Mission for Enhanced Energy Efficiency (NMEEE) *Nodal Department: Ministry of Power (MoP)*	Aims to strengthen the market for energy efficiency by creating conducive regulatory and policy regime and has envisaged fostering innovative and sustainable business models for improving energy efficiency.
National Water Mission (NWM) *Nodal Department: Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR)*	To conserve water, minimize wastage, and ensure equitable distribution both across and within States, through integrated water resources development and management.
National Mission on Sustainable Agriculture (NMSA) *Nodal Department: Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), Ministry of Agriculture*	To transform India's agriculture sector into an ecologically sustainable, climate-resilient production system to meet the country's food security and economic needs.
National Mission on Sustainable Habitat (NMSH) *Nodal Department: Ministry of Housing and Urban Affairs (MoHUA)*	To promote sustainability of habitats through improved urban planning, improved management of solid and liquid waste including recycling and power generation, energy efficiency measures, modal shift towards public transport and conservation of green spaces.
National Mission for a Green India (GIM) *Nodal Department: Ministry of Environment, Forests and Climate Change (MoEFCC)*	With the aim of protecting, restoring, and enhancing India's forest landscape, the Green India Mission, uses a combination of adaptation and mitigation measures to enhance carbon sinks in sustainably managed forests and other ecosystems.
National Mission on Sustaining Himalayan Ecosystem (NMSHE) *Nodal Department: Department of Science and Technology (DST), Ministry of Science and Technology*	To evolve management measures for sustaining and safeguarding the Himalayan glaciers and mountain ecosystem.
National Mission on Strategic Knowledge of Climate Change (NMSKCC) *Nodal Department: Department of Science and Technology (DST), Ministry of Science and Technology*	To identify the challenges and the responses to climate change through research and technology development.
National Action Plan for Climate Change & Human Health (NAPCCHH) *Nodal Department: Ministry of Health & Family Welfare Government of India*	To raise awareness and educate the public, healthcare providers, and policymakers about the impact of climate change on health and improve preparedness through strengthening healthcare, enhancing research, and partnerships.

India's varied geographical regions and multi-level regulatory governance systems require climate action to be initiated at the local, regional, and sectoral scales. The Paris Agreement, unlike most of the other discussions on climate action, took a bottom-up approach to target

climate action. This involved each country planning out its own targets and commitments for climate change. This not only ensured larger participation, but also allowed the countries to set targets as per the resources, capabilities, and requirements. Following a bottom-up approach, at the national level too, the role of subnational actors in committing to ambitious climate goals comes to the forefront. This encourages sub-national participation, allowing different local regions to willingly set their climate action agendas, and ensuring that the varied nature of India's climate needs do not get reduced to one-size-fits-all plans. Thus, to add to the climate actions at the national level, each state and union territory (UT) of India was tasked with preparing their State Action Plan on Climate Change (SAPCC) in 2011. The SAPCCs were developed on the foundations laid out under the NAPCC, and were to cover the eight National Missions, according to the specific needs of the state or UT. In 2015, new Missions were announced at the national level to address the impact of climate change on health, coastal zones, waste-to-energy and wind energy.

1.2 Revision of SAPCCs

Keeping in mind the changing national and international climate action and policy landscape, advancements in science, technologies, and methods for assessments, it was deemed necessary to revise the SAPCCs to enable states and UTs to update their action plans on climate change and better synergies them with the NDCs. Also, owing to the limited access to technical expertise prior experience in the area of climate action plans, the MoEFCC felt that the first set of SAPCCs could be improved on to become more feasible and to allow scaling up of climate actions in different parts of the country and sectors. This will also give the SAPCCs to update their climate actions, use the updated climate projections and methodologies for understanding their vulnerabilities, developing priority climate interventions to address these over the next decade. Therefore, in 2018, states and UTs were directed by the MoEFCC to revise their SAPCCs in view of evolving international and domestic landscape.

For this purpose, the MoEFCC developed an updated Common Framework for revision of SAPCC, aligning with the NAPCC and NDC targets. The broad guidelines proposed by the MoEFCC are as follows:

- SAPCCs should be a policy document of the States /U'I's 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. It should reflect the policy directions and strategies of the state for climate actions.
- SAPCCs should envisage an inclusive, sustainable and climate resilient low carbon development pathways with a focus on climate change adaptation and mitigation within the key sectors in the State/UTs and should protect the poor and vulnerable sections of society from adverse effects of climate change.
- SAPCCs should take into account recent scientific assessments and projections on global warming; vulnerability; and impacts.
- SAPCCs should synergise with the goals of NDCs under the Paris Agreement, though the targets under NDCs are national targets. It should also contribute towards achieving other development goals including Sustainable Development Goals (SDGs).
- SAPCC should highlight the links with national missions related to climate change. It should bring out climate actions of the state government from their own sources, over and above the Government of India schemes.

- The SAPCC should also be built on the evolving socio-economic development context and priorities of the state.
- States /UTs can strengthen existing climate action measures as well as launch new initiatives in their priority sectors.
- The time period of the implementation of SAPCCs should be clearly brought out starting with the implementation cycle of NDCs i.e., 2021-2030 and beyond.
- 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 SAPCC should bring out the likely funding from State's own resources over and above from the ongoing schemes and programs of Govt. of India.
- The SAPCCs should set out the institutional mechanism for implementation including stakeholder engagement ensuring inclusiveness along with the mechanism for capacity building and monitoring and evaluation with clear indicators for reporting.

1.3 Chandigarh's Climate Initiatives

To support India's climate commitments and climate actions, the first set of SAPCCs were developed through a decentralized approach, aligned with the eight missions of the NAPCC and the priority areas of concerns for the states. To support this exercise, MoEFCC developed a common framework as a guiding document for states[9]. Taking this forward, Chandigarh developed and released its first SAPCC, the Chandigarh Action Plan for Climate Change (CAPCC) in 2015. The CAPCC focused on climate initiatives under five National Missions with additional focus areas being health and transport. At the national level health mission was later announced and integrated in 2015 (Table 1.2).

Table 1.2: State Missions and alignment with National Missions

State Missions	Alignment with National Missions
Solar Mission and Enhanced Energy Efficiency (including solar, electricity, energy efficiency)	National Mission for Enhanced Energy Efficiency
Mission on Sustainable Habitat (including waste management, comprehensive mobility and health sector)	National Mission on Sustainable Habitat
Sustainable Water Mission	National Water Mission
Green India Mission (including forest, agriculture, animal husbandry, and horticulture)	Green India Mission
Mission on Health and Climate Change	National Mission on Health
Mission on Strategic Knowledge for Climate Change	National Mission on Strategic Knowledge for Climate Change

The CAPCC was developed keeping in mind the need for driving sustainable development of the UT and the aim was to allow an integration of climate agenda and mainstream it into the policies, schemes, projects, programmes, and missions developed for the economic and social growth of Chandigarh. A comprehensive analysis was drawn out to understand the

[9] Kumar, Vineet. 2018. Coping with Climate Change: an analysis of India's State Action Plans on Climate Change (Report). Centre for Science and Environment, New Delhi. Details available at <http://cdn.cseindia.org/attachments/0.40897700_1519110602_coping-climate-change-volII.pdf>

steps needed and the resources required to make Chandigarh resilient and capable of coping with the increasing impacts of climate change. Chandigarh focused on developing a sustainable urban habitat, for which its initiatives covered an array of interventions for developing and conserving its green spaces, managing its water supply, encouraging green and energy-efficient buildings, ensuring proper waste collection and treatment, and growing its renewable energy capacity. Chandigarh was successful in most areas and was selected by Ministry of New and Renewable Energy (MNRE) to develop as a model solar city as it has pioneered the development of solar city plans in India, and also as a green city due to its ambitious forestry targets. The first CAPCC stated the aim of developing Chandigarh as a model for sustainable water management, efficient energy use through renewable sources, and overall reduction of the carbon footprint of the city wherever possible, which can be further enhanced through the revised SAPCC. For instance, since the first CAPCC was developed, Chandigarh has undertaken several initiatives under the Smart City Mission, focusing on improving urban mobility and promoting non- motorised transport (NMT), along with the improved waste management models.

Building on the guidelines, Chandigarh's revised SAPCC aims to integrate climate action into development planning of the UT, as well as develop effective climate responses, so as to establish a green climate resilient city, by enhancing the physical infrastructure, and developing a well-balanced green urban life.

2. Chandigarh's Profile

Chandigarh, also known as 'The City Beautiful', represents one of the first major attempts at planning a complete city India's first Prime Minister, Shri Jawahar Lal Nehru, wished for Chandigarh to be a symbol of the "nation's faith in the future, unfettered by the traditions of the past". With this vision, the city was planned by the renowned French architect, Le Corbusier. The city is a Union Territory (UT) of India and is directly governed by the Union Government of India. The foundation stone of the city was laid in 1952. Subsequently, at the time of reorganisation of the States on 1 November 1966 into Punjab, Haryana, and Himachal Pradesh, the city assumed the unique distinction of being the capital city of both Punjab and Haryana.

Chandigarh derives its name from the temple of 'Chandi Mandir', located in the vicinity of the site selected for the city. The deity 'Chandi' (a form of Goddess Durga) and a fort or 'garh,' lying beyond the temple, gave the city its name, 'Chandigarh'. In its pre-historic period, the gently sloping plains on which Chandigarh exists, was a wide lake ringed by a marsh and the fossil remains found at the site indicate a large variety of aquatic and amphibian life. Later in history, the area was also known to be a home to the Harappan Civilization.

The basic planning unit of the UT is the sector, with each sector planned to be a self-contained unit providing residential accommodation, a shopping centre, educational and medical institutions, recreational spaces and parks (Figure 2.1). The architectural grandeur of Chandigarh is displayed in its beautiful layout and monumental buildings, which were designed to suit the climatic conditions.

Since its inception, the UT of Chandigarh has expanded and developed its housing, infrastructure, and public facilities in the ensuing decades. Besides development and improvement in its infrastructural facilities, the city has been decorated with a hub of information technology. The region is culturally rich and has a congenial climate for further expansion and growth.

2.1 Location, Geography, and Size

Chandigarh, at an altitude of 304–365 metres above mean sea level (MSL) lies between 30°44'14 North Latitude and 76°47'14 East Longitude. The UT is bounded by the state of Haryana on the east and by the state of Punjab on all other sides, with Himachal Pradesh in near vicinity (Figure 2.1). It is situated at the foothills of the Shivalik range of the Himalayas in northwest India. Lying in the northern plains, the city has vast area of flat, fertile land, with an area of 114 sq. km, and additional 25.42 sq. km of Sukhna Wildlife Sanctuary, the UT presently ranks 34 amongst states and UTs in terms of area (as per 2011 census).

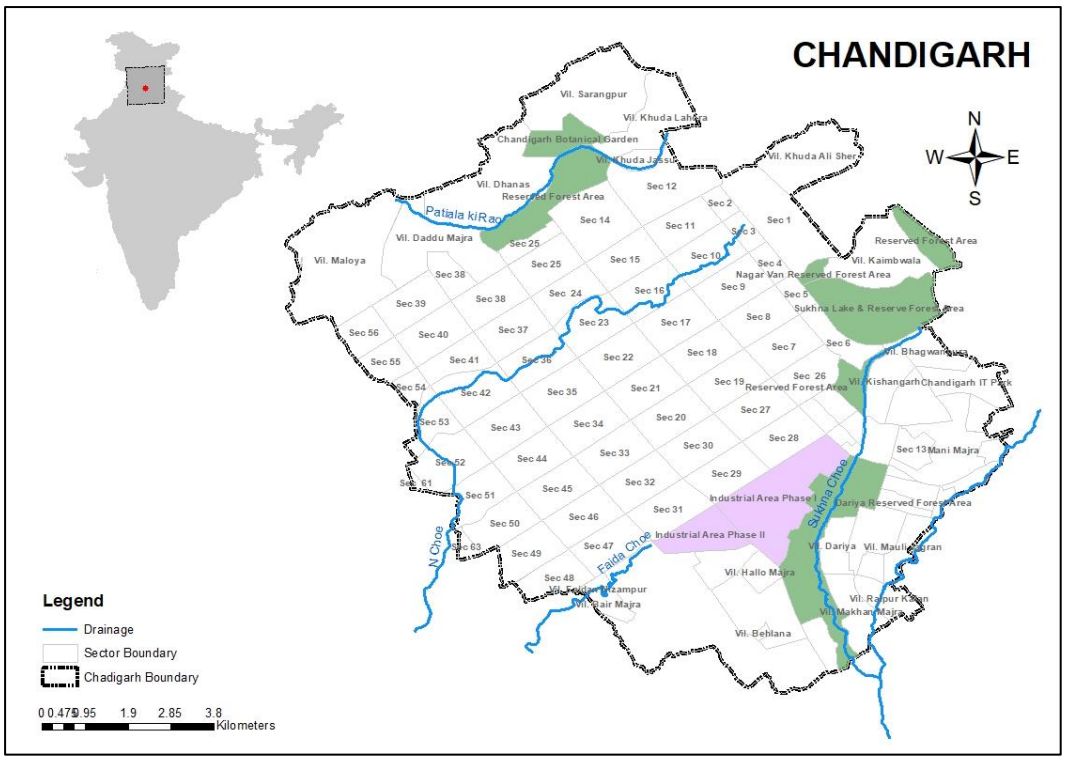


Figure 2.1: Physical map of Chandigarh

The UT is occupied by Kandi (Bhabhar) in the north-east and Sirowal (Tarai) and alluvial plains in the remaining part. The subsurface formation comprises of beds of boulders, pebbles, sand, silt, clays and some gravels. The area is drained by two streams viz. Sukhna Choe in the east and Patiala-Ki-Rao Choe in the west. The central part forms a surface water divide and has two minor streams. The stream passing through the central part is called N-Choe. Over the years, Chandigarh has gradually transformed completely to an urban area, with its area under rural administration decreasing by over 90%. As per 1971 census, the rural area was 56.40 sq. km (1971), decreasing over the years to 34.66 sq. km (2001). As per the 2011 census, this area had further decreased to 4.47 sq. km (Figure 2.2)[10]. Thirteen villages under the rural area of 4.47 sq. km, were included under the Municipal Area of the Municipal Corporation of Chandigarh in 2018[11], leaving Chandigarh as a complete urban city.

[10] Statistical Abstract, Chandigarh, 2018; Details available at <http://chandigarh.gov.in/sites/default/files/stat18/Abstract2018/stat18-T2.pdf>

[11] Statistical Abstract, Chandigarh, 2020; Details available at < https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

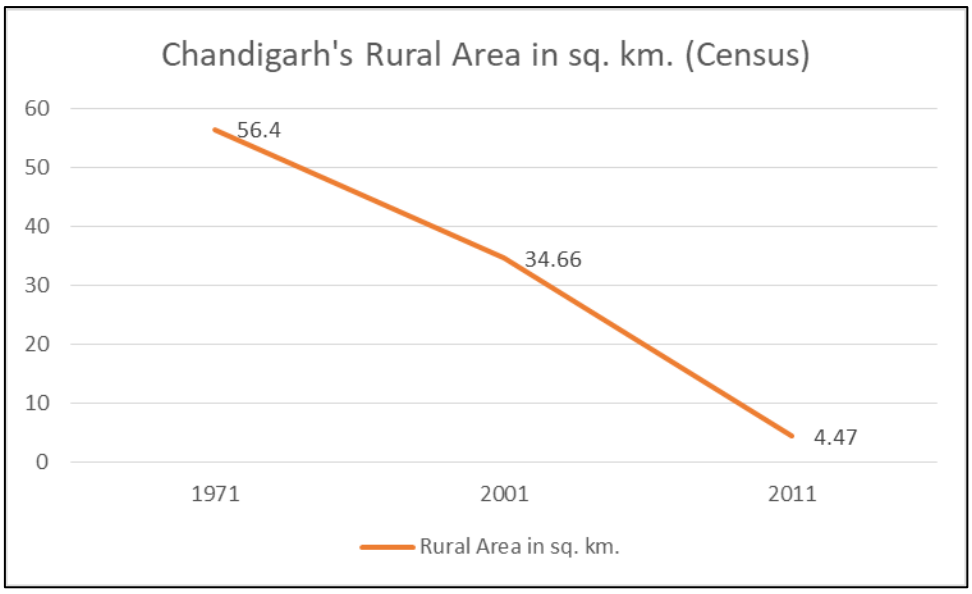


Figure 2.2: Chandigarh's share of rural area over Census Years
Source: Statistical Abstract, Chandigarh, 2020

2.2 Demographic Profile

The master plan prepared by Le Corbusier for Chandigarh was developed for a finite population of five lakhs. However, during the last six decades (1951–2011), Chandigarh has witnessed a manifold population increase, crossing the 10-lakh mark, as per the 2011 census. The estimated population of Chandigarh was 10.55 lakh in 2011 (Census of India 2011)[12]. As per the census data, the population density of the union territory increased from 7900 in 2001 to 9258 in 2011 per sq. km, which increased nine-fold since 1961. The city's decadal population growth rate has been consistently high, with the 17.10% growth rate for the 2001–11 period being the slowest since its inception (Table 2.1). Yet, Chandigarh shall continue to record higher densities with further population growth as projected, which is the estimated holding capacity of the city, and this poses a challenge for maintaining the quality of life and providing essential services even to its poverty-stricken residents, as envisioned by the city's planners (Chandigarh Master Plan – 2031)[13]. The population projection for the UT is based on mathematical method, where 2011 census data and sample registration system (SRS) use time series data of fertility and mortality. This population has been estimated to be 13,60,000 by 2036, showing an increase of ~29% (from 2011 census population) (Figure 2.3)[14].

[12] Census of India (2011). Government of India. Details available at <https://www.census2011.co.in/census/state/chandigarh.html>

[13] Chandigarh Master Plan- 2031. Chandigarh Administration. Details available at <https://chandigarh.gov.in/chandigarh-master-plan-2031>

[14] Population Projections for India and States 2011–36. Report of the technical group on population projections, July 2020. National Commission on Population, Ministry of Health, and Family Welfare. Details available at <https://chandigarh.gov.in/chandigarh-master-plan-2031>

Table 2.1: Population of Chandigarh from 1961 to 2011 (based on Census figures)

Year	Total	Males	Females	Decennial	Rate	of Growth
1961	119881	72576	47305	-		
1971	257251	147080	110171	+114.59		
1981	451610	255278	196332	+75.55		
1991	642015	358614	283401	+42.16		
2001	900635	506938	393697	+40.28		
2011	1055450	580663	474787	+17.19		

Source: Statistical Abstract, Chandigarh, 2020[15]

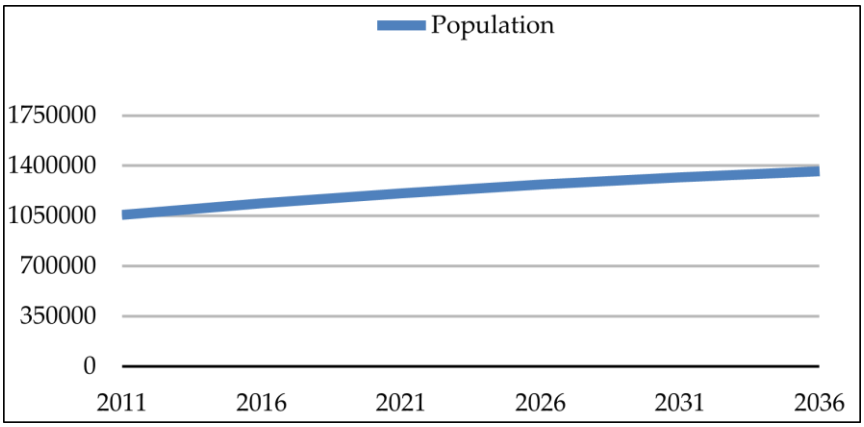


Figure 2.3: Proposed population projection for Chandigarh[16]

The rate of urbanization of the UT has also been increasing over the past decades, with 97.30% being the urban population, which will now be 100%, considering the complete urban transformation of the city. The slum population of total population had reduced to 9.01% in 2011 Census from 11.89% in 2001 Census. The sex ratio of Chandigarh has improved (818 females per 1000 males), however, it is still below the national average of 940 females per 1000 males, as per the 2011 census. Chandigarh has always recorded a high literacy rate since its inception due to the establishment of superior educational infrastructure. As per Census 2011, over 8 lakhs persons were literate in the UT, translating to a literacy rate of around 86%, compared to the all-India average of 74%. Though the literacy rate of females (81.2%, 2011 census) is not the same as that of males (90%, 2011 Census), there has been a steady increase over the years (Table 2.2)[17].

[15] Statistical Abstract, Chandigarh, 2020; Details available at < https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

[16] Population projections for India and States (2011-2036), Report of the technical group on population projections. July 2020. Ministry of Healy & Family Welfare. Details Available at <https://main.mohfw.gov.in/sites/default/files/Population%20Projection%20Report%202011-2036%20-%20upload_compressed_0.pdf>

[17] Statistical Abstract of Chandigarh, 2020. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

Table 2.2: Comparison of Demographic Profile of Chandigarh and India

Particulars	Chandigarh		India	
	2001	2011	2001	2011
Population (in Lakh)	900635	1055450	10287.38	12101.93
Population Decadal Growth Rate (%)	40.33	17.10	17.60	21.50
Population Density (person per sq km)	7900	9258	324	382
% of SC Population	157597	199086	-	8.63
Sex Ratio (Females per 1000 Males)	777	818	933	943
Literacy Rate (%)	81.9	86	64.83	74.04
Male Literacy Rate (%)	86.1	90	75.26	82.14
Female Literacy Rate (%)	76.5	81.2	53.67	65.46

Source: Statistical Abstract, Chandigarh, 2020

As per Census 2011, the poverty estimates for 2011–12, based on Tendulkar methodology suggested by the expert group on 'Methodology for Estimation of Poverty' chaired by Dr Suresh D. Tendulkar, Chandigarh's poverty rate was 21.81%, in close proximity to the national average of 21.92%[18]. The percentage of total workers (main workers + marginal workers + non-workers) to the total population of the UT has increased very minimally from 2001 to 2011, from 37.8% to 38.3%. The increase in marginal workers between this period has been more (1.3%–1.7%) than the increase in main worker to the total population (36.5%–36.6%). Of the total population, the proportion of agricultural labour to the total workers is only 0.4%[19].A notable point is the high level of gross enrolment ratio (GER) in the UT for higher studies, which is evident from the GER of 87.4% in senior secondary schools (classes XI–XII) in 2017–18, compared to the all-India average of 56.5%, and GER of 52.1% in higher education (18–23 years age group) in 2019–20, compared to the all-India average of 27.1%[20].

2.3 Economic Profile

Industry

Chandigarh is characterised as a regional hub in the areas of service industry, education, health, information technology, food, and vegetable processing, etc. Chandigarh has put efforts for ensuring sustainable growth, during last couple of years, by augmenting better fiscal consolidation and economic development. Chandigarh contributes INR 4367434 lakh in the country's gross domestic product (GDP) and ranks 25 among other states/UT in GDP contribution. According to the Economic Survey (2021-2022) Chandigarh's net state domestic product (NSDP) at current prices is estimated at INR 39173 crore in 2019-2020 as against INR 35793 Crore in 2018-2019, showing an annual growth of 9.4% during this year. This translated to a per capita NSDP for financial year 2019-2020 being INR 3.3 lakh, which was the fourth highest amongst all the states and UTs, and more than 2.5 times the all-India net national

[18] Press Note on Poverty Estimates, 2011-12, Government of India Planning Commission. Details Available at <https://pib.gov.in/newsite/erelcontent.aspx?relid=97365>

[19] Statistical Abstract, Chandigarh, 2020. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

[20] Statistical Appendix, Economic Survey, 2021-22. Details Available at <https://www.indiabudget.gov.in/economicsurvey/doc/Statistical-Appendix-in-English.pdf>

income of INR 1.15 lakh[21]. For the subsequent years, the per capita gross state domestic product has also seen an increase from INR 1.8 lakh in 2011-2012 to INR 3.3 lakh in 2020-2021 (Figure 2.4)[22].

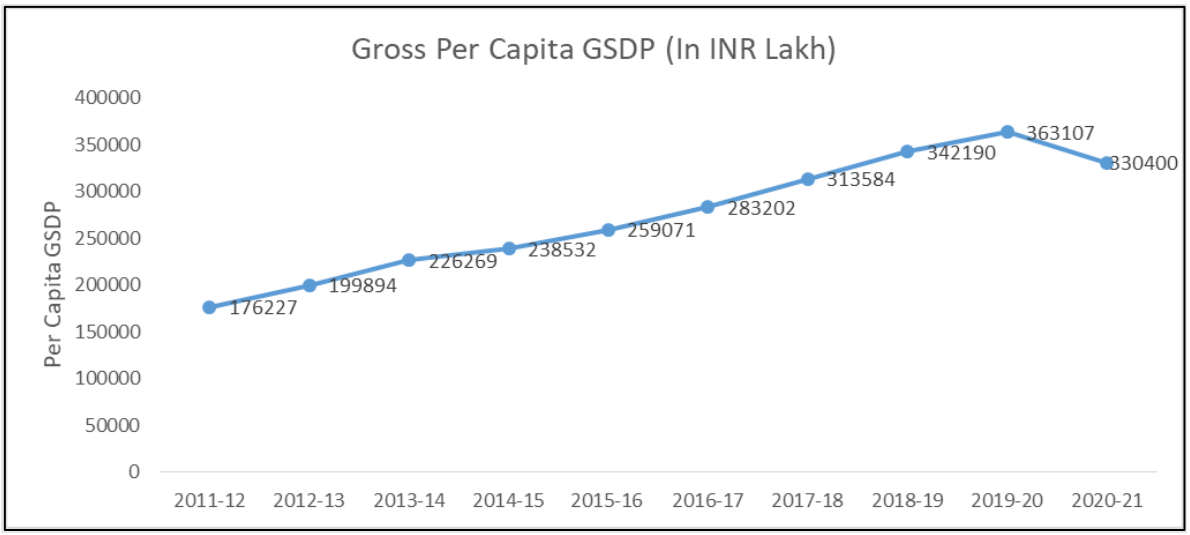


Figure 2.4: Per Capita Gross State Domestic Product (GSDP) [23]

Other industries based in the territory include IT, electronics, pharmaceuticals, machine tools, and plastics. A special emphasis by the Chandigarh Administration has been put on developing the Rajiv Gandhi Chandigarh Technology Park (RGCTP), to make Chandigarh a preferred destination for IT Companies and to generate employment opportunities in the UT for its skilled young citizens. This has been envisaged as an environmentally friendly IT park, spread across 350 acres, and has been accorded the special economic zone (SEZ) status since 2006[24].

The concept of industries has however, been changed to enterprises, which are broadly classified on basis of: 1. Enterprises engaged in the manufacture/production of goods pertaining to any industry; and 2. Enterprises engaged in providing/rendering of service. The production from micro, small/medium enterprises has been increasing in the past years, seeing the production nearly doubling between 2017–2018 and 2018–2019 (from INR 3196.33 crore (2017–2018) to INR 6292.55 crore (2018–19), reaching INR 7449.86 crore in 2019–20. The increase in production for large enterprises has been ~35%, reaching INR 2186.22 crore in 2019–20 from INR 1933.87 crore in 2018–19 and 1610.52 crore in 2017–2018[25].

[21] Statistical Appendix, Economic Survey, 2022-23. Details Available at <https://www.indiabudget.gov.in/economicsurvey/doc/Statistical-Appendix-in-English.pdf>

[22] Handbook of Statistics on Indian States. Details Available at <https://m.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+States>

[23] Handbook of Statistics on Indian States. Details Available at <https://m.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook+of+Statistics+on+Indian+States>

[24] Department of IT - Chandigarh Administration. Details available at <https://chdit.gov.in/rgctp>

[25] Statistical Abstract of Chandigarh, 2020. Chapter 9: Industries. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-industries.pdf>

As per the Economic Survey 2022-2023, the share of the services sector in Chandigarh's Gross State Value Added is over 86.7%, which is the highest in India (Table 2.3) [26].

Table 2.3: Gross state value added (GSVA) by economic activities at current prices: 2020-2021 (In INR lakh)

Sectors and Sub-Sectors	Amount (in INR Lakh)
Primary sector	**29,716**
Agriculture, forestry, and fishing	25,404
Livestock	23,265
Crops	2,139
Forestry and Logging	4,051
Mining and quarrying	0
Secondary sector	**3,82,983**
Manufacturing	1,40,180
Construction	1,70,678
Electricity, gas, water supply, and other utility services	72,125
Tertiary sector	**33,12,492**
Trade, repair, hotels, and restaurants	10,53,141
Transport, storage, communication, and service related to broadcasting	1,53,263
Financial services	5,38,220
Real estate, ownership of dwelling and professional services	9,63,014
Public administration	3,14,114
Other services	2,90,740
Total state value added at basic prices	**3,72,51,91**
Product Taxes	**2,54,756**
Product Subsidies	**8,538**
Gross State Domestic Product	**39,71,409**
Per capita GSDP	**3,30,400**

Source: Department of Economics and Statistics, 2022-2023

Tourism

Chandigarh being India's first planned city is a rich, prosperous, and green city and it is also a site for great architectural creations involving modern planning and landscape. Tourism sector is one of the important aspects of Chandigarh providing direct and indirect employment. Tourists from across the world visit Chandigarh for Sukhna lake, Capitol Complex, Kansal and Nepli Forests Reserve, Rajiv Gandhi Technology Park, Rock Garden, and Rose Garden. In 2016, the Capitol Complex was considered a UNESCO World Heritage Site.

The GSVA of the tourism sector has increased from 55945 in 2011-2012 to 117584 in 2019-2020 though there was a dip in 2020-2021 (52040) due to COVID-19. The UT witnesses a substantial number of tourists annually. The tourist footfall has been increased over the years, a rise in

[26] Statistical Appendix, Economic Survey, 2022-23. Details Available at <https://www.indiabudget.gov.in/economicsurvey/doc/Statistical-Appendix-in-English.pdf>

trend has been observed from 2017. It has been observed 25% increase in foreign tourists since after receiving UNESCO World Heritage Status for its Capitol Complex buildings in 2016. While 31549 foreigners visited Chandigarh in 2016, the figure increased to 39681 in 2018. Similarly, the domestic visitors, who were 11.8 lakh in 2016, increased to 15.4 lakh in the next two years. After 2019, there is a decline in the number of domestic and foreign tourists can be observed owing to COVID-19 situation and restrictions on travel during the pandemic.

Table 2.4: Tourist footfall in Chandigarh (2014–2020)[27]

	2014	2015	2016	2017	2018	2019	2020
Tourists	1089784	1103380	1213053	1457613	1578477	1607927	430171
Foreign	28365	29538	31549	31832	39681	44132	12218
Domestic	1061419	1073842	1181504	1425781	1538796	1563795	417953

Source: Statistical Abstract of Chandigarh, 2020

2.4 Natural Resource Profile

2.4.1 Land Resources

Out of total area in Chandigarh, the maximum area is residential of about 10672.16 acre, 1339.73 acre of land is under commercial purposes, 2046.1 acre is under transport, 1326.5 acre is under industrial area, 2968.79 acre is under public/semi-public, 2428.47 acre is under recreational use, 302.33 acre is under public utilities, around 136.29 acre is under railways, 1573 acre is under defence, 2113.97 acre of land is under forest land, 2046.1 acre of the total land is vacant, 277.29 acre of land is under green belts and 302.33 acre of land is under water treatment plant/sewage treatment plant[28].

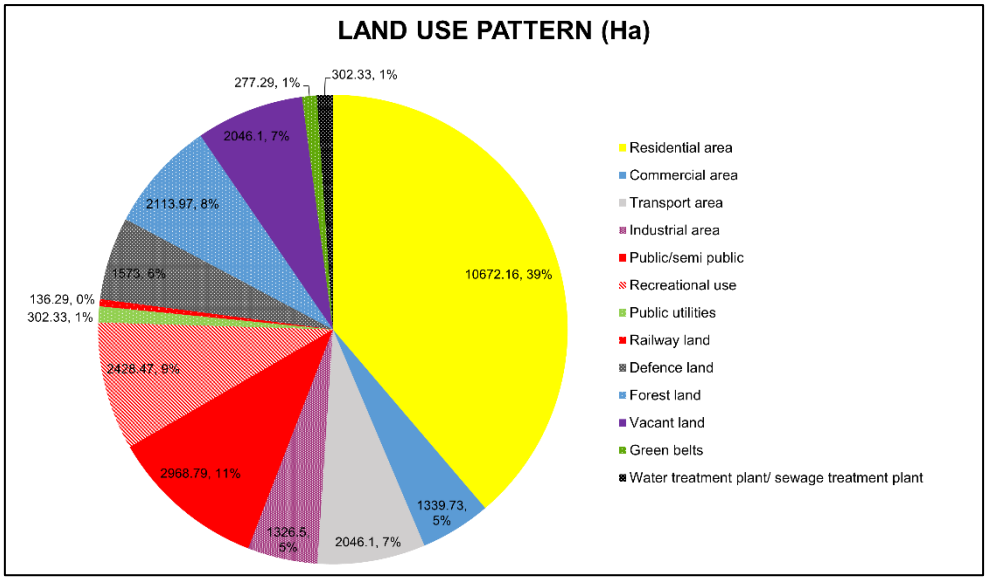


Figure 2.5: Category wise distribution of Land Use Pattern in Chandigarh

Source: Department of Environment, Chandigarh, 2018

[27] Statistical Abstract of Chandigarh, 2020. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

[28] Newsletter, ENVIS Centre. Land Use Pattern: Chandigarh (UT). Department of Environment, Chandigarh, April-June 2018. Details Available at <https://chandigarhenvis.gov.in/sites/default/files/documents/NL04062018.pdf>

2.4.2 Water Resources

The annual average rainfall of Chandigarh is 1059.3 mm which is calculated to be 60380.1 million litres or 13241 gallons or 36.28 MGD per annum. Chandigarh receives most of its rainfall during the months from July to September. This is a vital source of water that helps rejuvenate ground water resources and various other aquifers present at different locations in the UT[29].

The UT of Chandigarh falls under the Ghaggar Basin. Resources of surface water in Chandigarh comprise of Choe and lakes. Sukhna Choe and Patiala ki Rao are the two major streams of the UT with their origin in the Shivalik hills ranges and form the natural drainage of the UT. The Sukhna Choe flows north to south, drains the eastern part and joins the Ghaggar River. The other important stream is Patiala-ki Rao, which flows northeast to southwest and drains the northern parts of the UT. Both these streams are ephemeral in nature and carry high flows during monsoon. The N-Choe flows through the leisure valley and drains major parts of the city. It flows from northeast to southwest direction and traverses north central part of the city. Another Choe Choi Nala originates from Sector-31 and drains the southernmost part of the city. In case of lakes, there are three of them named i.e., Sukhna Lake, Dhanas Lake and New Lake in the UT. Sukhna Lake is also a major tourist attraction, was constructed in 1958 across Sukhna choe (Figure 2.6). The total catchment area of the lake is 42.07 sq.km. of which 34.42 sq.km. falls in the UT and 7.7 sq.km. falls in the state of Haryana. The water holding capacity of the lake is around 5 million cubic meters (MCM) [30].

[29] Newsletter, ENVIS Centre. Land Use Pattern: Chandigarh (UT). Department of Environment, Chandigarh, April-June 2018. Details Available at <https://chandigarhenvis.gov.in/sites/default/files/documents/NL04062018.pdf>

[30] Newsletter, ENVIS Centre. Lakes of Chandigarh. Department of Environment, Chandigarh, April-June 2021. Details Available at <https://chandigarhenvis.gov.in/sites/default/files/pdffiles/NL04062021.pdf>

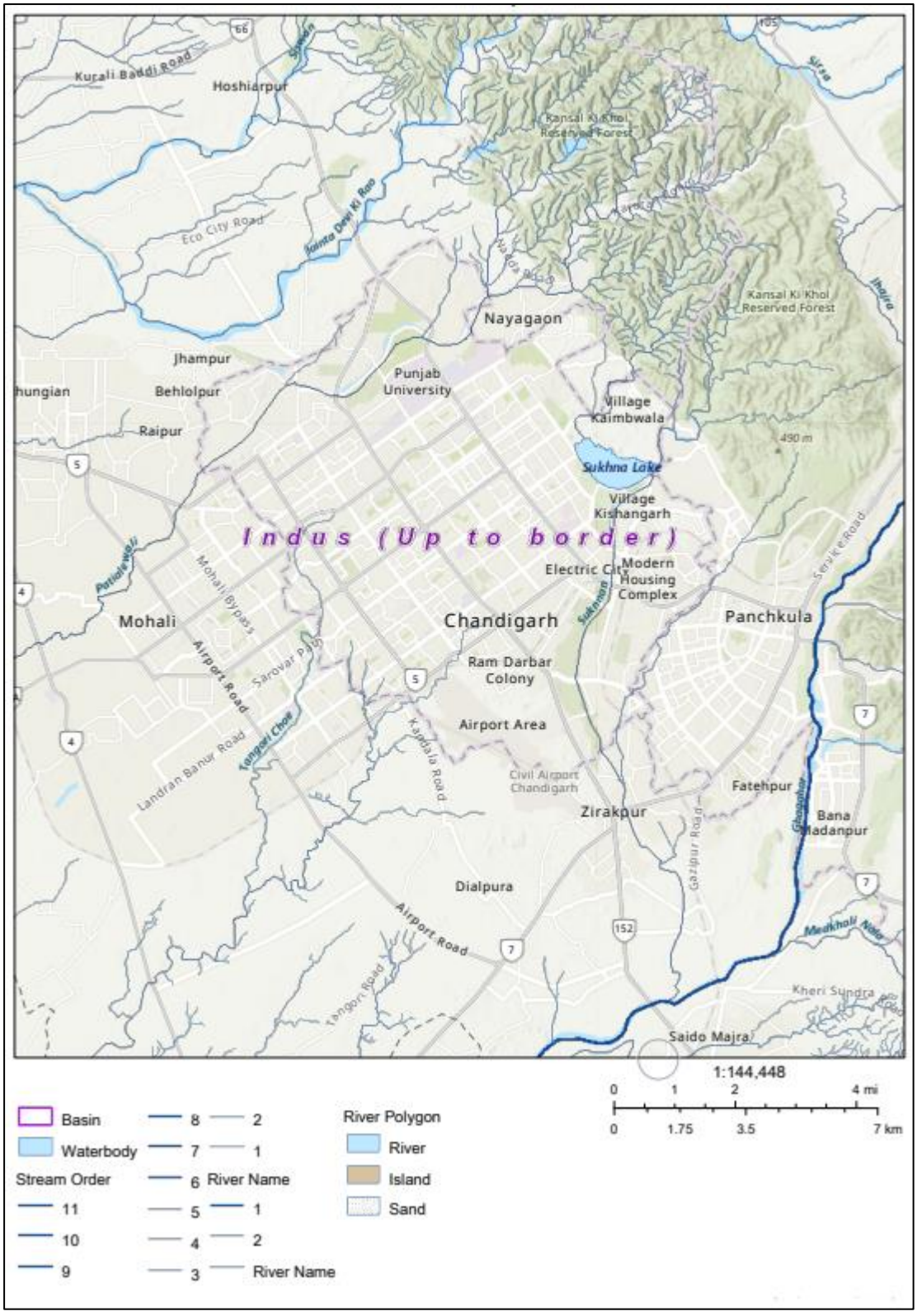


Figure 2.6: Drainage Map of the UT

Source: India Water Resources Information System, Department of Water Resources, RD & GR, Ministry of Jal Shakti[31]

[31] India Water Resources Information System, Department of Water Resources, RD & GR, Ministry of Jal Shakti. Details Available at <https://indiawris.gov.in/wris/#/riverBasins>

Chandigarh is underlain by the quaternary alluvial deposits and comprises layers of fine sand and clay. Coarser sediments occur along the Sukhna Choe and Patiala-ki Rao, whereas relatively finer sediments underlie the area between these two streams. Fair to good aquifer horizons occur in most part of Chandigarh comprising medium to coarse sand, to a depth of 180 mbgl below which they become finer. Ground water in the region in the UT occurs under confined as well as semi-confined conditions. In Manimajra, ground water occurs under unconfined conditions down to about 80m. In other areas, the semi-confined conditions prevail below 20 to 30 m. The depth of the shallow aquifer system is less than 30 mbgl, whereas the depth of the deeper aquifer system ranges from 40 to 450 mbgl of explored depth. Ground water is found to be fresh and suitable for drinking as well as irrigation purposes[32].

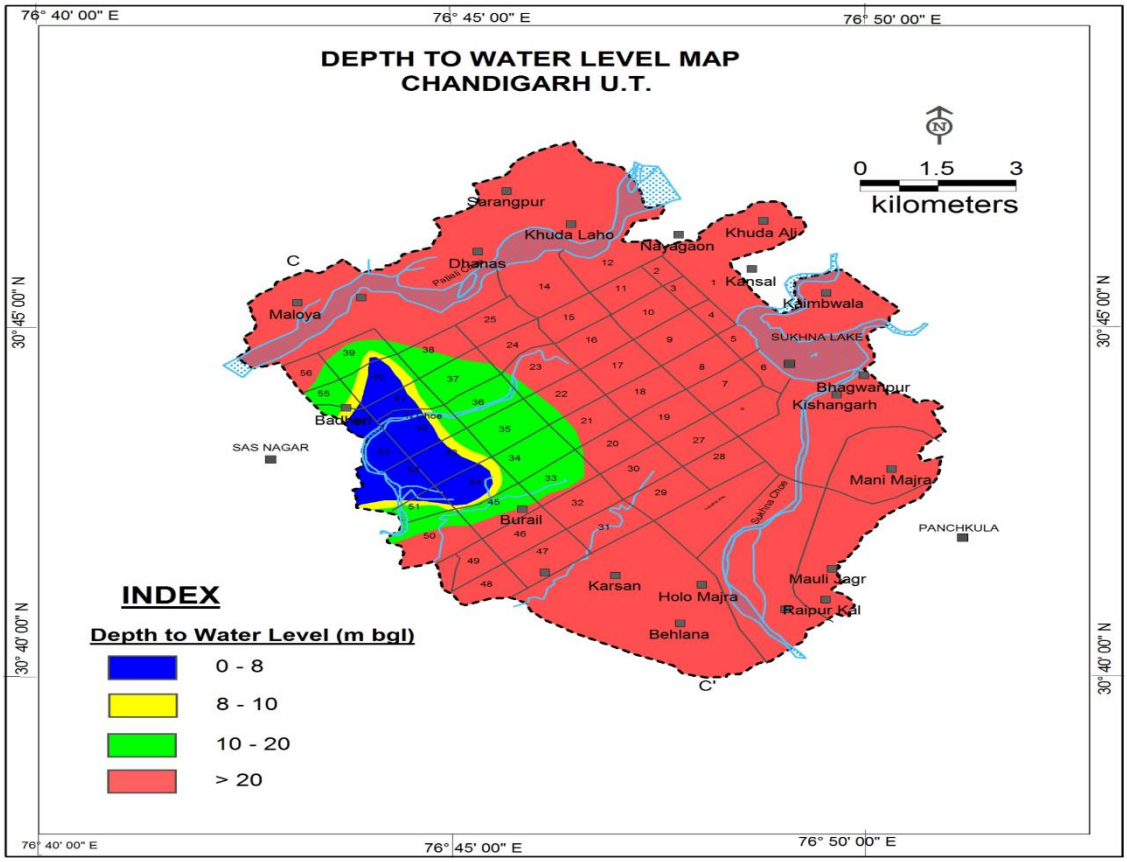


Figure 2.7: Depth to Water level map (2021) of Chandigarh UT

Source: Public Health Department, Municipal Corporation of Chandigarh

According to the CGWB groundwater assessment reports, 70 % of total annual ground water extraction i.e., 37.93 MCM is for domestic use. The rest 30% of the extraction is for industrial and irrigation use. The UT of Chandigarh has been categorized as 'Semi Critical' by CGWB with stage of ground water extraction at 80.99%. In comparison to 2020 assessment, total annual recharge has decreased from 63.75 MCM to 52.04 MCM. The current ground water

[32] Ground water Information booklet, Chandigarh UT, CGWB, 2013. Details Available at <http://cgwb.gov.in/District_Profile/Chandigarh/CHANDIGARH.pdf>

extraction also decreased from 46.24 MCM to 37.93 MCM owning to the decrease in the ground water extraction for domestic use (table 2.5) [33].

Table 2.5: Comparison of ground water resources of Chandigarh

	2004	2009	2011	2013	2017	2020	2022
Annual replenishable ground water resources (MCM)	22.55	21.73	21.56	21.59	42.16	63.75	52.04
Annual extractable ground water resource (MCM)	20.30	19.56	19.40	19.43	37.94	57.38	46.84
Annual ground water extraction for domestic use	NIL	NIL	NIL	NIL	33.20	34.83	26.25
Annual ground water extraction for industrial use	NIL	NIL	NIL	NIL	0	1.9	2.17
Annual ground water extraction for irrigation use	NIL	NIL	NIL	NIL	0.58	9.5	9.5
Gross ground water draft (MCM)	NIL	NIL	NIL	NIL	33.78	46.24	37.93
Stage of ground water development	0	0	0	0	89%	80.6%	80.99%
Category	Safe	Safe	Safe	Safe	Semi Critical	Semi Critical	Semi Critical

Source: CGWB, 2022, 2020, 2017, 2013, 2011, 2009, 2004

When it comes to the water supply, the UT depends on freshwater as surface and groundwater as its source. The Municipal Corporation of Chandigarh ensures piped water supply to almost 100% of all households. Chandigarh has one of the highest water availabilities in the country, with a per capita availability of 225 litres per capita per day (LPCD). In terms of surface water, the UT's resources include the Bhakhra Main Line (BML), the Sukhna Lake, Sukhna Choe, and the N Choe. For groundwater, the UT taps its deep aquifers because of better water quality than the shallow aquifers. As a result, the deep aquifers face the issue of over extraction while the shallow aquifers overflow at some locations mostly situated in the southern parts of the UT. The city has been divided into 6 zones for the purpose of water supply keeping in view the slope of the city. Each of these zones is fed through an independent water works namely water works-Kajauli, Jhandpur, 52, 39, 37, 32, 26, 12, 13-1, 13-2. These water works are fed from mother water works i.e., water works-39, which receive canal water from water works Kajauli and various tubewells (about 289 Nos.) spread all over Chandigarh.

2.4.3 Forest Resources

Chandigarh is one of the greenest cities, with over 50% of its area being under green cover. As per the India State of Forest Report (ISFR) 2021 released by the Forest Survey of India (FSI), 44.88 sq. km, or 40% of Chandigarh's total area, is under forest cover. Further, the protected area network in the UT has two wildlife sanctuaries, i.e., Sukhna Wildlife Sanctuary and the City Birds Wildlife Sanctuary, covering an area of 26.01 sq. km which is 22.81% of the total geographical area. The forest cover in the UT has increased by 0.85 sq. km as compared to the previous assessment reported in ISFR 2019. The area under gardens in the UT has also been

[33] National Compilation of Dynamic Ground Water Resources of India, CGWB, Department of Water Resources, Ministry of Jal Shakti, Government of India, 2022, 2020, 2017, 2013, 2011, 2009, 2004. Details Available at <http://cgwb.gov.in/Dynamic-GW-Resources.html>

increasing steadily with total increase of 16.7% from 2004–2005 till 2019–20 (reaching 953 acres). Similarly, as per data released by the Forest Department, Chandigarh there has been an increasing trend in the total green cover in the UT since 2001 till 2021 (Figure 2.8) [34,35]. To sustain the momentum and density of the green cover, regular plantation drives on significant days such as during the Van Mahotsav, World Environment Day along with the regular distribution of medicinal and fruit-bearing plants are carried out. The plantation drive has received a boost through the "Ek Ped Ma Ke NAAM" campaign drawing significant participation from the residents of Chandigarh.

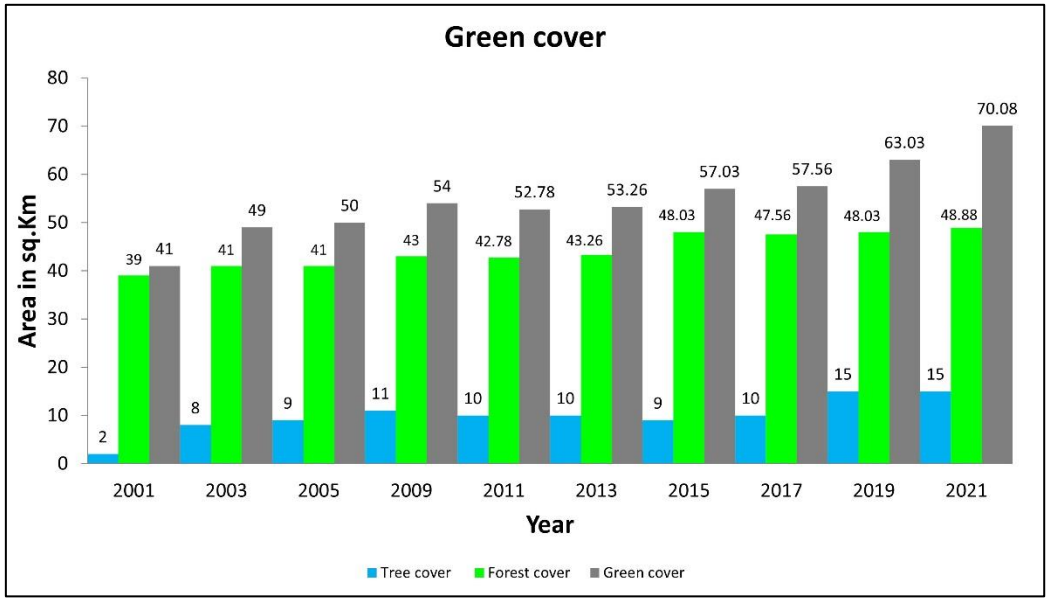


Figure 2.8: Trend of Increase in Green Cover (Forests and Tree Cover) of Chandigarh

Source: Greening Chandigarh Action Plan, 2022-2023

2.4.4 Biodiversity Resources

Chandigarh has a rich reservoir of biodiversity. A notable initiative of the Department of Forest of Wildlife involves replacing invasive lantana weed with native tree species in Sukhna Wildlife Sanctuary and other forest areas. From 2001 to 2008-09, a significant part of the wildlife sanctuary's forest, heavily infested with lantana, was restored. This eradication enabled the regeneration of indigenous species like Bansa, Ratti, Karipatta, and Karaunda, improved wildlife grazing grounds, and enhanced floral and faunal biodiversity. Additionally, the removal of lantana significantly reduced forest fire risks, aiding in habitat restoration and biodiversity conservation. Chandigarh Administration's Botanical Garden near village Sarangpur, Khudda Lahora and Dhanas which is spread over an area of 176 acres has Miyawaki plantation and is engaged in free distribution of saplings during Van Mahotsav, land levelling, construction of check dams which are the ongoing efforts under the adaptation interventions in the Forest and Wildlife Sector.

[34] Greening Chandigarh Action Plan 2022-2023. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2022/07/GCAP-1.pdf>

[35] India State of Forest Report 2021. Chapter 2 – Forest Cover. Details available at <https://fsi.nic.in/isfr-2021/chapter-2.pdf>

1. In 2010, the first wildlife census was conducted by the Forest and Wildlife Department of Chandigarh, and experts from other institutes and organizations. The following are the main species of flora and fauna found in the sanctuary:

    a. Flora: There is a wide range of trees, shrubs, herbs, grasses and climbers found in the sanctuary. The predominant species among them are: Kikar, Khair, Phulai, Raeru, Shisham, Chhal, Semal, Neem, Kachnar, Ama, Dhak, Jhingan, Musket, Amaltas, Ber etc.[36] Through various plantation drives Chandigarh is well aligned with the goals of the Kunming-Montreal Global Biodiversity Framework (GBF), National Biodiversity Targets (NBT) as well as the Green India Mission.

    b. Fauna: Birds - The sanctuary is home to more than 263 varieties, including aquatic birds. Peacock, Red Jungle Fowl, Cuckoos, Night Jars, Kingfisher, Hornbills, Woodpeckers, Doves, Plovers, Hawks, Geese, Swan, Ducks etc. are the predominant species of bird found in the area; Mammals: Common species found are- leopard, sambhar, spotted dear, wild boar, jackal, jungle cat, porcupine, squirrel etc[37].

2. More than 30,000 species of insects belonging to about 9 orders and more than 30 families are reported from Chandigarh region. The fauna of Chandigarh region includes about 2000 species of beetles, 100 species of Butterflies, 300 species of moths, about 70 species of bees and wasps, 62 species of ants, 60 species of dragon and damsel flies, 50 species of gryllids, 44 species of grasshoppers and about 60 species of flies.

3. The different zoological types found in the region are fishes (thail and rohu), frogs (Indian tiger frog, Indian rice frog and Indian burrowing frog), tortoise, snakes (russels viper, cobra, blind snake, Indian python, sand cobra and rat snake), birds of over 100 different kinds and mammals including grey musk, shrew monkey, langur, flying fox, tickellis bat, stripped squirrel, Indian rat, common rat, house mouse, Indian porcupine, Indian hare, common mongoose, stripped hyena, jackal, Indian fox, nilgai, blackbuck, sambhar, and chital. Additionally, 860 species of flowering plants are found in Chandigarh and its neighbourhood. These represent 526 genera from 116 families. Common species of mammals found are leopard, sambhar, spotted dear, wild boar, jackal, jungle cat, porcupine, squirrel etc[38].

4. With respect to Non-Timber Forest Products (NTFPs) in Chandigarh, the major species are as follows:

[36] Flora and Fauna of Chandigarh, n.a. Chandigarh Administration, Government of India. Details available at <https://chandigarh.gov.in/flora-and-fauna>

[37] Wildlife Census of Chandigarh, 2010. Department of Forest & Wildlife, Chandigarh Administration, Government of India. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2020/01/dept-forest-wild-census-dec10.pdf#:~:text=Firstever%20Wildlife%20Census%20conducted%20in%20Sukhna%20Wildlife%20Sanctuary%2C,UT%20Administration%20in%20overall%20supervision%20of%20experts%20from>

[38] Flora and Fauna of Chandigarh, n.a. Chandigarh Administration, Government of India. Details available at <https://chandigarh.gov.in/flora-and-fauna>

Table 2.6: Major species of NTFPs

S. No.	Species	Plant Type	Relative Abundance (%)
1.	Morus Species	Tree	61.54
2.	Ziziphus mauritiana	Tree	15.38
3.	Psidium guyava	Tree	5.13
4.	Cassia fistula	Tree	5.13
5.	Azadirachta indica	Tree	5.13

Source: Forest Survey of India (2019), Chandigarh[39]

2.5 Agriculture and Livestock Profile

Chandigarh is minimally an agriculture-based economy, being an urban area, it has a limited area under agriculture. The sectoral contribution of agriculture, forestry, and fishing to the gross state value added (GSVA) by economic activity at current prices for 2019–20 was a mere 0.05%[40]. The proportion of agricultural labour to the total workers is also just 0.4%, as per the 2011 census data.

The land utilization in the UT, has mostly been classified as 'land not available for cultivation purposes' (~76%), followed by 16% of land being under the category of 'net sown area'. However, the net sown area has decreased over the years. The area under the forest has remained same over the time duration (2015-2020) but there is considerable increase in the fallow and uncultivated land[41].

Table 2.7: Land utilisation in Chandigarh (2015-2020)

Land Utilisation (%)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
Forests	3.02	3.02	3.02	3.02	3.02
Not available for cultivation	77.94	76.24	76.48	76.51	76.61
Other uncultivated land excluding fallow lands	2.09	2.45	2.45	2.45	2.47
Fallow Land	1.11	1.47	1.47	1.46	1.46
Net Area Sown	15.84	16.82	16.58	16.56	16.44

Source: Statistical Abstract of Chandigarh, 2020

As per the 20th Livestock Census conducted in 2018-2019, Chandigarh had a total of 26928 livestock, the second lowest amongst all the states and UTs in India (above Daman and Diu), of which 25,617 was bovine livestock[42].

[39] Forest Survey of India (F.S.I) Report, 2019. Details Available at <http://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-chandigarh.pdf.>

[40] Statistical Appendix, Economic Survey, 2022-23. Details Available at <https://www.indiabudget.gov.in/economicsurvey/doc/Statistical-Appendix-in-English.pdf>

[41] Statistical Abstract of Chandigarh, 2020. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

[42] 20th Livestock Census.2019. All India Report. Details available at <https://www.dahd.nic.in/sites/default/filess/Key%20Results%2BAnnexure%2018.10.2019.pdf>

2.6 Energy Profile

Chandigarh does not have any power-generating units of its own. The power demand is being met through allocation from central and state generating stations. Chandigarh receives electricity mainly through the three lines, namely Mohali (PSEB), Dhulkote (BBMB) and Nalagarh (PGCIL). Chandigarh's energy requirement and energy supplied as of April 2021 was 105 MU[43]. Owing to its well-planned and managed infrastructure, the power supply is well connected to all the consumers. There have been no power shortages observed over the last few years. The peak demand for 2020 was 272 MW and in 2021 it is anticipated to reach 320 MW[44]. As a result, Chandigarh is aiming to be an energy-efficient city by moving strongly towards adopting solar city plan to reduce dependence on conventional energy resources. There has been an increase in the installed capacity of electricity generation from renewable sources (excluding hydro) of 16.83% between 2018–2019 and 2019–2020[45].

2.6.1 Primary Energy Supply

Due to the lack of having its own generating capacity, the power demand is being met through allocation from central generating Stations. It receives 40% of its power through Mohali (PSEB), about 9% through Dhulkote (BBMB) and remaining 51% through Nalagarh (PGCIL). It also has banking arrangement with Jammu & Kashmir for 30 MW[46]. Thus, Chandigarh has been successfully able to meet the peaking demand as well as energy demand of the UT every year.

Chandigarh has good potential for promotion and development of non- conventional energy projects. There has been an increase in the installed capacity of electricity generation from renewable sources (excluding hydro) of 16.83% between 2018–2019 and 2019–2020. This growth rate is largely attributed to solar power installed capacity of grid interactive renewable which increased from 34.71 MW in 2019 to 40.55 MW in 2020. Other non-conventional sources of energy are also aimed to be developed in the UT. However, since the city does not have the necessary vacant spaces, the installation of windmills or wind turbines and hydropower generation is not possible leaving solar energy as the main alternative source to be explored.

With a subtropical humid climate and with high intensity solar light being available during most of the period throughout the year, solar energy is being developed as a major source of energy. The generation of solar energy is being developed by using solar water heaters, solar lights, blinkers, solar cookers, and electricity generation by solar panels, etc. The city is also leading towards a complete solar city with installation of solar panels over the roofs of houses, commercial buildings, schools, colleges, universities, hospitals, and government offices, etc. Solar lights have been installed at various places including parks, streetlights at roadsides and blinkers on the roads interconnecting different sectors of the city connect. Chandigarh is making all feasible efforts to become a Model Solar City by 2030, achieving significant milestones in renewable energy and electric vehicle adoption. As of 31st December, 2024, a

[43] Executive Summary on Power Sector. Central Electricity Authority. Details available at <https://cea.nic.in/wp-content/uploads/executive/2021/05/Executive_Summary_May_2021-3.pdf>

[44] Chandigarh Administration website, Details available at <https://chandigarh.gov.in/engineering>

[45] 24X7 Power for all, 2016. A Joint initiative of government of India and Ut of Chandigarh. Details Available at <https://powermin.gov.in/sites/default/files/uploads/joint_initiative_of_govt_of_india_and_Chndigarh.pdf>

[46] 24X7 Power for all, 2016. A Joint initiative of government of India and Ut of Chandigarh. Details Available at <https://powermin.gov.in/sites/default/files/uploads/joint_initiative_of_govt_of_india_and_Chndigarh.pdf>

total of 81.857 MWp of grid-tied rooftop solar power has been installed across 10234 sites. Helped in producing 270.26 MU; CO_2 reduction 1864794 MT. As of January 21, 2025, under the PM Surya Ghar Muft Bijli Yojana in Chandigarh, a total of 5,366 registrations have been received, out of which 1,293 applications have been submitted, and 607 installations have been completed. Furthermore, a subsidy amounting to ₹1.07 crore has been disbursed to 139 beneficiaries. Additionally, 242 inspections have been approved to date. A total of 6,247 government residential houses have been identified as feasible for solar installation, with an aggregate capacity of 18.1 MWp. Solar systems have already been installed on 5,705 of these houses, representing a capacity of 16.7 MWp. However, installation work remains on hold for 542 houses, where materials have been received but the installations are pending due to either vacancy (102 houses) or ongoing maintenance (440 houses), accounting for a capacity of 1.9 MWp. Furthermore, 456 meters have been installed, with an additional 2,442 meters planned for installation by January 31, 2025.

2.6.2 Energy Demand (present consumption per capita and projected energy demand)

The energy and peak demands are well managed in the UT, as no shortage has been observed from last many years. For instance, the peak demand from April to August 2021, was 426 MW, which was fully supplied[47]. However, Chandigarh's peak electricity demand is projected to grow to 587 MW by the year 2026–2027, resulting in 28% growth from the peak demand of 457 MW in 2019–2020. It should be noted that, this is significantly lower than the nearly 50% peak demand growth at the national level.

There has been a slight variation in the consumption of electric-power by uses over the last three financial years (2017-2018 to 2019-2020) with a decrease of 1.6%, reaching 1562.38 M.kWh in 2019–2020, compared to 1588.80 M.kWh in 2017–2018. This decrease was most visible in domestic consumption which decreased from 731.94 M.kWh in 2017–2018 (46% of total) to 628.56 M.kWh in 2019–2020 (40% of total). An increase of consumption of ~40% between 2017–2018 and 2019–2020 was seen in the industrial sector from 258.68 M.kWh (2017–2018), 260.42 M.kWh (2018–2019), to 363.16 M.kWh (2019–2020). However, the share of industrial consumption to total has stayed constant at 16.19%[48].

[47] Peak Power Supply Position Report,2021. Central Electricity Authority. Details Available at < https://cea.nic.in/wp-content/uploads/power_supply/2021/08/psp_peak_08-1.pdf>
[48] Statistical Abstract, Chandigarh, 2020; Details available at <https://www.chandigarh.gov.in/sites/default/files/stat2020/stat20-energy.pdf>

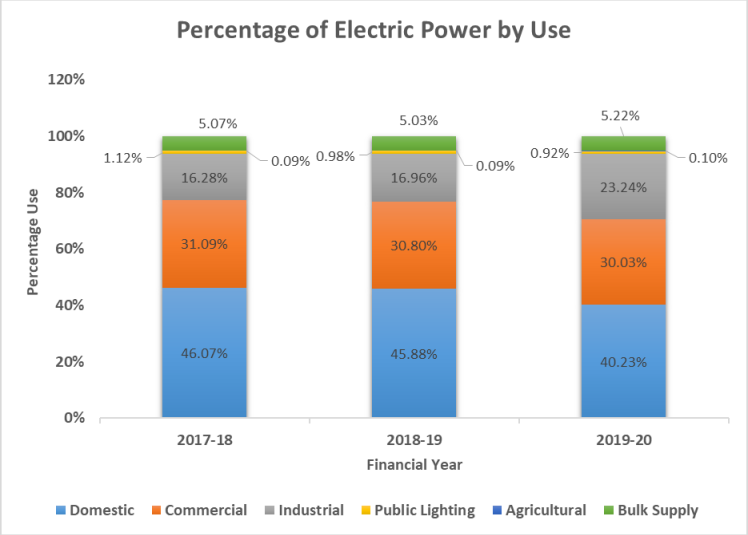


Figure 2.9: Percentage of electric power by use

Source: Statistical Abstract of Chandigarh, 2020

The Electricity Department is providing 24 hours power supply to all consumers and there is also no un-electrified household in the UT. The annual per capita consumption of electric power in Chandigarh was 1588 M.kWh in FY 2017–18, which has seen a drop in the following years reading 1562.38 M.kWh in 2019–20. The average sale of electricity per consumer in 2017–18 was 6526 kWh (Chandigarh government), seeing a variation in the following years—6844 kWh in 2018–19 and 6630 kWh in 2019–20. The electricity tariffs of the UT are determined by the approval of Joint Electricity Regulatory Commission (JERC)[49].

Table 2.8 Installed capacity of power utilities in Chandigarh and India (in MW)

Installed capacity of power utilities in Chandigarh and India as on 31 August 2021 (Including allocated shares in Joint and Central sector utilities) (in MW)

Ownership Sector	Mode-wise breakup								Grand total
	Thermal					Nuclear	Renewable		
	Coal	Lignite	Gas	Diesel	Total		Hydro	RES (MNRE)	
State	0	0	0	0	0	0	0	0	0
Private	0	0	0	0	0	0	0	51.97	51.97
Central	44.83	0	15.03	0	59.86	8.01	101.71	0	169.57
Sub-total	44.83	0	15.03	0	59.86	8.01	101.71	51.97	221.54

Source: Installed Capacity Report August 2021, Central Electricity Authority

There has been an increase in the installed capacity of electricity generation from renewable sources (excluding hydro) of 16.83% between 2018–2019 and 2019–2020. This growth rate is largely attributed to solar power installed capacity of grid interactive renewable which increased from 34.71 MW in 2019 to 40.55 MW in 2020. Other non-conventional sources of energy are also aimed to be developed in the UT.

[49] Statistical Abstract, Chandigarh, 2020; Details available at <https://www.chandigarh.gov.in/sites/default/files/stat2020/stat20-energy.pdf>

2.7 Infrastructure Profile

Chandigarh government has taken several major initiatives to upgrade its infrastructure to advance towards its vision of becoming a knowledge capital and emerge as a regional hub in the areas of service industry, education, health, information technology, food, and vegetable processing, etc. Presence of nationalised and commercial banks, educational institutions, medical institutions and good transport infrastructure, along with its growing IT Park, facilitate the UT's transformation into a 'smart' city.

2.7.1 Social Infrastructure

Chandigarh UT has a robust infrastructure for education and a good network of schools in the city. Department of Education, Chandigarh Administration is the main body looking after education in the city. The social infrastructure of the city has seen growth complementing the population growth. Educational outreach has increased to be 114 government run schools, 7 government aided schools, 7 central government schools and 75 private schools, run by the Kendriya Vidyalaya/ Navodaya Vidyalaya Samiti/Air Force. Chandigarh Administration is the main body looking after education in the city. These schools are composite and cover grades from 1st Standard to 10th/12thStandard. There are various schemes introduced in these schools, like mid-day meal schemes, free textbooks & stationary, and free uniforms.

There are 111 active healthcare facilities as of 2019-2020 in the city with includes 4 district hospitals, 3 community centres, and many sub-centres and primary health care centres[50].

2.7.2 Physical Infrastructure

From sanitation perspective, 100% of the city is under sewage coverage, supplemented with 100% toilet facility. The water infrastructure in the state has been improved over the years, with the number of water works increasing over time, from 5 till 2006–07 to 8 in 2008–09, and updated with 10 in the past years.

Availability of world-class infrastructure, including good air, road and railway connectivity with the rest of India, along with a burgeoning industrial sector has complemented the process of economic development in Chandigarh. Chandigarh is connected to the major cities in Punjab, Haryana, and Himachal Pradesh by road and to the national capital by NH-21, which goes through the city. The Inter State Bus Terminus (in Sectors 17 and 43) facilitates local travel and inter-state commute to nearby states of Uttar Pradesh, Delhi, Punjab, Haryana, and Rajasthan. Chandigarh's railway station, situated in the north-eastern border of the city, is close to the industrial area, and links the UT with hubs in Delhi and Mumbai, as well as its neighbouring states and the eastern, western, and southern regions. Chandigarh also has a well-connected international airport.

A unique feature in the layout of Chandigarh is its roads, classified in accordance with its functions. An integrated system of seven roads (addressed as 7'Vs) ensures efficient traffic circulation. The arrangement of road use leads to a remarkable hierarchy of movement, which ensures that residential areas are segregated from noise and pollution of traffic.

2.8 Sub-national sustainable development goals (SDGs)

Development plans and climate action plans developed in accordance with the needs of the local region, allow better targets to be set and achieved. The development of SAPCCs for every

[50] Statistical Abstract of Chandigarh, 2020. Details Available at <https://chandigarh.gov.in/sites/default/files/stat2020/stat20-bnutshell.pdf>

state and UT provides an opportunity for the regional and local governments to build on their existing policies, keeping in mind the ongoing developmental programmes and schemes and ensuring their integration with the larger national-level plans. Thus, the climate action policies could also have a spillover effect onto the development aspects, as the impacts of climate change on infrastructure, public health, or the general environment can also act as a barrier in the development planning of a state or the country. These can be best categorised under the SDGs and the SAPCC can be used as a tool to enable better integration of climate and development actions with the necessary SDGs.

For structuring this approach, the NITI Aayog, as the country's nodal institution for SDGs, has developed the SDG India Index and Dashboard, as a tool highlighting the action of different states and UTs with respect to SDG implementation[51]. As per the NITI Aayog-led annual assessments, generally Chandigarh's development actions and plans fit well within the SDG action plan. Resultantly, amongst all the UTs, Chandigarh has maintained its top position with a composite SDG Index Score (2023-24) of 77, against the national average of 71.[52]

Chandigarh achieved a full score of 100 on the SDG Index for SDG 7 (Affordable and Clean Cities) and SDG 11 (Sustainable Cities and Communities) being declared an 'Achiever'. Good Health and Well-being (Goal 3) continued its upward trajectory, improving to a score of 89, showcasing the city's ongoing commitment to enhancing public health. Additionally, Climate Action (Goal 13) saw significant progress with a score of 80. However, Responsible Consumption and Production (Goal 12) experienced a decline from 78 to 59. Gender equality (Goal 5) was only SDG under aspirant category. These mixed results highlight the UT's achievements and areas that require ongoing attention and intervention.

[51] NITI Aayog. SDG India Index and Dashboard (Webpage). Details available at <https://sdgindiaindex.niti.gov.in/#/>

[52] https://www.niti.gov.in/sites/default/files/2024-07/SDG_India_Index_2023-24.pdf

Table 2.9 Chandigarh's Performance on SDGs

Goal	Details	2019-2020		2020-2021		2023-2024	
		Chandigarh's score	**National average**	**Chandigarh's score**	**National average**	**Chandigarh's score**	**National average**
SDG 1	No Poverty	48	50	75	60	70	72
SDG 2	Zero Hunger	73	35	97	47	71	52
SDG 3	Good Health and Well-being	54	61	74	74	89	77
SDG 4	Quality Education	80	58	79	57	84	61
SDG 5	Gender Equality	47	42	58	48	48	49
SDG 6	Clean Water and Sanitation	100	88	99	83	99	89
SDG 7	Affordable and Clean Energy	84	70	100	92	100	96
SDG 8	Decent Work and Economic Growth	64	64	70	61	77	68
SDG 9	Industry, Innovation and Infrastructure	74	65	45	55	55	61
SDG 10	Reduced Inequality	33	64	100	67	75	65
SDG 11	Sustainable Cities and Communities	83	53	98	79	100	83
SDG 12	Sustainable Consumption and Production	77	55	78	74	59	78
SDG 13	Climate Action	54	60	61	54	80	67
SDG 15	Life on Land	93	66	85	66	80	75
SDG 16	Peace, Justice and Strong Institutions	89	72	73	74	75	74

Colour Coding Criteria

Category	**Score range**	**Colour code**
Achiever	100	
Front Runner	65–99	
Performer	50–64	
Aspirant	0–49	

Source: SDG India Index Dashboard, NITI Aayog

The development targets put forth under the SDGs provide a perfect opportunity for states and UTs to develop their action plans around the same. Chandigarh's existing actions, related to SDGs, lay out a perfect environment to scale up and continue the development and climate-resilient path.

Achievement of the SDGs should be complemented with the incorporation of climate concerns into developmental planning. As the impacts of climate change have been realised at the local levels, the need for sub-national climate policies and planning has been seen as imperative. India being a large country with a wide range of diversity in terms of climate impacts, requires localised actions and interventions to deal with regional variations of climate risks. Suitable development of SAPCC which has institutionalised sub-national climate action in India is the key to address local-level climate risks.

It is important to mention that various department of Chandigarh administration conduct various activities under the banner of Mission LiFE (Lifestyle for Environment) to raise awareness about environmental sustainability and encourage eco-friendly living. These activities include workshops, seminars, and collaborative events involving multiple stakeholders such as government departments, corporations, committees, educational and research institutions, and the public. The department of environment actively works to disseminate information and engage citizens through these efforts. In addition, the department periodically releases publications like Paryavaran Patrika and the annual Green Team report, along with other learning materials, to further spread the mission's message and provide resources for individuals and communities to adopt environmentally responsible practices. These initiatives contribute to building a more sustainable future for Chandigarh and beyond

3. Climate Profile

3.1 Introduction

Climate change is one of the major challenges of the 21st century, having its adverse effects on all spheres of humanity. It has been observed in the past few decades, globally the frequency and intensity of weather- and climate-related hazard events have been increasing. The frequency and intensity of such events like droughts, floods, heat waves, storm surges etc. have also shown an increase over India and are also expected to accelerate owing to climate change in future. It is also reported that impacts due to such events would substantially aggravate other combined effects such as population growth and urbanisation[53]. All these consequences have an impact on the country's water resources, agriculture, and economy.

3.2 Data and Methodology

The chapter present study aims to present the past and future climate profile over Chandigarh. To study the historical climate profile, observation data from the Indian Meteorological Department (IMD) has been used. For rainfall, a high-resolution (0.25°x 0.25°) daily gridded rainfall dataset was available by the IMD that has been used for the Chandigarh region to present a historical assessment for rainfall for the period of 67 years (1951–2017)[54]. The climatology and annual trend analysis for temperature has been carried out using IMD gridded temperature (T_{max}, T_{min}, and T_{mean}) data with 1° × 1° horizontal spatial resolution for the period of 1969–2016[55]. Trend analysis has been done using Sen's slope method[56]. A positive sign in the trend shows an increasing trend and a negative sign indicates a decreasing trend. Precipitation and temperature extreme indices have also been analysed over Chandigarh. For the present study Chandigarh region is considered between latitudes of 30° 40′ and 30° 46' North and longitudes 76° 42′ and 76° 51' East.

For studying the future climate, NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) NEX-GDDP[57] dataset has been used. The NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset contains downscaled climate scenarios for the entire world derived from Global Circulation Models (GCM) runs conducted as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5) and spanning two of the four greenhouse gas emissions scenarios known as Representative Concentration Pathways (RCPs).

The future analysis has been carried out for two climate scenarios, namely RCP4.5 (moderate future warming scenario) and RCP8.5 (high future warming scenario) for the period of 2021–

[53] IPCC 2018. Annex I: glossary. In: Matthews, et al. (Eds.) Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. Geneva, Switzerland: World Meteorological Organization. Details available at < https://www.ipcc.ch/sr15/>

[54] D. S. Pai, L. Sridhar, L., M. Rajeevan, O. P. Sreejith, N. S. Satbhai, and B. Mukhopadhyay. 2014. Development of a new high spatial resolution (0.25× 0.25) long period (1901–2010) daily gridded rainfall data set over India and its comparison with existing data sets over the region. Mausam 65(1): 1–18 Details available at <https://doi.org/10.54302/mausam.v65i1.851>

[55] A. K. Srivastava, M. Rajeevan, and S. R. Kshirsagar. 2009. Development of High Resolution Daily Gridded Temperature Data Set (1969–2005) for the Indian Region. Atmospheric Science Letters Atmos. Sci. Details available at < https://doi.org/10.1002/asl.232>

[56] P. K. Sen. 1968. Estimates of the regression coefficient based on Kendall's tau. Journal of the American Statistical Association 63 (324): 1379–89. DOI: 10.2307/2285891, JSTOR 2285891, MR 025820. Details available at < http://dx.doi.org/10.1080/01621459.1968.10480934>

[57] NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP). Details available at <https://www.nccs.nasa.gov/services/data-collections/land-based-products/nex-gddp>

50. For the present study, the multi-model mean of 21 NEX-GDDP models dataset have been used (refer ANNEXURE 1 for data set details). The NEX-GDDP dataset includes downscaled projections for RCP 4.5 and RCP 8.5 from the 21 models and the spatial resolution of the dataset is 0.25 degrees (~25 km × 25 km).

In the present study assessment of the trend of rainfall anomalies, dry days, wet days, consecutive wet days, consecutive dry days, and heavy rainfall days has been carried out. For the temperature assessment, temperature anomalies, warm days and very warm days analysis have been done. Annual (January to December), Monsoon (June to September), Pre-Monsoon (March to May), Post-Monsoon (October-November), and Winter (December to February) are the seasons studied for this study. Expert Team on Climate Change Detection and Indices (ETCCDI) (Karl et al. 1999, Peterson and Co-authors 2001) is used to provide comprehensive information of extreme over temperature.

The definition of the different indices used in the analysis is provided in Table 3.1.

Table 3.1: Definitions of different indices used in this study on the basis of gridded data

S. No.	Indices	Definition
1.	Dry days	Count of days with rainfall <1 mm
2.	Wet days	Count of days with rainfall ≥1 mm
3.	Consecutive dry days	Count of number of spells with <1 mm
4.	Consecutive wet days	Count of number of spells with ≥1 mm
5.	Heavy precipitation days	Count of days with rainfall >90th percentile value of the reference period
6.	Very heavy precipitation days	Count of days with rainfall >95th percentile value of the reference period
7.	Warm days	Count of days with maximum temperature >90th percentile value of the reference period
8.	Very warm days	Count of days with maximum temperature >95th percentile value of the reference period

Table 3.2: IMD's classification of precipitation amounts (accumulated in 24 hours)

Rainfall amount (in mm)	Descriptive term used
0	No rain
0.1–2.4	Very light rain
2.5–7.5	Light rain
7.6–35.5	Moderate rain
35.6–64.4	Rather heavy
64.5–124.5	Heavy rain
≥124.5–244.4	Very heavy rain
≥244.5	Extremely heavy rain

3.3 Historical Analysis

3.3.1 Rainfall Analysis

The climatological monthly accumulated rainfall is shown in Figure 3.1. Chandigarh receives 1120 mm average annual rainfall. Monsoon season receives about 939 mm (~80% of total rainfall). The maximum rainfall is received in July and minimum rainfall occurs in November. The winter months also receive significant rainfall. The climate of Chandigarh is characterised as dry (except in monsoon season). Chandigarh falls under Koeppen's Cwg [58] climate classification category, that is, it has a cold dry winter, hot summer, and sub-tropical monsoon. For the historical assessment for rainfall the period of 67 years (1951–2017) was considered and for temperature analysis 1969–2016 period was considered.

Figures 3.2 and 3.3 depict the IMD classification of rainfall events. The IMD classifies precipitation amounts (accumulated in 24 hours) in different categories (Table 3.2). In the case of Chandigarh, most of the days (~69%) are seen under no rainfall category. The remaining rainfall category contributes about ~31% to rainfall days. The categories of very light rainfall, light rainfall, and moderate rainfall days contribute around 29% in the total rainfall. The remaining 2% rainfall is received under heavy rainfall category events.

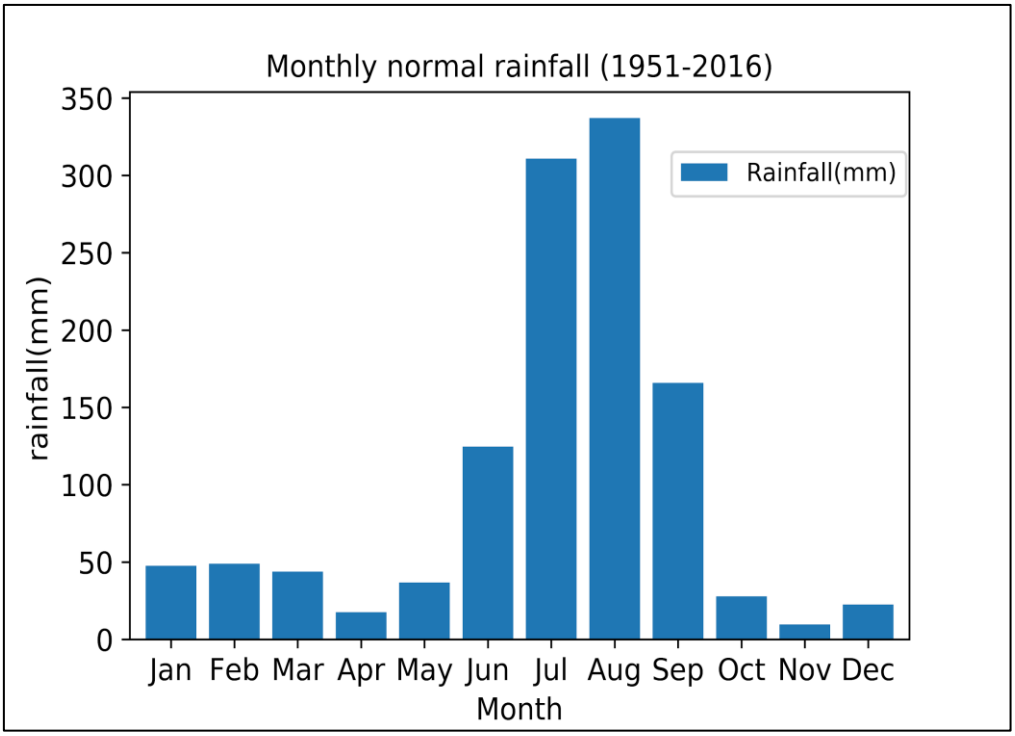


Figure 3.1: Monthly normal accumulated rainfall (1951–2016)

Source: IMD data

[58] Monsoon type with dry winters

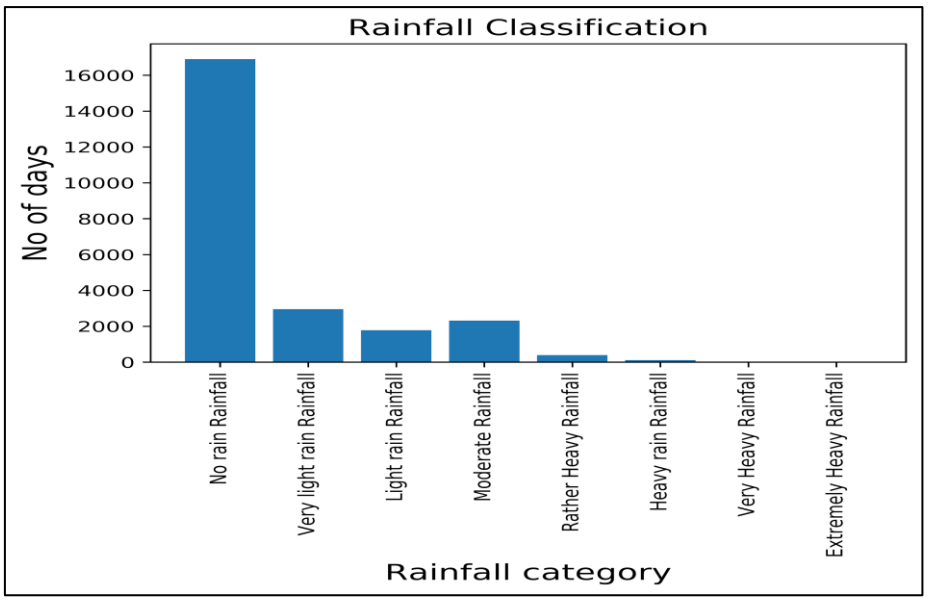


Figure 3.2: Classification of rainfall days over Chandigarh as per IMD (1951-2016)

Source: IMD data

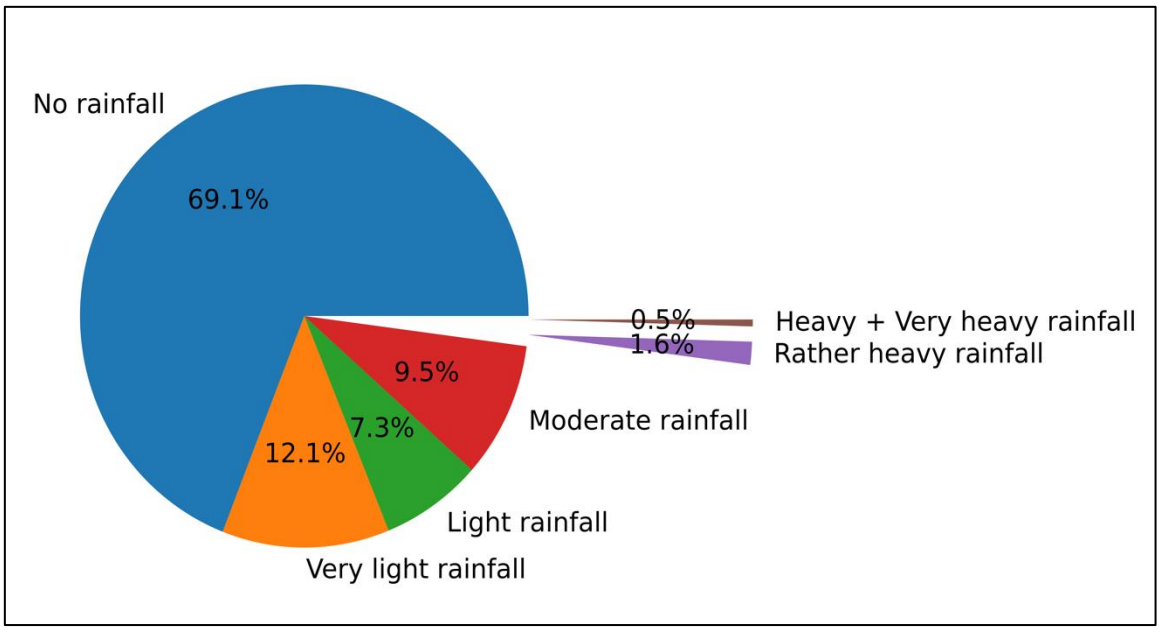


Figure 3.3: Pie chart of different rainfall categories contributing to total rainfall over Chandigarh (1951-2016)

Source: IMD data

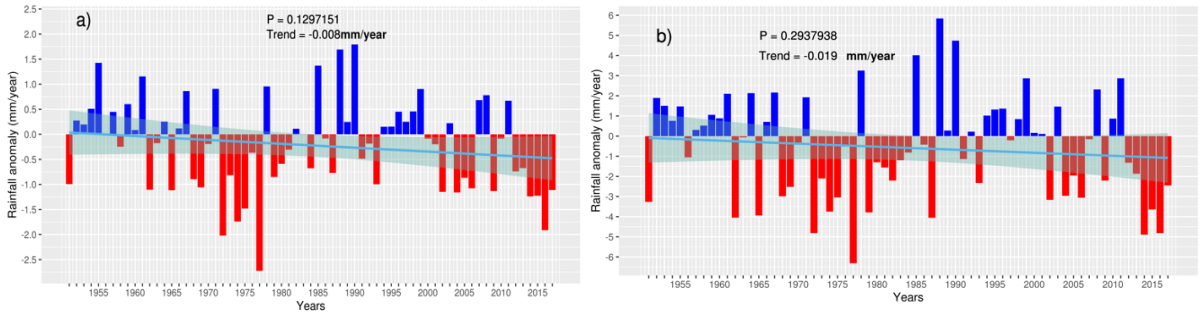


Figure 3.4: Inter annual variation and trend of rainfall anomalies over Chandigarh: (a) Annual (b) Monsoon season

Source: IMD data

The inter-annual variation of rainfall anomalies and trend over Chandigarh is shown in Figure 3.4 (a) and (b). The annual and monsoon season rainfall anomalies over Chandigarh show low variability with non-significant (at 95% level [59] negative trend). For calculating rainfall anomalies 30 years (1971–2000) period is considered as climate normal. Dry days analysis, however, shows a positive trend for both annual and monsoon season. Annual trend having a statistical significant trend (refer to Figure 3.5 (a) and (b)).

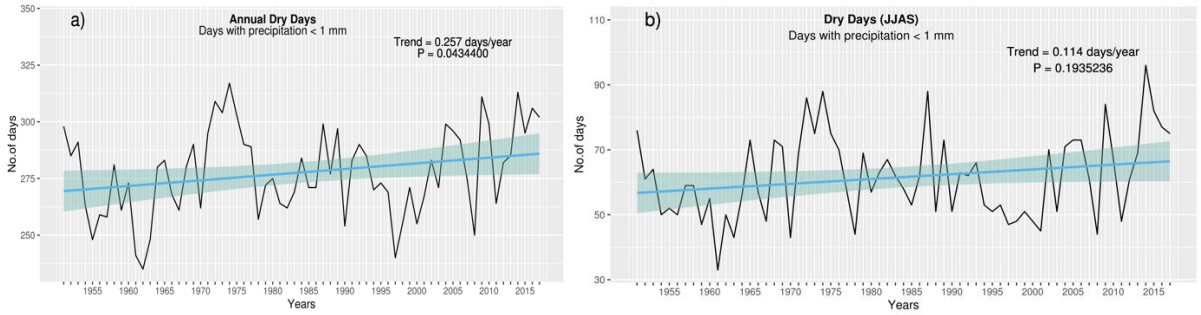


Figure 3.5: Inter annual variation and trend of dry days (< 1 mm) over Chandigarh: (a) Annual (b) Monsoon Season

Source: IMD data

Figure 3.6 (a) and 3.6 (b) shows a decreasing trend observed for annual and monsoon season wet days. It is seen that the annual trend observed for wet days is statistically significant than the monsoon season trend. The heavy rainfall assessment has been carried out by using percentile method wherein 90% and 95% corresponding values are fixed for identification of an extreme rainfall day. For Chandigarh, the data shows heavy rainfall and very heavy rainfall days to be decreasing however the trends are not statistically significant (refer to Figure 3.7 (a) and (b)). The recent past ten years shows increasing trend. The assessment of the frequency of consecutive dry days spells is shown in Figure 3.8 (a) and (b). The frequency of annual consecutive dry days shows no trend for annual and monsoon season for the time period analysed. Figure 3.9 (a) and (b) depicts the number of consecutive wet days spells, consecutive wet days spells show no trend for annual and monsoon season. The last ten years have seen an increasing trend.

[59] For Figure 3.4(a) P = 0.129 and P≥0.05, non-significant at 95% level and for Figure 3.4(b) P=0.293 and P≥0.05, non-significant at 95% level

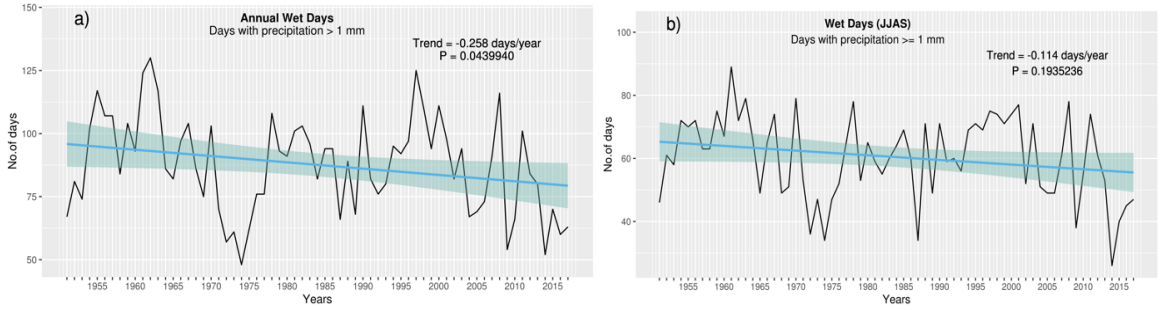


Figure 3.6: Inter annual variation and trend of Wet days (≥ 1mm) over Chandigarh: (a) Annual (b) Monsoon Season

Source: IMD data

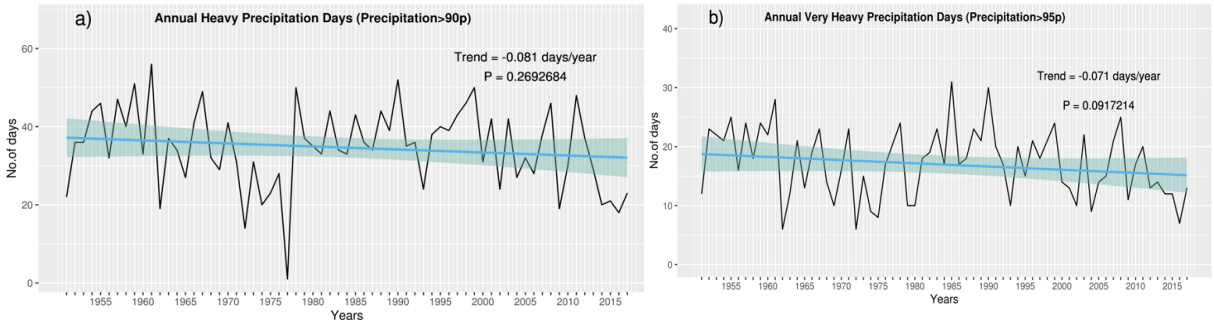


Figure 3.7: Inter annual variation and trend of annual: (a) heavy precipitation days (rainfall > 90 percentile) (b) very heavy precipitation days (rainfall > 95 percentile)

Source: IMD data

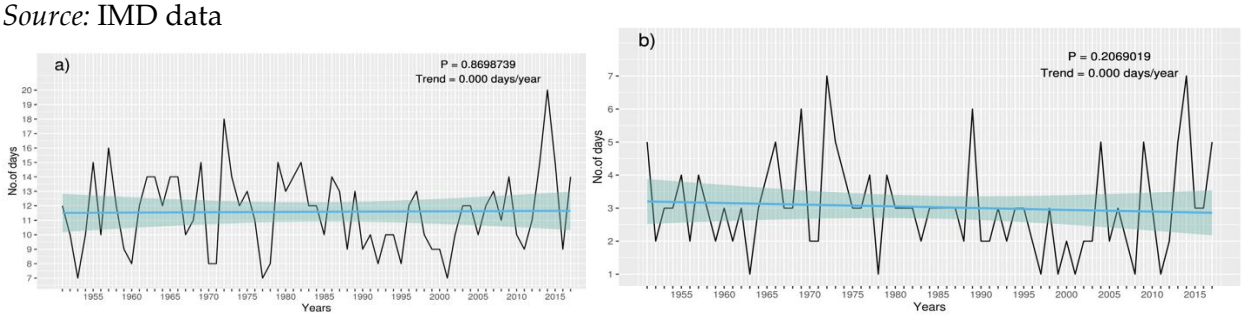


Figure 3.8: Inter annual variation and trend of number of consecutive dry days spells: (a) Annual (b) Monsoon Season

Source: IMD data

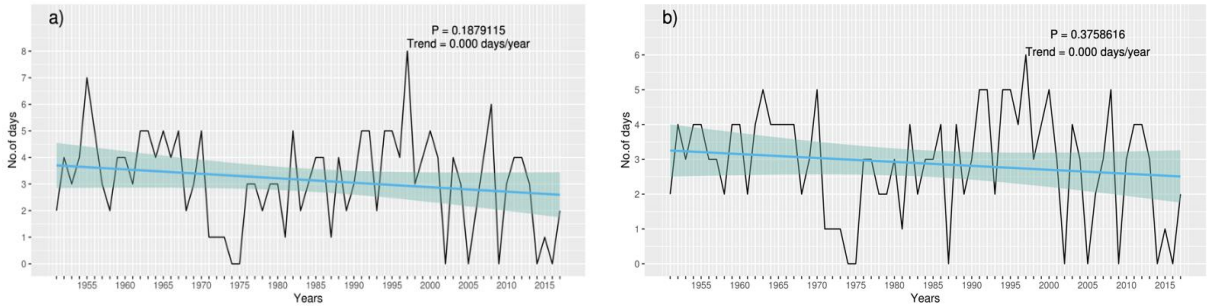


Figure 3.9: Inter annual variation and trend of number of consecutive wet days spells (a) Annual (b) Monsoon Season

Source: IMD data

3.3.2 Temperature Analysis

Monthly climatological temperature values are shown in Figure 3.10. May and June are the hottest months of the year with daily mean maximum temperature of about 39˚C. January is the coldest month with a daily mean minimum temperature of about 5˚C. Figure 3.10 shows that maximum temperature peaks during April to June. Temperatures start falling from the month of July. Both maximum and minimum temperatures decrease rapidly from October onwards. Over Chandigarh, the cold weather season is observed from November to February, while the summer season commences from March and ends in June.

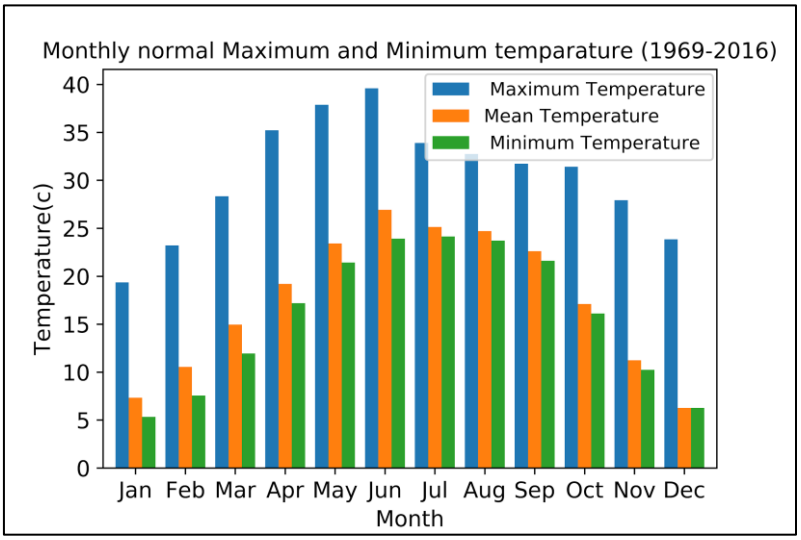
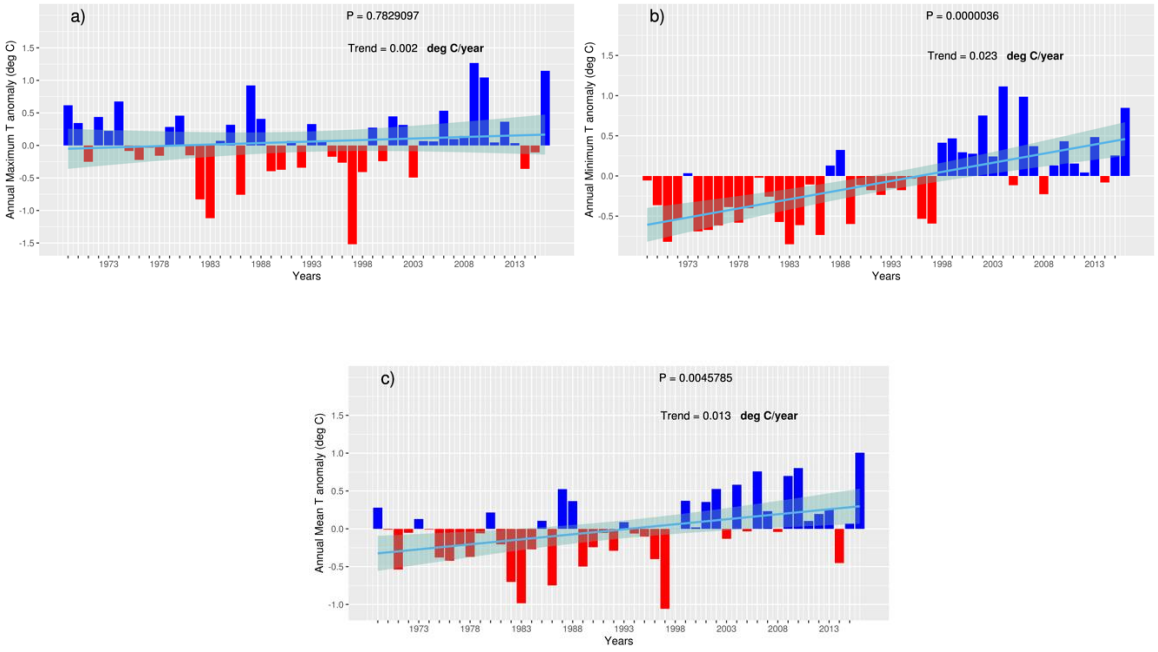


Figure 3.10: Monthly mean temperature over Chandigarh (1969–2016)

Source: IMD data



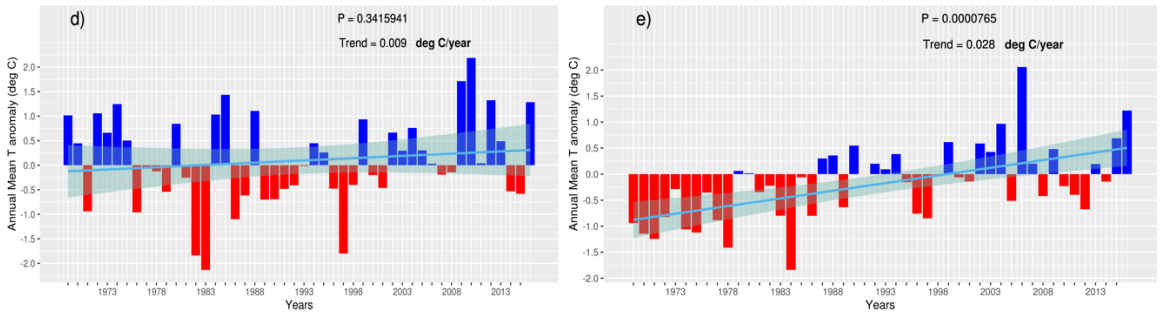


Figure 3.11: Inter annual variation and trend of annual temperature anomalies of: (a) Maximum temperature, (b) Minimum temperature, (c) Mean temperature, (d) Summer season anomalies of maximum temperature, and (e) Winter season anomalies of minimum temperature

Source: IMD data

Figure 3.11 shows the variation in annual mean temperature, annual maximum temperature, and annual minimum temperature over Chandigarh. It is seen that temperatures have continuously increased during the period of 1961–2016. Annual mean temperature has increased by 0.13°C/decade (refer to Figure 3.11 (c)), maximum temperature has increased by 0.02°C/decade and minimum temperature increased by 0.23°C/decade showing that most of the contribution towards the mean increase has been provided by the increase in minimum temperature (refer to Figure 3.11 (a) and (b)). The increasing mean temperature and minimum temperature trends are statistically significant at 95% level. However, the maximum temperature shows a slight increase with a positive trend. Seasonally, the summer months show an increase in maximum temperature by 0.09°C/decade (refer to Figure 3.11 (d)), however, the trend does not show any statistical significance at 95% level. The winter season (December to February) minimum temperature shows a significantly increasing trend by 0.28°C/decade (refer to Figure 3.11 (e)).

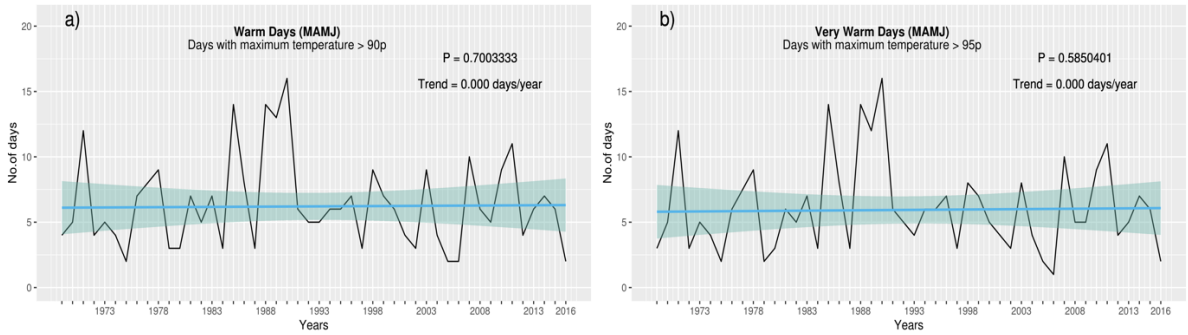


Figure 3.12: Frequency of occurrence of: (a) warm days (>90th percentile) and (b) very warm days (> 95th percentile) in summer period

Source: IMD data

Frequencies of warm days in the summer season are shown in Figure 3.12. The frequency of warm days is calculated as the count of days when the maximum temperature reported is greater than 90th and 95th percentile values. For Chandigarh, the data does not show any trend for the warm and very warm days.

3.4 Future Climate Projections

A high resolution statistically downscaled NEX-GDDP datasets have been used to analyse the future projections over the study area. The analysis has been carried out for the baseline (1976–2005) and mid-century (2021–2050). The future analysis includes assessment for two IPCC RCP[60] (IPCC 2014) scenarios: RCP 4.5[61] and RCP 8.5[62]. The ensemble from the 21 models have been used to carry out future climate assessments over Chandigarh. NEX-GDDP data set is a global bias-corrected, high-resolution, statistically downscaled product derived from the CMIP5 simulations, available from 1950 to 2100. For the preparation of this data, the CMIP5 simulations were downscaled to the 0.25° resolution. Global Meteorological Forcing Dataset (GMFD) was used for bias correction of NEX-GDDP data. The GMFD data was provided by the Terrestrial Hydrology Research Group at Princeton University[63]. Bias-corrected Spatial Disaggregation (BCSD) method was used for creation of NEX-GDDP (Wood, et al. 2002; Wood, et al. 2004; Thrasher, et al. 2012)[64, 65,66]. The GMFD data based on a combination of reanalysis products, remote sensing, and ground data.

[60] Representative concentration pathway (RCP) defines a specific emissions trajectory and subsequent radiative forcing (a radiative forcing is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system, measured in watts per square meter) (Moss, et.al. 2010)

[61] RCP 4.5 is a stabilisation scenario in which total radiative forcing is stabilized shortly after 2100, without overshooting the long-run radiative forcing target level (Clarke, et al. 2007; Smith and Wigley 2006; Wise, et al. 2009)

[62] RCP 8.5 is a scenario in which CO2 concentration continues to rapidly rise, reaching 940 ppm by 2100.

[63] J. Sheffield, G. Goteti, and E. F. Wood. 2006. Development of a 50-year high-resolution global dataset of meteorological forcings for land surface modeling. J. Clim. 19: 3088–11. Details available at <https://doi.org/10.1175/JCLI3790.1>

[64] A. W. Wood, E. P. Maurer, A. Kumar, and D. P. Lettenmaier. 2002. Long-range experimental hydrologic forecasting for the eastern United States. J, Geophys. Res. Atmos. 107: 4429. Details available at <https://doi.org/10.1029/ 2001JD000659>

[65] A. W. Wood, L. R. Leung, V. Sridhar, and D. P. Lettenmaier. 2004. Hydrologic implications of dynamical and statistical approaches to downscaling climate model outputs. Clim. Chang. 15: 189–216. Details available at < https://link.springer.com/article/10.1023/B:CLIM.0000013685.99609.9e>

[66] B. Thrasher, E. P. Maurer, C. McKellar, and P. B. Duffy. 2012. Technical note: bias correcting climate model simulated daily temperature extremes with quantile mapping. Hydrol. Earth Syst. Sci. 16 (9): 3309–14. Details available at < https://hess.copernicus.org/articles/16/3309/2012/hess-16-3309-2012.pdf>

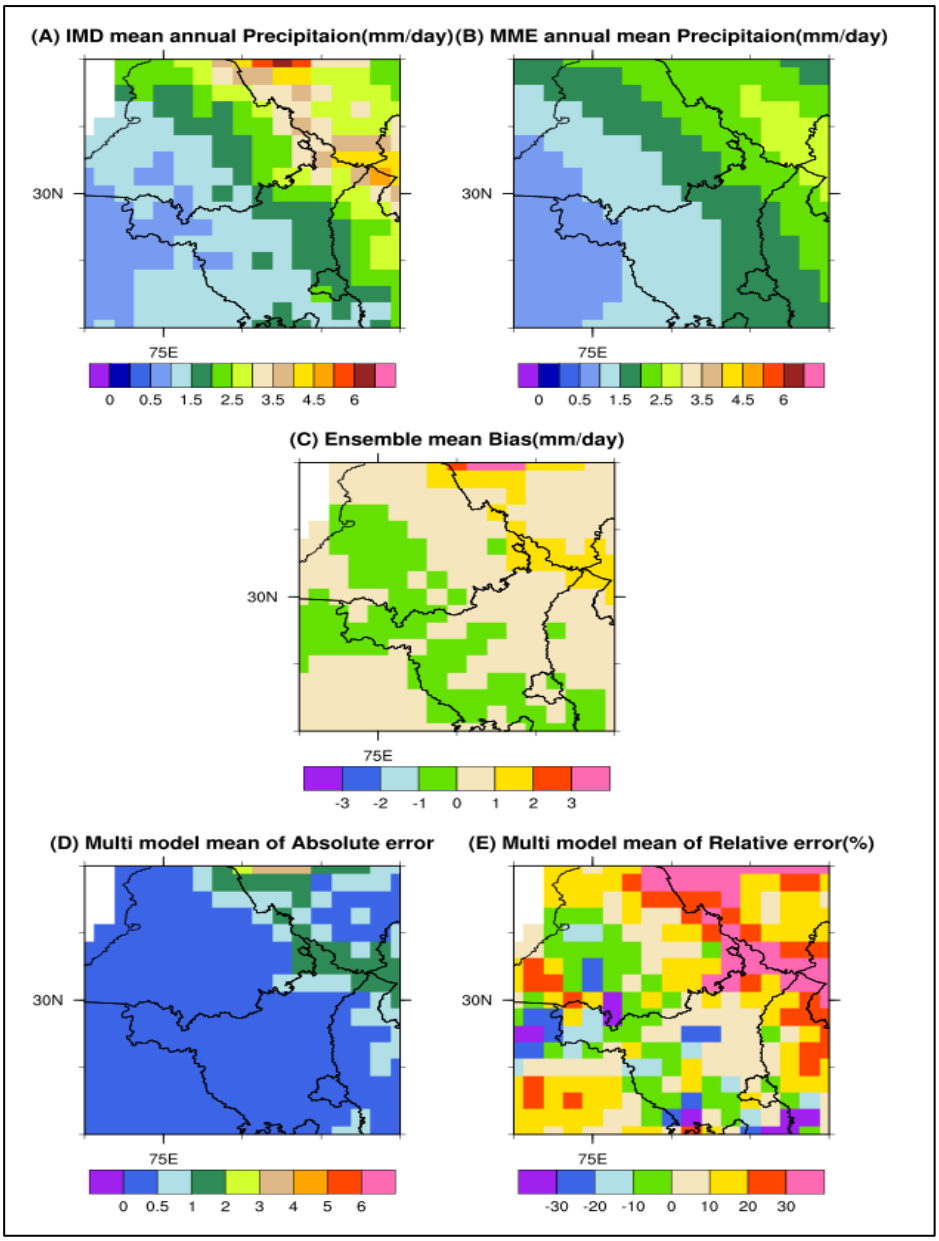


Figure 3.13: (a) Annual climatological (1976–2005) mean precipitation (mm) from IMD observations, (b) NEX-GDDP multi-model ensemble mean annual climatological (1976–2005) mean precipitation (mm), (c) bias (IMD-MME) in NEX-GDDP rainfall (mm) with respect to IMD observations, (d) absolute error in NEX-GDDP rainfall (mm) with respect to IMD observations, and (e) relative error in NEX-GDDP rainfall (%) with respect to IMD observations *Source:* IMD and NASA NEX-GDDP data

This section discusses the rainfall spatial pattern of observations and the NEX-GDDP dataset. The IMD observation shows minimum precipitation (< 2 mm/day) over north India, west India. Chandigarh receives ~ 3mm/ day rainfall (refer to Figure 3.13 (a)). The NEX-GDDP MMM precipitation for the same period is shown in Figure 3.13 (a). The biases in NEX-GDDP MMMs with respect to the observations are shown in Figure 3.13 (c). The NEX-GDDP MMM is unable to capture the orography-related rain bands over the foot of the Himalayas. Overall, the NEX-GDDP data set captures the precipitation pattern over northern parts of India. In NEX-GDDP MMM, the significant biases are noted only over a very small spatial region. The spatial pattern of the NEX-GDDP MMM is closest to the observations. The dry bias is seen

over some parts of Punjab and Haryana. The slight wet bias over most parts of northern India including Chandigarh (refer to Figure 3.13 (c)). Over Chandigarh, the NEX-GDDP data set has the lowest absolute error (~2 mm day−1), and relative error is also very small (~30%) and therefore best represents the observations. The time series of annual rainfall for IMD and NEX-GDDP data sets plotted in Figure 3.14. The area–average rainfall over Chandigarh is slightly underestimated in NEX-GDDP datasets, however the rainfall pattern matches with the observation.

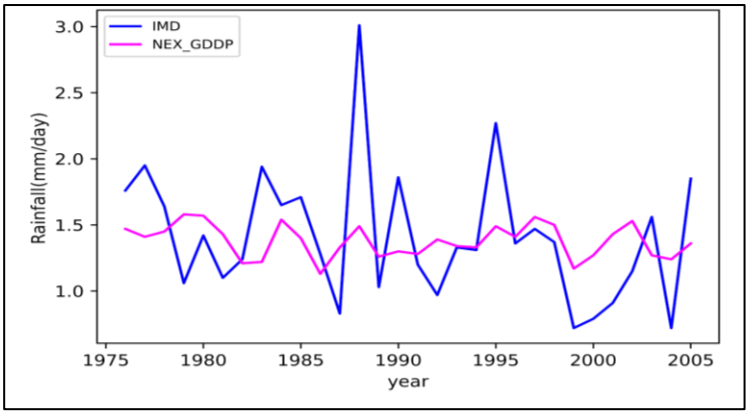


Figure 3.14:Time series of annual rainfall over Chandigarh (mm) from IMD observations (blue line) and NEX-GDDP (magenta line)

Source: IMD and NASA NEX-GDDP data

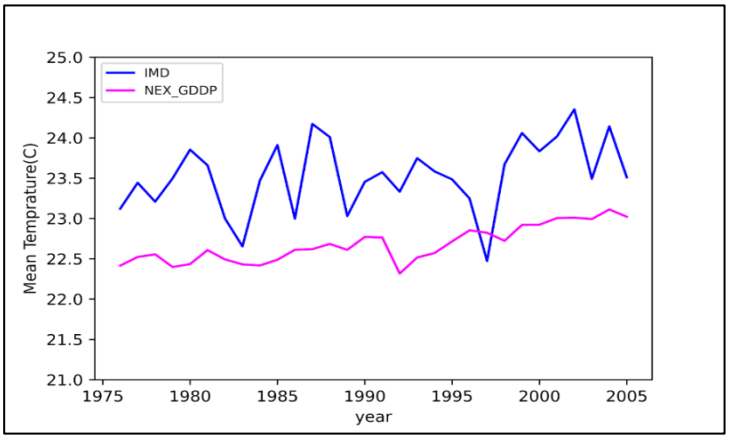


Figure 3.15: Time series of annual mean temperature over Chandigarh (°C) from IMD observations (blue line) and NEX-GDDP (magenta line)

Source: IMD and NASA NEX-GDDP data

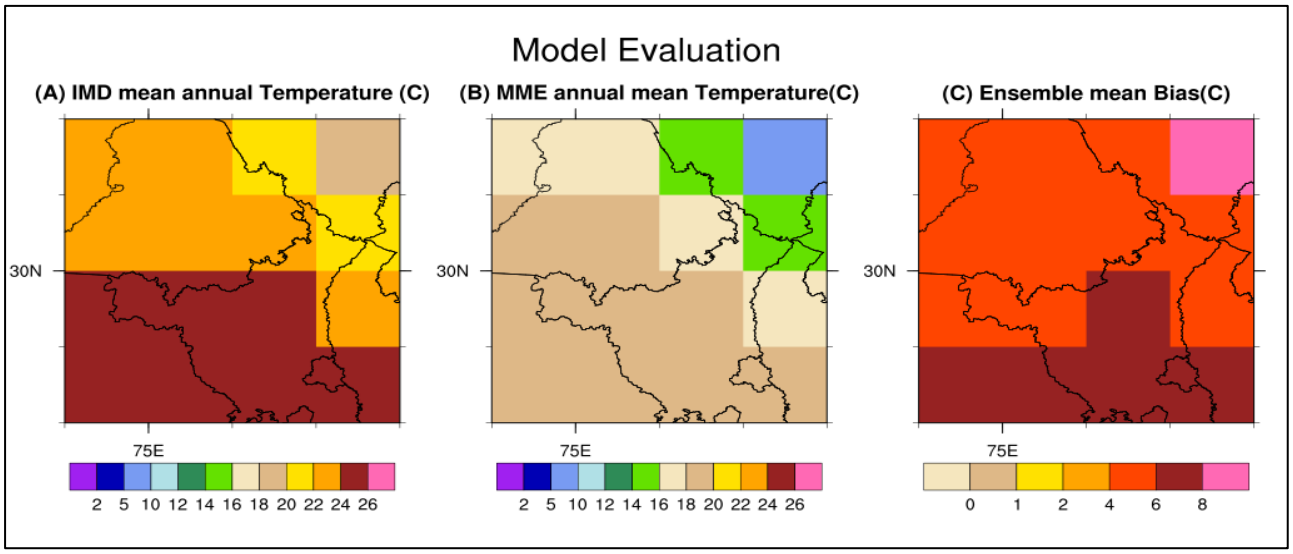


Figure 3.16: (a) Annual climatological (1976–2005) mean temperature (°C) from IMD observation, (b) NEX-GDDP multi-model ensemble mean annual climatological (1976–2005) mean temperature (mm) (°C) Bias (IMD-MME) in NEX-GDDP temperature with respect to IMD observations

Source: IMD and NASA NEX-GDDP data

The time series of annual mean surface air temperatures are plotted in Figure 3.15. The area-average temperatures are underestimated with the small cold bias in NEX-GDDP data sets. The biases in NEX-GDDP are calculated and shown in Figure 3.16. NEX-GDDP datasets capture the broad distribution of the observed temperatures in North India with spatially varying biases. The NEX-GDDP ensemble means data shows cold bias (of ~4–6°C) over the North Indian region (Figure 3.16).

3.4.1 Rainfall Projections

The ensemble mean NEX-GDDP model climate data for RCP4.5 and RCP8.5 scenarios for Chandigarh for the annual precipitation has been analysed. The projected annual and seasonal rainfall changes towards the mid-century (2021–2050) with respect to baseline for RCP4.5 and RCP8.5 scenarios. To minimise the uncertainty in the projections using many models, the global climate community usually applies averaging of the results from different regional models which are called multi-modal ensemble techniques. The multi-modal ensemble mean of NEX-GDDP models has been used to analyse changes in annual and seasonal rainfall for the near-future from 2021–2050, compared to the baseline period of 1976–2005. Figure 3.18 shows the percentage change in annual rainfall for Chandigarh and neighbouring regions for the RCP4.5 and RCP8.5 scenarios. Average annual rainfall is projected to increase under RCP4.5 and RCP8.5 by about 0–10%, for the near-future for both scenarios. The highest increase is projected for the post-monsoon season, which shows a projected change of 40%–100% in the near-future period compared to the baseline. The monsoon season also shows an increase in projected rainfall for the mid-century period under both scenarios. During the winter season, the models project a decrease in rainfall for all the future time-period under both scenarios. Average annual rainfall for RCP4.5 and RCP8.5 shows a projected decrease during the pre-monsoon season during the near future over Chandigarh and its surrounding regions (refer to Figure 3.17).

The annual rainfall is projected to increase by about 7% and 8% for RCP4.5 and RCP8.5 respectively towards the mid-century over Chandigarh. However, precipitation projections have larger uncertainties as is evident from the large spread of the precipitation change projections in Figure 3.18(a). In the winter season, the rainfall is projected to decrease by about 15% for RCP4.5 and about 14% for RCP8.5 scenarios. In monsoon and post- monsoon season rainfall is projected to increase, while the highest increase is projected for the post-monsoon season towards the mid-century over Chandigarh (refer to Figure 3.18 (B)).

The percentage change in dry days (count of days with rainfall <1mm) and wet days (Count of days with rainfall ≥1mm) are shown in Table 3.3. The change has been calculated as a difference between the 30-year average value of mid-century (2021–2050) with respect to baseline (1976–2005). The wet days show a projected increase very unlikely[67] as 3.01±1.9% and 1.30±1.1% in the monsoon period under RCP4.5 and RCP8.5. The analysis shows about –29.23±9.21% and –12.5±11.2% decrease in dry days for monsoon seasons RCP4.5 and RCP8.5.

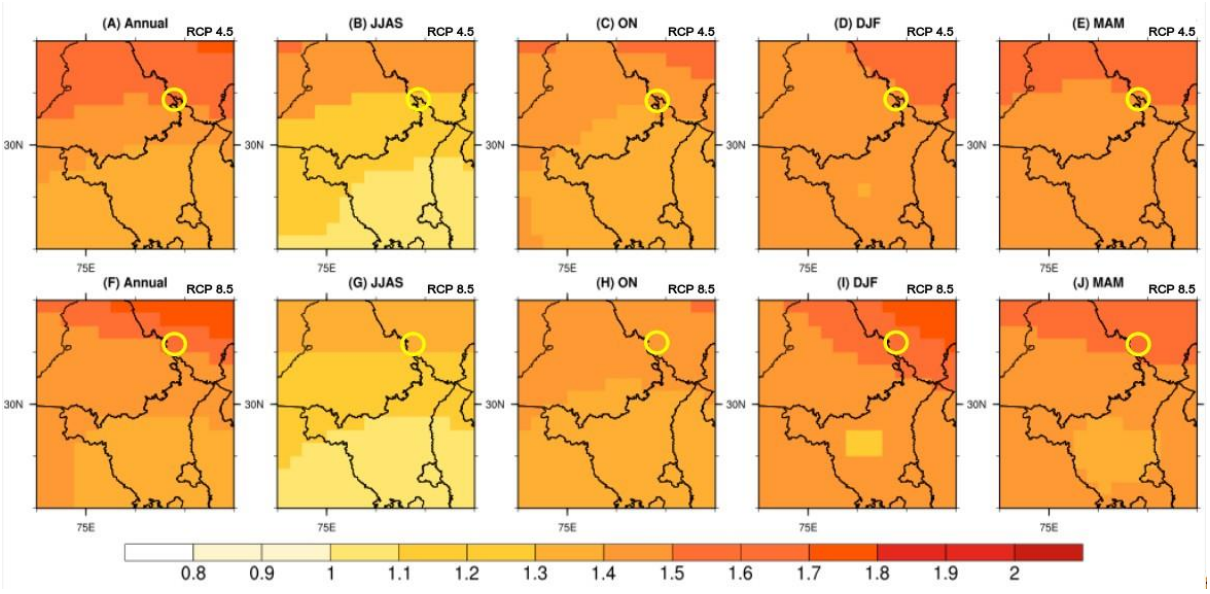


Figure 3.17: Projected future change in rainfall during 2021–2050 with respect to baseline (1976–2005) for RCP4.5 and RCP8.5 scenarios for different seasons

(Location of the study area shown in yellow circle)

Source: NEX-GDDP data

[67] Very unlikely: 0–10% likelihood level

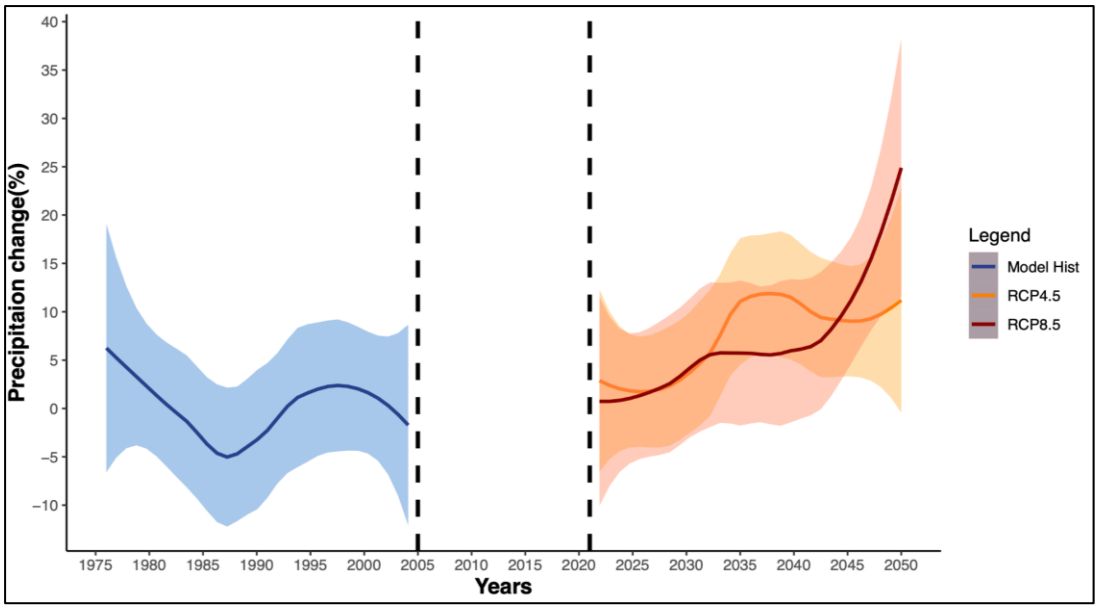


Figure 3.18(a): The NEX-GDDP dataset-based time series of annual precipitation change (%) (historical and projections) over Chandigarh from 1976 to 2050 relative to 1976–2005 baseline for the RCP scenarios

(Shaded area represents the range of changes projected by the ensemble mean of NEX GDDP data set for each year)

Source: NEX-GDDP data

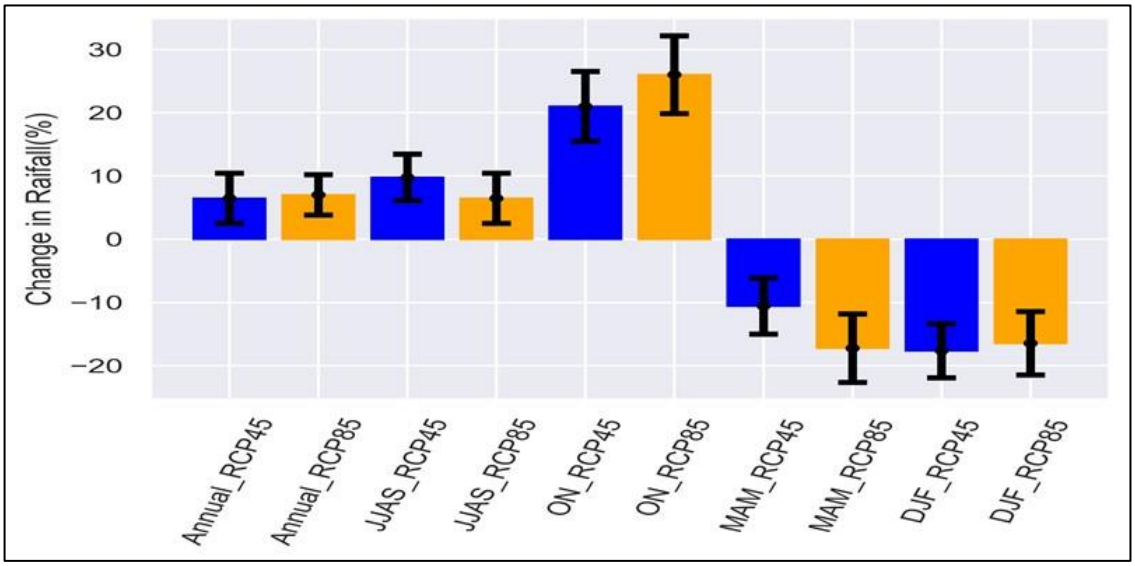


Figure 3.18(b): Projected changes w.r.t. baseline in annual and seasonal rainfall over Chandigarh for different seasons

Source: NEX-GDDP data

Table 3.3: Projected changes (%) in wet days and dry days in Annual and Monsoon season w.r.t. baseline over Chandigarh

		Change w.r.t. baseline (%)	
Indices	**Season**	**RCP4.5**	**RCP8.5**
Dry days	Annual	0.8±1.01	2.7±1.4
	Monsoon	–29.23±9.21	–12.5±11.2
Wet days	Annual	–0.73±1.3	–3.43±1.9
	Monsoon	3.01±0.9	1.30±1.1

Source: NEX-GDDP data

The consecutive wet day spells are projected to increase about as likely as 20±9.6% and 25±7.8% for monsoon seasons and by 3±1.6% and 5±2.2% annually under RCP4.5 and RCP8.5 respectively towards the mid-century. Consecutive dry days are projected to decrease unlikely[68] as 1±0.6% under RCP 4.5 and 3±1.2 % under RCP 8.5 annually and for the monsoon season by 30±12.2% under RCP4.5 and by 25±13.2% under RCP8.5.

Table 3.4: Projected percentage of changes in heavy rainfall days

		Change w.r.t. baseline (%)	
Indices	**Season**	**RCP4.5**	**RCP8.5**
Heavy rainfall days	Annual	12.72	10.89
	Monsoon	25.44	30.51
Very heavy rainfall days	Annual	19.93	22.39
	Monsoon	24.43	33.67

Source: NEX-GDDP data

The heavy rainfall (defined as the count the days where rainfall > 90th percentile value of reference or baseline period) and very heavy rainfall days (defined as the count the days which rainfall > 95th percentile value of reference period) are likely[69] to increase in both RCP scenarios toward the mid-century with respect to the baseline. As expected, higher changes are seen in monsoon seasons under the above categories which range in between 10.2%–48% compared to the baseline (refer to Table 3.4).

This clearly points towards increasing extremal behaviour of precipitation for future time periods as total rainfall is expected to increase, the total rainfall is confined to a lesser number of days as compared to baseline. The extremal behaviour of precipitation has far-reaching economic impacts on various sectors such as agriculture, water, tourism, infrastructure, and power.

3.4.2 Temperature Projections

The ensemble means of NEX-GDDP climate data for RCP4.5 and RCP8.5 scenarios over Chandigarh for temperature have been analysed. The Multimodal Ensemble mean of 21 NEX-GDDP models were used to analyse the future changes in annual and seasonal maximum temperatures during the mid-century for the period 2021–50 compared to the baseline period of 1976–2005. The analysis is done for two IPCC scenarios: RCP4.5 and RCP8.5. Figure 3.19

[68] Unlikely:0–33% likelihood level
[69] Likely: 66%–100% likelihood level

shows the change in annual and seasonal mean temperatures in northern states of India. The spatial representations of projected changes in seasonal and annual maximum temperatures are shown Figure 3.19. Under either RCP4.5 or RCP8.5 the annual minimum temperature is projected to increase during all seasons, in all regions of North India. The projected change is greatest during the pre-monsoon season and Winter Season for RCP4.5 and RCP8.5.

The changes in maximum, minimum, and mean temperature towards the mid-century period from 2021–50 with respect to the baseline period from 1976–2005 are shown in Table 3.5. The average annual maximum temperature is very likely to increase by 1.47±0.11°C for RCP4.5 and 1.70±0.15°C for RCP8.5. Highest maximum temperature increase over Chandigarh is projected in the pre-monsoon season for both RCP4.5 and RCP8.5 scenarios (refer to Table 3.5). The minimum temperature is *very likely* to increase in annual and all seasons towards the mid-century with respect to baseline over Chandigarh with a higher increase for RCP8.5 scenario as compared to RCP4.5 scenario as shown in Table 3.5. Annual average minimum temperature over Chandigarh for RCP4.5 scenario is projected to increase very likely about 1.48±0.11°C while it is around 1.76±0.15°C for RCP8.5 scenario, highest minimum temperature changes seen in pre-monsoon season for both the scenarios.

The annual hot and very hot days are projected to increase for both RCP4.5 and RCP8.5 with respect to baseline as shown in Table 3.6. Hot days and very hot days correspond to the percentage of days where the maximum temperature is greater than 90th and 95th percentile of the baseline, respectively. Over Chandigarh the hot days are very likely[70] to increase towards the mid-century for both scenarios of future with a change of 42.2±3.32% and 48.84±3.84% for hot days for RCP4.5 and RCP8.5, respectively. The very hot days are also very likely to increase by 77.44±5.32% and 85.44±5.68% towards mid-century with respect to baseline for RCP4.5 and RCP8.5, respectively.

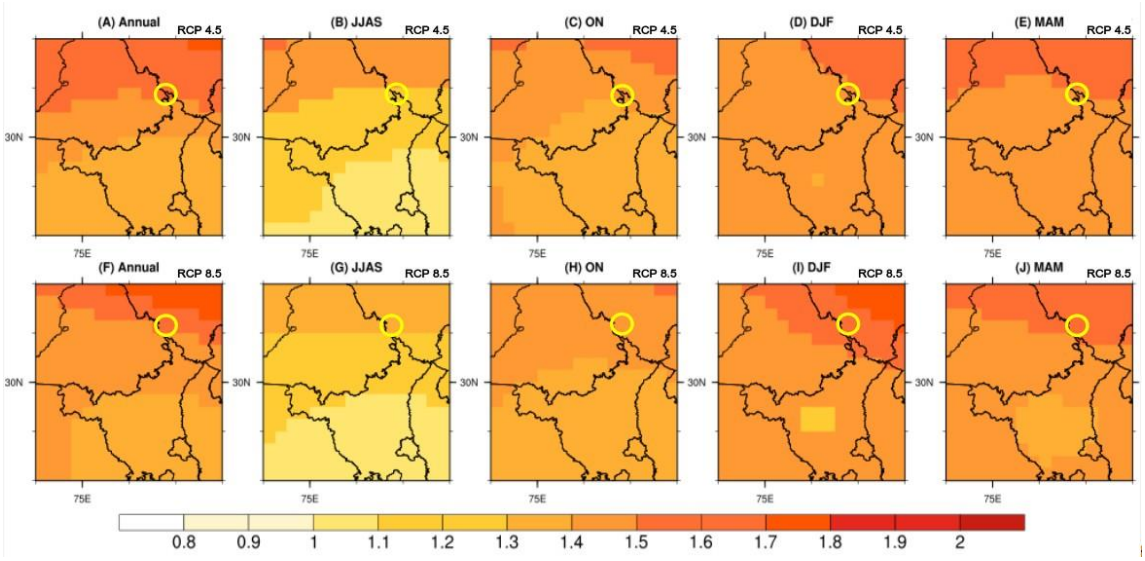


Figure 3.19: Projected future change in mean temperature during 2021–50 with respect to baseline (1976–2005) *(Location of the study area shown in yellow circle)*
Source: NEX-GDDP data

[70] Very unlikely: 90%–100% likelihood level

Table 3.5: Projected changes in temperature over Chandigarh

	Change w.r.t. baseline period (°C)	
Mean temperature	RCP4.5	RCP8.5
Annual	1.02±0.11	1.28±0.15
Monsoon	1.33±0.10	1.54±0.13
Post-monsoon	1.41±0.11	1.65±0.14
Winter	1.54±0.13	1.81±0.15
Pre-monsoon	1.66±0.14	1.95±0.20
Maximum temperature		
Annual	1.47±0.11	1.70±0.15
Monsoon	1.26±0.10	1.48±0.12
Post-monsoon	1.31±0.11	1.52±0.14
Winter	1.60±0.13	1.84±0.16
Pre-monsoon	1.71±0.15	1.99±0.20
Minimum temperature		
Annual	1.48±0.11	1.76±0.15
Monsoon	1.40±0.09	1.6±0.14
Post-monsoon	1.50±0.11	1.79±0.16
Winter	1.46±0.13	1.77±0.15
Pre-monsoon	1.60±0.13	1.91±0.19

Source: NEX-GDDP data

Table 3.6: Projected changes in annual hot days and very hot days over Chandigarh

		Change w.r.t. baseline (%)	
Indices		**RCP4.5**	**RCP8.5**
Hot days	Annual	42.2±3.32	48.84±3.84
Very hot days	Annual	77.44±5.32	85.44±5.68

Source: NEX-GDDP data

For both RCP4.5 and RCP8.5 scenarios, the data clearly shows increase in annual and seasonal maximum and minimum temperatures. Hot days (defined as the number of days with temperature greater than 90th percentile) and very hot days (defined as the number of days with temperature greater than 95th percentile) show a high increase (39% - 91%) towards the mid-century. The extreme temperatures have their high impacts on various sectors agriculture, water, and power apart from integrated impacts on health and associated productivity.

3.4.3 Surface Urban Heat Island Effect

The Department of Environment, Chandigarh is carrying out a study on Surface Urban Heat Island (SUHI). The department developed algorithms and technology stack, to capture the Surface Urban Heat Island (SUHI), detectable using the Thermal Infrared Sensor (TIRS) of the Landsat 8 and Landsat 9 series of satellites. The imagery is available at a 30m square pixel resolution, good enough to discern visible pockets of surface UHIs.

The satellite data does not provide readily interpretable information about which areas are heat pockets and which are not. After running the satellite data via a several steps, it returns

the Land Surface Temperature (LST). This Land Surface Temperature layer is then subjected to a Hot-spot Analysis, which aids in identifying locations (in this case, a grid cell of 100m x 100m) that are concentrated inside high LST or low LST neighbourhoods. This is supported statistically by spatial analytical approaches. These 'Hot-spots' are regarded as Heat Islands, whilst the 'Cold-spots' give a 180 degree opposite picture of the same problem, places that tend to do better in dispersing heat and preserving a relatively cooler surface temperature.

According to satellite photos, the land surface temperature has a Max-Min range of 39.82°C to 26.68°C. The north-western, eastern, and south to south-eastern parts of the city have the highest temperatures. The Airport, the Industrial Area, Mani Majra, Mauli Jagran, Maloya, Dhanas, Daddu Majra, Khuda Lahora, and Kaimbawala hamlet are among these localities. In terms of LST, the areas near Sukhna Lake, the Daria Forest, the forest belt beyond PU, the south-western forest belt towards Mohali, and the areas near the Nepli and Kansal forests are relatively cooler.

Similarly, when comparing the city's LST image to the Grid-based hotspot detection of places with a cluster of high temperature (and low temperature) neighbourhoods near to each other. This result is based on a spatial analytics algorithm that examines each grid cell (100m x 100m) in relation to neighbouring characteristics. Although a grid cell with a high LST value is interesting, it may not represent a statistically significant hot spot. That grid cell must have a high value and be surrounded by other features with high values to constitute a statistically significant hot spot. The local sum for a feature and its neighbourhood region is compared proportionally to the sum of all features; when the local sum differs significantly from the expected local sum, and the difference is too large to be due to random chance, a statistically significant z-score results, indicating a hotspot.

These hot spots are interpreted as Surface Urban Heat Islands (SUHIs). A statistically significant negative z-score is interpreted as an Urban Cold-spot, which means that the grid cell is part of a cluster that is significantly cooler than its surroundings.

According to the study, the areas on the North-Western, Western, Eastern, and South-Eastern sides (Khudda Lahora, Dhanas, Daddu Majra, Maloya, Burail, Airport, Industrial Area Phase I & II, Daria, Mani Majra, Mauli Jagran, and so on) are key hotspots. The areas surrounding Sukhna Lake, norther sectors, along the Choe towards Sector 16, 23, 36, 42, Daria Forest, Water Treatment Plant, Southern Peripheral Road, PU campus, and forest area near to it are all statistically significant cold spots.

Figure 3.20: Google Earth© image of the Chandigarh study area

(Shaded area represents the range of changes projected by the ensemble mean of NEX GDDP data set for each year)

3.5 Conclusion

The UT of Chandigarh is likely to experience noticeable shifts in its climate. The climate is projected to be wetter and warmer and prone to increased instances of heavy rainfall as well very hot days. While the historical data suggests that the annual rainfall shows no significant pattern of change, the climate modelling projections indicate that the future will experience increased number of rainy days, including increased instances of rain continuing for more days, particularly during the monsoon months. It is also projected that in addition to increase in total annual rainfall, the instances of heavy and very heavy rainfall will also increase compared to the historical period considered in this study.

The temperature conditions in the UT will also see an acceleration of the historical trend of growing annual average temperature as well as increase in the annual average of minimum temperatures. In the future, the UT is also likely to experience an increasing trend in annual average maximum temperatures, a departure from the historical trend. Compared to the historical trend, the maximum temperatures are projected to increase by 1.47^0C to 1.70^0C. The minimum temperatures are likely to increase by 1.49^0C to 1.76^0C. In the context of Chandigarh, this would imply overshooting the global goal of limiting the temperature rise to 1.5^0C from the levels at industrial revolution. This trend is likely to intensify the observed urban heat island effect in the UT.

4. Vulnerability Assessment

4.1 Introduction

Vulnerability can be broadly understood as the reduced ability to foresee, cope, resist, and recover from the adverse effects of a natural or manmade hazard/disaster. The concept in itself is complex in nature and is a result of multiple factors such as income, education, gender, livelihood practices, ethnic groups, etc. Developing countries exhibit a high degree of vulnerability given the high rates of poverty that prevail.

With the changes in the climate that are seen unfolding rapidly, especially in the recent years, the assessment of vulnerability becomes crucial for understanding the social and economic implications of the impacts of climate change. More scientifically, the term 'vulnerability' is used to examine interlinkages between humans, their economic and physical environments.

In this chapter, the methodology used for determining the vulnerability of the Chandigarh is the one that defines vulnerability as a function of exposure, sensitivity, and adaptive capacity under the *AR4* of the Intergovernmental Panel on Climate Change (IPCC). An indicator-based approach has been followed.

This chapter explores in detail the impacts of climate change faced by the UT, with special focus on water logging, health, and surface urban heat island (SUHI) effect. This is followed by a section on the aspects that drive the vulnerability of the UT with respect to population rise and economic growth. The next section contains a composite vulnerability assessment for the UT of Chandigarh and describes in detail, the concepts and approaches to vulnerability, the methodology that has been used, and the analysis conducted. In order to probe deeper into the key vulnerabilities of the UT of Chandigarh an assessment of the key fragile sectors has been done which is followed by a detailing of the challenges and limitations faced in the analysis conducted.

4.2 Drivers of Vulnerability

The Union Territory of Chandigarh is a highly urbanised city. With the increasing population and demanding urbanisation, the UT has been found to be highly susceptible to the impacts of climate change, such as increased exposure to high temperature, inconvenience caused due to water logging including affecting living conditions especially of the poor and marginalised communities. The UT of Chandigarh is working towards achieving sustainable growth without compromising on the developmental needs. The strategies adopted by the UT aspire towards a way forward for various sectors to integrate and adapt to the effects of climate change.

In the section below, the chapter discusses the drivers of vulnerabilities of climate change in the UT of Chandigarh.

4.2.1 Rise in Population

The sectors of concern include water, health, and sustainable city growth. The growth of population is a major factor in driving the vulnerability of the UT of Chandigarh. The population has been estimated to be 1,3,60,000 by 2036, showing an increase of ~29% from 2011 census population[71]. The UT's average per capita availability of water stands at 225 litre

[71] Population Projections for India and States 2011–36. Report of the technical group on population projections, July 2020. National Commission on Population, Ministry of Health and Family Welfare. Details available at < https://main.mohfw.gov.in/sites/default/files/Population%20Projection%20Report%202011-2036%20-%20upload_compressed_0.pdf>

per capita per day (LPCD) of water as against benchmarking of Ministry of Urban Development (MoUD) which is 135 LPCD. With the increase in population in Chandigarh, the water demand has increased tremendously. The city covers 100% of households with water connections with 10 hours per day of potable water supply. Chandigarh has two sources of water supply. One of the two sources being surface water from Bhakra Main Canal which is tapped at Kajauli located at a distance of 27 km from Chandigarh. A major part of water requirement of the city is met by canal water. Canal water supply to the city is approximately 87 MGD. The second source of water supply is under groundwater being pumped through deep bore tube wells. According to the Municipal Corporation of Chandigarh, at present, there are 289 deep tube wells in the UT through which 20 MGD water is supplied to the UT. The continuous rise in population of Chandigarh has resulted in high demand of water, causing water shortage. It is estimated that by 2026, the water demand will be 523.41 MLD, i.e., 22.73% higher than 2011 demand of 426.50 MLD[72].

In the case of water resources, the UT of Chandigarh has the twin problem of groundwater decline in deep aquifers and overflow of water in shallow aquifers in some areas. Since the UT extracts groundwater from the deep aquifers, its shallow aquifers remain untapped. This has resulted in the overflowing of its shallow aquifers and depletion of resources of its deep aquifers. The issue is found to have contributed to conditions of urban flooding in the city that have been observed, notably in the southern parts, where the shallow aquifers are located[73].

The UT of Chandigarh possesses excellent health care services, it is debatable: if with the increasing population, will it be still able to sustain the same position? The health care facilities in the UT do not seem to have expanded as much as its population has. The primary reasons for this can be pertained to the lack of medical professionals and suitable infrastructure availability. There is shortage of adequate hospital beds in the UT with increase influx of patients as well as the population from the adjoining states in the UT. The number of hospital beds per 1000 of population has only increased from 3061 to 3356 from 2010 to 2020. A report states, there has been pending recruitments of 150 doctors against new and old posts[74]. The same report states "there are more than 200 sanctioned posts across all categories lying vacant at various government hospitals in Chandigarh."

The health administration of the UT has been facing some major drawbacks with the outbreak of COVID-19 pandemic. Chandigarh with the above-mentioned availability of bed per 1000 of population did not have enough resources during the second wave of COVID-19[75]. Not only during the pandemic but even usual scenario too, Chandigarh needs to rethink about its medical facilities and needs to have parallel private health care system. The Post Graduate Institute of Medical Education and Research (PGIMER), followed by Government Multi Specialty Hospital (GMSH) in Sector 16 and Government Medical College and Hospital (GMCH) in Sector 32 have been observed to witness the highest patient rush.

[72] Consultations with Public Health, Municipal Coorporation of Chandigarh (MCC) held in December 2022.
[73] Chandigarh Master Plan, 2031. (n.d.). Details available at <http://chandigarh.gov.in/cmp2031/physical-infra.pdf>
[74] M. A. Sagar. 2021 (May). Covid crisis exposes gaping holes in Chandigarh's health policy. Hindustan Times. Details available at <https://www.hindustantimes.com/cities/chandigarh-news/covid-crisis-exposes-gaping-holes-in-chandigarh-s-health-policy-101620326513994.html>
[75] G. Kapoor, S. Hauck, A. Sriram, J. Joshi, E. Schueller, I. Frost, I., A. Nandi. 2020 (18 June). State-wise estimates of current hospital beds, intensive care unit (ICU) beds. Details available at <https://www.medrxiv.org/content/10.1101/2020.06.16.20132787v1.full.pdf >

Chandigarh which was originally built to accommodate half a million people today is brimming with at least a population of 1.5 million. With the increase in population, the numbers of infrastructures (residential and non-residential) build in the UT are also increasing, leading to rapid urbanisation in its periphery. The concretisation of the city has led to blocking of the natural drainage system which makes suburbs and the city prone to situations such as water logging and flood-like emergencies[76]. The most affected by such incidences are the people residing in the slums who do not have access either to proper shelter or in fact to health system. This put them in a vulnerable state, making them susceptible to water-borne diseases.

According to 2001 census, the slums population in Chandigarh was 107,125 which has recorded a decline in 2011 census where the slum population of Chandigarh was recorded to be 95,135[77,78]. With a slight decline in slum population, Chandigarh still deals with slum dwellers. As on today, around 60 acres of land is occupied by 8000 slum-dwellers in 10 colonies[79]. Initial planning of Chandigarh city promised a healthy lifestyle with basic amenities to the poverty-stricken people, however, as per today, around 9.08% of total population is residing in the slum areas[80]. Housing of the slums have always been a major issue faced by Chandigarh during its course of urbanisation. Chandigarh which is built upon a well-planned programme where proper allocation of space has been provided to commercial, official, and residential buildings; however, very little attention was paid to providing shelters to labour force. The government of the UT has taken a few steps to rehabilitate the slums to residential complexes under Chandigarh small flat scheme (Nallathiga, Housing for the Urban Poor: the case of Chandigarh Model 2019). As reported, the Chandigarh Housing Board had completed the construction of these flats in 2017[81].

4.2.2 Economic Growth

The economy of the UT of Chandigarh is increasing and expanding on yearly basis. The gross state domestic product (GSDP) of Chandigarh has been growing at the rate of about 7%–8% annually. The UT recorded an increase in its GSDP by 7.29% in 2018–19 period (Chandigarh GSDP 2021). It can be observed that the major sector that contributes about 88% to the GSDP of Chandigarh in terms of the gross value added (GVA) is its tertiary sector that includes hotels, restaurants, etc. With the growth of the economy, this sector is also bound to expand within the UT. This would have huge implications for the UT in terms of the waste generated with regard to both solid and liquid waste. While the UT has a good system of municipal solid

[76] C. Vinayak. 2019 (28 February). Chandigarh slum residents languish on city outskirts as houses promised under govt scheme are yet to be handed over. First Post. Details available at <https://www.firstpost.com/india/chandigarh-slum-residents-languish-on-city-outskirts-as-houses-promised-under-govt-scheme-are-yet-to-be-handed-over-6173371.html>
[77] Chandigarh City Population. 2011. Census. Details available at. Details available at <https://www.census2011.co.in/census/city/22-chandigarh.html#:~:text=Total%20no.,its%20outgrowth%20which%20is%20970%2C602>
[78] N. Mahajan. 2013 (6 September). Pleasant surprise: UT's slum population down to 9.7 pc. The Pioneer. Details available at <https://www.dailypioneer.com/2013/state-editions/pleasant-surprise-uts-slum--population-down-to-97-pc.html>
[79] H. Victor. 2018 (26 September). Slum-free Chandigarh a distant dream. Retrieved from Hindustan Times. Details available at <https://www.hindustantimes.com/punjab/slum-free-chandigarh-a-distant-dream/story-X1DQ2CCk3YaiVdtMKKQHZI.html>
[80] Chandigarh City Population. 2011. Census. Details available at. Details available at <https://www.census2011.co.in/census/city/22-chandigarh.html#:~:text=Total%20no.,its%20outgrowth%20which%20is%20970%2C602>
[81] C. Vinayak. 2019 (28 February). Chandigarh slum residents languish on city outskirts as houses promised under govt scheme are yet to be handed over. First Post. Details available at <https://www.firstpost.com/india/chandigarh-slum-residents-languish-on-city-outskirts-as-houses-promised-under-govt-scheme-are-yet-to-be-handed-over-6173371.html>

waste management, this would need to be upgraded to meet the growing demands of its economy.

The tremendous urbanisation that comes with economic growth in the UT of Chandigarh will also pose a huge pressure on its environment and landscape in the coming years. With the increase in population, the number of motor vehicles in the city has also seen a steady growth within the city. Chandigarh has the highest ratio of per capita ownership of cars in the country[82]. Owing to the rise in its population and consequently in the ownership of motor vehicles, the UT has observed a shift from plotted development to group housing, multiple families inhabiting per plot which leads to encroachment of open spaces for parking of cars and in construction of new residential and non-residential infrastructures. Such open spaces which could be used for the purpose of afforestation of native trees. Practices such as concretisation of pavements continue to choke many trees in the UT. In addition to this, developmental advances such as construction of flyovers, bridges, and widening of roads continue to increase to accommodate the needs of the rising population and growing economy of the UT. Chandigarh, at present, needs to protect its green spaces from the rapid expansion of concrete structures and develop strategies on how it can move beyond just increasing the green cover in the parks to greening its open spaces and wastelands. This would help in controlling the microclimate and further reduce occurrences of incidences like dust storms and other climatic stresses[83].

With rapid urbanisation, the concretisation of the UT in terms of the increased number of buildings and other infrastructures has been increasing. This can contribute to conditions of surface urban heat island effect in the UT. The concrete structures trap the heat radiations, resulting in increased temperatures for the UT, thereby, contributing to an increase in its demand for air conditioning and other cooling devices in buildings and housing structures.

4.3 Impacts of Climate Change on the Sectors of Chandigarh

4.3.1 Water Logging

The change in precipitation patterns in the region include an increased intensity of heavy and very heavy rainfall events that will be concentrated within short time spans. Such instances generate very heavy runoff rates that cause water logging and flood like conditions in low-lying regions. The elevation of the UT ranges from 304–365 metres above mean sea level (MSL), with an average elevation of about 321 MSL. The low-lying areas in the UT are largely concentrated in the southern part, with many of them getting flooded during periods of heavy rainfall. The repeated occurrence of water logging in the low-lying areas has also resulted in an increase in the soil salinity of those areas[84].

While the UT has 100% coverage of the city with storm water drainage, the capacity of these was designed for 12 mm/hr, exceeding which results in situations of water logging[85].

[82] Revised action plan for control of air pollution in non-attainment city of Chandigarh. Chandigarh Pollution Control Committee (CPCC), Chandigarh Administration. October 2019. Details available at <https://cpcb.nic.in/Actionplan/Chandigarh.pdf>

[83] K. S. Chowdhary. 2021. Chandigarh needs innovative approaches to save its green cover in the face of growing urbanisation. Details available at <https://scroll.in/article/996071/chandigarh-needs-innovative-approaches-to-save-its-green-cover-in-the-face-of-growing-urbanisation>

[84] Report of the High-Level Expert Group on Water Logging in Punjab. 2013. Government of Indian, Planning Commission

[85] A. Sharma, S. Sharma, and B. Zaman. 2017. Need and Scope of Stormwater Management in Chandigarh City. 12th International Conference on Civil, Agricultural, Biological and Environmental Sciences. Pattaya, Thailand.

The map given in Figure 4.1 is a Digital Elevation Model of Chandigarh. The map shows the different elevations in the UT with lighter tones showing higher elevation and dark tones showing low elevation. From the map the low-lying parts of the UT of Chandigarh are situated in the southern part of the UT. As such, high intensity rainfall could result in cases of water logging for areas in the southern sub-division of the UT.

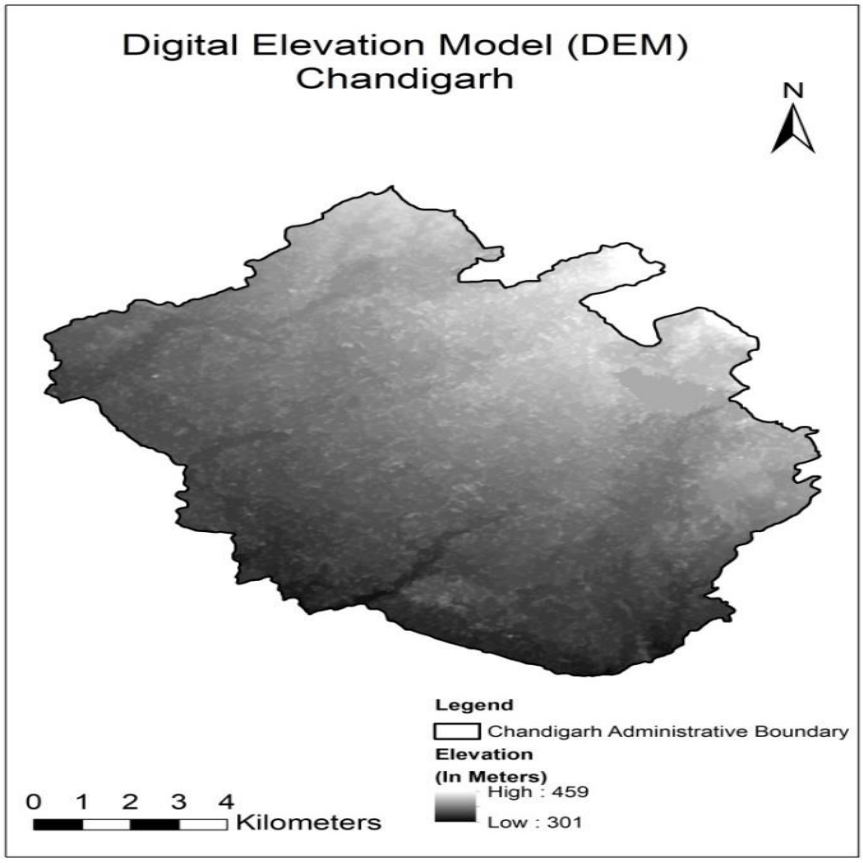


Figure 4.1: Digital Elevation Model of Chandigarh

In this regard, urban planning in the UT needs to be reflective of regional variations within the UT to address such issues.

The southern part of the UT of Chandigarh often faces the issue of water logging. It has been found that a major cause for this is the inadequate drainage system in these areas. While a major reason is that of inadequate capacity of the existing drainage network, another factor is the overflowing of the shallow aquifers in the region that are untapped due to issues in their quality. Such aspects need to be taken into consideration while addressing this issue.

Water logging is a hazard for the citizens as it leads to an increase in the cases of water and vector-borne diseases. In order to address these, adaptation interventions such as the development of flood early warning systems for the city have been suggested. While these are not measures that not only address the issue of flooding, but they also go a long way in reducing the impacts of flooding on society and human health. An important component to this end is to undertake detailed flood risk assessment studies to identify specific zones prone to flooding.

While the city has a functional storm water drainage system, the recent years have witnessed a tremendous increase in the runoff rates leading to situations of water logging[86]. This can be attributed to two important factors: the increased intensity of rainfall within shorter time spans and the increase in paved or concrete surfaces that do not allow seepage of water into the ground, leading to increased instances of water logging. The issue of water logging has been seen very frequently in low-lying areas that are now new residential areas such as Zirakpur, Mullanpur, Manimajra and Mohali. Out of these, only the area of Manimajra falls under the administrative boundaries of the Chandigarh Administration. In an attempt to address this, the chapter on adaptation interventions has suggested increasing the capacity of the current and existing storm water drainage systems, especially in the area of Manimajra. This stems from the fact that despite having 100% coverage of the city with storm water drainage network, the issue of water logging persists. As such, increase in the capacity of the drainage systems can go a long way in addressing this issue.

With increased concretisation the ability of water to seep through the ground has also been significantly affected. As more and more permeable land is being replaced by paved and concrete roads and grounds, the runoff during precipitation increases substantially, leading to a two-fold problem for the UT: urban flooding and decline in natural recharge of groundwater aquifers. With the development of the city as more and more land come under concrete spaces, the capacity of the city to expand its green spaces become limited making the existing green spaces also very vulnerable[87].

To address this pertinent and recurring issue of water logging in the UT it is important that crucial assessments are carried out at the administrative sector level to understand the spatial coverage of the issue. In this regard, flood hazard maps or flood zone mapping are important assessments that need to be undertaken. Water logging assessments require assessment of different water indexes like Normalised Differences Water Index (NDWI), Normalised Differences Vegetative Index (NDVI), Normalised differences Moisture Index (NDMI) in addition to an assessment of groundwater tables across the region. These assessments will provide a clear picture of vulnerability of the UT to the issue of water logging and will consequently assist decision-makers and policy planners in working towards the development of a climate resilient city of Chandigarh.

With water logging being observed as a major impact of climate change on the UT, there are significant implications for the population in terms of an increase in cases of water- and vector-borne diseases. The issue also results in congestion and traffic in the UT, leading to reduction in productive time for its citizens, thereby affecting economic growth and productivity. As such, robust planning mechanisms need to be developed so that this issue is contained at the earliest to avoid negative implications for the health of the citizens and economic losses for the UT.

4.3.2 Health

With the changing climate and the rapid rates of urbanisation, the UT is experiencing rising temperatures that are exacerbated by the surface urban heat island effect. The rising pollution levels with the increase in the number of motor vehicles in the UT have also impacted the

[86] Storm Water Drainage. 2020 (7 June). Municipal Corporation of Chandigarh. Details available at <http://mcchandigarh.gov.in/?q=storm-water-drainage>

[87] Sharma, K., & Chaowdhary, S. (2021, May 27). A forest in a city: Maintaining Chandigarh's green cover in the face of urbanisation. Mongabay

health of the people residing in the UT. An increase in diseases such as asthma has also been reported in the UT. In addition to these, there has been an increase in the diseases related to water in the UT in terms of water- and vector-borne diseases. This section details out the health-related issues faced in Chandigarh as a result of climate change.

Heat waves: The climate projections for the region show an increase in the average annual maximum and minimum temperatures as well as in the minimum temperatures during winters. The resultant rise in overall temperatures in the UT can lead to increased instances of heat wave-like conditions. The informal labour in the UT is quite high. About 93% of the total casual workers lack a written job contract[88]. This implies a large part of the population being exposed to higher temperatures while working in outdoor conditions. The population of the UT exposed to heat wave-like conditions would contribute to increasing the vulnerability of the population significantly.

Vector-borne diseases: The increasing frequency and intensity of water logging issues in the UT, would lead to instances of diseases spread by water such as dengue, malaria, etc. to rise significantly. Such insects breed in stagnant water and spread diseases that can affect the population of the surrounding regions. The higher temperatures with increased humidity are also conducive environments for the transmission of such diseases. In order to contain the spread of such diseases, the interventions on adaptation have detailed out awareness generation strategies along with workshops to sensitise the population regarding how these can be avoided and reduced.

Water-borne and water-related diseases: A major hazard due to water logging is that of manholes and electrocution. Such incidences lead to instant death of an individual and hence needs to be minimised as much as possible. In addition to such fatalities, water-borne diseases such as cholera, diarrhoea, etc. also lead to such instances. This makes it a serious threat to the health and well-being of the population residing in areas that face the issue of flooding. The area that faces such issues persistently in the UT include the new residential area of Manimajra. In order to reduce instances of water-borne diseases vector-borne diseases adaptation interventions have suggested the penalisation for cases where dirty water is accumulated, and sensitisation workshops are recommended to ensure that the citizens are aware of the threats from such diseases and can take appropriate steps to contain their spread. In terms of health, the UT of Chandigarh needs to upgrade its existing infrastructure in terms of design, materials, and enhanced capacity of existing systems to accommodate and address rising climate risks in the region, especially in terms of heat waves, which are further accentuated by issues of surface urban heat island effect. In addition to this, the UT also needs to focus on sensitising and generating awareness for its citizens so that the spread and outbreak of water- and vector-borne diseases can be controlled and contained to the maximum level possible.

4.4 Vulnerability Assessment

4.4.1 Concepts and Approach

There have been many frameworks and conceptualisations of the term vulnerability and accordingly its assessments. The most widely accepted definition and methodology followed for the assessment of vulnerability is the one presented in the *Fourth Assessment Report* (AR4)

[88] Report on Employment in Informal Sector and Conditions of Informal Employment, 2014. Details available at < http://labourbureaunew.gov.in/UserContent/Report%20vol%204%20final.pdf>

by the Intergovernmental Panel on Climate Change (IPCC). This report defines vulnerability as a function of exposure, sensitivity, and adaptive capacity and explains it as, "Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity"[89].

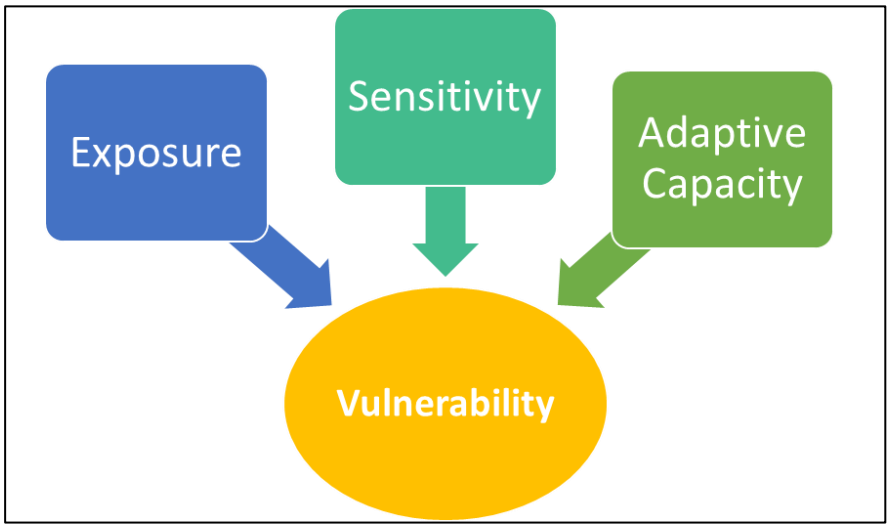


Figure 4.2: AR4 definition of vulnerability

Therefore, the following formula sums up vulnerability in the AR4 report,
V= f (E, S, AC)
In this definition, the following components were defined as given below (Figure 4.2):

- **Exposure (E)**: The magnitude and duration of the climate-related stress such as a drought or change in precipitation.
- **Sensitivity (S)**: The degree to which the system is affected by the climate-related stress or extreme events.
- **Adaptive Capacity (AC)**: Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

The approach for vulnerability assessment used in this report, considers the exposure variable as an integral part of the assessment, as per the IPCC AR4 methodology. As such, any future assessment on risk for the UT can exclude the exposure component to avoid double counting. The assessment of risk contains three integral parts that include exposure, hazards, and vulnerability. Since the vulnerability assessment conducted in this report takes into account vulnerability, in terms of sensitivity and adaptive capacity, as well as exposure, a risk assessment, which is likely to be undertaken, can be conducted using the vulnerability scores obtained in this report and an assessment of the hazards faced in the UT. Vulnerability assessment in this report along with assessing the characteristics of the system itself also assess its response to hazards – sensitivity, as well the system's ability to deal with anticipated

[89] M. Parry, J. P. Canziani, P. J. Palutikof, O. F. van der Linden, J. P. Palutikof, and P. J. van der Linden. 2007. IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment. Cambridge, UK: Cambridge University Press

impacts – adaptive capacity. This allows us to estimate the actual extent of climate impacts and, accordingly, gives a better understanding of the need to prioritize necessary interventions and gives evidence-based direction to formation of policies.

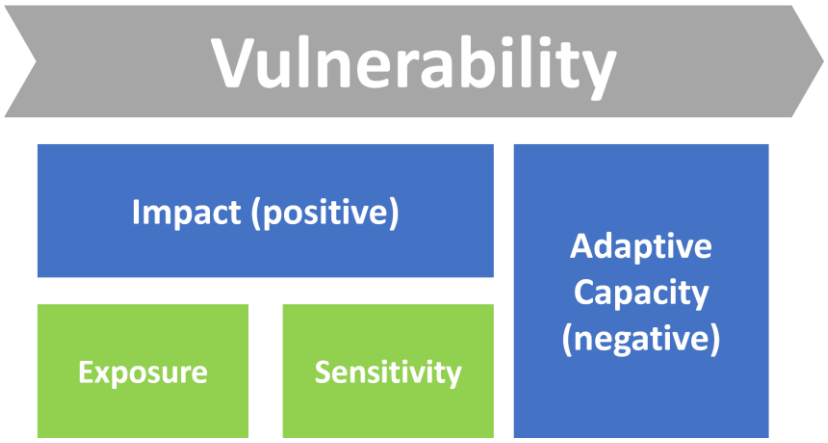


Figure 4.3: Vulnerability assessment defined in this report

Therefore, in this report (see Figure 4.3), vulnerability has been defined as follows:
V= f (I, AC),
Where, I = f (E, S)
In this definition, the following components were defined as given below:

- **Impact (I)**: The character, magnitude, and rate of climate change and variation to which a system is exposed and its sensitivity.
- **Exposure (E)**: The magnitude and duration of the climate-related stress such as a drought or change in precipitation.
- **Sensitivity (S)**: The degree to which the system is affected by the climate-related stress or extreme events.
- **Adaptive Capacity (AC)**: Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

4.4.2 Methodology

This report uses the AR 4 methodology to define the vulnerability of the UT of Chandigarh. The component of impact has been defined as a function of exposure and sensitivity, which captures the climate-related stresses over the UT as well as the extent to which the society will be affected by it.

An indicator-based approach has been used to assess the vulnerability of Chandigarh at the UT level. The vulnerability assessment has been conducted with reference to the impact and adaptive capacities of the region on a time series basis, for two points in time, the years 2010 and 2020 to rank them in the order of the extent of their vulnerability to climate change faced, given the data available from the UT.

The steps involved are:

(1) Selection of indicators which aptly capture the region-specific vulnerabilities of the UT in terms of adaptive capacities and impacts of climate change

(2) Data collection for the listed indicators and finalising the unit of analysis
(3) Data analysis and aggregation
(4) Development of the vulnerability index

Indicator Selection and Data Collection

Through a thorough understanding of the current and projected climate risks of the region and the impacts that they are likely to face, based on which, a set of indicators have been identified. These indicators will reflect the impacts of climate change faced by the UT along with their capacities to adapt. The indicators for all the sectors will be divided into the categories of impacts, which is a function of exposure and sensitivity, and adaptive capacity and will thereby aim to cover all aspects of vulnerability in the context of the UT.

The following indicators have been chosen for assessing the impacts and adaptive capacity of the UT of Chandigarh. The Table 4.1 details out the indicators along with the rationale for choosing them.

Table 4.1: Indicators for vulnerability assessment

Nature of Impacts	Rationale	Indicators	Data Sources
Heat stress, negative impacts of urbanisation	Heat waves and surface urban heat island effect has been projected for the UT	No. of days where temperature remain considerably high from the required thresholds	IMD data used for climate modelling
Health impacts	With instances of increased water logging and urban flooding, common water- and vector-borne diseases are bound to increase and needs to be kept in check	Cases of water- and vector-borne diseases	MoSPI (Ministry of Statistics and Programme Implementation) data
Groundwater decline	Groundwater tables of the UT are falling drastically; in the advent of climate change, freshwater resources such as groundwater are under threat	Groundwater extraction	Central Groundwater Board Chandigarh
	As groundwater tables are falling, extraction rates need to be monitored	Total number of tube wells	Municipal Corporation of Chandigarh

Nature of Impacts	Rationale	Indicators	Data Sources
Heat stress, economic impact	This implies the increasing demand in electricity as a result of rising temperatures	Annual per capita consumption of electricity (kWh)	Statistical Handbook of Chandigarh
Unregulated colonies and their exposure	This implies the number of extremely vulnerable population in the UT in terms of infrastructure	Total no. of *Jhuggis*	ENVIS Hub, Department of Environment, Chandigarh Administration
Adaptive capacity	**Rationale**	**Indicators**	**Data source**
Capacity to adapt to water logging conditions	UT's consecutive wet days shows an increasing trend, implying high run off during shorter time spans, therefore requiring robust storm water drainage system	Percentage coverage of the city under storm water drainage	Public Health Department, Municipal Corporation of Chandigarh
Sewage treatment capacity	Management of waste so that pollution levels of the UT are kept in check	Number of sewage treatment plants (STPs)	Public Health Department, Municipal Corporation of Chandigarh
Wastewater management	Better management of waste in the UT reduces vulnerability to instances of diseases and their spread	Percentage of wastewater treated to wastewater generated	Public Health Department, Municipal Corporation of Chandigarh
Health capacity	This shows the accessibility of the population to medical care in times of crisis or disasters	Number of doctors/hospital beds/health infrastructure per 1000 population	Directorate of Economics and Statistics, Chandigarh Administration
Countering the SUHI effect	This negates to some extent effects of surface urban heat island that can be intensified by warmer days and rising	% Green cover in Chandigarh (Forest + tree cover)	Greening Chandigarh Action Plan (2021–22)

Nature of Impacts	Rationale	Indicators	Data Sources
	temperatures for the UT		
Solid waste management	Better management of waste in the UT reduces exposure to instances of diseases and their spread	Solid waste processed as percentage of waste generated	Data obtained from Indian State Level Basic Environment Information Database (ISBEID)

The indicators on impacts are directly related to the level of vulnerability of the region and are hence negative indicators. This implies that if impacts are higher, the vulnerability of the region will also increase. The indicators on adaptive capacity are indirectly related to the vulnerability of the region and are therefore positive indicators. This implies higher adaptive capacities will lead to lower vulnerability in the region.

Data Analysis and Aggregation & Vulnerability Index

The four-step process for the calculation of the vulnerability index for the UT of Chandigarh is as follows:

Step 1: Standardizing the indicators used through the process of normalisation, since they have different scales of measurement.

For impact indicators, the following formula was used for arriving at the normalised values:

$$\text{Normalised } X(i) = [\{X(i)-Xmin\}/\{Xmax-Xmin\}]$$

For the adaptive capacity indicators, the following formula was used for arriving at the normalised values:

$$\text{Normalised } X(i) = [\{Xmax-X(i)\}/\{Xmax-Xmin\}]$$

Where:

– X(i): actual value of indicator 'X' for year 'i'
– Xmax: Maximum value of indicator 'X' from the years in consideration
– Xmin: Minimum value of indicator 'X' from the years in consideration

Step 2: This was followed by an aggregation of the scores for the two years used for assessment, that is, 2010 and 2020.

Step 3: Averaging the aggregated indicator values obtained across the two indices (impacts and adaptive capacity) for the years in consideration.

$$I(i) = \Sigma \text{ Aggregated } (Xi)$$
$$AC(i) = \Sigma \text{ Aggregated } (Xi)$$

Where:

– I(i): Impacts index and AC(i): Adaptive capacity index
– Aggregated (Xi): represents the aggregated values for each indicator for each data point (year)

Step 4: Calculating the composite vulnerability index (CVI) for 2010 & 2020 using the indices for impacts and adaptive capacity, using the following equation:

$$CVI\ (i) = Average\ [I\ (i), AC\ (i)]$$

Where:

– CVI (i): the calculated composite vulnerability score for year 'i'
– I (i): the calculated impacts score for year 'i';
– AC (i): the calculated adaptive capacity score for year 'i'

The CVI for the UT ranges between 0 and 1, with 0 showing low vulnerability and 1 showing high vulnerability.

Figure 4.4 shows the methodology that was used for the assessment of vulnerability for the UT of Chandigarh for the years 2010 and 2020.

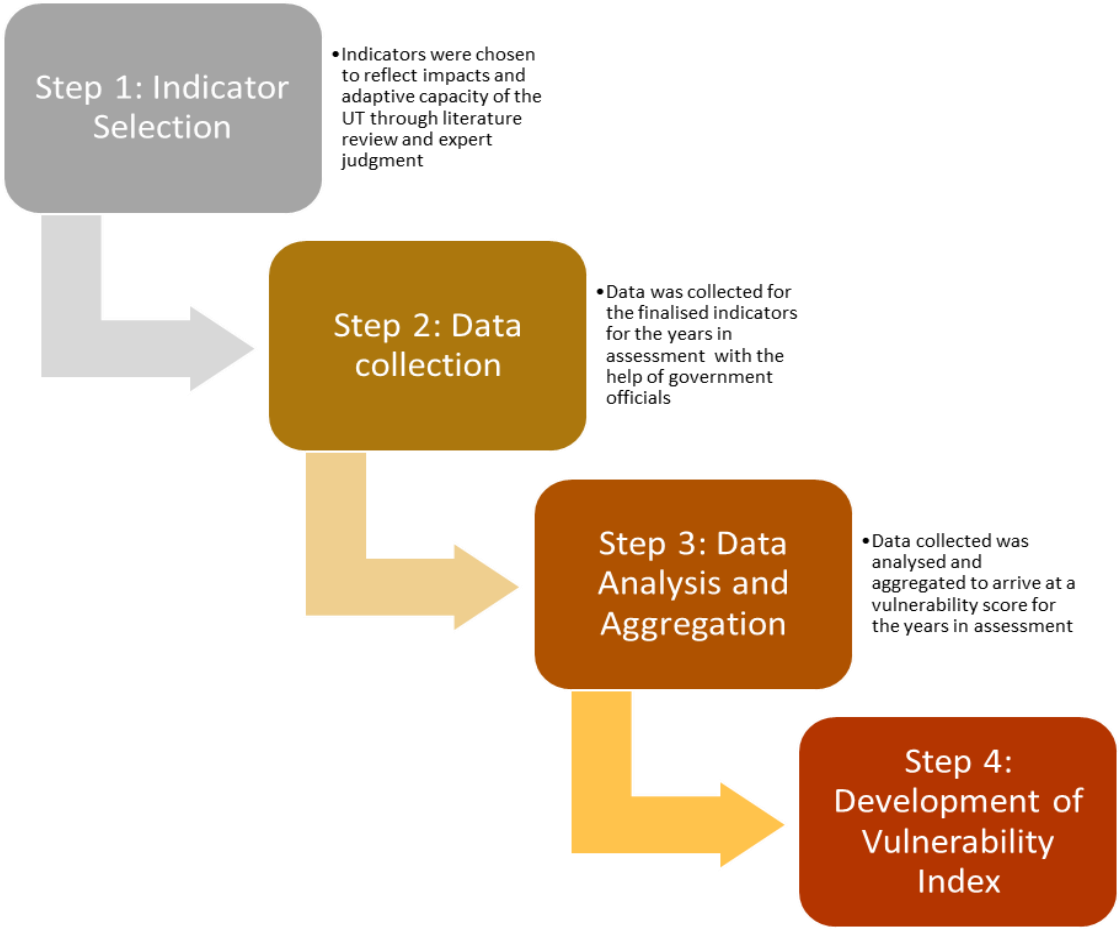


Figure 4.4: Stepwise methodology for Vulnerability Assessment

4.4.3 Vulnerability Assessment: Analysis and Findings

The vulnerability assessment that was conducted for the UT of Chandigarh was a time series analysis, wherein the vulnerability for the years 2010 and 2020 were assessed. It was found that the score for impacts showed an increasing trend from 2010 to 2020, implying greater vulnerability in the region. The assessment also found that the adaptive capacity of the UT is increasing at a rate much higher than the impacts.

The impact scores were significantly affected by indicators that showed an increase from 2010 to 2020, that include, increased cases of water-borne diseases, increase in the number of tube wells, increased annual per capita electricity consumption etc. thereby increasing its vulnerability from 2010 to 2020. Figure 4.5 shows the impact and adaptive capacities of Chandigarh for the years of 2010 and 2020. In the figure, a lighter tone depicts low impacts or adaptive capacities, and a darker tone shows high impacts or adaptive capacities.

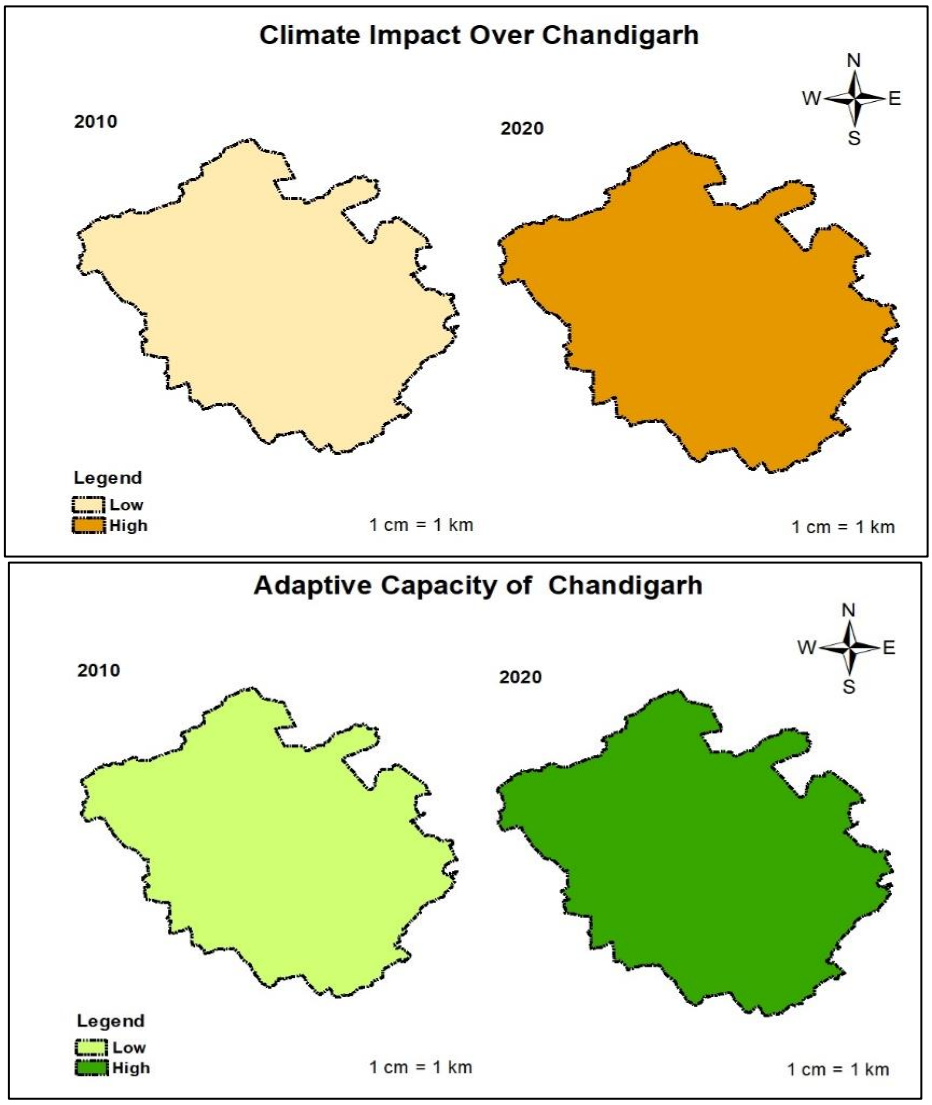


Figure 4.5: Climate Impact and Adaptive Capacity maps of Chandigarh for the years 2010 and 2020

The adaptive capacity scores also have increased from that in 2010 to that in 2020. Since adaptive capacity is a positive indicator implying an inverse relationship with vulnerability, the vulnerability of the UT has been reduced considerably but not as much as the rise in impacts. Therefore, the composite vulnerability index for the two years, 2010 and 2020, shows a marginal increase in the vulnerability of the UT.

Figure 4.6 shows the composite vulnerability index for the UT of Chandigarh for the years 2010 and 2020.

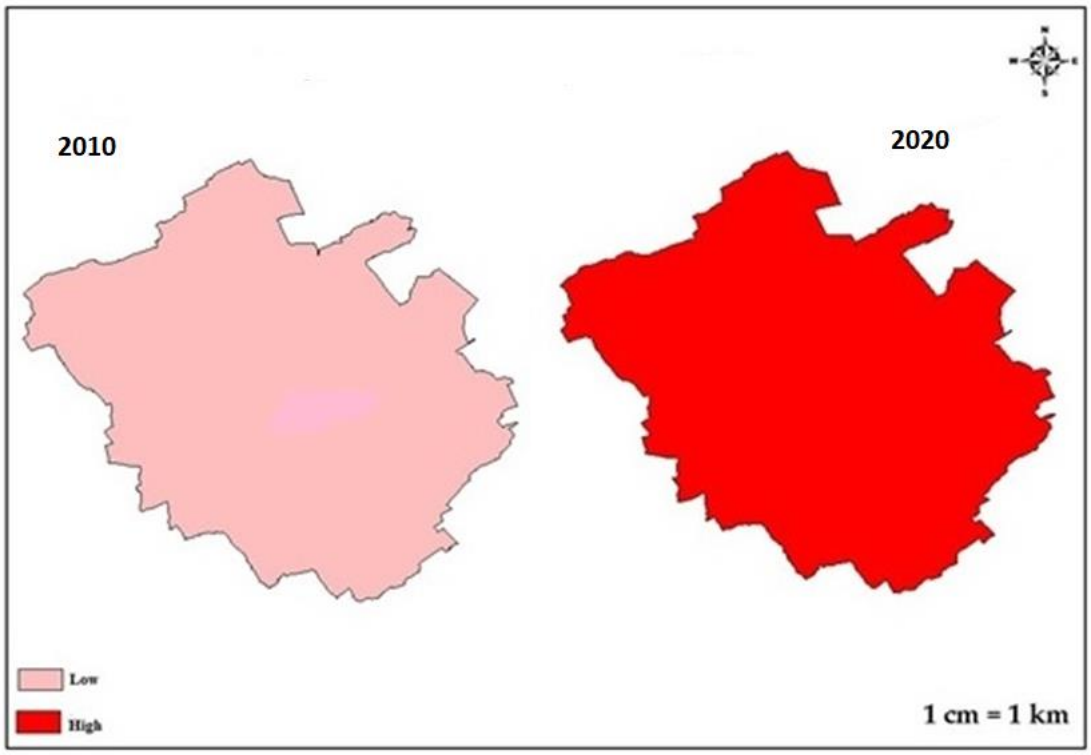


Figure 4.6: Composite Vulnerability Assessment for Chandigarh for 2010 and 2020

Figure 4.6 depicts an increase in the vulnerability of the UT of Chandigarh. It has been observed that while the impacts have increased considerably over the UT, the adaptive capacities have also increased. However, there is a felt need to enhance infrastructural and technological developments in the UT to enable efficient and effective adaptive capacities to address the impending climate impacts.

4.4.4 Challenges and Limitations

In order to develop a robust vulnerability assessment for the UT of Chandigarh, the availability of consistent data on an annual basis and at the administrative sector level is very crucial. While data for the identified indicators was available for some years, there were significant gaps and discrepancies in the data. This mandates that a database on important aspects related to climate change and its impacts be developed so that robust analysis of the data can be undertaken to arrive at an index for vulnerability at the administrative sector level of Chandigarh including capturing ward-level information.

The robustness of data for different aspects of vulnerability is also a major need. The planning of the entire UT is contingent on analysis that is conducted based on available data and hence in order to ensure adequate measures are undertaken this is a key requirement. Besides data

correction methods and checks need to be put in place for relevant authorities responsible for collection of such data. The assessment of vulnerability to understand the on-ground distribution of impacts and the capacities to adapt will go a long way in strengthening the planning process of the UT and making them more robust. In addition to contributing to SDG 13 on Climate Action, this will also boost the resilience of the UT significantly.

Such assessments are crucial to bring out the key vulnerabilities that are faced and the interventions that are needed to be planned and implemented to ensure adequate climate proofing.

4.4.5 Assessment of Selected Fragile Sectors

Land Use

Unplanned and uncensored urbanisation witnessed by the country through an increase in built-up areas, decrease in area under cultivation and vegetation will result in UHI which in turn will exacerbate the exposure to heat waves associated with global warming, thus risking the health nearly 24% of India's urban population. It is imperative that urban planning policies address UHI because of the causal relations to factors such as heat-related mortalities and morbidities and unpredictable climatic changes[90].

The concept of 'Green City' is at the crux of the development plan of Chandigarh and has mandated the development of adequate green and open spaces and extensive regulation of normal urban expansion of buildings in the city. The master plan of Chandigarh demarcates an area of 2616.55 acres (as required green area; @12 sq. m/person) for the development of green spaces with adequate open areas and access of the city's population to the three elements of 'Sun, Space and Verdure'.

Exposure: Owing to higher area under build-up spaces, reduced green spaces and water bodies, and indirect solar heating leading to urban heat island effect is the reason why urban spaces have higher air and surface temperatures. The 2011 census identifies 31% of Indian population in urban areas and this number is expected to rise up 60% by 2050. Chandigarh, with 97.25% of urban population is next only to the National Capital Region of Delhi[91]. The peri-urban urban and the urban areas in the city are fast increasing, putting stress on area under green spaces and agriculture. A 2016 study by Mathew, *et al.* using the land surface temperature of Chandigarh from 2009 to 2013, has found that the city has witnessed a significant surface urban heat island (SUHI) effect between the band 4.98k to 5.43k in the said period[92]. Owing to factors such as road networks, infrastructural spread and high raised buildings, central Chandigarh was found to be hotter compared to the rest of the city.

Sensitivity: An increase in the peri-urban and urban fringes around Chandigarh makes area under agriculture and green spaces sensitive to changes in land use. Increasing pace of urbanisation leads to newer development in the form of real estate and industrial spaces.

Adaptive Capacity: The Greening Chandigarh Action Plan (GCAP), prepared annually since 2008–09, is an integral component of urban planning of the city. The Plan details out target setting of greening departments, strategies to achieve the same, implementation and

[90] Deilami, M. Kamruzzaman, and Y. Liu. 2018. Urban heat island effect: a systematic review of spatio-temporal factors, data, methods, and mitigation measures. International Journal of Applied Earth Observation and Geoinformation

[91] D. Behal. 2020 (18 May). Why rapid urbanisation in peri-urban areas is a concern for Chandigarh. Down To Earth

[92] A. Mathew, S. Sreekumar, S. Khandelwal, and R. Kumar. 2019. Prediction of land surface temperatures for surface urban heat island assessment over Chandigarh city using support vector regression model. Solar Energy

monitoring of the strategies. Tree plantation drives, open spaces, green belts. The GCAP was introduced in the 2008 to counter the effects of pollution from the increasing population and vehicular traffic in the UT through tree plantation and maintenance drives, within a participatory framework. It also involves generating awareness and sensitising the masses about the variety of flora and fauna of the UT. The Plan also accounts for post-plantation maintenance, regular monitoring and evaluation, soil and water conservation and protection from grazing.

Chandigarh has been implementing the National Mission on Sustainable Agriculture, including tree plantation, awareness generation, increasing of green covers in peri-urban and urban areas, eco-restoration of degraded lands, etc.

As a landlocked and growing urban space, the ambition of increasing its green cover and forest cover in the coming years will get limited by its primary need for developmental activities or housing purposes. A well-defined and holistic urban planning strategy that accounts for the UT's developmental prerogatives while being cognizant of climate-induced challenges will help to increase the adaptive capacity to the challenges posed by changing climate.

Health

Exposure: In India, heat stress and resultant mortality and morbidity is expected to rise, owing to the interactions between anthropogenic factors and variability in temperature and humidity[93]. For Chandigarh, while the data for 'warm and very warm days' have no discernible trend, the numbers of 'hot and very hot days' are projected to increase towards the mid-century. The UT will also experience higher average annual maximum and minimum temperature towards the mid-century. Chandigarh is also projected to note an increase in heavy rainfall days as we move towards mid-century.

Sensitivity: Interactions between the predominantly urban landscape of the UT with large build-up area and the rising temperatures increase the risk of heat stress within the population due to urban heat island (UHI) effect. This exposure to excessive temperature increases the risk to cardiovascular and respiratory health of old and young population[94].

Extreme temperature coupled with increased variability in rainfall in future provides favourable conditions for pathogens and vectors such as mosquitos, thus increasing the risk of water and vector-borne diseases.

Vector-borne diseases: Dengue and Malaria are prevalent in the UT, along with emerging instances of Chikungunya. Between 2015 and 2022, the UT has seen an increased number of cases for Dengue, with 1953 in 2017 being the highest reported in a year. Reported instances of Malaria and Chikungunya saw spikes in 2017 but have since decreased. Underground water containers (*haudis*) and exposed overhead tanks are the breeding ground for larvae.

[93] K. K. Rao, T. L. Kumar, A. Kulkarni, C.-H Ho, B. Mahendranath, S. Desamsetti, S. Sabade. 2020. Projections of heat stress and associated work performance over India in response to global warming. Scientific Reports.

[94] A. Mathew, S. Sreekumar, S. Khandelwal, and R. Kumar. 2019. Prediction of land surface temperatures for surface urban heat island assessment over Chandigarh city using support vector regression model. Solar Energy.

Water-borne diseases: Similar mixed trend can be noticed in the case of water-borne diseases. Chandigarh saw an increase in reported cases of Hepatitis (A and E), but a decline in Cholera and in Diarrhoea[95].

Table 4.2: Instances of diseases (2015–2022) in Chandigarh

Vector-borne diseases				
Time period	**Dengue**	**Malaria**	**Chikungunya**	
2015	966	152	0	
2016	885	122	272	
2017	1951	114	54	
2018	301	44	4	
2019	286	22	0	
2020	265	7	0	
2021	1596	6	7	
2022 (till Dec 2022)	903	2	147	
Water-borne diseases				
Time period	**Diarrhoea**	**Typhoid**	**Cholera**	**Hepatitis (A and E)**
2015		430	66	222
2016		341	57	389
2017		389	12	634
2018	50936	365	18	434
2019	48254	412	2	277
2020	23799	166	0	135
2021	16514	127	41	62
2022(till Dec 2022)	10381	426	22	383

Source: ENVIS Newsletter Chandigarh 2019; Health Department, Chandigarh Administration, 2022

Climate variability also increases the risk of water-borne diseases; higher instances of heavy and very heavy rainfall days lead to urban flooding, runoff (especially into boreholes used for sourcing potable water) and consequent concentration of sediment and minerals in water increase the exposure of the population to contaminated water. Similarly, a projected rise in hot (and very hot) days also increase the risk of concentration of sediment and minerals in water.

High incidences of both water and vector-borne diseases are measures of poor quality of living, lack of access to health infrastructure and high sensitivity. The increased stress on existing health care facilities due to the incremental health risk also affects the access and the availability of health care facilities.

Adaptive Capacity: Availability and access of health care facilities have been a priority of Chandigarh administration and the UT has been pro-active in integrating climate-induced and exacerbated health risk as part of its climate action. The number of active health care

[95] ENVIS Chandigarh. 2019 (Jan-March2019). Disease Pattern Newsletter. Retrieved from Chandigarh ENVIS Government Web site. Details available at: <https://chandigarhenvis.gov.in/sites/default/files/documents/NL01032019.pdf>

facilities such as has hospitals and number of beds has increased by 28% and 17% between years 2010 and 2020 respectively (Table 4.3)[96]. The UT also has one of the highest densities of health workers per 10,000 population, doctor to per 10000 population ratio (20.39) and the nurse to per 10000 population ratio (27.04) (Table 4.4).

Awareness generation activities held periodically in slums and labour colonies, including health/screening camps, social gatherings, celebration of health days, counselling, and health educational sessions, etc. have sought to improve prevention and control of diarrhoea and cholera cases.

Table 4.3: Active health care facilities in Chandigarh

Type of Facility	2020–21	2010–11
Allopathic hospitals	7	5
Allopathic dispensaries	37	27
Ayurvedic dispensaries	15	9
Homoeopathic dispensaries	17	10
Unani dispensaries	2	1
No of Hospital beds	3712	3061

Source: Statistical Abstract, Chandigarh, 2021

Table 4.4: Medical staff in Chandigarh[97]

Category	Subcategory	2015–16
Doctors	Total /10,000 population	20.39
Nursing staff	Total /10,000 population	27.04

Source: UNDP, 2023

It must be noted that despite its continued action, the UT faces increasing challenges from health-related vulnerabilities to climate change and a consequent need to adapt more aggressively.

Water Resources

The strain on water resources has been a much-discussed aspect of climate change in the past few years. With increasing instances of rainfall variability, temperature fluctuations, and melting glaciers, the freshwater resources of the world are facing threats. India being a diverse country of varying topographies, geographies, and climate zones, faces issues of both floods and droughts in different parts of the country. While the country is working towards ensuring the optimum utilization of the available water resources, identifying, and examining region-specific vulnerabilities related to water will go a long way in ensuring better adaptive strategies.

[96] Statistical Abstract, Chandigarh, 2021; Details available at <https://chandigarh.gov.in/sites/default/files/stat2021/stat21-medhlth.pdf>

[97] UNDP, 2023. Chandigarh vision document 2030 & beyond, 2023. Details available at < https://www.undp.org/india/publications/vision-future-ready-chandigarh>

Exposure: The UT of Chandigarh has an average annual rainfall of about 1120 mm of which 80% is received during the monsoon months of June to September. While the overall climate of the UT is categorised as dry, the winter months of December to February also receive sufficient rainfall. However, with heavy and very heavy rainfall days showing a decreasing trend, a situation of water scarcity may arise in the UT. The average annual rainfall is projected to increase towards mid-century. The number of hot and very hot days are projected to increase significantly in the UT.

The UT of Chandigarh depends on both surface water and groundwater to meet its water requirements. Currently, the surface water source for the water requirements of the UT is through the Bhakhra Main Line canal (BML). The groundwater tables of the UT are depleting at a very fast rate. The UT taps the deep-water aquifers as their water quality is better than the shallow ones. However, in the southern parts of the UT, it has been observed that shallow aquifers get saturated and lead to water logging in the low-lying parts of the city. Another problem that contributes to the water logging issue of the city is the increase in paved and concrete surfaces, leading to minimal percolation and high rates of run off. The increase in the average annual rainfall will lead to high run off rates and therefore flooding and water logging in the low-lying parts of the city.

Sensitivity: The water requirements for the UT of Chandigarh are primarily for the domestic sector. The UT aims for a 24/7 water supply for all households by 2030. In 2022, the water supply of the UT stood at 225 litres per capita per day (LPCD). However, as the availability of freshwater resources is declining across regions, the judicious use of the existing resources will be a boon for the UT. Due to depleting groundwater levels, many of the existing tube wells will eventually run out of water.

The increase in the population and increasing water supply has resulted in increased sewage flow. This has necessitated augmentation of sewage treatment plants. The amount of sewerage generated in Chandigarh is around 57 MGD which includes both domestic and industrial waste. To treat the sewerage generated, there are currently six sewerage treatment plants (STPs) in Chandigarh with an overall capacity of 53.85 MGD.

The water supply of the UT is sometimes misused for gardening and washing purposes. This can be treated as a huge pressure on the existing freshwater resources. The use of tertiary treated water can be recommended for such tasks.

Adaptive Capacity: In terms of adaptive capacity the UT has taken several initiatives to ensure sustainability of the water resources. A major successful initiative of the UT is the rainwater harvesting scheme that the administration has made mandatory for all public buildings and new private constructions. All these rainwater harvesting tanks are used for groundwater recharge purposes by converting closed tube wells into groundwater recharge shafts.

To avoid wastage of water, the UT is also promoting the use of water-efficient fixtures. The UT also aims to close all its bore wells to reduce extraction of groundwater resources. However, much of the adaptive capacity of the UT is focused primarily on its groundwater resources. In terms of surface water resources, the UT needs to focus on quality and even freshwater storage systems. This would ensure that freshwater resources of the UT do not fall short in times of delayed monsoons, etc.

4.5 Conclusion

In this chapter the key impacts of climate change identified for the UT of Chandigarh have been identified such as water logging, surface urban heat island effect and health issues related to heat waves, water- and vector-borne diseases. In addition to this, the pressure on existing resources has increased significantly due to rapid growth of population and economic growth. While the current adaptive capacity mechanisms of Chandigarh are quite robust, these will need to be strengthened in the future to address rising impacts of climate change in the region.

The assessment of vulnerability for the UT shows that the vulnerability of Chandigarh has increased from 2010 to 2020. The climate impacts over the region have increased considerably. While adaptive capacities of the UT have also improved, it was not at par with the increase in the impacts. As such, the vulnerability of the UT has increased, although marginally, over the years and hence appropriate measures need to be undertaken to address this.

As water logging has been identified as a major issue in the UT, the development of flood hazard maps for the UT is crucial for identifying the flood hotspots and for undertaking key interventions in this regard. Such assessments will also play a key role in enabling decision makers and policy planners in incorporating climate concerns into developmental planning. This will go a long way in making the UT a climate proof and climate-resilient region.

The following chapter on strategies for the UT on adaptation and mitigation further detail out various ways in which the UT can reduce the effect of climate impacts and increase their capacities to adapt to these changes in line with the prevailing socio-economic status of Chandigarh.

5. Mitigation Strategies

5.1 Introduction

The UT is well recognized for its mitigation interventions, particularly on solar deployment. In the last SAPCCC, the UT focused on renewable energy, transport, energy efficiency and waste related mitigation interventions. This chapter takes stock of the progress and suggests additional interventions for raising the mitigation ambition at the UT level. The revised SAPCC of the UT of Chandigarh has mapped out several short, medium and long-term climate interventions for lowering emissions from carbon-intensive sectors.

The mitigation strategies are organized according to sectors with the highest emission potential such as transport, energy, infrastructure, and waste. For each sector, activities have been proposed for the UT aligned with the relevant national missions, Sustainable Development Goals (SDGs), and Nationally Determined Contributions (NDCs) goals.

The proposed interventions have been identified through various stakeholder consultations workshops, followed by departmental deliberations. Mitigation strategies in the UT of Chandigarh are mainly focused on four areas that align with the following national missions, namely:

- National Solar Mission
- National mission on Sustainable Habitat
- National Mission for Enhanced Energy Efficiency

The strategies also further achievement of the goals of the Mission LiFE and the specific goals of NDC related to overall reduction in the emission intensity of GHG, increasing the share of power installed capacity to 50% from non-fossil fuel sources, and adoption of a cleaner development path. Various SDGs, particularly SDG 3, 6, 7, 9, 11, 12 and 13 are also advanced through these strategies as mapped in the sectoral strategy tables in this chapter.

Since the last SAPCC of the UT, various technological development and upgradation, strategies for low-carbon development have been introduced. These have been incorporated in respective sectoral interventions to make it more efficient and effective. Keeping this in mind, the interventions proposed have been categorized as:

Table 5.1: Categorisation of interventions

Continuing	New Proposed
- Already existing/proposed in the previous SAPCC - Activities that are included in new plans and policies of the UT - The targets that are based on long-term timeline - The targets that have/have not been completed and have further mitigation potential	- Activities based on new and potential technologies Activities in alignment with the new initiated plans/policies of the UT

Each intervention is further classified and aligned according to the timelines, target, nature of interventions, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs). Regarding the timelines, the interventions proposed have been categorized as:

Short term: Completion of activity by 2023

Mid-term: Completion by 2025

Long term: Completion by 2030

5.2 Power Sector

The UT does not have a power generating plant of its own and depends on the neighboring states for the power supply. According to the 20th Electric Survey of India, the electrical energy requirement of Chandigarh is projected to be 2157 MU by the year 2031-2032, resulting in 34% growth from the requirement of 1606 MU in the year 2021-2022[98]. This projected growth brings in the opportunity of increasing the share of renewable energy sources. Over the past decade, Chandigarh has largely focused on increasing the share of renewable energy as per the Chandigarh Model Solar City Plan under the 'Development of Solar Cities' program of Ministry of New and Renewable Energy (MNRE). This is aligned with the National Solar Mission (NSM), which was formed as a primary lever to address the issue of climate change. The ambitious plan of the UT to make its power supply 100% based on non-fossil fuel sources including through implementation of the various schemes promoting solar power such as the PM Surya Ghar, use of the renewable purchase obligations to buy 40 MW power from wind sources contributes significantly to the economy wide NDC goal of reducing GHG intensity of the GDP by 45% below 2005 levels in 2030 and having 50% of power installed capacity based on non-fossil fuel sources. It is also in line with the LT-LCDS priority area 1: Low Carbon Development of Electricity Systems Consistent with Enhanced Development Benefits.

The mitigation interventions and related activities in the power sector are listed in Table 5.2.

[98] Report on Twentieth Electric Power Survey of India (Vol I), November 2022. Details available at<https://cea.nic.in/wp-content/uploads/psl f/2022/11/20th EPS Report Final 16.11.2022.pdf >

Table 5.2: List of mitigation interventions related to power sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Harnessing Solar Energy								
5.2.1	Maximize installation of Solar PV Power Plants	CREST[99]	National Solar Mission LT-LCDS: ES2.1	Long	224 MW by 2030	Continuing	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
5.2.2	Deployment of solar rooftop systems in all public, private and government buildings, including PM Surya Ghar Muft Bijli Yojna	CREST	National Solar Mission LT-LCDS: ES2.3	Long		Continuing	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030

[99] Chandigarh Renewable Energy Science and Technology (CREST)

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
							SDG 13: Climate Action	
5.2.3	Installing floating solar power plants	CREST	National Solar Mission LT-LCDS: ES2.1	Short	10 MWp by 15th Aug, 2023	New	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
Increasing the Share of Non-Solar Renewable Energy								
5.2.4	Power purchase from Wind and Hydro	CREST	National Solar Mission LT-LCDS: ES2.1 Renewable Purchase Obligations	Medium	40 MWp of wind by 2025 Balance from Hydro	New	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Creating Public Awareness and Capacity Building Programmes								
5.2.5	Special area Demonstration project	CREST	Special Area Demonstration Project Scheme by MNRE	Long	NA	Continuing	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 Target 7.a SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate action Target 13.3	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 NDC 8: Build capacities
5.2.6	Promotional activities on solar energy	CREST	National Solar mission Mission LiFE	Long	NA	Continuing	SDG 13: Climate action Target 13.3	NDC 8: Build capacities

5.2.1 Maximize installation of Solar PV Power Plants

The UT envisions to become a model solar city by 2030. The Chandigarh Renewable Energy Science and Technology (CREST) is keen to take steps to make Chandigarh the first green city of the country fully powered with Renewable Energy by 2030. The UT Administration is concentrating on its efforts to increase solar energy share and identifying new opportunities for minimizing dependence on Non-RE sources under "AZADI KA AMRIT MAHATOSAV – To Commemorate the India's 75 years of Independence". The UT plans to meet all its power needs through non-fossil fuel sources including the enhanced installed capacity of solar power and purchase of non-fossil power from other sources. The UT currently purchases less than 25% of its power from non-fossil fuel sources. Some of the innovative solar power plant projects taken up by CREST are as following:

Table 5.2(a): Innovative Solar Power Plants

S. No.	Project Name	Capacity (kWp)
1	Floating SPV Power Plant at Water Works Sector-39	2000
2	Rate Contract Tender for 2kWp to up to 100kWp, Phase-II	480
3	Rate Contract Tender for 2kWp to up to 100kWp, Phase-III	1000
4	SPV Power Plant at Parking Area of Lake, Sector-42	800
5	Floating SPV Power at Dhanas Loake	500

The following Table 5.3 mention the total CO_2 saved during three phases (I, II, III):

Table 5.2(b): Total carbon emission reduction through installing Solar PV systems

Year	Capacity Installed (MW)	Electricity Generated (Mwh)	Total CO_2 Saved (million tCO_2e) per year
2022	52	216660	0.149
2023	75	311555	0.214
2025	100	415407	0.286

5.2.2 Solar rooftop system

Under CAPEX model, As of 31st December, 2024, a total of 81.857 MWp of grid-tied rooftop solar power has been installed across 10234 sites. Since Chandigarh has limited scope and potential for ground mounted solar system, solar rooftop is the only area where potential can be tapped. The UT has made it compulsory for residential houses above 500 sq. yards to have rooftop solar power system.

Table 5.2(c): Total installed capacity of solar rooftop systems

	Government buildings (including govt. Residential buildings)	Commercial/private buildings
Total no of buildings installed with solar rooftop systems	5873	4361
Total installed capacity	50.019 MWp	31.838 MWp
Total power generated	270.26 MU	

The UT currently is proposing to introduce the solar rooftop systems through RESCO (Renewable Energy Service Company) using a BOT (Build-operate-transfer) model. This is expected to benefit users due to zero investment, free maintenance, and access to cheaper solar

power has been sent for final approval to the Joint Electricity Regulatory Commissioner (JERC). Installation under the RESCO model will improve the uptake of solar energy in residential houses as it addresses the challenges of financing as well as protection and maintenance of assets. Under the Build Operate Transfer model, solar PVs with a capacity ranging from 5kWp-10kWp in 2000–2400 residential households will be installed. A total of 6,247 government residential houses have been identified as feasible for solar installation, with an aggregate capacity of 18.1 MWp. Solar systems have already been installed on 5,705 of these houses, representing a capacity of 16.7 MWp. However, installation work remains on hold for 542 houses, where materials have been received but the installations are pending due to either vacancy (102 houses) or ongoing maintenance (440 houses), accounting for a capacity of 1.9 MWp. Furthermore, 456 meters have been installed, with an additional 2,442 meters planned for installation by January 31, 2025. The UT is also leading the implementation of the PM Surya Ghar Muft Bijli Yojna. A total of 5,366 registrations have been received, out of which 1,293 applications have been submitted, and 607 installations have been completed. Furthermore, a subsidy amounting to ₹1.07 crore has been disbursed to 139 beneficiaries. Additionally, 242 inspections have been approved till December 2024.

5.2.3 Floating solar power plants

A floating solar or floating photovoltaics (FPV), sometimes called floatovoltaics, is a solar panel mounted on a structure that floats on a body of water, typically a reservoir or a lake. The UT has set the target of 10MWp installed capacity of floating solar systems by 15th August, 2023[100]. As of 2022, the UT has installed 500 kWp floating solar energy power plant at Dhanas Lake, 2 MWp of installation work is already in process, and additional 8 MWp of work is aimed to be completed by 15th August 2023. These plants will be installed at Dhanas Lake and water works sector-39 at six different raw water tanks. This also helps to keep panels cool increasing the generational capacity of Module and also decreases loss of water due to evaporation in summers.

5.2.4 Wind power purchase

To become 100% reliant on renewable energy, the UT has decided to purchase wind generated power as well. This step also fulfills the non-solar renewable purchase obligation (RPO) targets. In this, the wind RPO target is in the range of 0.81 percent in 2023 to 6.94 percent in 2030[101]. The CREST is planning to purchase 40 MWp of power from wind projects under power sale agreement (PSA) through Solar Energy Corporation of India (SECI) by 2025[102].

5.2.5 Special area demonstration project scheme

The special area demonstration project (SADP) scheme is to demonstrate the use of renewable at prominent places. The objective of the programme would be to create publicity of the renewable energy systems and also to disseminate information on technological development and promotional activities taking place in the area of the new and renewable energy. CREST has taken concerted steps to make the best use of available solar energy by ramping up the installation of grid connected solar rooftop systems in government buildings including hospitals, schools, and colleges as well as private residential buildings. The UT installed

[100] Consultation with CREST Department
[101] Chandigarh road map to tap 75MWp solar power by August 15 next year, 22nd September 2022. Details Available at < https://powermin.gov.in/sites/default/files/Renewable_Purchase_Obligation_and_Energy_Storage_Obligation_Trajectory_till_2029_30.pdf >
[102] Discussed with CREST Department

20kWp of flexible Atrium SPV power plant over Paryavaran Bhawan during 2020. This plant has generated 72.70 MWh of power as of 31st Dec 2022. The renewable technologies such as floating solar plants and wind power purchase are also considered under the SADP scheme.

5.2.6 Promotional activities on solar energy

Under the National Solar Mission, the Chandigarh Solar City cell has been established under the CREST. It holds the responsibility of promoting and creating awareness regarding solar energy systems. The following activities have been undertaken by CREST in this direction:

- ***Dissemination of leaflets/brochures:*** 36,000 leaflets were inserted in the newspapers for creating awareness among renewable energy and promotion of energy conservation measures in UT, Chandigarh.
- ***Conferences:*** A conference on Solar Energy for Sustainable Future – Solar Tech was organized on September 13–15, 2019, Parade Ground, Sector-17, Chandigarh by CREST. Initiatives under "Solar City Chandigarh" have also been disseminated to a local and international audience at 14th Global Youth Peace Fest-GYPF 2019.
- ***Awareness generation in youth*:** UT Chandigarh is doing concerted efforts to keep the youth aware and engaged in efforts to inculcate the use of energy conservation measures. The World Environment Day and Akshay Urja Diwas – 2020 were celebrated in collaboration with Yuvsatta, Chandigarh. Funds have also been released to the Colleges of UT Chandigarh for Celebration of Akshay Urja Diwas by involving students in clean energy-centric competitions.
- ***Radio campaigning***: UT Chandigarh has also leveraged radio, which is the most popular and cost-effective medium for mass awareness campaign. Radio campaigning on five different radio channels has been carried out for enhancing uptake of renewable energy through dissemination of information about online process of availing subsidies on solar power installation.

5.3 Transport Sector

The rise in the population and rapid expansion of infrastructure across the UT has led to the increase in the rates of vehicle ownership. This has severed the issues of traffic congestion, lack of adequate parking space, vehicular pollution, and inadequate space for improving public transportation. Availability of an efficient public transportation system is an essential step towards promoting mobility and alleviating traffic congestion due to ever increasing private vehicles in the UT of Chandigarh. Chandigarh has huge potential to become a leading city in e-mobility in India due to its well-planned structure, which allows it to introduce charging stations in public places and make this transition successful.

The mitigation interventions and related activities in the transport sector are listed in Table 5.3. Each intervention is further classified and aligned according to the timelines, target, nature of interventions, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs).

Table 5.3: List of mitigation interventions related to transport sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Promoting Electric Vehicles								
5.3.1	Increasing penetration of electric vehicle	Chandigarh Transport Undertaking	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Long	To replace and increase all city buses by electric buses in a phase-wise manner by 2032. To increase share of annual EV registration to 70% by 2030	Continuing	SDG 9 Build resilient infrastructure Target 9.1 SDG 11 Make sustainable cities and communities Target 11.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.2	Enhancing energy efficiency through E-rickshaws	State Transport Authority (Chandigarh EV Policy 2022)	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Medium	Convert all existing three-wheeler rickshaws (passenger and goods) to E-rickshaws by 2030	Continuing	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
								GDP by 45 percent by 2030, from 2005 level
5.3.3	Policies for household and commercial electric vehicle adoption	State Transport Authority CREST- Public awareness	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Medium	50% adoption of electric vehicle in personal vehicle category and 100% in commercial vehicle category by end of the policy period	New	SDG 3 Ensure healthy lives and promote well-being for all at all ages Target 3.9 SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b SDG 11 Make sustainable cities and communities Target 11.6 SDG 13: climate action Target 13.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
Encouraging Sustainable Transport Systems								
5.3.4	Intelligent traffic management system	Chandigarh Smart City Limited	National Mission on Sustainable Habitat	Short	To install ITMS across all the locations by 2026.	New	SDG 7: Affordable and clean energy Target 7.b	NDC 1: Healthy and Sustainable Way of Living

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
			Mission LiFE LT-LCDS: ES2.2				SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 levelNDC 8: To build capacities, create domestic framework and international architecture
5.3.5	Replacing the current fleet of vehicles to BS VI fuel standard and provision for vehicle scrapping for old vehicles	Chandigarh Transport Undertaking - for Interstate buses State Transport Authority - for other vehicle categories	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Long	Convert all vehicles to 100% BS VI fuel compliance with the national fuel requirements.	Continuing	SDG 11 Make sustainable cities and communities Target 11.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
								by 2030, from 2005 level
5.3.6	Promoting Public bike sharing system	State Transport Authority	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Long	To encourage use of public bike sharing systems	Continuing	SDG 11 Make sustainable cities and communities Target 11.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.7	Promotion and systematic utilization of school bus system	State Transport Authority	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	Long	To promote environment-friendly school transportation systems	New	SDG 11 Make sustainable cities and communities Target 11.2	NDC 2: Climate friendly and cleaner path

5.3.1 Increasing electric buses and establishing EV charging stations

As part of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme and EV Policy 2022, the Chandigarh Transport Undertaking (CTU) is planning to replace all bus fleet to electric buses in phase wise manner. As of 31st December 2022, the UT has 80 electric buses plying on the road. These were deployed through two phases. During Phase I, 40 electric buses were deployed to strengthen city buses and in Phase –II, 40 more electric buses will be deployed for the replacement of existing diesel buses. The UT is planning to replace 70 diesel buses to electric buses in next phase by end of 2023. The aim is to replace a total of 358 local TriCity diesel buses currently plying on the roads.

The long-term target is to deploy 750 electric buses across the UT by 2032 in Tricity area. The electric buses are air-conditioned and have a seating capacity of 35 and standing space for 20 passengers. These buses will be integrated with the intelligent transport system recently introduced in the city by the transport department.

The charging infrastructure for current electric buses in the UT is responsibility of the operator. The operator will provide the plan for the installation, maintenance, need for the charging station in the UT. Currently, UT has around 24 public and 20 private EV charging stations installed. Additional 44 charging stations are planned in the policy period, 30 of which are expected to be operational by 2025.

As per the Electric Vehicle Policy Chandigarh 2022, adoption of electric vehicles in every category prioritizing phase-wise transition with targets. EVs accounted for 15.26% of total vehicle registrations from January, 2024 to December 2024. INR 33 crore have been provided in subsidies to the EV buyers to encourage EV adoption. In December 2024, there were 14,315 total EVs registered in the city of which 4,207 are two-wheelers, 5,809 three-wheelers, 93 goods carrier four-wheelers, 4,155 personal four-wheelers, 16 commercial four-wheelers, and 35 buses. These vehicle account for annual emission reduction of 14,940 metric tons. The EV Policy of Chandigarh aims to increase the EV penetration to 70% of total annual vehicle registrations by 2027.

The UT's planned interventions in the transport sector are well in line with the LT-LCDS priority area . Develop an Integrated, Efficient, Inclusive Low-Carbon Transport System and the overall NDC goal of reducing emission intensity of the GHG as well as promoting a healthy and sustainable life-style. Green hydrogen feasibility for clean alternative for transportation and energy is under exploration. As it becomes cost-efficient, initial applications can focus on re-fueling stations for zero-emission local buses and providing backup electricity during peak demand. Its versatility and potential to decarbonize hard-to-electrify sectors make it a game-changer for achieving long-term emission reductions. Bio-CNG and biofuels which offer a sustainable solution for long-term emission reduction in Chandigarh is also being explored. Bio-CNG utilizes city waste to power low-emission public transport, while biofuels derived from agricultural residues reduce reliance on fossil fuels. These renewable alternatives improve air quality, support waste management, and promote a circular economy, paving the way for a cleaner, greener Chandigarh.

5.3.2 Enhancing energy efficiency through e-rickshaws

In 2017, Chandigarh adopted an E-Rickshaw policy with an aim to launch a fleet of e-rickshaws to drop commuters to their doorstep promoting the sustainable transport mission. As per the policy, e-rickshaws can operate on contract carriage permit and the application for obtaining permit will be made as per the provision of Chandigarh Motor Vehicle Rules, 1990. According to the nodal department, the State Transport Authority, LPG/CNG rickshaws are prohibited across the UT, only e-rickshaws are permitted for operation. Currently, 2440 e-rickshaws are in operation across the UT along with incentivized permit or pass fees and road tax exemption.

As per the Electric Vehicle Policy, 2022, following are the targets for both passenger and cargo Electric Three Wheelers:

Table 5.3(b): Five-year target plan for Electric Three Wheelers (Cargo and passenger)

Category	**Target (Share of EVs in new Vehicle registration by the end of the policy Period)**				
	Year-1	Year-2	Year-3	Year-4	Year-5
E-3W (passenger auto)	100%	100%			100%
E-3W(Goods)	20%	40%	60%	80%	100%

5.3.3 Policies for private and commercial electric vehicle adoption

With the objective of reducing pollution and emissions from transport sector, the UT drafted the Electric Vehicle Policy, 2022. The policy makes registration of private and commercial e-vehicles easier and quicker by offering immediate online registration. The UT Administration has also provided more incentives to city residents to encourage them to buy electric vehicles including exemption from road taxes, purchase incentives, etc. Foreseeing the drawbacks of fuel-based vehicles, which includes rising fuel prices, pollution and GHG emissions, CREST is planning to create awareness among the masses, particularly focussing on the residents to increase the demand for household electric vehicles. Along with the promotion of household electric vehicles, infrastructure for electric charging station will be established in the UT.

Table 5.3(c): Five-year target plan for Personal Electric Cars

Category	**Target (Share of EVs in new Vehicle registration by the end of the policy Period)**				
	Year-1	Year-2	Year-3	Year-4	Year-5
Personal Electric Cars	10%	20%	30%	40%	50%
Commercial Electric Cars (Local Permit)	20%	40%	60%	80%	100%
Charging Infrastructure	Setting up of 100 charging station across UT by covering at least 1 charging station in every parking				

5.3.4 Intelligent traffic management system

An intelligent traffic management system (ITMS) enables users to be better informed and make safer, more coordinated, efficient and smarter use of transport networks. CTU and Chandigarh Smart City Limited (CSCL) have installed the ITMS at 40 locations. The UT is envisaging to install ITMS across all the locations by 2026.

CSCL is planning to do the assessment of these system to study the benefits in terms of fuel consumption reduction, waiting time reduced and GHG emission reduced by August 2023. The Adaptive Traffic Control System with a Variable Message signage has also been installed on the traffic junction to adapt to the real-time traffic condition of the junction and provide maximum green time to the vehicles. The sensors will detect the rush and automatically the signal would be green. While there would be no vehicle, the signal will turn red. This will help in managing the rush, thus reducing the emissions caused by idling during red traffic light signal, which results in enhancing the sustainable transport mission. The Integrated Command and Control Centre (ICCC) of Chandigarh has been extensively analyzing and monitoring the benefits of the traffic management system.

5.3.5 Replacing the current fleet of vehicles to BS VI fuel standard

In association with sustainable transport mission, CTU has planned to convert all diesel buses to 100% BS VI fuel compliance with the national fuel requirements by the year 2025. While switching to vehicles with cleaner fuel is pertinent for decarbonizing the transport sector, strengthening the public transportation and increasing the ease of its accessibility also plays an important role to drive this objective. In this regard, the UT has included the provision of promoting vehicle scrappage policy for government and heavy commercial vehicles.

5.3.6 Promotion and systematic utilization of school bus system

School bus transportation has become an integral part of the educational system. Promotion of school buses addresses few of the issues related to pollution, GHG emission, and traffic congestion. They can prevent many individual cars that may otherwise run on the road. Some of the additional strategies that can be included are retrofitting diesel school buses with technologies that reduce emissions, replacing diesel school buses with electric options, providing additional funding opportunities to incentivize environmentally friendly school transportation, carpooling and support innovative partnerships. Some of these strategies provide relatively affordable and accessible ways to lessen the environmental effects of school transportation, and some can even create long-term savings for the UT by reducing fuel use, maintenance needs, and energy costs. Also, personal convenience and cost savings are the major benefits of using school bus transportation services. For the promotion of school bus system, CTU can target implementing school bus transport services across every school in UT.

5.3.7 Promoting public bike sharing system

Chandigarh has the highest per capita ownership of motorized vehicles in the country and is also experiencing a dramatic increase in daily floating traffic from the extensive urbanization, which has taken place around the city. With a view to holistically address the traffic and transportation problems, the Chandigarh Administration took the initiative of promoting environment-friendly commute systems under sustainable transport mission.

The Public Bike Sharing (PBS) system in Chandigarh is one of the biggest bicycles sharing projects in India. A total of 5000 bicycles is proposed to be made available at 617 stations in

Chandigarh. Currently, there are more than 2 lakhs registered users for the PBS system. The UT has been divided into various zones/parts with stations to be installed in all zones thereby improving access to bicycles. By 2023, UT is planning to launch Phase III with 1250 bicycles and 155 dock stations.

Table 5.3(d): No of PBS launched in the UT

Phase	Launch	Bicycles	Stations
I	August 2021	1250	155
II	February 2022	1250	155
III	January 2023	1250	155

5.4 Energy Efficiency & Net Zero Buildings Sector

The UT of Chandigarh has a comprehensive infrastructure plan. Due to the increase in population along with lack of suitable land and limited space, the expansion in the infrastructure sector has been facing constraints. Therefore, in the need of accommodating the new and emerging demands and pressures, the infrastructure and building sector requires to be planned. Also, the opportunities of energy efficient options have a huge potential in the building sector. Retrofitting the existing buildings as well as promoting energy efficient appliances and cost-effective solutions can help in reducing the overall energy consumption and carbon emissions. The need of mandating energy and green certifications for buildings can also help in Chandigarh to become a low carbon city.

The mitigation interventions and related activities confining to the transport sector are included in Table 5.4. Each intervention is further classified and aligned according to the timelines, target, nature of interventions, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs).

Table 5.4: List of mitigation interventions in energy efficiency and buildings sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Energy Efficient Buildings								
5.4.1	Encourage use of BEE Energy Star Labelled Appliances	Chandigarh Smart City Limited; Electricity Wing, Electricity Department	Enhanced Energy Efficiency Mission Mission LiFE LT-LCDS: ES2.3	Medium	Installing BEE Energy Star Labelled Appliances in all households by 2026	Continuing	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.2	Introducing Energy conservation building code (ECBC 2017)	Chandigarh Smart City Limited; Electricity Wing and Construction circle, Electricity Department; Urban Planning	To adopt the concept of ECBC norms in all newly constructed government buildings, 2030 Mission LiFE LT-LCDS: ES2.3	Long		New	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.3	Smart surface coalition in buildings	Electricity Wing and Construction circle, Electricity Department; Urban Planning	Enhanced Energy Efficiency Mission Mission LiFE LT-LCDS: ES2.3	Long	To be incorporated in all newly constructed government buildings by 2030	New	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.4	Promoting green building standards and certification	Electricity Wing, Electricity Department,	Enhanced Energy Efficiency Mission	Long	To mandate green certificate across all the	New	SDG 7: Affordable and clean energy Target 7.1	NDC 1: Healthy and Sustainable Way of Living

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
		Department of Urban Planning Chandigarh	Mission LiFE LT-LCDS: ES2.3		newly constructing government and other public buildings.		Target 7.3 Target 7.b	 NDC 2: Climate friendly and cleaner path
5.4.5	Introducing Net-Zero emissions buildings	CREST	Enhanced Energy Efficiency Mission LT-LCDS: ES2.3	Long	To introduce net-zero emissions building concept in government building by 2026	New	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
Capacity Building Programmes								
5.4.6	Capacity building programmes and initiatives	Electricity Wing, Electricity Department	Enhanced Energy Efficiency Mission Mission LiFE	Long	NA	Continuing	SDG 7: Affordable and clean energy Target 7.1 SDG 13: Climate action Target 13.3	NDC 8: To build capacities, create domestic framework and international architecture

5.4.1 Encourage use of BEE Energy Star Labelled Appliances

The Standards and Labelling Programme for Equipment & Appliances was launched in 2006 with an objective to provide the consumer an informed choice about energy-saving, the cost-saving potential of the relevant products available in the market and to support the enhanced energy mission. The BEE's star labelling rates the energy efficiency of appliances on the scale of 1-5 with a 5-star label being the most energy-efficient. Currently, the scheme covers 26 types of equipment and appliances, out of which 10 are under the mandatory category, and the remaining 16 are covered under the voluntary category. The Electricity Wing, Chandigarh administration promote activities related to energy efficient appliances such as air conditioners, microwaves, washing machines, TV, etc.

Under UJALA programme, domestic grid-connected users get LED bulbs, LED tubelights and energy-efficient BEE 5-star rated fans at a price of INR 70, INR 230, and INR 1150, respectively. As of May 2022, about 6,04,071 LEDs, 58,750 LED tubelight and 17,149 BEE 5-star energy efficient fans have been distributed in Chandigarh. The UT intends to effectively implement energy efficient appliances in all household by 2026.

5.4.2 Introducing Energy Conservation Building Code (ECBC 2017)

In 2017, the Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power released revised Energy Conservation Building Codes (ECBC) guidelines providing current and futuristic advancements in building technology to reduce building energy consumption and promote low-carbon growth. ECBC 2017 sets parameters for builders, designers and architects to integrate renewable energy sources in building design with the inclusion of passive design strategies. Recently, in December 2019, Chandigarh adopted the ECBC 2017 guidelines and set a target to certify at least 50% of newly constructed buildings under new ECBC Rules by 2030. The nodal department of complying the ECBC 2017 for the UT is Chandigarh Administration–Engineering Department and associated national mission is enhanced energy mission.

Currently, all the new buildings being constructed in the UT are in accordance with ECBC norms. One such building is the Paryavaran Bhawan situated in sector 19B of Chandigarh. The building has incorporated features such as construction of an earth air tunnel forced ventilation system for the lower two floors and evaporating cooling for the top three floors. The rooftop of the Paryavaran Bhawan building has been installed with 50 kW solar grid-interactive photovoltaic power plant and, is able to meet its day-to-day energy needs from solar energy. Excess energy generated is being exported to grid. Another example of an ECBC compliant green building is the Nehru Centre for Performing Arts located in Sub City Centre in Sector 34 a project of the Chandigarh Administration. Also, ECBC norms are being followed in the new DC office and Chandigarh UT secretariat. Further, Chandigarh is a part of the common ECBC cell constituted for all the Union Territories in India.

5.4.3 Smart surface coalition in buildings

Smart surface coalition refers to cool roofs, green roofs, solar PV, porous pavements, urban tress. Combined surface solutions help to maximize the benefits from a single area. Incorporating smart surface coalition solutions in all new constructions, also retrofitting in existing public and commercial buildings, to the extent viable provides cost-effective solutions to reduce urban heat island effect. The UT envisions to deploy cost-effective smart surface solutions across at least 50% of the newly constructing and existing buildings. The nodal

department is Chandigarh Administration -Engineering Department and this programme aligns with Sustainable Habitat Mission. The following are some of the surface coalition solutions:

Cool roofs: Cool roofs are light coloured and engineered to reflect most of the heat. Light coloured surfaces heat only 8% of city and reflect a lot of sunlight and heat back.

Green roof concept: Green roofs have the potential to improve the thermal performance of a roofing system through shading, insulation, evapo-transpiration, and thermal mass, thus reducing a building's energy demands for space conditioning. Other measures are use of high reflective material on rooftop and roof treatment to reduce heat gain.

Porous pavements: They help to reduce storm water run-off by allowing rain to pass through the surface, recharging groundwater, while reducing flood risk.

Trees: Trees help to decrease the temperatures, release oxygen, clean air pollutants, and reduce flood risk by absorbing water during heavy rains.

Solar passive designs: Inclusion of solar passive measures in the architectural design can help in reducing the annual electricity consumption of buildings by 5–20%. By designing solar passive buildings, the load on conventional systems on HVAC (Heating Ventilation and Air Conditioning) and artificial lighting reduces.

5.4.4 Promoting green building standards and certification

Buildings have major environmental impact over their entire life cycle and therefore the aim of the Chandigarh Administration is to ensure that all new buildings that come within the city in future are green buildings and that the existing buildings are also retrofitted to meet the same standards. Buildings that have achieved green and energy efficient certificate reaps a lot of benefits such as energy efficiency, material sourcing, water usage, reducing chemicals used in interior finishes, and site characteristics, producing fewer carbon emissions, and also, offer a number of economic and financial benefits. The UT envisages to mandate green certificate for encouraging sustainable design across all the newly constructing government and other public buildings.

As of 2021, the Municipal Corporation Chandigarh (MCC) office building is in the process of achieving gold standard. Currently, the buildings are being retrofitted by solar rooftop system, brick bat coba on roofs, fly ask bricks, LED lighting systems, solar lighting, aluminium UPBC instead of wood, on-site water treatment and re-use. Paryavaran Bhawan building has also incorporated efficient and green features such as construction of an earth air tunnel forced ventilation system and 50 kW solar grid-interactive photovoltaic power plant.

As of 2022, the Chandigarh Housing Board Building became a "5 Star Rating" buildings as per GRIHA (Green Rating for Integrated Habitat Assessment) and was inaugurated by the Minister of Home Affairs-cum-Minister of Co-operation of India.The new Secretariat Building is also in the process of becoming one shortly.

5.4.5 Introducing net-zero emissions buildings

The UT of Chandigarh is planning to make all government buildings net zero which means optimally efficient, and generating energy onsite, using clean renewable resources, in a quantity equal to or greater than the total amount of energy consumed onsite. This activity will be overlooked by CREST. For this intervention, Total consumption department wise would be analyzed for all the buildings. The targeted buildings for this exercise are police stations; government school buildings; forest department buildings or complex in the city; sports complex; hospitals; and the Central Jail; etc. The prospective timeline to achieve the target is by 15th August 2023.

5.4.6 Capacity building programmes on energy efficiency and renewable energy technologies

Creating mass awareness and increasing the capacity building programmes are important for educating people about the benefits of using renewable energy and adopting energy conservation measures for facilitating its uptake. As a part of enhanced energy mission, several conferences, development programmes, seminars and training have been conducted by associated departments of UT in the domain of energy efficiency and renewable energy technologies for the climate action progress.

Energy Park: The Department of Science and Technology, Chandigarh Administration with financial assistance from the Ministry of New and Renewable Energy (MNRE) has set up the Chandigarh Energy Park in the Botanical Garden of the Sarangpur village in 2013 with an interactive set-up in place. The park has installed various demonstration units depicting themes like energy conservation, solar videogames, automobiles, energy storage to name a few. It has also set up multiple indoor and outdoor exhibits showcasing various renewable energy technologies like solar streetlights, solar power pumps, solar cookers, water pumping windmills, etc., which are enhancing the responsiveness of citizens and school students in the adoption of renewable energy.

Promoting energy efficient and renewable energy technologies: The National Institute of Technical Teachers Training & Research (NITTR) is actively promoting energy efficient and renewable energy technologies through awareness creation. It has organized multiple conferences and seminars on green technology and sustainable development. In addition to running courses related to environment, energy efficient instrumentation, the Institute has also conducted a green skill development programme under ENVIS Centre to train the local youth. Training has also been imparted to 23 students about solar energy and effluent/ sewage treatment plants. While the institute is focused on increasing awareness of the youth, it is also pertinent to build capacities of government officials who can push forward the agenda of green energy in the UT.

The State Designated Agency (SDA), which Electricity wing of Chandigarh Administration is providing financial assistance to Government Schools of the UT to establish Energy Clubs and to organize energy conservation activities like painting, slogan writing, quiz competition etc. More than 30 Schools of Chandigarh have established Energy/ECO Clubs and are organizing energy conservation activities on the relevant days. School awareness programs such as poster competitions, seminars, game activities etc. are held at 60 schools every year.

5.5 Waste Sector

Chandigarh UT has systematic waste management schemes and programmes under the Swachh Bharat Mission and sustainable habitat mission. Municipal solid waste, biomedical waste, and wastewater are being efficiently segregated, processed, treated, and disposed. Chandigarh was ranked 16th in the central government's cleanliness survey, Swachh Survekashan 2020. Full-proof methods are being undertaken for management of municipal solid waste (MSW) in an efficient manner. Also, medical centres are equipped with proper treatment of biomedical waste and wastewater through effluent treatment plants. Treated wastewater can be further used for tertiary purposes. Implementing various systems to consolidate the existing operations are needed, also deriving energy from solid waste can benefit the system in terms of overall energy generation.

The mitigation interventions and related activities confining to the waste sector are included in Table 5.5. Each intervention is further classified and aligned according to the timelines, target, nature of interventions, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs).

Table 5.5: List of mitigation interventions related to waste sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Waste Management								
5.5.1	Augmentation of sewage treatment plants	Chandigarh Smart City Limited	National Mission on Sustainable Habitat Mission LiFE	Short	Augmentation of 5 STP plants	Continuing	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path NDC 6: better adapt to climate change
5.5.2	Biomedical waste management	Chandigarh Pollution Control Committee (CPCC)	National Mission on Sustainable Habitat	Long	2030	Continuing	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production	NDC 2: Climate friendly and cleaner path NDC 6: better adapt to climate change

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
							Target 12.4 Target 12.5	
5.5.3	Bio-mining of Legacy waste	Chandigarh Smart City Limited	National Mission on Sustainable Habitat	Medium	Short- To reclaim 20-acre dump site by 2023 Medium-to reclaim 8-acre dump site by 2026	Continuing	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 6: better adapt to climate change NDC 2: Climate friendly and cleaner path
5.5.4	Door-to-Door Municipal Solid Waste management	Chandigarh Smart City Limited	National Mission on Sustainable Habitat Mission LiFE	Long	To encourage door-to-door waste management system efficiently and systematically	Continuing	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
							production Target 12.5	
5.5.5	Integrated Solid Waste Processing & Management System	Chandigarh Smart City Limited	National Mission on Sustainable Habitat Mission LiFE	Medium	2024	New	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path

5.5.1 Augmentation of sewage treatment plants

The increase in the population and resulting water supply has resulted in increased sewage flow in the UT. This has necessitated augmentation of the sewage treatment plants (STPs) associated with sustainable habitat mission. Out of 7 STPs, 5 are being upgraded to meet with latest norms by February 2023[103]. The installation of 8th New STP at Kishangarh has been completed. The total Installed capacity of all the STPs is 293 MLD against the sewage generation of 188 MLD. According to the District Environment Plan for the UT of Chandigarh, as part of the Smart Cities Mission, STP Dhanas and 3BRD have been upgraded and are fully operational. STP Diggian and STP Raipur Khurd are under commissioning. The tender for STP Raipur Kalan has been awarded in December 2023. All sewage discharge outlets in seasonal drains are being plugged.

The sludge treatment methods are pathogen free, and it is also treated for power generation. The sewage water will be treated at these captive plants and the tertiary treated water will be used for the irrigation of open spaces in these institutions. This will not only help in reducing the burden on the sewerage network of the city but also help in reducing the cost of taking the sewage from the residential and commercial premises to the STP and thereafter recycling it back to the city after treatment for irrigation of open spaces/parks.

5.5.2 Biomedical waste management

In Chandigarh, there are 44 bedded hospitals and nursing homes and 664 clinics and dispensaries. The hospitals generate high quantities of biomedical waste that contain HIV, hepatitis viruses, antibiotics, cytotoxic drug, radioactive materials, etc. This waste if not disposed safely has immense potential to contaminate the environment and cause potential health hazards. To manage this issue, the Government of India formulated the Biomedical Waste Management Rules, 2016 (later amended in 2018) with an intent to organize the waste collection, processing, and disposal processes. The UT is compliant with these rules. In line with the Sustainable Habitat Mission, biomedical waste generated from the city is partially handled by the incineration plant set up at PGIMER after disinfection, and remaining waste sent to the hazardous waste dumping site (Secure Landfill, Nimbua, SAS Nagar, Mohali) for final disposal as per Hazardous Wastes. Biomedical waste is collected and treated with 100% efficiency.

For efficient treatment of liquid waste from hospitals, CPCC is planning to set up Effluent Treatment Plant (ETP) across all the hospitals by 2023. ETPs are being implemented across the six hospitals, namely, GMCH 32,16; Dispensary 22, 45; Manimajhara 48.

[103] District Environment Plan for Chandigarh. 2021. Details Available at <https://chandigarh.gov.in/sites/default/files/August21/dc21-dep20.pdf>

Table 5.5(a): Information on bio-medical waste treatment and disposal facilities (2021)[104]

Bio-medical Waste Generation (in Kg/day)	Existing Total bio-medical waste treatment capacity (both captive and BMWTF) in kg/day		Total BioMedical waste Treated in kg/day
	Equipment	Total	
5374	Incinerator	4000	3505
	Autoclave	3000	1869
	Any other: Shredder	12000	739

5.5.3 Bio-mining of Legacy waste

The project of legacy waste bio-mining and land recovery was recently inaugurated in September 2022. The project, which is being partially funded by the central government under the Swachh Bharat Mission 2.0 and will target legacy waste dumped at the site after 2005. Legacy waste plant has been set up in the city by the Municipal Corporation, Chandigarh at Dadu Majra, Chandigarh. Of this, 5 lakh MT from before 2005 measuring 20 acres is being biomined under a Smart City project and is planned to be completed by March 2023 as a short-term target. The project, which is being partially funded by the central government under the Swachh Bharat Mission 2.0 and will target the 7.67 lakh metric tonnes (MT) legacy waste dumped at the sites.

5.5.4 Door-to-Door Municipal Solid Waste management

As a part of the Sustainable Habitat Mission, the handling of solid waste, its transportation and disposal rests with the MCC. For collection, removal, and storage of MSW, the MCC has allotted around 1/5th of the city's area to private entrepreneurs for providing sanitation services. The garbage is collected from door-to-door in large cycle carts by the Residents Welfare Associations (RWAs) and several NGOs from all the wards 6 days a week. All sectors have been covered and around 390 cycle carts have been deployed in the UT under smart city mission. Also, the MCC has deployed 99 Bolero, 390 Tata Intra and 35 Tata Ace CNG for collection of garbage. 100% door-to-door collection of segregated waste has been achieved[105]. The collected MSW is disposed of in community bins known as Sehaj Safai Kendras. The waste is then transported to the dumping ground regularly through hydraulic fitted fast moving vehicles.

Currently, MCC is collecting daily around 550–600 tonnes daily of municipal waste from all over Chandigarh. In commercial areas, colour coded 3 bin system has been installed for collection of wet (green bin), dry (blue bin), and domestic hazardous waste (black bin). Domestic hazardous waste is also collected and processed separately by MCC. For wet waste, the city has two wet waste processing facilities, the first is a composting facility of rated capacity of 300 TPD and second is biomethanation unit of 5 TPD. For dry-Waste Management, 3 Nos. mechanical MRFs are operational and 1 RDF Plant having capacity 500 TPD is already in existence.

[104] District Environment Plan for Chandigarh. 2021. Details Available at <https://chandigarh.gov.in/sites/default/files/August21/dc21-dep20.pdf>

[105] https://chandigarh.gov.in/sites/default/files/updation2024/dc24-dep24-3004.pdf

5.5.5 Integrated Solid Waste Processing & Management System

As a part of Sustainable Habitat Mission, the handling of solid waste, its transportation and disposal rests with the MCC. The plan intends for managing the generated Municipal Solid Waste (Wet Waste, Dry Waste and Hazardous waste) end to end i.e., collection at source till processing and converting this waste into energy along with some other useful products by employing advanced, modern, and latest technologies. The integrated plan is envisioned to be setup by December 2024. Through the plan, MCC is designing, installation, commissioning, operations, and maintenance of "Integrated Solid Waste Processing & Management System" for the city for ensuring utmost cleanliness, Public Health through waste reduction/ reuse/recycle operations.

5.6 Emission Reduction Potential

The following table shows the emission reduction potential for some of the mitigation activities till 2030:-

Table 5.6: Potential GHG emission reduction till 2030

S. No.	Activities	Potential GHG emission reduction till 2030 (tCO_2/yr)
5.2.1	Maximize installation of Solar PV Power Plants, 100% renewable energy by 2030	11882333
5.3.1	Increasing electric buses and establishing EV charging stations	6,45,959
5.4.1	Encourage use of BEE Energy Star Labelled Appliances	5,54,752
5.4.5	Replacing the current fleet of vehicles to BS VI fuel standard	1,36,102
5.4.7	Promoting public bike sharing system	765.1
5.5.1	Augmentation of sewage treatment plants	337.44
5.5.4	Door-to-Door Municipal Solid Waste management	1,20,705
	Total	12694994.54

5.7 Recommendations

The mitigation strategies proposed in this chapter addresses Chandigarh's climate change concerns through a low carbon pathway. Special awareness raising and technical capacity building efforts aimed to achieve these goals also needs to be designed and deployed.

- Smart City parking solution would be implemented which gives the details regarding vacant spaces for parking to the citizen through digital platform. This will ensure lesser traffic on the road and less fuel consumption as it will make the process of locating the parking spot convenient for the citizens.
- The UT would facilitate continuous collation, monitoring, and evaluation of GHG emissions. This requires robust data management systems across each department and other stakeholders. Therefore, strengthening the institutional mechanisms through capacity building programmes are required for ensuring the data collection processes.

- E-Governance – solution of all grievance online will reduce the carbon footprint of individual and paper saving.
- Underground utility mapping will help to reduce the digging emission.
- Energy efficiency in buildings is encouraged in the public and private infrastructure through introducing energy efficient building codes. There is a need for creating public awareness programmes at the UT level for encouraging the incorporation of EE amongst the public citizens. Also, there should be systematic monitoring and evaluation of buildings that are following efficient norms.

6. Adaptation Interventions

6.1 Introduction

The city of Chandigarh was planned with the modern concept of 'sustainable habitat'. It was planned far ahead of its time and combined both the concepts of city planning and regional planning. The city concept is inclusive of natural gradient of the site facilitating storm water drainage, availability of water, scenic beauty, backdrop of the hills, used natural material for building construction, etc. Meanwhile, the regional concept focuses on the periphery with the expanse of green belt surrounding the city to nourish, and aims to improve microclimate, enable scope of future expansion, and so on. However, rapid urbanization and development have made it significantly prone to climate change. To reduce the impact of climate change, further development needs to be sustainable in a manner that it reduces the emissions on one hand and addresses risks and enhances resilience on the other. The State Action Plan for Climate Change (SAPCC) of Chandigarh has introduced various development and upgradation strategies for potential adaptation.

In this chapter, the adaptation strategies include implementation centric, capacity building and awareness generation activities in respect of, forestry, water, health, infrastructure etc. The proposed interventions have been identified through various stakeholder consultations workshops, followed by departmental deliberations. Each activity that has been proposed is identified under the relevant national missions and linked to Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs). Potential adaptation strategies are aligned with the following national missions, namely:

- National Water Mission
- National Mission for a Green India
- National Mission on Sustainable Habitat
- National Health Mission
- National Mission on Strategic Knowledge Management for Climate Change

The strategies are also aligned with achievement of the goals of the Mission LiFE, and the specific goals of NDC related to overall reduction in the emission intensity of GHG, increasing the cumulative carbon sink, promotion of a healthy and sustainable lifestyle, adoption of a cleaner development path, enhancing adaptation, and building capacities. Various SDGs, particularly SDG 3, 6, 11, 12, 13 and 15 are also advanced through these strategies as mapped in the sectoral strategy tables in this chapter. In addition, alignment with the GBF, NBT and the Ek Ped Ma Ke Naam campaign has also been ensured. Overall, the adaptation strategies advance the LT-LCDS priority areas 6: Enhancement of Forest and Vegetative Cover Consistent with Socio-Economic and Ecological Considerations, and the chapter on adaptation and resilience.

Since the last proposed SAPCC of the UT of Chandigarh, various development and upgradation strategies for potential adaptation have been introduced. While some of the previously proposed interventions are completed, some are still being implemented. Keeping this in mind, the interventions proposed have been categorized as:

Table 6.1: Categorisation of intervention

Continuing	New Proposed
- Already existing/proposed in the previous SAPCC - Activities that are included in new plans and policies of the UT - The targets that are based on long-term timeline - The targets that have/have not been completed and have further mitigation potential	- Activities based on new and potential technologies - Activities in alignment with the new initiated plans/policies of the UT

Each intervention is further classified and aligned according to the timelines, target, nature of interventions, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs). Regarding the timelines, the interventions proposed have been categorized as:

Short term: Completion of activity by 2023

Mid-term: Completion by 2025

Long term: Completion by 2030

6.2 Water Sector

With the rising population, the UT could face major challenges in managing water demand stress in the coming years. The cause of concern is a projected higher increase in UT's demand for water than the supply, despite its average supply being higher than the national standards of 135 LPCD. Another area of concern is the non-revenue water, or the leakage loses which currently are up to 35%. A large volume of the UT's water supply depends on groundwater. According to the Central Groundwater Board (CGWB) reports the groundwater tables of the UT are depleting at a very fast rate. The UT taps the deep-water aquifers as their water quality is better than the shallow ones. The shallow aquifers in the southern part of the city that are not tapped into often overflow, leading to situations of water logging in the city. The increase in impervious areas in the UT due to paving of roads, footpaths, etc., also contributes significantly to the issue of waterlogging. It is noted that the storm water drainage infrastructure was made when the city was built; thus, they have now become inadequate to deal with the current run-off as the intensity of rainfall in the region has increased.

The potential adaptation interventions and related activities in the water sector are listed in Table 6.2.

Table 6.2: List of potential adaptation interventions in water sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Water Logging and Flood Management								
6.2.1	Upgrade drainage system to manage the runoff in intense rains, especially in the flood prone areas, such as building new and renewing old storm water drains, residential areas that face consistent water logging issues	Public Health Department, Municipal Corporation of Chandigarh (MCC)	National Water Mission Mission LiFE	Medium	Laying of additional storm water drainage system by 2024	Continuing	SDG 11: Sustainable cities & communities Target 11.5 SDG 13: Climate Action Target 13.1, 13.2	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.2	Development of Flood Early Warning Systems	Public Health Department, MCC	National Water Mission National Mission on Strategic Knowledge	Medium		New	SDG 3: Good health and well being Target 3.d SDG 13: Climate Action Target 13.1, 13.2, 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
Enhancing Water Use Efficiency								
6.2.3	Revamping/retrofitting water supply transmission and distribution network system with the latest technology (water-efficient fixtures)	Public Health Department, MCC	National Water Mission Mission LiFE	Medium	24/7 water supply project (water supply, sanitation, waste management) in Chandigarh under Smart City initiative. The project to start from 2023 for duration of five years with financial and technical support from AFD within	New	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
					the framework of smart city mission.		cities & communities Target 11.1	NDC 7: Mobilizing additional funds to bridge the resource gap
6.2.4	Mandatory water meters and audits in high consumption segments/ sectors - industries, hotels, public clubs, restaurants, residential complexes, and public buildings	Public Health Department, MCC; CGWB	National Water Mission Mission LiFE	Medium	1.70 lakh meters to be installed under the smart city mission	Continuing	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.5	Periodic water budgeting to understand the actual demand, usage, and supply of water by sector (domestic + commercial)	Public Health Department, MCC	National Water Mission Mission LiFE	Long		New	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
Groundwater Conservation								

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
6.2.6	Prohibition/restriction on new borewells	Public Health Department, MCC	National Water Mission Mission LiFE	Medium	All borewells to be closed in phased manner by 2028	Continuing	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.7	Metering of groundwater usage by industries and commercial establishments and taxation for over extraction	Public Health Department, MCC; CGWB	National Water Mission Mission LiFE	Long	Starting from 2023, CGWB to check regulation of flow meters in industries	New	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
Reuse and Recycling of Water								
6.2.8	Wastewater treatment plants and use of treated water	Public Health Department, MCC	National Water Mission Mission LiFE	Medium	Upgrading all the Sewage Treatment Plants prescribed limits i.e., BOD <5mg/l, *E-Coli*<100 and work will be completed by 2023 (Under smart city mission);	Continuing	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable	NDC 1: Healthy and Sustainable Way of Living NDC 6: Enhancing investments

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
					Implementation of SCADA System for Recycled Water Distribution Network for pan-city under smart city mission to start from 2023 for a duration of five years (implementation phase)		cities & communities Target 11.1, 11.6	in developing programmes and vulnerable sectors
Rainwater Harvesting – Enforcement and Monitoring								
6.2.9	Mandatory RWH systems in the public buildings and large houses with periodic audit and check	Public Health Department, MCC; Housing Board	National Water Mission Mission LiFEs	Long	Installation of 42 RWH in community centres and 40 in government buildings/institutions (2022-2024)	Continuing	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: Enhancing investments in developing programmes and vulnerable sectors

6.2.1 Drainage system of the UT to be upgraded

Chandigarh being a planned city has a complex storm water drainage system in place that combines both natural and man-made drains and waterbodies, to discharge surface run-off into the 'N' Choe. Storm water drains in the city are constructed and maintained by the Public Health department of the Municipal Corporation of Chandigarh (MCC) and storm water lines have been laid in almost 100% of the UT area, with most water being discharged into the N-Choe near Sector 47. The size of storm water drains varies from 12" to 96" including brick drain and RCC box channels, and the total length of storm drain network is 713 km.

While the UT has a well-constructed network for storm water management, the system's capacity is stressed with the population increasing and the increased variability in rainfall patterns. The capacity of these 50-year-old storm water drains were designed in phases, for 15mm rainfall/hour in phase 1 (northern sectors), 20mm in phase 2 (central sectors), and 25mm in phase 3. The frequency, intensity and duration of extreme precipitation events has shown an increase in the region, which has consequences for the UT in terms of facing issues such as water logging in low lying areas. The UT also faces issues of silting of the N-Choe as well as the Sukhna Choe, which ultimately affect the efficiency of the drainage system by reducing its' carrying capacity during torrential rains. Additionally, the problem is exacerbated by the diversion of natural water drainage courses to accommodate habitation leading to increased run-off. The increase in impervious areas in the UT due to paving of roads, footpaths, etc., also contributes significantly to the issue of waterlogging. Therefore, there is a felt need for the UT to strengthen the existing infrastructure on storm water management.

The MCC has started the process of upgrading and replacing the UT's storm water drainage system and plans to complete the implementation by 2024. The detailed project report (DPR) has already been prepared which includes parameters like procurement plan, cost estimates and time frame for execution.

6.2.2 Development of Flood Early Warning system

With increasing incidences of flash floods and waterlogging in the UT, it becomes necessary to equip the UT with flood early warning system for better management of situations with havoc rains resulting in disaster-like situations. The flood early warning systems will help better disaster management by forecasting whenever the flood-like incidences would be predicted. It will help in issuing warning when a flood like situation is eminent or already occurring. With effective governance arrangements, a flood warning system would help in better mitigation of risk and designing a good monitoring and evaluation system.

6.2.3 Revamping/retrofitting the existing water supply

a) Under the Smart City Initiative, the Chandigarh UT plans to change to a 24/7 water supply by 2030, thus, addressing the challenges of water storage. At present, the administration of the UT has a shortage of infrastructural capacity to store water to meet its demands. Previous years have seen shortages in supply due to these storage limits, along with maintenance issues such as leakages in the main pipeline from Kajauli. The MCC has signed an MOU with the Agence Française de Développement (AFD) for the next five years starting from 2023 to provide technical support to the UT of Chandigarh for strengthening the strategy and management of urban services like water supply, sanitation, waste management within the framework of the Smart City Mission. Under the component on providing 24/7 water supply across the UT in the

MOU the aim is to ensure a continuous supply of water to meet the UT's water demands. It includes other sub-components as well like construction of new underground reservoirs for raw water and clear water storage, installation & upgradation of existing pumping machinery for 24/7 water supply and retrofitting of existing pipeline network.

b) It is estimated that water efficient fixtures in new buildings can reduce water demand by about 25%. While new buildings are getting retrofitted, it is planned that old fixtures will be replaced with newer, more water efficient ones. All the public toilets are to be installed with water efficient fixtures taps in the next three years. In the last 5 years, 500 taps have been installed with water efficient fixtures.

c) The MCC also plans to work on leakage control management. The idea is to strictly monitor and improve existing structures to ensure reduced supply-chain losses. Currently, the leakage losses are up to 35% and UT is working towards minimizing the leakage losses to below 15% by 2030. The Project Management Consultant (PMC) has been engaged to study non-revenue water (NRW) and suggest measures for the same.

6.2.4 Enforcing water meters and water audits in high consumption segments/sectors

a) As part of the MOU with the AFDone of the project components is also to install 100% automatic meter reading (AMR) systems at the consumer's ends in the UT. Around 1.75 lakh meters are to be installed in the UT in the next five years.

b) The UT has introduced by laws mandating that all faulty meters be replaced by consumers. In order to ensure compliance, a panel rate will be charged till the replacement of the faulty meter.

c) To address indiscriminate use of good quality water in the UT, water audits for existing buildings are proposed by the MCC. The audits will assess the use of water for various purposes such as in washrooms, cooking, and others. The Project Management Consultant (PMC) has been engaged to study and conduct water audit and suggest steps/actions for designing an efficient 24/7 water supply in city. Based on the audit results, it is planned that the use of tertiary treated water for non-potable purposes will be promoted.

6.2.5 Periodic water budgeting

According to the Chandigarh Administration, the present water supply service area of MCC is 114 km^2. The peak demand for water in the UT is about 116 MGD, while the current availability of water from all sources is only 107 MGD. Around 81% of the UTs demand is met through water sourced from Kajauli Waterworks/Bhakra Main Canal (87 MGD) and 19% through bore-wells located within the UT (20 MGD). The UT has been divided into 7 zones for the purpose of distribution. The total installed capacity of water from the six phases of surface source is about 87 MGD. Approximately 85% connections are metered, and flat rate connections are given to rehabilitated colonies.

There is a projected increase in UT's demand for water more than the supply, despite its average supply being one of the highest in the nation. Following a series of concentrated efforts to reduce consumption, the average supply stands at 225 LPCD as opposed to the standard norm of 135 LPCD for domestic water supply in India, prescribed by the Ministry of Housing and Urban Affairs. Thus, periodic water budgeting should be initiated and carried

out at the UT level to understand the actual demand and usage of water in the UT by sector (domestic + commercial) and the supply available from internal and external sources.

6.2.6 Prohibition/restriction on new borewells

Due to rapidly declining ground water levels, the Municipal Corporation of Chandigarh is working towards phasing out all borewells. Additionally, the administration plans to integrate all non-functional tube wells into RWH systems and convert them into groundwater recharge shafts. So far, approximately 60 borewells have already been phased out in the last five years in the Western sector, some of which were drying up. The remaining 230 borewells are planned to be phased out in the next five years.

6.2.7 Metering of groundwater usage and taxation for overextraction

Chandigarh does not have many surface water sources and faces rapid groundwater depletionby almost 2–3 metres annually. It is among the most water-stressed state/UT in the country according to a study by World Resources Institute (WRI) on global aqueduct water risk indicators[106]. The depletion of groundwater levels is not only due to rapidly increasing demand, but also exacerbated by the decrease in regeneration of aquifers due to increased erratic patterns of rainfall. Industries and commercial establishments are the bulk users of the groundwater. Usage of groundwater by industries and commercial establishments are to be metered by framing updated groundwater usage regulations and ensuring its effective enforcement. Taxation for overextraction beyond a set limit for different categories of the population also needs to be implemented in the UT.

Currently, flat rate of INR 50,000/month is charged to the industries for groundwater extraction. Around 32 industrial shallow tube wells, which were not metered yet, have to be connected with flow meters in the next one year. The State Groundwater Authority (SGWA) has been established in the UT which will be responsible for regulation and enforcement of flow meters in the industries starting from 2023. The SGWA will report to the CGWB and the CGWB will be carrying out the quality checks.

6.2.8 Reuse and recycling of water

a) The UT has five Sewage Treatment Plants. All of them are being upgraded with latest prescribed limits i.e., BOD <5mg/l, E-Coli<100 under the Smart City Mission. The upgradation is expected to be completed by 2023.
b) Besides upgrading STPs the MCC is supplying a percentage of treated water for watering purpose around the green belts, gardens, neighbourhood parks while practising activities such as gardening and horticulture. Total available tertiary treated (T.T) water in the UT is 31 MGD and the present T.T water demand is 10 MGD. In the UT 4 underground reservoirs have been constructed for the distribution of T.T water in sector-28B, 29B, 29C and 48-A. At present, tertiary treated water connection has been provided in 72 green belts, 26 gardens, 1807 neighborhood parks, 1800 no of residential premises (all the green belts and parks have been covered with T.T water).
   To promote the use of tertiary treated water, use of water for non-potable purposes such as gardening, car washing and flushing, etc., in residential plots having an area

[106] Aqueduct Global Maps 3.0 Data, 2019. World Resources Institute (WRI). Details available at< https://www.wri.org/data/aqueduct-global-maps-30-data>

more than 500 sq. yard has been made mandatory. About 85% of tertiary lines have been laid out in the city and the rest will be completed in the next 5 years. Under the AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme distribution lines are being laid out in left out sectors and industrial area of Chandigarh for the use of T.T water in industries as well as in parks. This implementation is being planned to be completed by 2027. This will save about 10 MGD potable water i.e., 16 MCM/Year.

c) Implementation of Supervisory Control and Data Acquisition (SCADA) System for Recycled Water Distribution Network for pan-city under the Smart City Mission is to start from 2023 to monitor the quantity and quality of recycled water to save the precious water resources. Presently, the T.T water is being supplied to all the sectors without any automatic monitoring resulting in non-equitable distribution of TT water. The proposed SCADA system will include monitoring of BOD, COD, TSS, pH, DO, Residual Chlorine, as well as Flow measurement, pressure measurement etc. by installing various analysing equipment and sensors.

6.2.9 Rainwater Harvesting (RWH)

To reduce dependence on groundwater, the UT recognized the potential of utilizing harvested rainwater. Chandigarh has a total rainwater harvesting capacity of more than 70% of the total land area (Table 6.2(a)). The total capacity of water that would be available for recharge annually is: *58 km² (area) x 1059.3 (rainfall) x 0.5 (rainfall coefficient) = 30,720 million litres*.

Table 6.2(a): Estimated rainwater harvesting capacity of Chandigarh

Source Area	Area (in sq. km)
From Roads	15.89
From the Rooftop of Residential area	30.19
From Public and Institutional Buildings	7.94
From Shopping area	3.97

Source: ENVIS Centre, Chandigarh, 2019[107]

To reduce dependence on groundwater, a short-term legal framework has been laid by the administration making RWH mandatory while granting the additional covered area to all plots above 500 sq. yard area. The administration has also made rooftop rainwater harvesting as a mandatory provision in educational institutions, residential and industrial buildings constructed on plots above one kanal, group housing societies, commercial establishments, hospital, cultural and religious institutions, clubs, etc. The harvested water then will be used for groundwater recharge, gardening, and other grey water purposes in houses and for non-domestic use. Around 269,170 sq. m of the rooftop area is already installed with RWH systems. The annual average water recharge through these systems recorded is 269.17 million ltrs.

Around 77 government schools, 8 government colleges, other 30 non-residential building and 23 residential building have been equipped with RWH systems in the last 10 years by Public Health department of Municipal Corporation of Chandigarh (MCC). In addition, 10 RWH structures have been constructed by the Housing Board since 2011, in urban housing areas (Table 6.2(b)).

[107] Newsletter, ENVIS Centre. Rainwater Harvesting: Chandigarh. Department of Environment, Chandigarh, October-December 2019. Details Available at <https://chandigarhenvis.gov.in/sites/default/files/documents/NL04062018.pdf>

Table 6.2(b): List of completed projects where rainwater harvesting structures (RWHS) have been constructed by Housing Board

Number of Flats/Buildings	Location	Number of RWHS constructed*	Date and Year of Completion
8448 Small Flats	Dhanas	4	June 30, 2013
1024 Small Flats	Sector 49D	2	February 7, 2011
Chandigarh Housing Board Building	Sector 9	2	April 5, 2012
200- 2 Bed-Room Flats	Sector 51	2	December 31, 2019

Note: *1 RWHS= 56 m^3

Source: Data obtained from stakeholder consultations held with Housing Board of Chandigarh on March 16, 2020

The UT, along with mandating RWH structures in newer plans, has also been proactive in promoting groundwater recharge through RWH. The UT administration has been successful in installing 93 government buildings, including 65 schools and colleges, with RWHS.

6.3 Forest and Wildlife sector

According to the India State of Forest Report (ISFR), 2021, the green cover of UT has increased by more than 50%. The total increase in green area reported from 2019 to 2021 in the UT is around 4.25% by the IFSR report. As per the report there is also a rise in the forest cover and open forest area by 85 ha and 158 ha respectively. It signifies that more non forest area has been brought under green cover in the last two years. However, with the rapid urbanization and concretization of the UT, the green areas are being taken up for developmental activities or housing purposes, as in most developing cities. This has caused the city to face huge gaps and challenges in achieving the targets of increasing green cover and forest cover in the coming years.

The various activities being carried out by the Chandigarh Administration to enhance the greening and biodiversity of the UT are listed in the table below (table 6.3), also given are the new or proposed activities.

Table 6.3 List of potential adaptation interventions in Forest and Wildlife sector

S. No.	Activities	Nodal Department and other departments involved	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	Alignment with SDGs, NDCs, Other National Missions and policies
6.3.1	Promoting increase in tree/green cover in portions of public parks, premises of schools and colleges and community spaces -free distribution of seedlings of various species to the institutions, eco clubs, NGOs & residents of Chandigarh for plantation	Department of Forest and Wildlife; Horticulture Division (MCC); Horticulture Division, Engineering Department	National Mission for a Green India Ek Ped Ma Ke Naam LT-LCDS: ES2.6	Long	Total – 750000 saplings to be planted by 2030	Continuing	SDG 15: Life on land Target 15.2 NDC 5: Additional carbon sink Kunming-Montreal Global Biodiversity Framework (GBF): GOAL A GBF Target 11, 12 National Biodiversity Target (NBT): 3, 5 Ek Ped Ma Ke Naam
6.3.2	Demonstration of herbal gardens, bamboosetum, orchids, arboretum along with other means of ex situ conservation	Department of Forest and Wildlife	National Mission for a Green India LT-LCDS: ES2.6	Long		New	SDG 15: Life on land Target 15.2 NDC 5: Additional carbon sink GBF GOAL A GBF Target 11, 12 NBT: Target 11
6.3.3	Replacing invasive and ornamental species by planting native trees in the forest areas, degraded lands	Department of Forest and Wildlife	National Mission for a Green India Ek Ped Ma Ke Naam	Long		New	SDG 15: Life on land Target

S. No.	Activities	Nodal Department and other departments involved	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	Alignment with SDGs, NDCs, Other National Missions and policies
	and green belts; enhancing biodiversity		LT-LCDS: ES2.6				15.2, 15.a, 15.8 NDC 5: Additional carbon sink GBF GOAL A Target 6, 11 NBT: Target 4
6.3.4	Developing a city biodiversity index or dashboard for forest health assessment and to inform officials and generate public awareness	Department of Forest and Wildlife	National Mission for a Green India	Medium		New	SDG 15: Life on land Target 15.5 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF GOAL C, D GBF Target 14, 21,22 NBT: Target 7
6.3.5	Study on Forest health assessment	Department of Forest and Wildlife	National Mission for a Green India	Medium		New	SDG 15: Life on land Target 15.5 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF GOAL C, D

S. No.	Activities	Nodal Department and other departments involved	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	Alignment with SDGs, NDCs, Other National Missions and policies
							GBF Target 14,20, 21,22 NBT: Target 2
6.3.6	To reduce the silt inflow to Sukhna lake through carrying out various kinds of soil conservation works like construction of silt retention dams, masonry check dams, spurs/revetments, desiltation of dams, construction of grade stabilizers.	Department of Forest and Wildlife	National Mission for a Green India	Long		Continuing	SDG 15: Life on land Target 15.1 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal A Target 3, 10 NBT: Target 3, Target 6
6.3.7	Building and maintaining fire breaks and other latest techniques of fire suppression in the forest areas, and training and equipping fire fighters on techniques to control forest fires	Department of Forest and Wildlife	National Mission for a Green India	Long		Continuing	SDG 15: Life on land: Target 15.2 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal A Target 8 NBT: Target 3

S. No.	Activities	Nodal Department and other departments involved	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	Alignment with SDGs, NDCs, Other National Missions and policies
6.3.8	Celebration of Wildlife week, world forestry day, world earth day, wetland day; Eco-Clubs; Publication of Chandigarh Greening Action Plan	Department of Forest and Wildlife; Department of Environment (DoE); Department of Education	National Mission on Strategic Knowledge Management for Climate Change	Long		Continuing	SDG 12: Responsible consumption and production Target 12.8 SDG 13: Climate Action Target 13.2, 13.3 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal D GBF Target 11, 20, 22 NBT: Target 1
6.3.9	Building a peoples' biodiversity register (including traditional knowledge)	Department of Environment (DoE); Department of Forest and Wildlife;	National Mission on Strategic Knowledge Management for Climate Change National Mission on Sustainable Agriculture	Long	2030	new	SDG 15: Life on land NDC 8 Building Capacities GBF: Goal A NBT: Target 1

6.3.1 Increase in green cover

In Chandigarh, there are three greening agencies that look into aspects of increasing the green cover of the UT. These are the Forest Department, Horticulture wing of Municipal Corporation of Chandigarh and Horticulture wing of Engineering Department. There are targets assigned to these three agencies that are identified in the Greening Action Plan of the UT every year. These three departments are also assigned their own jurisdictional areas and the entire UT is divided into three areas, with each area being managed by one of these agencies, as allocated. There is also constant monitoring and evaluation of these activities through on-site visits by officers. A quarterly meeting is held among the departments to assess the progress of the activities and targets. For instance, the target set for the year, 2022-2023, is 280000 saplings to be planted in the UT[108]. Since, in these cases, the GPS coordinates are not taken, field staff are assigned to regularly cross check the actual number of plants through physical verification that have been planted against the targets assigned. Under the existing processes, field staffs are assigned to regularly cross check the actual number of plants through physical verification. In the year 2020-2021 and 2021-2022–the plantation target was 255000 and 280000 respectively. The UT has overachieved its target by planting 283435 saplings in 2020-2021 and 291848 in 2021-2022[109].

A new scheme has been initiated by the Forest department in 2019 to encourage greening of the UT: 'Forest Department at your doorstep' or 'Van Vibhag aap ke dwar'. The scheme has three vehicles operating at the same time in different sectors of the UT for free distribution of plants and saplings to people at their respective houses. The initiative was inaugurated during Van Mahotsav (an annual plantation drive conducted by the Department) and every year during the monsoon period in July the vehicles cover all the sectors over period of 21 days for door-to-door distribution[110].

In order to ensure that forest land is not encroached upon, there is regular patrolling by the police and other concerned authorities. Forest guards are also kept for similar purposes. Apart from these measures, the administration has also ensured that much of the forest area is fenced. The areas that have wildlife habitation are the ones that are not fenced so that their movement is not constrained.

The Forest Department is also working towards enrichment plantations in the catchment area of Sukhna Lake:

i. Promoting plantation of fruit bearing species such as Mango, Jamun, Amrood, Imli, etc., in specific plots allocated in the Sukhna Wildlife Sanctuary.

ii. Increasing plantation of indigenous and palatable variety of trees and shrubs on the slopes and plain areas of the Sanctuary.

iii. Enriching the hill tops and slopes of the Sanctuary with green cover by patch sowing of seeds by contour trenching and trench-cum-ridge method.

[108] Greening Chandigarh Action Plan, 2022-2023. Department of Forests & Wildlife, Chandigarh Administration. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2022/07/GCAP-1.pdf>
[109] Greening Chandigarh Action Plan, 2021-2022. Department of Forests & Wildlife, Chandigarh Administration. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2021/06/GCAP-2021-22.pdf >
[110] Greening Chandigarh Action Plan, 2021-2022. Department of Forests & Wildlife, Chandigarh Administration. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2021/06/GCAP-2021-22.pdf>

6.3.2 Demonstration activities enhancing biodiversity

Residents learn best when they find interest in what they are see demonstrated. Demonstration of herbal gardens, bamboo setum, orchidary, and arboretum will be encouraged along with other means of ex-situ conservation in the UT for the residents. These demonstration gardens could be the learning gardens for the visitors and the local residents. The endeavor will help the residents realize their interests, which can be tapped and nurtured through exposure and guidance by technical expertise basically, to guide and provide training to the residents in the UT through hands-on training and field demonstration.

6.3.3 Replacing invasive and ornamental species by planting native trees

Invasive species are generally exotic or alien species having the ability to compete with and replace native species in natural habitats, thereby threatening native biological diversity. As the UT continues to rely on tree-planting as a form of green infrastructure, more consideration is being given to replacing non-native or invasive species in the degraded lands, forest areas and the green belts in the UT with native species to increase diversity.

The department of forest & wildlife in the last couple of years is making sustained efforts in improvement of the quality of the forest by planting indigenous species such as Shisham, Shahtoot, Khair and Babul etc. The department celebrated 'Amrit Mahotsav '(celebration of 75 years of country's independence) in 2021 by planting saplings of various indigenous trees in the UT. During the event trees of Mango, Peepal, Ashoka and other species which are native to the UT were planted on land recently reclaimed by the UT administration after the demolition of illegal structures[111,112].

6.3.4 Developing a city biodiversity index or dashboard

With the increasing urbanization and urban population, the major impacts on biodiversity will be felt inevitably in the urban settlements. The decisions, behavior and consumption habits of this large population in urban settlements could potentially affect the biodiversity conservation. It is, hence, necessary to formulate a methodology for benchmarking the biodiversity and environmental stewardship of the UT. Developing a biodiversity index possibly including ways to evaluate the ecological footprint of UT and its impact on environmental services, would be a way forward in this direction.

The biodiversity index could act as a self-assessment tool for the UT to evaluate and monitor the various biodiversity conservation efforts that are being implemented by the UT. To list a few the index could include list of indicators that measure the native biodiversity, ecosystem services by the biodiversity, governance, and management of biodiversity. The quantitative scoring against each indicator in the index could be useful in building capabilities of the UT in biodiversity conservation, setting their priorities for conservation actions and for financial allocations as well.

[111] Greening Chandigarh Action Plan, 2022-2023. Department of Forests & Wildlife, Chandigarh Administration. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2022/07/GCAP-1.pdf>

[112] Chandigarh administrator releases green action plan: Times of India, July 14, 2022. Details available at<http://timesofindia.indiatimes.com/articleshow/92862443.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst>

6.3.5 Study on forest health assessment

As per FSI report there is a rise in the forest cover but assessing the health condition of forest is essential to help forests adapt to projected climate change, and achieve forest-related ecological, economic, and social benefits. Forest health is a driving factor of an ecosystem, and the phenomenon of ongoing climate change is directly and indirectly dependent on it. Therefore, in this perspective, assessment and regular monitoring of the forest health is necessary. Here, a study is proposed to analyse the forest health in terms of its vegetation status in the UT.

However, fragmentation of forest areas is a major problem in our terrestrial ecosystem, and it has been widely discussed among the several research groups of people. Forest areas are mainly distressed by deforestation, basically by a transformation of forestland into farmland and for other commercial purposes. Therefore in this perspective, assessment and regular monitoring of the forest health are necessary.

6.3.6 Restoration of water bodies

The Sukhna Lake was constructed in 1958 at the foothills of the Himalayas Shivalik hills which are ecologically sensitive and geographically unstable and thus highly prone to soil erosion during rains. Therefore, after initial years of construction of Sukhna lake, the rate of siltation was very high due to this soil erosion by surface run-off from its catchment area. A silt survey was carried out during the period from 1960-1961, and it was found out that on an average the lake was silting up at the rate of 500 acre feet per annum. The original storage capacity of the lake was 8710 acre feet in 1958 which reduced to 2970 acre feet (34% of original) in 1988. Thus in 30 years, 66% of the original water holding capacity of the Lake was lost due to siltation. This alarming rate of soil erosion and fast siltation of the lake forced the erstwhile Punjab Government and later governments to take various steps to reduce the silt inflow to the Lake from the catchment area. Formation of Sukhna wildlife sanctuary was one of the initial initiatives that was taken that time for improving soil & moisture conservation regime of the area[113]. Afterwards, to reduce the silt inflow to the lake various other kinds of soil conservation works like construction of silt retention dams, masonry check dams, spurs/revetments, desiltation of dams, construction of grade stabilizers have been carried out by the Forest department at regular intervals which has considerably reduced the silt inflow to the lake presently. 190 silt retention dams, more than 200 check dams, spurs revetments and brushwood structures have been constructed till now to conserve the soil and to retain the silt in the water bodies created behind silt retention dams. Fully silted up water bodies have been desilted on regular basis to revive its silt retention capacity[114].

6.3.7 Managing/Preventing Forest fires

In preventive action against possible forest fires, the Forest Department in UT carries out various activities such as maintaining fire breaks, demarcating forest fire lines, passages under transmission lines are cleared on timely basis to avoid catching fire of the organic component, enhancing techniques of fire suppression in the forest areas, and training and equipping fire

[113] Management plan of Sukhna Wildlife Sanctuary Chandigarh (UT), 2018-2019 to 2027-2028. Society for development of forest, environment and natural resources, Chandigarh. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2021/04/MANAGEMENT-PLAN-OF-SUKHNA-WILDLIFE-SANCTUARY-2018-19-TO-2027-28.pdf >
[114] Greening Chandigarh Action Plan, 2022-2023. Department of Forests & Wildlife, Chandigarh Administration. Details available at <https://chandigarhforest.gov.in/wp-content/uploads/2022/07/GCAP-1.pdf>

fighters on techniques to control forest fires. As a result, there has not been any case of forest fire reported since 2017.

6.3.8 Awareness campaigns

To raise awareness about a range of environmental issues like depleting natural resources, water scarcity, carbon footprint, habitat loss, deforestation, pollution and ways to maintain a clean habitat, recycle/reuse, significance of wildlife conservation the Forest & Wildlife department organize various events throughout the year such as celebration of Wildlife week, world forestry day, world earth day, wetland day; a number of students, teachers, working professionals, general public participate in these events.

Under the National Green Corps (NGC), the MoEFCC established eco-clubs in a nationwide programme with an aim to protect and conserve environment has received significant success. The MoEFCC has partnered with state government agencies and NGOs working in field of environmental education under this programme and has grown the network in the last 10 years with more than one lakh eco-clubs involving 6 million students across the country. In Chandigarh more than 75% of schools and 100% colleges are registered under the NGC programme. The eco-clubs are guided by the Department of Environment and Department of Education under the Chandigarh Administration. These clubs conduct various environmental awareness activities and campaign and plantation drives.

Publication of the Greening Chandigarh Action Plan (GCAP) every year is an effort of the Forest department to further improve greening of the UT and address the UT's challenges of rapid urbanization by integrating sustainable urban development & environmental planning. The GCAP summarises the initiatives and measures the UT administration has taken over the past year towards greening in the UT and sensitization of the masses on environment protection. The GCAP also sets the plantation targets for the next financial year for the green Chandigarh task group i.e., Forest department, Horticulture wing of Engineering department and Municipal Corporation.

6.3.9 Alignment with National and International Frameworks

Chandigarh's interventions in the Forest and Wildlife Sector are well aligned with the National Green Mission under the NAPCC, the Kunming-Montreal Global Biodiversity Framework (GBF), and the National Biodiversity Targets (NBT). Three of the four long-terms goals of the GBF (A, C, D) and 10 of the 23 targets set for 2030 are relevant for Chandigarh. These efforts focus on conservation and restoration under Goal A through carbon reduction, renewable energy transition, and forest cover restoration; equitable sharing of biodiversity genetic resources under Goal C through involvement of local communities in biodiversity management and mainstreaming biodiversity under Goal D integrating climate adaptation and financial resources into policies. In terms of the targets of National Biodiversity Strategies and Action Plans there are 12 National Biodiversity Targets and the adaptation interventions in the Forest and Wildlife Sector covers 10 out of 12 targets.

Key interventions of the department that align with Kunming-Montreal Global Biodiversity Framework (GBF) and National Biodiversity Targets includes activities to enhance U.T. Chandigarh's green cover, protect wildlife and raise public awareness about biodiversity preservation. The "Annual Greening Chandigarh Action Plan" being prepared by the Department of Forest and Wildlife guides these efforts. Additionally, as mandated by the Biological Diversity Act, 2002, a People's Biodiversity Register (PBR) of Chandigarh will be

developed. PBR documents the biodiversity and traditional ecological knowledge gathered through detailed discussions with an array of stakeholders such as farmers, *vaids*, people involved in the rearing of animals, and officials. Overall efforts are aligned with India's Long-Term Low-Carbon Development Strategies' pillar 6: Enhancement of Forest and Vegetative Cover Consistent with Socio-Economic and Ecological Considerations.

6.4 Health sector

An analysis of projected temperature variations for Chandigarh suggests that the numbers of 'hot and very hot days' are likely to increase towards the mid-century. The UT will also experience higher average annual maximum and minimum temperature along with a projected increase in heavy rainfall days as we move towards the mid-century. Extreme temperature coupled with increased variability in rainfall in future provides favourable conditions for pathogens and vectors such as mosquitos, thus increasing the risk of water and vector-borne diseases. Dengue and Malaria are prevalent in the UT, along with emerging instances of Chikungunya. In the past few years, the UT has seen an increased number of cases of vector borne diseases. Similar mixed trend can be noticed in the case of water-borne diseases in the UT.

The potential adaptation interventions and related activities in the health sector are listed in the table 6.4.

Table 6.4 List of potential adaptation interventions in Health sector

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Improving Risk Preparedness against Vector- and Water-Borne Diseases								
6.4.1	Door-to-door awareness generation programmes on mitigating risk of vector- , water-borne diseases, non-communicable diseases (NCDs)	Health Department	Health Mission Mission LiFE	Long	No of households visited (raising awareness on vector borne diseases): 2018 – 407641; 2019 – 410130; 2020 – 532412; 2021 – 773091; 2022 - 898678 No of households visited (raising awareness on water borne diseases): 2021 – 144 2022 - 221	Continuing	SDG 3: Good health and well being Target 3.3 SDG 6: Clean water & sanitation Target 6.b SDG 13: Climate Action Target 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.2	Develop online platforms/websites for information	Health Department	Health Mission Mission LiFE	Short		New	SDG 3: Good health and well being	NDC 1: Healthy and Sustainable

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
	dissemination regarding vector and water borne diseases						Target 3.3 SDG 6: Clean water & sanitation Target 6.b SDG 13: Climate Action Target 13.3	Way of Living NDC 6: Better adopt to climate change
Reducing Health Risks due to Air Pollution								
6.4.3	Creating awareness among the people to reduce exposure to dust allergies and air pollution	Health Department	Health Mission Mission LiFE	Long		New	SDG 3: Good health and well being Target 3.9 SDG 11: Sustainable cities & communities Target 11.6 SDG 13: Climate Action Target 13.1, 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes& Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
6.4.4	Formulation of public protocol in case of severe air quality	CPCC; Health Department; Department of Environment (DoE)	National Mission for a Green India Mission LiFE	Short		New	SDG 15: Life on land Target 15.5	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.5	Real-time surveillance, rapid response teams, and public advisories to combat heatwaves	Department of Health & Family Welfare	National Program on Climate Change and Human Health	Long		Ongoing	SDG 3: Good health and well being Target 3.D SDG 13: Climate Action Target 13.1	NDC 6: Better adopt to climate change

6.4.1 Awareness generation programmes on mitigating risk of vector-, water-borne diseases and non-communicable diseases (NCDs)

The UT administration has been pro-active in controlling instances of water and vector-borne diseases. Non-communicable diseases (NCDs) are chronic diseases lasting for long period of time and these are slowly progressing in the UT. Mortality from communicable diseases have decreased while those from NCDs have increased. Capacity building/awareness generation of communities is required for prevention, early detection, and control for NCDs in the UT. The UT carries out various information, education, and communication (IEC) activities to generate awareness on NCDs. These activities include door-to-door awareness generation, rallies, distributing pamphlets, health/screening camps, social gatherings, celebration of health days, counseling & health educational sessions being held on regular basis at NCD Clinics established at GMSH-16, CH-22, CH-45 and CH-Manimajra (Health Department, 2021). The aim defined is to educate public about how to keep surroundings clean and stop mosquito breeding in and around their homes.

Furthermore, in 2021, more than 7.5 lakh households in Chandigarh were visited to generate awareness and take stock of prevailing conditions (Health Department, Chandigarh Administration, 2022). In 2019, June and July were observed as anti-malaria and anti-dengue months, respectively. Four camps and advocacy workshops were organized along with special marches in June and three advocacy workshops in July were carried out as part of the IEC activities.

Along with increasing awareness on water-borne and vector-borne diseases, the health department took to fining to ensure compliance to regulations related to sanitation and water storage rulings. In 2017, around 3534 notices, 42 show-cause notices and 18 challans were issued and in 2019, the Malaria Task Force alone issued more than 5000 notices, besides show-cause notices and challans to house owners who allowed waterlogging. In 2022, 11,786 notices have been issued to residents found flouting the norms and 495 challans and 298 show-cause notices have also been served on public institutions[115,116].

As part of the Chandigarh Action Plan on Climate Change and Human Health, the Action Plan for controlling vector-borne diseases in Chandigarh includes joint operations between the Municipal Corporation and the Malaria wing to manage water stagnation, special strategies for high-risk areas, and an Early Warning System to detect and respond to increases in fever cases. The plan emphasizes building partnerships with citizens and organizations, integrating surveillance with private sector reporting, and conducting awareness campaigns through IEC activities and capacity building. Special drives and interventions during Anti-Malaria and Anti-Dengue months, along with strengthening existing vector control measures, are key components of the plan.

[115] Hindustan Times. Chandigarh health department gears up to combat vector-borne diseases, well in advance. 25th April 2018. Details available at <https://www.hindustantimes.com/punjab/chandigarh-health-department-gears-up-to-combat-vector-borne-diseases-well-in-advance/story-zsT9Mt2Jd2dXn5z2BZ0pxL.html>

[116] The Tribune. Vector-borne diseases grip Chandigarh tricity; Panchkula sees 1.7K dengue infections. 14th November 2022. Details available at <https://www.tribuneindia.com/news/chandigarh/vector-borne-diseases-grip-tricity-pkula-sees-1-7k-dengue-infections-450653>

6.4.2 Online platforms/websites/mobile app for dissemination of information on vector-, water-borne diseases and non-communicable diseases (NCDs)

The health department plans to develop an online platform/website/mobile app for information dissemination regarding vector-, water-borne diseases and NCDs to the residents in the UT. The platform/app can be used to share information with the residents on any major outbreaks and precautionary measures. The residents can also register their complaints in the platform/app such as water stagnation in their areas and it can facilitate in faster addressal of the issues.

6.4.3 Public awareness on air pollution and its health effects

The ambient air quality in the UT has been affected by the vehicles with the highest per capita number of cars in India. There is an increase of around 60% in numbers of vehicles in the last ten years with no change in length of roads. In order to combat the air pollution, the UT has come up with an action plan which includes raising awareness of the residents on impacts of rising pollution levels on human health and also preventive measures to keep the pollution levels within limits[117]. Thus, the Chandigarh Administration plans to conduct regular events and information drives at various levels in the UT on air pollution and its effects, including measures to mitigate health risk. Though there are efforts by the Health Department in conducting regular Health Melas & Camps in which, through IEC activities, awareness regarding diseases due to pollution and pollen allergies is created among the general public (Health Department, Chandigarh, 2020).

As part of the awareness generation on air quality, the Chandigarh Pollution Control Committee (CPCC) is distributing data on air quality data at six locations in the UT, according to the District Environment Plan for the UT of Chandigarh. There has also been a proposal to create a dedicated link in app "I am Chandigarh" of MC Chandigarh for tackling air pollution issues.

As mentioned in the Chandigarh Action Plan on Climate Change and Human Health, the Health Action Plan for controlling air pollution-related diseases in Chandigarh focuses on awareness generation through mass media, including posters, hoardings, social media, print media, radio, and health talks during VHND and UHND days. It involves developing and disseminating IEC materials to ensure the public is informed about air pollution and its health impacts. The plan includes surveillance establishment for air pollution-related diseases, hospital preparedness, and issuing timely warnings to hotspot areas and vulnerable populations. It also emphasizes building partnerships with various stakeholders, including community health workers and local committees, to create awareness and manage health issues related to air pollution effectively.

6.4.4 Formulation of public protocol in severe air quality

Air pollution has severe health impacts due to increasing morbidity and mortality, and presently it is one of the highest-ranking environmental challenges in the world. Along with the public awareness on the health effects from air pollution, the UT should also formulate a public protocol for measures to be enforced if in case there is severe air quality in the region

[117] Revised action plan for control of air pollution in non-attainment city of Chandigarh. Chandigarh Pollution Control Committee, Chandigarh Administration. October 2019. Details available at <https://cpcb.nic.in/Actionplan/Chandigarh.pdf>

such as ban on the construction activities and burning of waste, vehicle rationing, health advisory etc.

6.4.5 Extreme Heat related diseases and stress

As per the Chandigarh Action Plan on Climate Change and Human Health, the Health Action Plan on Extreme Heat in Chandigarh focuses on several key areas to manage and mitigate the impact of heatwaves. It targets vulnerable populations, including children, the elderly, pregnant women, labourers, outdoor workers, and those with chronic diseases. The plan includes pre-heat season activities such as updating surveillance protocols, developing and translating IEC materials, and preparing health facilities with necessary supplies and cooling centres. During the heat season, real-time surveillance, rapid response teams, and public advisories are prioritized. Post-heat season activities involve evaluating the plan's effectiveness and reviewing surveillance data. Additionally, capacity building and awareness campaigns are integral, with training for healthcare providers and community-level IEC activities to educate the public on heat-related illnesses and preventive measures.

6.5 Interventions cutting across the sectors

The table 6.6 present the key interventions which does not belong to a particular sector but are cross cutting. The interventions and related activities listed in the table are mainly aiming at enhancing the capacities of the line departments in UT and raising awareness generation amongst the residents towards impacts of climate change.

Table 6.5 List of potential adaptation interventions in cutting cross sectors

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes & Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
Capacity Development								
6.5.0	Establish the Programme Cell for the CCC	Department of Environment	National Mission on Strategic Knowledge	2025-2030	2030	New	All relevant to SAPCC 2.0	NDC 8: Building capacity
6.5.1	Supporting already existing libraries for creating a section on climate change	Department of Environment (DoE); Directorate of Higher Education; Directorate of School Education; Punjab Engineering College	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	Short		New	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.2	Conduct studies on climate change scenarios and impacts specific to Chandigarh and disseminating the information	Department of Environment (DoE)	National Mission on Strategic Knowledge Management for Climate Change	Long	2 studies/projects per year	Continuing	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.3	Training for town planners, architects, administrators on climate change & disaster management	Department of Urban Planning	National Mission on Strategic Knowledge Management for Climate Change	Long		Continuing	SDG 6: Clean water and sanitation Target 6.a SDG 13: Climate Action	NDC 8: To build capacities,

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes & Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
							Target 13.1, 13.2, 13.3	
Awareness Generation								
6.5.4	Distribution of study material related to climate change to students participating in various events	Department of Environment (DoE)	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	Long	100 books per year	New	SDG 3: Good health and well being Target 3.9 SDG 11: Sustainable cities & communities Target 11.6 SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.5	Organise climate change day	Department of Environment (DoE)	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	Short		New	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.6	Seminars/workshops/ conferences on thematic areas relevant for or impacted by climate change, such as energy, water, transport, health	Department of Environment (DoE); Directorate of Higher Education; Directorate of School Education;	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	Long		Continuing	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,

S. No.	Activities	Nodal Department	Relevant National Mission/ Schemes & Programme	Timeline	Target and Target year	Nature of Intervention	SDG	NDCs
		Punjab Engineering College						
6.5.7	Extension activity to promote simple and sustainable way of life-style	Department of Environment. Department of Education Department of Forest Dept. of Science and Technology CPCC	Mission Life	2030	1 Lakh persons	New	SDG 13 GBF Goal A NBF Target 1	NDC-1
Dissemination of Knowledge								
6.5.8	Develop a dashboard/platform for compiling data and information from different government departments for tracking of climate interventions and developing/publishing cross-sectoral analysis	Department of Environment (DoE)	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	Long		New	SDG 13: Climate Action Target 13.1, 13.2, 13.3	NDC 8: To build capacities,

6.5.1 Supporting already existing libraries on climate change issues

There are sections in school libraries on climate-related books in some schools. All the schools and colleges should establish a section or keep books on the climate change issues for the students' awareness in their respective libraries. Few colleges affiliated with the State Board of Technical Education have incorporated modules pertaining to environmental sciences in the academic curriculum of all departments, to equip the students with technical knowledge and developments in the field. Further, these institutions are also endorsing cleaner energy models (rooftop solar) and rainwater harvesting and incorporating these in their infrastructure.

6.5.2 Studies on climate change

a) In 2017, Centre for Research in Rural and Industrial Development (CRRID), Chandigarh organized an International Conference on "Mountain Cities, Climate Change and Urban Sustainability" in November 2017 along with a two-day Pre-Conference Workshop on "Towards Achieving Green Growth, Eco-Efficiency & SDGs for Urban Sustainability". This International Conference was a part of Chandigarh's Climate Meet (first in the series) that was organized in collaboration with the Asia Climate Change Education Center (ACCEC), Jeju, South Korea; the Department of Environment Studies, Panjab University, Chandigarh, and the Centre for Study of Administration of Relief (CSAR), New Delhi.
b) Publication of Chandigarh Greening Action Plan—the plan for the year 2019–2020 has been made publicly available. Similarly, the Department of Environment, Chandigarh aims at generating the action plan every year and also to support studies on climate change relevant issues.

6.5.3 Training on climate change and disaster management

a) For dissemination of sustainable practices, the Punjab Engineering College (PEC) organized a short-term course on "Sustainable Practices in Solid Waste Management". The participants included the faculty and staff members of PEC, students at educational institutes, resident welfare association members, officers from municipal corporations and Urban Local Bodies of Chandigarh, Mohali, and Panchkula.
b) Under the Green Skill Development Program (GSDP) of the Ministry of Environment, Forest & Climate Change (MoEFCC), the Chandigarh ENVIS Hub conducted a Certificate course on "Sustain and Enhance Technical Knowledge in Solar Energy Systems". This aimed at providing skill development for youth and equipping green skilled workers with technical knowledge and understanding of sustainable development. It covered the engineering, procurement and construction of works involved in the proposed solar photovoltaic system.
c) Trainings are also conducted regularly for the workforce of the departments in order to enhance capacity building of the staff. This is usually conducted during events such as Wildlife Week, etc. During the Wildlife Week in the year 2020, the department had organized a training session for their employees, in collaboration with the Forest Research Institute (FRI). The session consisted of two modules, one on bird identification and the other on butterflies.

6.5.4 Distribution of study material related to climate change

The DoE has suggested during the consultations and shown interest in distributing books or reading material on climate change to school students during various awareness programs or various competitions conducted by them during the year.

6.5.5 Organize Climate Change Day

The DoE suggested during the consultations and has plans to organize Climate Change Day every year to raise awareness of the residents on environment and climate change issues. Such activities in a way also align to the LiFE mission of Central Government on sustainable lifestyle motivating the public to undertake simple acts in their daily lives that can contribute significantly to climate change.

6.5.6 Organizing seminars/workshops on climate change issues

a) Chandigarh's Department of Science and Technology and Renewable Energy is providing financial assistance to schools, colleges, and institutions for organizing seminars, lectures, conferences, etc., to create awareness about climate change. In addition, the department had purchased battery-operated vehicles (2-wheelers and 4-wheelers) for creating awareness amongst the residents about eco-friendly transport.
b) Under Eco-club activities, technical institutions are conducting national and international seminars related to climate change, air pollution, sustainable development, etc.
c) Compulsory subject on environment science in all technical education/architecture department

6.5.7 Developing a dashboard for tracking and compile climate interventions

The DoE plans to develop a dashboard of data to track the progress on various interventions. The data may be updated monthly/bi-monthly. This includes data on environment and social parameters from different government departments for tracking of climate interventions and thereafter developing cross-sectoral studies based on the compiled information and publishing the analysis through newsletters.

6.6 Recommendations

Groundwater recharge

Declining groundwater levels, coupled with insufficient recharge due to rainfall variability, may not pose any issue to the domestic and commercial supply, but will certainly impact vegetation and wildlife habitats in the region, thereby, leading to ecological degradation. It is, thus, crucial for the UT to not only seek alternate options for sourcing water, but also necessarily work towards raising its ambitions with regard to recharging its groundwater, investing in water conserving infrastructure and directing efforts towards reduction in consumption.

Upgrading and renewing storm water drainage infrastructure

The shallow aquifers in the southern part of the city that are not tapped into often overflow, leading to situations of waterlogging in the city. The issue arises out of the lack of storm water drainage infrastructure in the southern part of the city. However, since the storm water drainage infrastructure was made at the time of city's establishment, the infrastructure has become inadequate to deal with the current run-off as the intensity of rainfall in the region has increased. Many of the storm water drains need to be improved and renewed. Other major reasons that contribute to the waterlogging menace of the city include, dumping of wastes and garbage in open drains making them clogged; illegal encroachments on natural and artificial drains and streams thereby disrupting the natural flow of storm water; urbanization

and expansion activities over water channels leading to a reduction in the drainage capacity of the city and diversion of the natural water courses of the UT.

Proper assessments of these issues need to be conducted, with phased plans to address the most critical issues, using a judicious mix of infrastructural, retrofitting and regulatory measures.

Integrated urban watershed management (IUWM) approach

Currently, Chandigarh's three watersheds and three spring lines do not feature under any watershed management plans. The development of an Integrated Urban Watershed Management (IUWN), i.e., the practice of managing freshwater, wastewater, and storm water as components of a basin-wide management plan, builds on existing water supply and sanitation considerations within an urban settlement by incorporating urban water management within the scope. Given the current issues with regard to wastewater and storm water the UT faces, IUWM can be an effective alternative with positive environmental and economic impact. Furthermore, if traditional methods are considered, it would allow for integration of a socio-cultural sustainability aspect in water resource management in the UT.

Enhancing the green cover

To further enhance its green cover, going forward, Chandigarh should start focusing on strengthening the biodiversity of its forested areas as well as other green belts and plantations. The UT has already started emphasizing plantation of native trees and fruit trees, while removing invasive species. Such measures should be further focused on.

Training and capacity building of the health officials of the UT

Supplementary training and development of tools for health providers and, coordination among environment, sanitation, and health departments to understand influence of climate change and variability on transition of vector- and water-borne diseases and other health issues would help improve the UT's adaptive capacity for health in the face of climate impacts.

Capacity building of the teaching staff and academic experts

Modules in the academic curriculums need to foster climate change and sustainable development apart from environmental sciences to comprehensively engage with the objectives of the Mission and Chandigarh's aspirations of being a leading example for climate action. The UT need to ensure that students in Chandigarh, in all colleges and universities are well trained in digital and technical skill sets, which will further equip them to venture into climate sciences and related studies as large part of that includes having knowledge and practice of technical soft wares and scientific temperament. Institutionally, the UT shall aim to build better coordination and a to-and-fro mechanism for engaging with all stakeholders such as the colleges and universities and government departments like Department of Environment (DOE), Pollution Control Board (PCB), Punjab Technical Board, Horticulture Department, Department of Higher Education, and Department of Technical Education.

7. Financing the SAPCC

The SAPCC of Chandigarh (2020-2030) while it builds on national priorities relating to climate change, its specific climate risks in the developmental context, and opportunities constitute the substance. The existing national schemes such as the Smart Cities Mission and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) have had a beneficial role to play towards achieving climate targets in the UT. Financial resources through various central and state schemes drive actions for conventional developmental goals such as improving infrastructure, access to amenities, water, and sanitation. The previous SAPCC had estimated that INR 17,500.00 crores will be needed to implement the SAPCC till 2050. The estimates corresponding to the period till 2030 were INR 7,387.00 crores. While the existing schemes and policies under the various National Missions will be the primary source of finance for many of the planned initiatives, the UT recognises that the extent of financing need cannot be wholly met via public funding primarily from the central government. Moving forward, the UT will explore alternate financing options over and above the usual sources of funding via state departments and existing schemes. For this, the chapter identifies the potential sources of additional finance from external sources including private investment and to tap into international climate finance. Mobilizing additional finance would require capacity building of key nodal departments, to enable them to identify the relevant channels of financing and develop bankable projects for the UT. The capacity building aspect for climate finance is envisaged from a long-term perspective, to become an integral feature for the UT's existing and future climate change actions. Emphasis will be put on regularly identifying capacity gaps and providing the required technical assistance, training, and workshops to bridge these.

7.1 Finance Needs Assessment

For the priority interventions put forward in Chandigarh's revised SAPCC, the financial estimates have been carried out through consultations with the nodal departments. For the planned and new initiatives, the estimation has been done through certain assumptions, extrapolation of data and experience of similar interventions in literature. The interventions are classified as four categories based on the scope of work. These categories are implementation, capacity building, knowledge management, and regulatory. The figure below illustrates the nature of the interventions identified in this revised SAPCC.

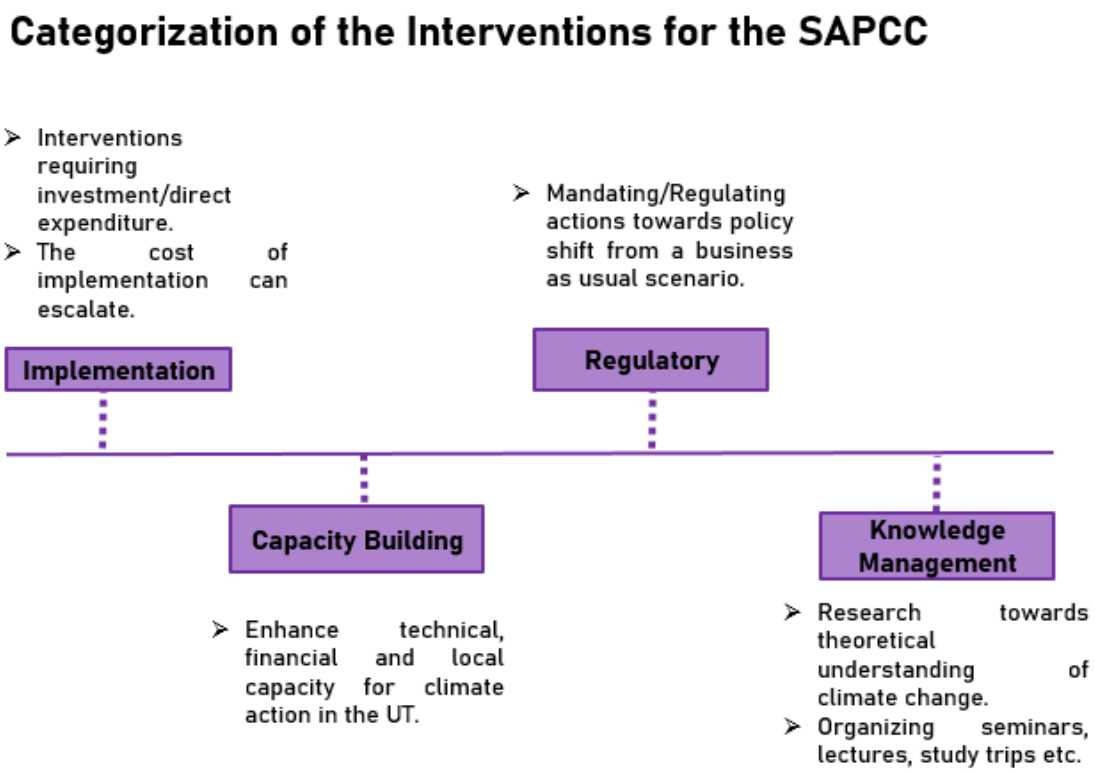


Figure 7.1: Categorization of the interventions for the revised SAPCC

7.1.1 Transport

The interventions in this sector largely include adoption of electric vehicles (buses and three-wheelers) in the UT by 2030.

Table 7.1: Estimated finance for the Transport sector in the UT

S.No. (from Chapter 5)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
5.3.1	Increasing EV buses and establishing EV charging stations	Implementation	1522	Total 750 buses. Cost of a 'Tata Starbus EV 4 12 Low Entry Electric Bus @ INR 2 Cr. Total 88 fast charging stations (CCS-60 kW) at the unit cost of INR 12.5 Lakh[118] to be installed during 2020-2030. 'Operations and Maintenance (O&M) cost: Assumed to be 10% of capex per year, accounted for 10 years.
5.3.2	Incentives for Enhancing energy efficiency through E-rickshaws, 2 wheeler, 4 wheelers (commercial and private)	Implementation	146.45	Estimated subsidy burden with caps as per the EV policy 2022.
5.3.4	To develop and enhance Intelligent traffic management system such as traffic control systems	Implementation	16.05	Target: Estimate that the UT will require 287 junctions by 2030 out of which 40 are already installed. Cost of setting up an ITMS- Rs. 6.5 Lakhs/unit[119]
5.3.5	Replacing the current fleet of vehicles to BS VI fuel standard and provision for vehicle scrapping for old vehicles	Regulatory	Regulatory	
5.3.6	Public Bike Sharing System	Capacity Building	0.6	=do=
5.3.3	Policies for household Electric Vehicle adoption	Regulatory	N/A	
5.3.7	Promotion and systematic utilization of school bus system	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
	Total (INR)		**1685.7**	

[118] https://www.cars24.com/blog/cost-electric-car-charging-station-india/
[119] https://indianexpress.com/article/cities/mumbai/mumbai-to-get-rs-891-crore-smart-traffic-management-system/

7.1.2 Waste

The interventions in this sector mainly include sustainable segregation and management of the waste through augmentation of the existing sewage treatment plant, sustainable biomedical waste management and bio mining of legacy waste in the UT.

Table 7.2: Estimated finance for the Waste Sector in the UT

S.No. (from Chapter 5)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
5.5.1	Augmentation of Sewage Treatment Plants	Implementation	712.5	Target: 50 MGD, out of which 30 MGD is already carried out. Cost of setting up the STP: 1 MLD inclusive of O&M cost for a span of 10 years is Rs. 9.5 Crore. 20 MGD is equal to 75 MLD[120].
5.5.2	Biomedical waste management to be handled through Effluent Treatment Plant (ETP)	Implementation	36	Departmental Estimates
5.5.3	Bio mining of Legacy waste	Implementation	98	Ref: Through existing literature source[121].
5.5.4	Door to door municipal solid waste collection	Implementation	N/A	The intervention is already taking place in the UT.
5.5.5	Integrated Solid Waste Processing & Management System	Implementation	200.7	Target: UT has a target of processing 550 tonnes of MSW by 2030. Cost of ISWM: MSW management in large cities approximates Rs. 1000/tonne[122]. This number is then calculated annually for a total span of 10 years.
	Total (INR)		**1047.2**	

[120] https://timesofindia.indiatimes.com/city/chandigarh/kishangarh-village-to-get-new-stp-for-around-rs-19-crore/articleshow/76822736.cms
[121] https://indianexpress.com/article/cities/chandigarh/chandigarh-legacy-waste-bio-mining-starts-at-dadumajra-8179397/
[122] https://www.downtoearth.org.in/dte-infographics/57865-clean_your_backyard_2.html#:~:text=In%20India%2C%20annual%20per%20capita,269%20for%20operation%20and%20maintenance.

7.1.3 Power

The interventions in the sector mainly include increasing the renewable energy capacity of the UT through installation of solar PV and floating solar power plants along with enhancing the wind energy capacity in order to become 100 percent renewable dependent by 2030.

Table 7.3: Estimated finance for the Power Sector in the UT

S.No. (from Chapter 5)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
5.2.1	To maximize the use of renewable energy by means of power purchase/generation	Implementation	5700	INR 300 cr. Is allocated to support roof top solar and other solar plants; INR 300 cr. is expected from the PMSGMFY, and INR 5100 cr is estimated to be the cumulative cost of purchasing renewable power during 2020-2030 to meet the goal of decarbonizing power consumption by 2030.
5.2.2	Deployment of solar rooftop systems in all public, private and government buildings	Implementation		
5.2.5	Special area Demonstration project	Implementation		
5.4.5	Establishment of Net Zero Government Buildings	Implementation		
5.2.3	Construction of floating solar power plants	Implementation		
5.2.4	Wind power purchase	Implementation		
5.2.6	Promotional activities on solar energy	Implementation	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
	Total (INR)		**5700.6**	

7.1.4 Water

The interventions in the sector mainly include adaptive measures for sustainable use of water through revamping and retrofitting existing supply in the UT.

Table 7.4: Estimated finance for the Water Sector in the UT

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.2.1	Upgradation of the drainage system in the UT	Implementation	101	Ref: The UT has received an outlay of INR 80 Cr. Under the AMRUT scheme and INR 21 Cr. To the MCC[123][124].
6.2.2	Development of Flood Early Warning Systems for the UT	Implementation	10	Ref: Estimate is based on a similar project in Tamil Nadu[125].
6.2.3	Revamping/retrofitting the existing water supply transmission and distribution network system with the latest technology (water-efficient fixtures), and real time monitoring of consumption through a dashboard.	Implementation	591.57	Ref: The project web-page at Chandigarh Smart City website[126].
6.2.4	Mandating and enforcing water meters and water audits in high consumption segments/sectors – industries, hotels, public clubs, restaurants, residential complexes, and public buildings	Regulatory	N/A	

[123] https://timesofindia.indiatimes.com/city/chandigarh/sewerage-overhaul-to-cost-21cr-in-city/articleshow/98956631.cms
[124] https://www.tribuneindia.com/news/chandigarh/rs-15-85-crore-to-prop-up-sewerage-system-in-chandigarh-479150
[125] https://www.newindianexpress.com/states/tamil-nadu/2022/mar/18/tn-to-set-up-advance-early-warning-system-for-floods-allocates-rs-10-crore-in-budget-2431595.html
[126] https://www.chandigarhsmartcity.in/24x7-water-supply-pilot-project-for-pan-city-chandigarh

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.2.5	Periodic water budgeting to be initiated and carried out at the UT level to understand the actual demand and usage of water in the UT by sector (domestic + commercial) and the supply available from internal and external sources	Regulatory	N/A	
6.2.6	Prohibition/restriction on new borewells and any new structure for extraction of groundwater resources, to be imposed in the areas where the groundwater has been depleting at a higher rate	Regulatory	N/A	
6.2.7	Metering of groundwater usage by industries and commercial establishments and taxation for over extraction	Regulatory	N/A	
6.2.8	Wastewater treatment plants to be installed and a percentage of treated water should be used for watering purposes around the green belts , while practising activities like gardening and horticulture.	Implementation	4.04	Ref: The project webpage at Chandigarh Smart City website[127].
6.2.9	Mandatory RWH systems in the public buildings and large houses with periodic audit and check	Regulatory	N/A	
	Total (INR)		**706.61**	

[127] https://www.chandigarhsmartcity.in/scada-system-for-recycled-water-distribution-network-for-pan-city

7.1.5 Forest and Wildlife

The interventions in the forest and wildlife sector mainly include adaptive measures for enhancing the green cover and conserving the biodiversity in the UT.

Table 7.5: Estimated finance for the Forestry and Agriculture Sector in the UT

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.3.1	Promoting increase in tree/green cover in portions of public parks, premises of schools and colleges and community spaces ,free distribution of seedlings of various species to the institutions, eco clubs, NGOs & residents of Chandigarh for plantation.	Implementation	20	Departmental Estimates.
6.3.2	Demonstration of herbal gardens, bamboo setum, orchidary, arboretum should be encouraged along with other means of ex situ conservation	Implementation	5	Departmental Estimates.
6.3.3	Replacing invasive and exotic species by planting native trees in the forest areas, degraded lands, and green belts	Implementation	5	Departmental Estimates.
6.3.4	Developing A City Biodiversity Index or dashboard to inform officials and generate public awareness	Implementation	1	Departmental Estimates.
6.3.6	To reduce the silt inflow to Sukhna lake through carrying out various kinds of soil conservation works like construction of silt retention dams, masonry check dams, spurs/revetments, desiltation of dams, construction of grade stabilizers etc.	Implementation	10	Departmental Estimates

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.3.7	Building and maintaining fire lines and other latest techniques of fire suppression in the forest areas, and training and equipping fire fighters on techniques to control forest fires.	Implementation	1	Departmental Estimates.
6.3.8	Celebration of Wildlife week, world forestry day, world earth day, wetland day; Eco-Clubs; Publication of Chandigarh Greening Action Plan	Capacity Building	1	Departmental Estimates.
6.3.5	Study on Forest health Assessment	Knowledge Management	0.2	Ref: Third party hiring cost.
6.3.9	Peoples' Biodiversity Register	Knowledge Management	0.6	Departmental Estimates
	Total (INR)		**43.8**	

7.1.6 Health Sector:

The interventions in the sector mainly include adaptive measures for enhancing the health of people in the UT from environmental degradation through capacity building and regulatory measures.

Table 7.6: Estimated finance for the Health Sector in the UT

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.4.1	Door-to-door awareness generation programmes on mitigating risk of vector-borne water-borne, and noncommunicable diseases (NCDs)	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
6.4.2	Develop online platforms/websites for information dissemination regarding vector and water borne diseases	Capacity Building	0.275	Average cost of a website is approximately INR 75,000. Assuming an annual domain cost of INR 5,000 and an annual maintenance cost of INR 15,000.
6.4.3	Creating awareness among the people to reduce exposure to dust allergies and air pollution	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
6.4.4	Formulation of public protocol in severe air quality	Regulatory	N/A	
	Total (INR)		**1.475**	

7.1.7 Energy Efficiency & Net Zero Buildings Sector

The interventions in this sector mainly include mainstreaming sustainable habitat in the UT through deployment of smart surface coalition measures along with some capacity building and regulatory measures.

Table 7.7: Estimated finance for the Building Sector in the UT

S.No. (from Chapter 5)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
5.4.3	Smart surface coalition in buildings	Implementation	-	Needs a detailed study including all possible interventions constituting smart surface technologies.
5.4.2	Introducing Energy conservation building code (ECBC 2017)	Regulatory	N/A	
5.4.1	Encourage use of BEE Energy Star Labelled Appliances	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
5.4.4	Promoting green building standards and certification	Capacity Building	0.6	=do=
5.4.6	Capacity Building Initiatives and Programs	Capacity Building	0.6	=do=
	Total (INR)		**1.8**	

7.1.8 Capacity Building

The interventions in this sector mainly include standalone capacity building interventions that cut across all the sectors. The interventions identified includes setting up libraries and providing formal training to state government officials and key stakeholders for climate action in the UT.

Table 7.8: Estimated finance for Capacity Building/Knowledge Management in the UT

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.5.0	Establish Program Cell for CCC	Capacity Building	2.5	Technical Manpower for CCC
6.5.1	Supporting already existing libraries on creating a section on climate change	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
6.5.4	Distribution of study material related to climate change to students participating in various events.	Capacity Building	0.6	=do=
6.5.2	Conduct studies on climate change scenarios and impacts specific to Chandigarh and disseminating the information	Capacity Building	0.6	=do=
6.5.3	Training for town planners, architects, and administrators on climate change & disaster management	Capacity Building	0.6	=do=
6.5.7	Extension activity to promote simple and sustainable way of life-style	Capacity Building	6	Departmental Estimates

S.No. (from Chapter 6)	Proposed Interventions	Type of Interventions	Estimated Budget (In Crores)	Notes
6.5.8	Developing a dashboard/platform for compiling data and information from different government departments for tracking of climate interventions and developing cross-sectoral studies based on the compiled information and publishing the analysis through a newsletter	Capacity Building	1	Departmental Estimates
6.5.5	Organise climate change day	Capacity Building	1	Departmental Estimates
6.5.6	Seminars/workshops/conferences on thematic areas relevant for or impacted by climate change, such as energy, water, transport, health	Capacity Building	0.6	(3 Subdivision in the UT) (4 programs per year with a cost of Rs. 50,000 for 20-25 participants). Hence, for 10 years: 50,000 x 4 x 3x 10 is 0.6 Cr.
	Total (INR)		**13.5**	

7.2. Total Financial Needs

The total financial estimates for the identified interventions for climate action in the UT is INR 9200.685 Crores (Table 7.9). The UT has a long-standing history of climate action and hence the interventions identified in the revised SAPCC are in line with India's national targets. The UT has a long-term vision of becoming 100 percent renewable dependent by 2030 and hence the bulk of the financial estimates are towards the power and transport sector. During the stakeholder consultations with the various nodal departments, it was observed that there is a vision to enhance adaptation-based interventions and hence a significant portion of the financial estimates is dedicated towards enhancing water availability and conservation of the existing water sources in the UT. Lastly, since the revised SAPCC is a futuristic document, it entails certain interventions, in which the targets are not identified as of now by the nodal departments and hence the estimates have been calculated through assumptions and extrapolation of data through multiple literature sources.

Table 7.9: Sector-wise cost breakup in the UT

S. No.	Sector	Finance Estimates *(in INR crores)*
01	Transport	1685.7
02	Waste	1047.2
03	Power	5700.6
04	Water	706.61
05	Forest and Wildlife	43.8
06	Health	1.475
07	Energy Efficiency and Net Zero Buildings	1.8
08	Capacity Building	13.5
Total Estimated Budget for Sector wise Interventions in the UT		**9200.685**

7.3 Sources of Finance

There are many sources of finance that support climate action projects through various instruments (Box 7.1). However, the UT relies heavily on public finance to fulfil its climate action targets. Considering the wide array of schemes, the finance for climate action in the UT is being channelized from a combination of sources, primarily through budget allocations from the Central Government under the National Missions. For specific projects, the UT utilizes the budget allocated to nodal departments. Domestic sources of finance continue to be the major sources of finance for climate action in India with 87% in FY2019 and 83% FY2020[128]. Of these domestic sources, the private sector contributed about 59%–INR 156.9 thousand crores (USD 22 billion). Public sector flows were evenly distributed between Government Budgetary spends (Central and State) and PSUs at approximately 54% and 46% respectively. Existing literature on climate finance landscape in India illustrates that most of the public funds was directed towards greening the power sector (almost 70%), followed by energy efficiency and power transmission (almost 20%), followed by sustainable transportation (10%)[129].

[128] Landscape of Green Finance in India. 2022. Climate Policy Initiative. More Details at <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2022/#:~:text=India%20needs%20approximately%20INR%20162.5,Net%2DZero%20emissions%20by%202070>

[129] Landscape of Green Finance in India. 2020. Climate Policy Initiative. More Details at <https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance/>

1. **National Sources of Finance:**

a. Public Sources: Taxes, Subsidies, Budgetary Support, Domestic 'Market Based Mechanisms', PSUs etc.

b. Private Sources: Debt Instruments, Partial Risk Guarantee Facility, Equity Investment etc.

2. **International Sources of Finance:**

a. Adaptation Fund, Green Climate Fund (GCF), Global Environment Facility (GEF) etc.

b. Multilateral and Bilateral Assistance from institutions like the WB, ADB, GIZ etc.

c. Market Based Mechanisms under Article 6 of the Paris Agreement, Voluntary Carbon Markets etc.

Box 7.1: Sources of finance for climate action in the UT

PSUs are crucial funding distribution avenues for the federal and state governments, bond markets, and international aid organizations. Additionally, they function as an important source of green financing and hence it is important to tap into PSU's finance for climate action for the UT. The UT receives limited international climate finance for climate actions projects. Contribution of private finance is also limited. While the central budget will continue to remain a major source of finance for climate interventions, there is a need to design specific projects for mobilizing funding from a wider pool of sources. Capacity building for mobilizing resources from different sources, such as private sector, international climate finance mechanisms, multilateral financial institutions, and domestic as well as international market-based mechanisms is also needed. Table 7.10 provides an overview of some examples of potential sources of climate finance for different priority sectors.

Table 7.10: Additional opportunities for mobilizing climate finance for priority sectors

Sector/ Area	Opportunity	Potential Sources of Climate Finance	Instruments of Climate Finance	Challenges for Accessing Climate Finance
Forestry/ Greening	Projects focusing on enhancing plantation activities in the UT along with bio-diversity conservation will be in continuation for the UT in the years to come.	Ministry of Environment Forests and Climate Change, National Development Finance Institutions (NDFIs), Biodiversity funds, Climate finance vehicles (voluntary market projects), National Government Funds like NAFCC and CAMPA, Private sector finance etc.	Technical assistance grants, Green Loans, CSR funding, Results-based finance.	It is often seen that small ticket size periodic funding are granted for this sector which may not be able to cover all the objectives of the interventions and hence eventually it will need additional fund from external sources to complete the deliverables.
Water/ **Sustainable Habitat / Buildings/** **Waste**	Due to the wider scope of these sectors, identifying well-defined climate action projects or components of larger programmes/ is required to attract funding from specific climate funds. There is a wide scope of leveraging developmental and green finance in this sector to deploy innovative pilot projects, new models, and technologies	National Development Finance Institutions (NDFIs), Smart City Mission, Ministry of Housing and Urban Affairs (MOHUA), (NDFIs), USAID, GIZ, DFID, Private sector finance, etc.	Blended Finance, Green Loans, Green bonds, grants, private venture/equity finance.	Mobilizing finance for these sectors would require preparatory work for building transparency and governance frameworks. Mobilizing private finance i.e., bringing private investors on board to invest in projects/interventions pertinent to these sectors is a significant challenge as of now.

Sector/ Area	Opportunity	Potential Sources of Climate Finance	Instruments of Climate Finance	Challenges for Accessing Climate Finance
Health	There is a wide scope of research on climate change and health which will gain more attention especially after the on-going pandemic. Proposal/s in particular to the mental health linkages with climate change and other niche areas of health can be explored by the UT in the years to come.	**Sources:** Ministry of Health, National Missions like Swatch Bharat Mission, World Bank, private sector finance.	Research grants, technical assistance grants, results-based finance.	Short term funding cycles is an issue especially when it comes to attract private finance. Moreover, financing for this sector would require a robust assessment to link with climate impacts.
Energy / Energy Efficiency	This sector is relatively well-developed and saturated from the national perspective. Hence business led or industry-oriented interventions can be deployed the UT which will result in fast and direct investments from the private sector.	Ministry of New and Renewable Energy (MnRE), World Bank, National Development Finance Institutions (NDFIs), private sector, voluntary market, SIDBI, ADB, GIZ etc.	Blended Finance, Loans, Green Loans, Green bonds, private commercial finance, results-based finance.	Mobilizing finance for this sector will require clear sustainable business models and a profit-making orientation for the projects. Modalities like aggregators or pilots for new technologies may need to be integrated for making projects attractive to specialized climate funds.

Sector/ Area	Opportunity	Potential Sources of Climate Finance	Instruments of Climate Finance	Challenges for Accessing Climate Finance
Sustainable Transport	With its ability to scope sector-wide programmes allowing for transformational change, sustainable transport has the potential to attract funding from multilateral and bilateral funds or design a programme which blends different types of finance.	Ministry of Road Transport, Shipping and Highways. World Bank, Asian Development Bank, private sector finance, National Schemes such as Faster Adoption and Manufacturing of the (Hybrid) & Electric Vehicles (FAME).	Blended finance, Loans, Concessional Loans, Green bonds, private commercial finance.	The interventions/activities in general requires large scale funding. Designing such comprehensive programmes can be a complex process requiring skilled proposal developers, with resources being made available for a detailed project preparation and hence backing and guidance of senior officials from the Chandigarh Administration would help facilitate the process.
Knowledge Management	Phased projects, emphasizing capacity building and awareness raising for different sub-groups can be attractive for smaller grants and CSR funding. There are existing ambiguities in terms of emerging concepts in climate action (for example: Net Zero Target and roadmap to achieve that), which will require research and can be a lucrative option for the UT to pursue.	Central and State Government. GIZ, private sector.	Technical assistance grants, CSR funding.	Short term funding cycles with small ticket-size funding is an issue as it does not attract private investors. May not be able to cover all the objectives of the Mission, which would eventually require budget support from external sources.

One of the crucial aspects of enabling climate action in the UT is to integrate it with long term developmental goals of the city. This serves all the essential prerequisites of driving green finance. It makes climate action part of the long-term planning and enables resources to be used towards those developmental activities which will provide a green stimulus to the growth trajectory. Rajkot is a prime example of identifying climate action synergies with development strategy. The city's climate action plans can be formulated through active involvement of the non-state actors such as civil society groups, philanthropic organizations, academic institutions, international development organizations etc. The multistakeholder engagement often can pave the path for innovative climate action strategies in the UT and can also mobilize additional finance which will ease implementation of many identified interventions in the SAPCC. The UT can also identify several climate action interventions as a part of their developmental initiatives i.e., as a co-benefit of an existing or upcoming development plans.

7.4 Enhancing Climate Finance Capabilities

In order to access diverse sources of climate finance, it is critical to build the readiness of the departments and project developers at the UT to be able to leverage and effectively utilize these funds for ambitious climate actions targets. Such funding often comes with far more stringent requirements than budget allocations, requiring a strategic assessment and phased approach to building the internal capabilities. The key steps in this process are summarized here.

7.4.1 Building capacities

Figure 7.1 below explains the three broad components of Chandigarh's strategy to build capacity to mobilize and utilize climate finance. In order to finance climate action in the UT, it is of utmost importance to enhance capacity of different actors and stakeholders involved in the process. The capacity building initiatives has been divided into three stages: conception, mobilization and implementation.

a) Conception: It is important to calculate the finance requirement for each intervention. Financial estimation will require development of a project document which will entail the objectives of the intervention along with targets and key milestones. On basis of that, the team will need to calculate how much finance is required to carry out the objectives of that intervention. Training in certain data analysis tools is important to enhance the accuracy of the financial estimates and hence capacity building of the relevant actors and stakeholders becomes critical.
b) Mobilization: As mentioned in the above sections, the key for the UT to fulfil its climate action targets is to tap into international sources of finance. Along with that, mobilizing private capital will also be crucial to invest in mitigation activities identified by the UT. Capacity building in particular for training and conducting workshops for the government departments with respect to the climate finance landscape in India will be effective to tap into multiple existing avenues of finance.
c) Implementation: Once the finance estimation along with channelization of the funds are identified, the challenge that nodal departments often face is to effectively implement the finance for the targeted activities. Capacity building through workshops and seminars of best practices will certainly enhance the implementation process and also bring together relevant stakeholders along the way.

Hence, while identifying interventions, at least one capacity building related interventions has been mentioned in each sector which will help actors and stakeholders to engage effectively and contribute to climate action in the UT. There is also one sector dedicated entirely towards capacity building initiatives in the UT. The interventions identified in that sector are standalone activities that cuts across all the sectors in the UT i.e., implementation of such interventions will ensure progress towards fulfilling targets of all the sectors aiming towards climate action in the UT.

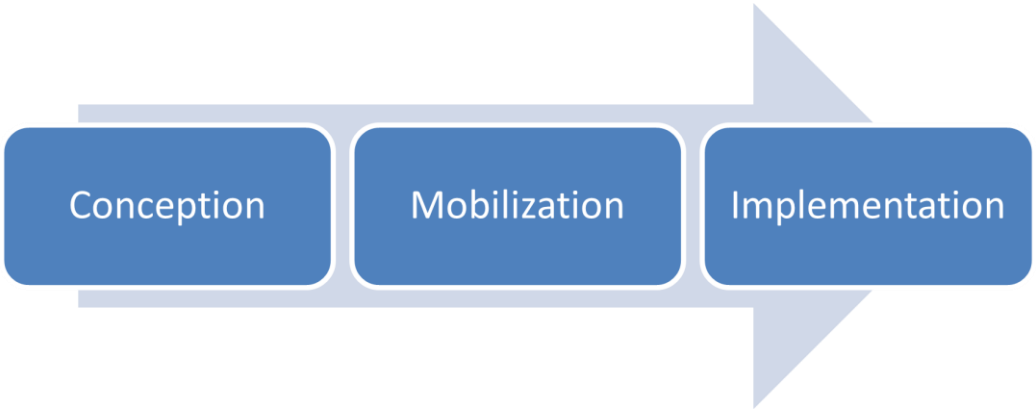


Figure 7.2: Stages for capacity building for climate action in the UT

These capacities will be enhanced across departments, as effective mobilisation of climate finance for comprehensive climate programmes which will require coherent cross-functioning between departments. Institutional capacity also gives entitlements to pursue finance from different sources. To elaborate, regulations through introduction of certain taxes or mobilizing direct access finance from multilateral or bilateral institutions like the WB, GCF, ADB etc. can be done by enhancing institutional capacity for the UT. Moreover, to improve the UT's project financing capacity for climate relevant projects, regular training workshops will be organised and supplemented with an effort to capture lessons learned from other cities and states to replicate good practices.

Capacity building will also be undertaken from the point of view of supporting better access to funding and financing from international financiers. Accessing international financing sources such as the green climate fund and adaptation fund will benefit the UT as it maps out large-scale long-term climate projects. In this context, capacities will have to be developed on the basis of necessary pre-requisites in the projects to be able to access the funds, instating the necessary MRV mechanisms. Working with specific departments, under the aegis of the Knowledge Management Centre and the Centre for Capacity Building (see Chapter 7 for more details), tailored technical assistance should be provided for designing climate-relevant projects and supporting their early-stage development to make them more bankable from the perspective of international climate financers.

7.4.2 Developing bankable projects

Identifying the available financing sources, understanding their specific requirements, and assessing them to identify the feasible ones, is an essential skill for climate project developers. Till now, the most widely used source of finance for Chandigarh's SAPCC has been from existing schemes and policies of the Centre and the UT Departments. Aligning its climate interventions with the National Missions was advantageous for enabling finance flows in the

past. Going forward, the UT needs to focus on expanding its pool of financial sources by tapping intoadditional financing made available via private and international sources. This will allow the UT to explore innovative instruments which can be leveraged to mobilise large scale private and international finance, such as green bonds, blended finance, results-based payments, among many others. Here, 'bankability' refers to a project's ability to meet the climate finance providers fiduciary requirements and align with the investment framework, which seeks to make transformative impact or lead to a paradigm shift, thus making it different from the business-as-usual projects with an added layer of green. In the recent past, the UT's experience with international financing and market-based mechanism has been limited to a few projects, including one from GEF- on promotion of Solar Water Heating in Industries, and another from the World Bank for promoting access to sustainable public transport. Besides public welfare, the active involvement and support from the private sectors will be crucial to fulfil the climate action requirements for the UT. Coalitions and collaborations with the private sector for undertaking large-scale climate projects remain unexplored in the domain of SAPCCs in India. Additional funding mobilized, especially from the private sector, can act as a much-needed supplement to the limited public resources available for addressing climate change. By building engagement platforms for the private sector based out of the UT, aimed at working transparently and in a participative manner with them, the local government can build interest in new collaborative climate and sustainability projects, which may pan out in the short or medium timeframe. This could be further enhanced with participation of NGOs, research organizations and academia to mobilize the additional finance which often becomes the last piece of the puzzle during implementations. The platform could also act as a forum for awareness raising and capacity building. Hence, increasing the scope and ease of venturing into public private partnerships for large scale projects (especially for resilient infrastructure, sustainable transport, green energy) under the SAPCC, could increase the pace of work and facilitate flow of more finance. One of the key aspects that determines the ease with which private finance can be accessed is the financial viability of the proposed project.

8. Institutional Mechanism

The Institutional Mechanism is the most crucial element for the implementation plan of the State Action Plan on Climate Change (SAPCC). The well-planned mechanism assists in institutionalizing the process of implementing the SAPCC across the various departments and administrative functions, helping to ensure the proper execution of the interventions and actions identified in the SAPCC, as this requires proper coordination among the nodal and line departments involved. The institutional mechanism can also facilitate the mainstreaming of climate concerns in development plans of the UT.

The development of a strong institutional mechanism for the UT is a critical aspect of the SAPCC given the reality of periodic transfer of officials in the government. The establishment of an institutional mechanism will ensure that effective processes are institutionalized, with clear departmental roles and responsibilities defined, to facilitate consistency as well as sustainability in the design and implementation of the action plan, that seeks to climate proof development activities of the UT.

While helping to improve technical and institutional capacities, a well-defined institutional structure can also enable greater participation of civil society and external experts at the relevant areas. This will eventually lead to improved awareness and priority setting around climate change issues, thus helping integrate climate change in planning efforts. Establishing a comprehensive and well-integrated institutional mechanism, also helps to ensure that learning becomes institutionalized, with the potential of success stories, experiences and mechanisms resulting in cross-functional planning to address challenges and strengthening implementation.

In Chandigarh, the Department of Environment (DoE) is the nodal agency that undertakes the process of developing the State Action Plan on Climate Change (SAPCC). The nodal department coordinates with the line departments to ensure that the interventions laid out in the SAPCC are implemented. Most of the strategies and interventions fall with different departments of the UT. This requires constant communication and coordination between the designated departments and the nodal to ensure that the desired objectives of the strategies are met. Figure 8.1 provides an overview of the institutional framework planned and being established in Chandigarh for enabling and implementing climate actions.

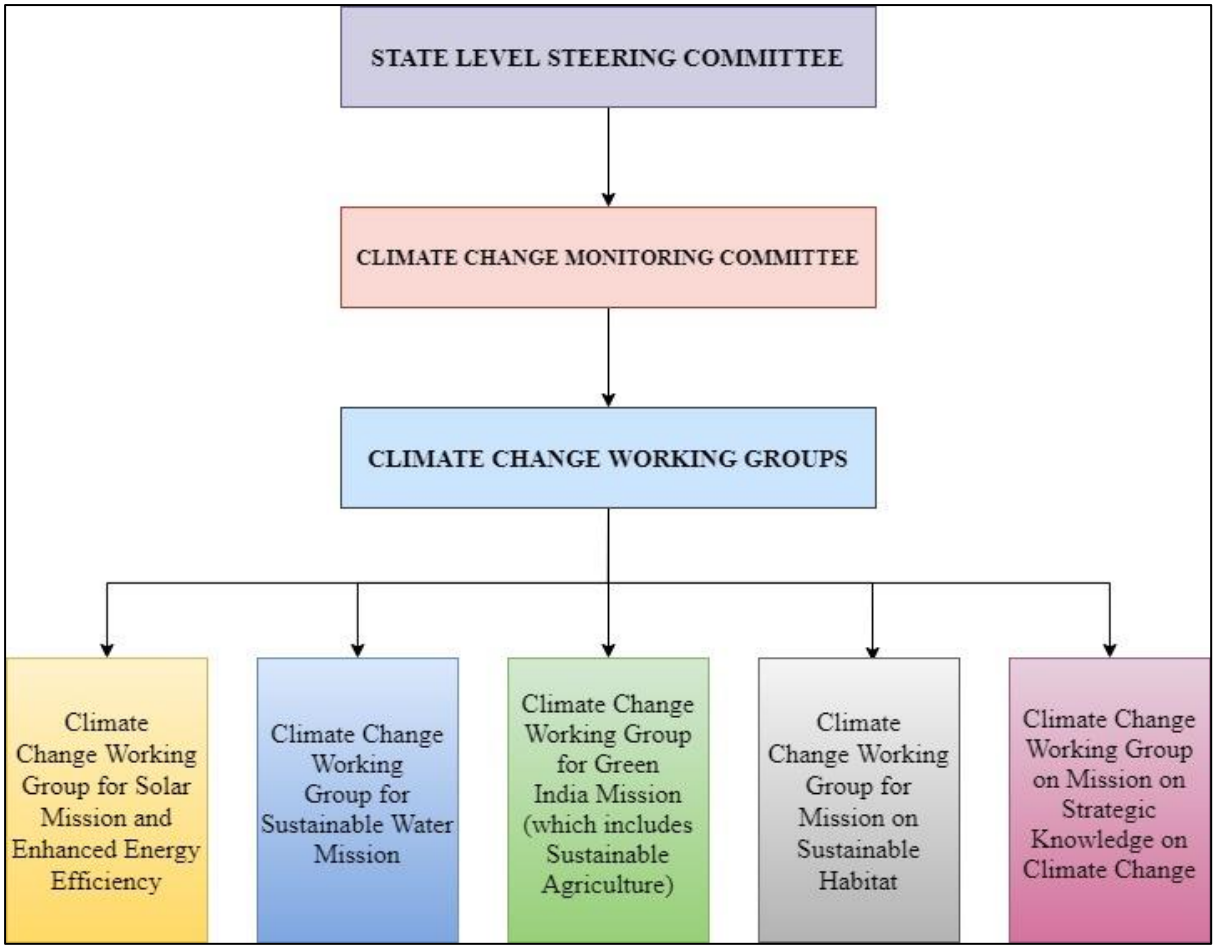


Figure 8.1: Institutional framework for Chandigarh's SAPCC

8.1 State Level Steering Committee

The State Level Steering Committee was first formed in 2008 by the Chandigarh administration, in order to review the issues and challenges faced by the UT due to impacts of climate change. It would then assist in the development of the Chandigarh SAPCC for the UT, as proposed by the Ministry of Environment, Forest and Climate Change, Government of India.

The State Level Steering Committee is chaired by the Chief Secretary of the UT of Chandigarh. The Committee members are the highest-level officials from the relevant line departments linked to the SAPCC, with the responsibility of reviewing the progress of the implementation of the plan and approving measures for addressing challenges and gaps. The Committee also advises the nodal departments on aligning the interventions and strategies of the document with national targets outlined in India's NDCs as well as the developments under the various National Missions under the NAPCC. The Member Secretary of the Committee is the Director of the nodal department for SAPCC, i.e., the Department of Environment, with the responsibility of coordinating the periodic meetings and ensuring the objectives of the Committee's role are met through proper agenda setting for directing the discussions. The Committee is also responsible for stabling linkages to ongoing development policies in the state and accrue funds from the Central government and other donor agencies as and when required. This Committee approves the final draft of the SAPCC for the UT of Chandigarh.

The Committee will meet on a biannual basis in order to take stock of the progress and ensure that better coordination between the line departments facilitates the climate proofing of existing development policies and strategies of the UT.

The members of the Steering Committee are as follows:

1. **Chairman:** Chief Secretary, Union Territory Chandigarh
2. **Member Secretary:** Director, Department of Environment, Union Territory Chandigarh
3. Home Secretary, Union Territory Chandigarh
4. Finance Secretary, Union Territory Chandigarh
5. Principal Secretary (Environment), Union Territory Chandigarh
6. Deputy Commissioner, Union Territory, Chandigarh
7. Commissioner, Municipal Corporation, Chandigarh
8. Director (Science and Technology), Union Territory, Chandigarh
9. Special Secretary, Health, Union Territory Chandigarh
10. Secretary, Urban Planning, Union Territory, Chandigarh
11. Secretary, Education, Union Territory, Chandigarh
12. Secretary, Transport, Union Territory, Chandigarh
13. Secretary, Industries, Union Territory, Chandigarh
14. Chief Conservator of Forests, Department of Forests and Wildlife, Union Territory, Chandigarh
15. Chairman, Chandigarh Pollution Control Committee

8.2 Climate Change Monitoring Committee

The Climate Change Monitoring Committee (CCMC) was formed to review and monitor the implementation of the Chandigarh SAPCC. The Committee closely oversees and supervises the implementation of the SAPCC, with the objective of providing timely guidance to the nodal departments for effective functioning and coordination, through technical guidance from the NAPCC, if and when required.

The Committee is chaired by the Director of the Department of Environment for Chandigarh. This Committee is responsible for bringing together experts on climate change for the process of revision of the SAPCC document. They assist in mapping the existing developmental policies of the UT with the climate action plan (SAPCC) to enable effective and efficient implementation, taking care to minimize overlaps and redundancies, and raising additional resources, if required. The Committee would also oversee the implementation of the actions identified in the SAPCC for the various departments. It also guides the monitoring protocol for the implementation of the SAPCC and will be responsible for prioritizing the climate interventions under the SAPCC and approving and providing periodic financial estimates for seeking funds and grants from Central government authorities. This Committee also identifies the nodal department for all the missions based on the mandates of the different departments and the requirement of each mission and the interventions planned under these at the UT level. It is empowered to form technical working groups for specific issues, as required during the implementation phase. The Committee would also try and achieve targets set to meet the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), and the SAPCC of Chandigarh.

A Climate Change Dashboard is prepared in order to record, analyse, monitor and report on Climate Change Resilience Indicators. The list of 35 identified indicators that span across 11 departments is envisaged to help the authorities in decision making based on evidence and prioritization of projects. The Committee would monitor and review the status of implementation of the dashboard. Data owners, nodal officers and data coordinators have been identified for each department by the Chandigarh Administration to enable effective coordination and reporting of data. The Committee would ensure that data is entered on the Dashboard in a timely manner by the designated officials of each department and could even upscale the same for incorporating future requirements as deemed necessary.

The Committee meets biannually to take its activities forward.

The members of CCMC include the following:

- **Chairman**: Director, Department of Environment, Union Territory, Chandigarh
- Additional Deputy Commissioner, Union Territory, Chandigarh
- Additional Chief Executive Officer, Chandigarh Renewable Energy and Science and Technology Promotion Society (CREST)
- Director, Indian Meteorological Department, Union Territory, Chandigarh
- Member Secretary, Chandigarh Pollution Control Committee
- Chief Engineer, Engineering Department, Union Territory, Chandigarh
- Secretary, State Transport Authority, Union Territory, Chandigarh
- Director, Department of Health, Sector 16, Chandigarh
- Conservator of Forests, Department of Forests and Wildlife, Union Territory, Chandigarh
- Regional Director, Central Ground water Board, Union Territory, Chandigarh
- Additional Director, Department of Science and Technology, Union Territory, Chandigarh
- Director, Chandigarh Transport Undertaking
- Head, ICAR-Indian Institute of Soil and Water Conservation, Regional Centre, Chandigarh

A Climate Change Centre (CCC) is proposed to support the work of the CCMC. Considering the continuous work related to coordination across departments, tracking progress on SAPCC implementation, and managing data, dedicated human resources would be essential. It is proposed that a Program Cell under the CCC, with adequate technical manpower equipped with IT and data science capabilities will be established. The Program Cell under the CCC will be housed within the Department of Environment, under the supervision of the Director and will be responsible for coordination, data management, tracking progress, analysis, report preparation, and capacity building programmes and executing the MER dashboard management as elaborated in Chapter 9.

8.3 Climate Change Working Groups

Based on the missions of the Chandigarh SAPCC document, five Climate Change Working Groups (CCWG) have been created to ensure that the interventions and activities identified under the different missions for the various departments are carried out in an efficient manner. The five working groups would ensure the implementation of the tasks and interventions identified in the SAPCC document. These groups can consult the Climate

Change Monitoring Committee of Chandigarh for guidance so that they can identify UT-specific climate change related issues and problems as well as relevant technology and even develop project proposals to address the same. These groups would be responsible for the collection, compilation, analysis, and interpretation of the data required for the SAPCC as well as for modelling future scenarios and undertaking field surveys. The groups would also organize trainings, capacity building programmes and workshops to enhance awareness about issues relating to climate change in the UT.

The Climate Change Working groups would be meeting on a quarterly basis.

The five working groups along with their members have been detailed out below:

Table 8.1: Working Group 1 - Climate Change Working Group for Solar Mission and Enhanced Energy Efficiency

S. No.	Member	Designation
1	Director, Department of Environment, Chandigarh	Chairman
2	Scientist 'SD', Department of Environment, Chandigarh	Member
3	Project Director, Chandigarh Renewable Energy and Science & Technology Promotion Society (CREST)	Member
4	Junior Engineer, Department of Science and Technology, Chandigarh	Member
5	Superintending Engineer, Electrical Wing, Engineering Department, Chandigarh	Member
6	Superintending Engineer (Electrical), Municipal Corporation of Chandigarh	Member
7	Superintending Engineer (Electrical), Chandigarh Housing Board	Member
8	Scientific Officer, Chandigarh Climate Change Cell, Department of Environment, UT, Chandigarh	Convener

The Climate Change Working Group for the Solar and Enhanced Energy Efficiency missions has been formed to undertake interventions identified in the SAPCC in these areas. The Group has the Director of the Department of Environment in Chandigarh as the Chairman. The Scientific Officer of the Chandigarh Climate Change Cell is the Convener who is responsible for organizing and convening the quarterly meetings for the group. The group has representation from all major stakeholders in the area that include the Department of Environment, Chandigarh Renewable Energy and Science & Technology Promotion Society (CREST), Department of Science and Technology, Engineering Department, Municipal Corporation of Chandigarh and the Chandigarh Housing Board.

Table 8.2: Working Group 2 - Climate Change Working Group for Sustainable Water Mission

S. No.	Member	Designation
1	Director, Department of Environment, Chandigarh	Chairman
2	Scientist 'SD', Department of Environment, Chandigarh	Member
3	St. D (Senior Hydrologist), Central Ground Water Board, Chandigarh	Member
4	Principal Scientist (Agriculture Economics), ICAR- Indian Institute of Soil and Water Conservation, Regional Centre, Chandigarh	Member
5	Assistant Director, Malaria (NVBDCP)-cum-State Surveillance Officer (IDSP), Chandigarh Administration	Member
6	St B, Chandigarh Pollution Control Committee	Member
7	Superintending Engineer, Public Health, Municipal Corporation of Chandigarh	Member
8	Superintending Engineer, Engineering Department, Chandigarh Administration	Member
9	Chief General Manager, Chandigarh Smart City Limited	Member
10	Superintending Engineer, Public Health, Chandigarh Housing Board	Member
11	Scientific Officer, Chandigarh Climate Change Cell, Department of Environment, UT, Chandigarh	Convener

The Climate Change Working Group for the Sustainable Water Mission has been formed to undertake interventions related to the water resources of the UT of Chandigarh identified in the SAPCC. The Group has the Director of the Department of Environment in Chandigarh as the Chairman. The Scientific Officer of the Chandigarh Climate Change Cell is the Convener who is responsible for organizing and convening the quarterly meetings for the group. The group has representation from all major stakeholders in the area that include the Department of Environment, Central Ground Water Board Chandigarh, ICAR- Indian Institute of Soil and Water Conservation Regional Centre, Chandigarh Pollution Control Committee, Engineering Department, Municipal Corporation of Chandigarh, Chandigarh Smart City Limited and the Public Health Division of the Chandigarh Housing Board.

Table 8.3: Working Group 3 - Climate Change Working Group for Green India Mission (which includes Sustainable Agriculture)

S. No.	Member	Designation
1	Director, Department of Environment, Chandigarh	Chairman
2	Scientist 'SD', Department of Environment, Chandigarh	Member
3	DCF, Department of Forests and Wildlife, Chandigarh	Member
4	Principal Scientist (Agroforestry), ICAR- Indian Institute of Soil and Water Conservation, Regional Centre, Chandigarh	Member
5	Superintending Engineer, Horticulture Wing, Municipal Corporation of Chandigarh	Member
6	Superintending Engineer, Horticulture Wing, Engineering Department, Chandigarh Administration	Member
7	Senior Extension Specialist (SM), Punjab Agricultural University, Camp Office, Sector 19B, Chandigarh	Member
8	Scientific Officer, Chandigarh Climate Change Cell, Department of Environment, UT, Chandigarh	Convener

The Climate Change Working Group for the National Mission for a Green India also includes the Mission on Sustainable Agriculture has been formed to undertake interventions related to the greening of the UT and the agriculture practised within its borders that are identified in the SAPCC. The Group has the Director of the Department of Environment in Chandigarh as the Chairman. The Scientific Officer of the Chandigarh Climate Change Cell is the Convener who is responsible for organizing and convening the quarterly meetings for the group. The group has representation from all major stakeholders that includes participation from government departments as well as academic institutions working on that sector in the area. These include the Department of Environment, Department of Forests and Wildlife, ICAR-Indian Institute of Soil and Water Conservation Regional Centre, Punjab Agricultural University, Engineering Department and the Municipal Corporation of Chandigarh.

Table 8.4: Working Group 4 - Climate Change Working Group for Mission on Sustainable Habitat (which includes, Air, Waste, Transport and Health)

S. No.	Member	Designation
1	Director, Department of Environment, Chandigarh	Chairman
2	Scientist 'SD', Department of Environment, Chandigarh	Member
3	St B, Chandigarh Pollution Control Committee	Member
4	Scientist C, Meteorology Centre, Chandigarh	Member
5	Chief General Manager, Chandigarh Smart City Limited, Municipal Corporation	Member
6	Motor Vehicle Inspector, State Transport Authority	Member
7	General Manager, Chandigarh Transport Undertaking	Member
8	Assistant Director, Malaria (NVBDCP)-cum-State Surveillance Officer (IDSP), Chandigarh Administration	Member
9	Superintending Engineer, Public Health, Municipal Corporation of Chandigarh	Member
10	Superintending Engineer, Public Health, Chandigarh Housing Board	Member
11	Medical Officer of Health (Health and Sanitation), Municipal Corporation of Chandigarh	Member
12	Medical Officer of Health, Sector 16, Chandigarh	Member
13	Representative from School of Public Health, PGIMR	Member
14	Representative from Department of Pulmonary Medicine, PGIMR	Member
15	Representative from Department of Public Health, Punjab University, Chandigarh	Member
16	Scientific Officer, Chandigarh Climate Change Cell, Department of Environment, UT, Chandigarh	Convener

The Climate Change Working Group for the Sustainable Habitat Mission has been formed to undertake interventions related to the sustainability of the UT that are identified in the SAPCC. The Group has the Director of the Department of Environment in Chandigarh as the Chairman. The Scientific Officer of the Chandigarh Climate Change Cell is the Convener who is responsible for organizing and convening the quarterly meetings for the group. The group has representation from all major stakeholders that range from government departments to academic institutions in the area. These include the Department of Environment, Chandigarh Pollution Control Committee, Meteorology Centre, Chandigarh Smart City Limited, State

Transport Authority, Chandigarh Transport Undertaking, Malaria (NVBDCP)-cum-State Surveillance Officer (IDSP), Chandigarh Housing Board, School of Public Health, and Department of Pulmonary Medicine from PGIMR, Department of Public Health of Punjab University and the Municipal Corporation of Chandigarh.

Table 8.5: Working Group 5 - Climate Change Working Group on Mission on Strategic Knowledge on Climate Change

S. No.	Member	Designation
1	Director, Department of Environment, Chandigarh	Chairman
2	Scientist 'SD', Department of Environment, Chandigarh	Member
3	Junior Engineer, Science and Technology Department, Chandigarh	Member
4	Nodal Officer, Department of School Education	Member
5	State Liaison Officer, Department of Higher Education	Member
6	Chairperson, Department of Environment Studies, Punjab University, Chandigarh	Member
7	Representative from Punjab Engineering College, Chandigarh	Member
8	Representative from NITTR, Sector 26, Chandigarh	Member
9	Representative from School of Public Health, PGIMER, Chandigarh	Member
10	Representative from Institute of Microbial Technology, Chandigarh	Member
11	Scientific Officer, Chandigarh Climate Change Cell, Department of Environment, UT, Chandigarh	Convener

The Climate Change Working Group for the Mission on Strategic Knowledge on Climate Change has been formed to enhance the available knowledge on climate change and its impacts in the UT. The Group has the Director of the Department of Environment in Chandigarh as the Chairman. The Scientific Officer of the Chandigarh Climate Change Cell is the Convener who is responsible for organizing and convening the quarterly meetings for the group. The group has representation from all major stakeholders that include the Department of Environment, Department of Science and Technology, Department of School Education, Department of Higher Education, Department of Environment Studies in the Punjab University, Punjab Engineering College, School of Public Health in PGIMER, and the Institute of Microbial Technology of Chandigarh.

9. Monitoring, Evaluation and Reporting

Monitoring, evaluation, and reporting (MER) of climate interventions is a critical aspect for ensuring effective implementation. The success of national climate interventions at the state and local levels, especially necessitate a robust MER process, so that gaps and issues can be identified in time, and measures taken to correct them.

9.1 Current Status of MER in Chandigarh

Chandigarh had envisaged a MER framework for covering a wide range of activities and a coordinated engagement with the concerned departments. The technical activities herein include organizing data sources, creating a database and constant monitoring of climate change variability. Under this, the Climate Change Monitoring Committee (CCMC) is responsible for guiding and implementing the activities of the various missions under the SAPCC, in coordination with other line departments. The structure of CCMC is given under Chapter 8, section 8.2. The CCMC is required to meet twice annually to review the progress and approve the annual action plan of climate action for Chandigarh. Additionally, it facilitates inter-ministerial/departmental coordination for effective implementation of the SAPCC. The overall programme implementation, however, is facilitated, supervised, and monitored by the designated line departments, as outlined in the SAPCC. The line departments are responsible for monitoring and evaluating their interventions and reporting these to the nodal department, the Department of Environment (DoE).

Working as the Secretariat of the CCMC, the Climate Change Centre (CCC), under the guidance of the Strategic Knowledge Management Mission, has the responsibility to develop the structure for MER for the SAPCC along with coordination on all the activities pertaining to the missions under the SAPCC. The CCC and Secretariat to the CCMC is also responsible for maintaining a database and knowledge products developed by the various missions, while also carrying out knowledge dissemination activities. It is the nuclei of all research that is critical to the climate action plan and undertakes studies and research with other agencies that are directly related to the SAPCC of the UT. The CCMC guides the Monitoring and Evaluation Cell (within the CCC) for the development of a monitoring protocol and also reviews the progress of the action plan based on this monitoring protocol. Thus, the CCC has three proposed activities under MER, to firstly set up M&E protocol for the climate change action plan, data collection and analysis on the various parameters annually and, supporting the climate change authorities on the various aspects of MER.

Strategizing for financing of the SAPCC strategies and climate actions is also under the mandate of the CCMC, which seeks financial support for the SAPCC from the Central government as well as other donor agencies, as and when required. It can also include new sectors or missions and, members under the respective missions (under the SAPCC), as and when deemed necessary.

The CCMC, therefore, leads the MER framework in coordination with CCC and, the Review Committee, while seeking guidance from the National Action Plan for Climate Change (NAPCC) on various technical matters.

9.2 Implementing the MER

The Union Territory (UT) of Chandigarh is motivated towards reforming the existing MER structure and building a robust MER framework, for ensuring successful implementation of climate actions. Chandigarh is taking an iterative approach to design its MER processes for

climate actions, with an overall objective of creating an enabling and transparent environment for efficiently realizing it climate goals. Monitoring is needed to assess the progress made in implementing planned climate initiatives and tracking the financial and non-financial resources spent on these. Further, a periodic evaluation of this information is required to assess if the climate actions are on track and having the desired impact. Finally, the reporting requirements on the NDCs, SDGs and environment aspects, cascade down from the national level to the UT and the concerned nodal officers across various departments. To facilitate this, Chandigarh Administration has developed a simplified semi-automated MER platform, where updated, uniform information and status of the various interventions will be available. A crucial component of such a framework would include an institutionalized process with periodic review of the strategies under the SAPCC missions. This robust MER system would also enable the UT to design forward-looking programmes and policies, which are aligned with national goals and have proven efficacy for enhancing the city's climate resilience, environment, and overall sustainable development.

9.2.1 Integrated platform

With the aim of moving to a transparent and efficient MER system, Chandigarh Administration has developed a dedicated web-based platform to enable a virtual mode of MER processes. Ideally, the platform is to be integrated with other existing platforms, such as Chandigarh's Integrated Command and Control Centre, for facilitating interoperability. Other key features built in the platform are data visualization and report generation with select parameters, as per user requirements, to support decision-makers. This digital platform will strengthen and clarify the roles of different departments and improve the accountability of the MER process.

9.2.2 Target-oriented strategic indicators for assessing outcomes

The MER process shall be initiated with the identification of a list of quantifiable outcome indicators, clearly defined in scope and theme, which would be contextual to the UT. Each of these indicators, related to Chandigarh's SAPCC missions or thematic areas, would be identified and selected on the basis of the national level indicators being collated and after discussions with officials of the line departments. They can further be defined on the basis of international frameworks for climate change, where possible, to avoid duplication as the world starts moving towards common frameworks.

These indicators would be used for measuring outcomes of strategies, for each of the line departments responsible under the SAPCC missions. Such a strategy would delineate the tasks amongst the line departments and help in better coordination from the inception. Recommendations based on the 'outcome indicators', in coordination with the CCC shall be submitted to the CCMC. For instance, some indicators which are relevant are shown in the Table 9.1, aligned to the key thematic areas and the nodal department responsible for its reporting.

Table 9.1 provides a list of comprehensive indicators for important thematic areas for Chandigarh. These indicators cover both areas of mitigation and adaptation. The list covers both soft and hard measures that can be tracked to understand progress of implementation. An indicative list of departments/nodal agencies have also been provided for each indicator. This will further help in the process of implementation and tracking the progress of interventions in each thematic area.

The 11 thematic areas are briefly explained below:

1. ***Clean energy use and energy efficiency increase***: Effective utilization of electricity and harnessing renewable sources for electricity generation can reduce the GHG emissions and demand for energy imports. Energy efficiency can be achieved through promotion of green buildings, adopting measures to reduce consumption of fossil fuel in vehicles, using energy efficient machinery and devices to deliver municipal services like water supply, streetlights, waste treatment, etc.
2. ***Water and sanitation, and water resources preservation***: Climate change is expected to impact water resources and hence, water availability. It mandates the need to manage water resources, both in terms of quantity and quality. Assessment of current stock availability and expected demand is important to initiate adequate actions, if required. Reducing Non-Revenue Water (NRW) can be an effective demand management measure to reduce the stress on existing water resources. Maintaining water quality is imperative to ensure availability of potable water and prevent contamination, and thus, water-borne diseases.
3. ***Air Quality Index (AQI) improvement***: Promoting public and non-motorized transport and adopting low emission vehicles and electric vehicles can be the few measures to improve Air Quality Index (AQI) of the city.
4. ***Municipal solid waste reduction***: Actions such as increasing reuse and recycling of construction and demolition wastes can help the city to adopt measures to significantly reduce amount of waste generated and to treat all generated waste. In addition, zero waste target will not only provide for significant GHG mitigation but will also improve public health and environmental quality.
5. ***Land and natural resources conservation and preservation***: Rapid urbanization has built up a pressure on the urban environment that include water bodies, open spaces, and built-up area. Open spaces play a crucial role by acting as carbon sinks and groundwater recharge areas.
6. ***Slum free city***: The aim would be to improve current living conditions to reduce vulnerabilities to climate change.
7. ***Improving the preparedness to risk of rising instances of vector-borne and water-borne diseases***: There is evidence to show that climate change will cause an increase in water-borne and vector-borne diseases. There is a need to address this issue to ensure preparedness, reduce vulnerabilities, and improve public health.
8. ***Awareness programmes***: These programmes will help in raising awareness at various levels (students, residents, government, and non-government departments etc.) on various climate change related issues.
9. ***Capacity development***: This would be imperative to stay updated on the changing scenario of climate and associated impacts.
10. ***Monitoring and evaluation:*** Regular assessments and use of data-driven indicators to ensure continuous improvement in both mitigation and adaptation strategies.
11. ***Knowledge of dissemination***

The last four thematic areas will be imperative to track progress of implementation of the interventions that have been identified for both mitigation and adaptation and identify the gap areas—so that they can be addressed in a timely manner.

Table 9.1: Indicative shortlist of indicators for key thematic areas

S. No.	Thematic Area	Indicators	Responsible Nodal
1	Clean Energy & Energy Efficiency	Per capita and per unit area electricity consumption for municipal services	MCC (Electrical Division)
		% Solar out of total electricity consumption for municipal services	MCC (Electrical Division)
		Fossil fuel consumption per 1000 population for municipal services	MCC (Electrical Division)
		% of streetlights in city that are energy-efficient	MCC (Electrical Division)
		% of streetlights powered through Solar PVs	MCC (Electrical Division)
		% of total piped water pumped through energy-efficient pumps	MCC (Public Health)
		% of total wastewater pumped through energy-efficient pumps	MCC (Public Health)
		% Increase in power consumption from solar and wind sources	Engineering Dept (Electricity Wing)
		% of buildings using Energy Conservation Building Codes (ECBC) to reduce energy consumption	Dy Commissioner (Estates Office)
2	Water and Sanitation, and Water Resources Preservation	Water consumption (litres per capita per day)	MCC (Public Health)
		% non-revenue water (NRW) reported during the year	MCC (Public Health)
		% of malfunctioning water meters replaced in all residential, commercial, industrial and public buildings	MCC (Public Health)
		% Treated wastewater reused out of total wastewater generated	MCC (Public Health)
		Percentage of treated wastewater reused out of total wastewater treated	MCC (Public Health)
		Total number of annual tests carried out (on all parameters) on drinking water quality [both (a) physical and chemical tests and (b) microbiological tests]	MCC (Public Health)
		% Increase in groundwater level	Central Ground Water Board (CGWB), Chandigarh
		% Plots with rainwater harvesting system	Dy Commissioner Office (AEO, Estates)
3	Air Quality Index (AQI) improvement	Number of days SO_2/NO_2/PM_{10}/$PM_{2.5}$ concentrations exceeded current NAAQS standard for permissible limits	Chandigarh Pollution Control Committee (CPCC)
		Number of days in the concentration of additional criteria pollutants exceeded	Chandigarh Pollution Control Committee (CPCC)

S. No.	Thematic Area	Indicators	Responsible Nodal
		current NAAQS standards for permissible limits: lead (Pb)/ Carbon Monoxide/ Ozone	
		Increase in average daily Public Transport Ridership per 1000 population	Transport Department
		% Share of Low Carbon Bus Fleet	Transport Department
		% Vehicles running on alternate fuels	Transport Department
		% of non-motorized network (NMT) network on total road network	1. Engineering Department 2. MCC (Buildings and Roads)
		% of population affected by noise levels above prescribed standards	Chandigarh Pollution Control Committee (CPCC)
4	Municipal Solid Waste (MSW) Reduction	% Change in per capita MSW generated annually	MCC (Health and Sanitation Department)
		% of MSW segregated at-source	MCC (Health and Sanitation Department)
		% of MSW treated out of total generated	MCC (Health and Sanitation Department)
		% of recyclable MSW sold to authorised dealers	MCC (Health and Sanitation Department)
		% of Construction and Demolition (C&D) waste reused	MCC (Buildings and Roads)
		Greenhouse Gases (GHGs) emission due to municipal waste processing and treatment facilities	MCC (Health and Sanitation Department)
5	Land and Natural Resources Conservation and Preservation	% Increase in green cover per 100,000 population	1. DoE 2. Eng. Dept. (Horticulture Division) 3. MCC (Horticulture Division) 4. Forests & Wildlife 5. Indian Society of Remote Sensing (ISRS) Chandigarh Chapter
		Annual increase in carbon sink created through increase in forest cover	Forest and Wildlife
		% of native tree species by population	1. DoE 2. Forest and Wildlife 3. Eng. Dept. (Horticulture Division) 4. MCC (Horticulture Division)
		% Number of native species to total species richness	1. DoE 2. Forest and Wildlife 3. Eng. Dept. (Horticulture Division) 4. MCC (Horticulture Division)
		Area under wetlands (sq.km.)	Forest and Wildlife
		% of change in ratio of open spaces to total built-up area	1. Dy Commissioner Office (AEO, Estates) 2. MCC

S. No.	Thematic Area	Indicators	Responsible Nodal
			3. Indian Society of Remote Sensing (ISRS) Chandigarh Chapter
		Unused spaces, including contaminated or derelict land areas (sq.m.)	1. Dy Commissioner Office (AEO, Estates) 2. MCC
		% Change in tree-felling offences	1. Engineering (Horticulture) 2. MCC (Horticulture) 3. Forest and Wildlife
6	Slum free city	Dashboard to be created with relevant data points for information on slum dwellers, housing conditions, diseases prone to, etc.	Housing Board
		Change in percent slum areas to total areas	Housing Board
7	Improving the preparedness to risk of rising instances of vector- and water-borne diseases	Percentage change in water- and vector-borne diseases	Health Department
8	Awareness Programmes	No. of awareness campaigns and targeted seminars conducted annually	1. DoE 2. Department of Science & Technology & Renewable Energy 3. Directorate of School Education 4. Directorate of Higher Education 5. Punjab Engineering College
9	Capacity Development	Percentage increase in the no. of functional libraries	1. DoE 2. Directorate of School Education 3. Directorate of Higher Education 4. Punjab Engineering College
		No. of targeted seminars organized annually	
		No. of studies supported on Climate change scenarios and impacts	
		Publication of report at the end of study	
		No. of Trainings organized annually	
10	Monitoring and Evaluation (M&E)	Development of protocol for M&E on Chandigarh SAPCC	DoE
		Maintain dashboard of data collected to be updated monthly	DoE
11	Dissemination of Knowledge	Monthly updates on the website	DoE

At the initial stages of SAPCC implementation, an extensive assessment across the various sectors and interventions will be conducted, to develop a list of priority indicators for the UT. These will then be formally adopted and regular updating of these will be expected.

9.2.3 Institutional development for MER

In line with these considerations, the Climate Change Centre (CCC) would be formed to facilitate inter-departmental coordination for all the missions under the SAPCC. The CCC would also regularly engage with the Climate Change Monitoring Committee (CCMC), to receive feedback on implementation and contribute towards the MER by identifying gaps, outcomes, and impacts for all the activities which are carried out. The CCMC would also be reviewing the progress across the climate change relevant actions and strategies, and the assessment done by the CCC.

The CCC would be collating the achievements and evaluating the work of the various nodal departments. At each of the nodal departments, a nodal officer will be identified with the responsibility of inputting valid data points for the indicators and submitting the same. The nodal officers can further leverage the support of data coordinators from their departments.

For an institutionally-sound MER framework, the institutions involved must have timely and non-disruptive channels of interaction. Presently the MRV system is being developed for the evaluation of 35+ reporting indicators (given in Table 9.1). The CCC would be anchoring the analysis of the indicators, which would be provided to it by department level nodal officers and data coordinators. The analysis by the CCC would capture the indicator trends in alignment with the climate change goals of the UT and share observations with the CCMC. Further, the CCC would be responsible for preparation of the annual report and in providing recommendations to the CCAC at the respective time intervals (biannually). At the departmental level, a nodal officer shall be assigned for each of the line departments to ensure timely recording and reporting of all datasets by the data coordinators, through a clearly defined process within their respective departments.

The Figure 9.1 highlights the distinct roles and responsibilities under the proposed system.

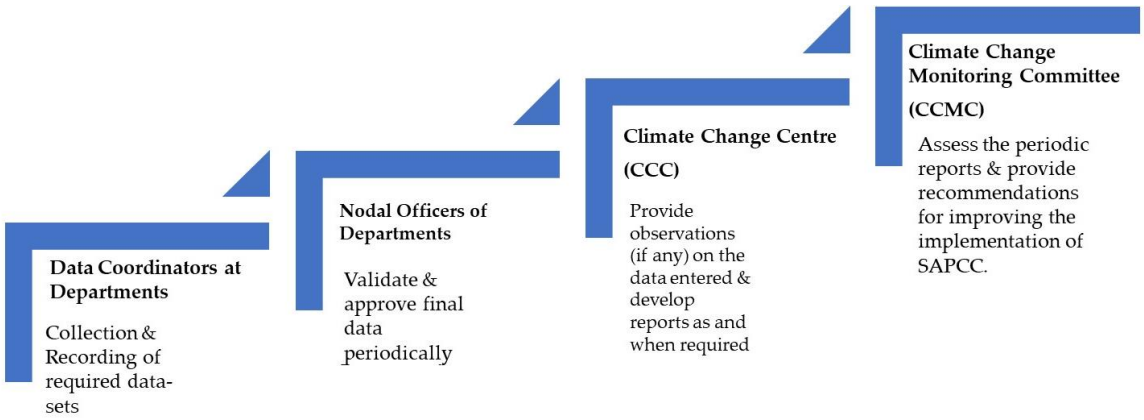


Figure 9.1: Proposed MEL Framework for the SAPCC

A detailed description of this process is given in Figure 9.2.

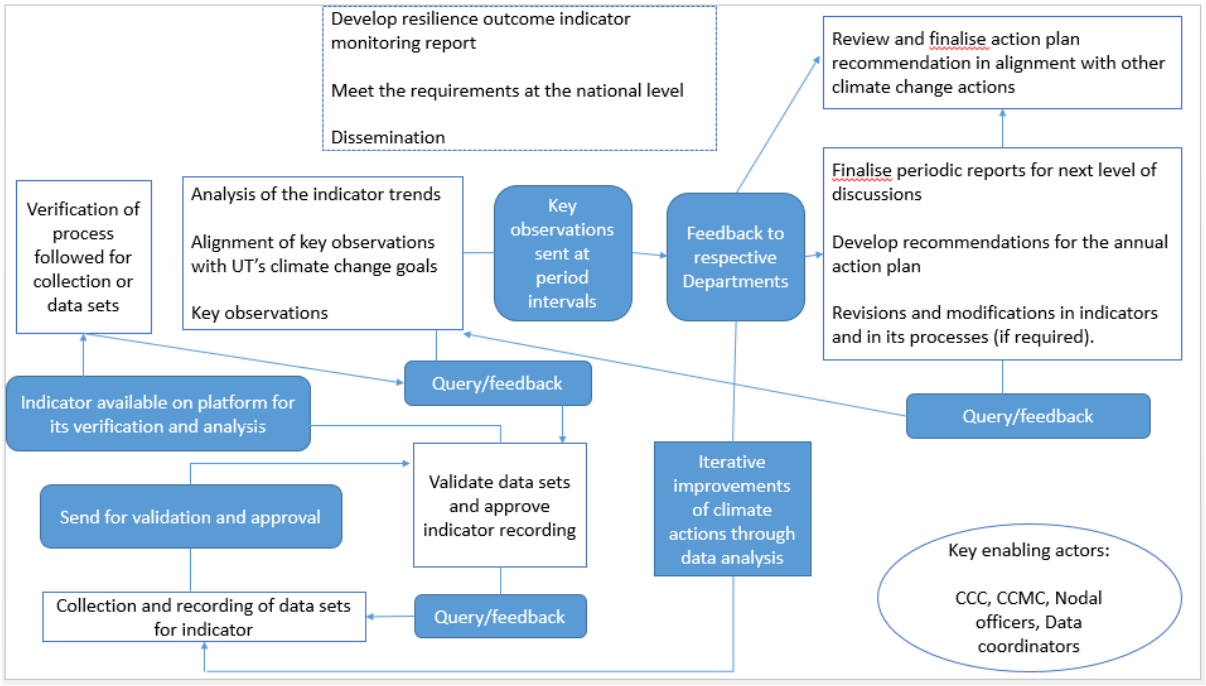


Figure 9.2: Recommended process flow for recording, monitoring, and reporting of climate change actions

The process workflow demonstrated in Figure 9.2 will contribute towards ascertaining the UT's progress on the MER. The process will begin from data collection by data collection coordinators of the concerned departments and agencies as per the nodal person's prescribed process. The nodal officers of respective departments will then validate the data sets for its completeness and accuracy. At the next stage of the process, the CCC under the Department of Environment, UT of Chandigarh, will further verify the recorded indicators and respective datasets, on a monthly basis and in case of discrepancies, inform and update the nodal officers. CCC will catalyse the process towards verification and enhancement of datasets and indicators for quality check and control and to ensure that the indicator trends are aligned with the UT's other climate change goals in general, reporting on the same to the CCMC. The CCMC shall meet biannually, shall review and finalize the recommended climate change actions provided by the CCC. This entire process and the ultimate culmination of the MER processes shall be used for revising, improving and modifying the SAPCCs and other ongoing climate change activities in the city.

A digital platform in the form of a dashboard has been created by the Department of Environment (DoE) to subsume all the SAPCC-related information and updates. This database would include all the outlined activities corresponding to different missions, and their respective MER status. Such a dashboard aims to create a coordination platform for managing information on stakeholders, datasets, climate actions, and other related issues. Over the years as the SAPCC is implemented, the platform would also provide information on the progress made on strategies under the missions and generate key learnings therein for enhancing goals in the next revision cycle of the SAPCC. It is recommended that the CCC would be responsible for overall functioning of the platform. The platform should be updated on a quarterly basis so that it is in line with the working of the CCMC. The platform developed by the DoE has the ability to host coherent data visualization with interactive output charts and infographics, accessibility to datasets for the viewer following Government of India's

National Data Sharing Accessibility Policy[130], and also upload periodic reports summarizing the key observations under all the indicators. Such an evidence-based MER framework will create an institutional architecture, which can enhance climate ambition for the UT in a transparent and accountable manner.

[130] National Data Sharing Accessibility Policy, 2012. Details available at <https://dst.gov.in/national-data-sharing-and-accessibility-policy-0>

ANNEXURE 1: Mapping of strategies against National Missions, NDCs, SDGs, LT-LCDS and other framework documents

Power Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDGs	NDCs
5.2.1	Maximize installation of Solar PV Power Plants	National Solar Mission LT-LCDS: ES2.1	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
5.2.2	Deployment of solar rooftop systems in all public, private and government buildings	National Solar Mission LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
5.2.3	Installing floating solar power plants	National Solar Mission LT-LCDS: ES2.1	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDGs	NDCs
				capacity from non-fossil fuel-based energy resources by 2030
5.2.4	Wind power purchase	National Solar Mission LT-LCDS: ES2.1 Renewable Purchase Obligations	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate Action	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
5.2.5	Special area Demonstration project	Special Area Demonstration Project Scheme by MNRE	SDG 7: Affordable and clean energy Target 7.1 Target 7.2 Target 7.a SDG 12: Ensure sustainable consumption and production patterns Target 12.2 SDG 13: Climate action Target 13.3	NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level NDC 4: To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 NDC 8: Build capacities
5.2.6	Promotional activities on solar energy	National Solar mission Mission LiFE	SDG 13: Climate action Target 13.3	NDC 8: Build capacities

Transport Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
5.3.1	Increasing electric vehicle penetration	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 9 Build resilient infrastructure Target 9.1 SDG 11 Make sustainable cities and communities Target 11.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.2	Enhancing energy efficiency through E-rickshaws	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.3	Policies for household and commercial electric vehicle adoption	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 3 Ensure healthy lives and promote well-being for all at all ages Target 3.9 SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b SDG 11 Make sustainable cities and communities Target 11.6 SDG 13: climate action Target 13.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.4	Intelligent traffic management system	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 7: Affordable and clean energy Target 7.b SDG 12: Ensure sustainable	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
			consumption and production patterns Target 12.2	NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 levelNDC 8: To build capacities, create domestic framework and international architecture
5.3.5	Replacing the current fleet of vehicles to BS VI fuel standard and provision for vehicle scrapping for old vehicles	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 11 Make sustainable cities and communities Target 11.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.6	Promoting Public bike sharing system	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 11 Make sustainable cities and communities Target 11.2 SDG 12: Ensure sustainable consumption and production patterns Target 12.2	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path NDC 3: reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level
5.3.7	Promotion and systematic utilization of school bus system	National Mission on Sustainable Habitat Mission LiFE LT-LCDS: ES2.2	SDG 11 Make sustainable cities and communities Target 11.2	NDC 2: Climate friendly and cleaner path

Energy efficiency and buildings sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
5.4.1	Encourage use of BEE Energy Star Labelled Appliances	Enhanced Energy Efficiency Mission Mission LiFE LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.2	Introducing Energy conservation building code (ECBC 2017)	To adopt the concept of ECBC norms in all newly constructed government buildings, 2030 Mission LiFE LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.3	Smart surface coalition in buildings	Enhanced Energy Efficiency Mission Mission LiFE LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.4	Promoting green building standards and certification	Enhanced Energy Efficiency Mission Mission LiFE LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.5	Introducing Net-Zero emissions buildings	Enhanced Energy Efficiency Mission LT-LCDS: ES2.3	SDG 7: Affordable and clean energy Target 7.1 Target 7.3 Target 7.b	NDC 1: Healthy and Sustainable Way of Living NDC 2: Climate friendly and cleaner path
5.4.6	Capacity building programmes and initiatives	Enhanced Energy Efficiency Mission Mission LiFE	SDG 7: Affordable and clean energy Target 7.1 SDG 13: Climate action Target 13.3	NDC 8: To build capacities, create domestic framework and international architecture

Waste Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
5.5.1	Augmentation of sewage treatment plants	National Mission on Sustainable Habitat Mission LiFE	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path NDC 6: better adapt to climate change
5.5.2	Biomedical waste management	National Mission on Sustainable Habitat	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.4 Target 12.5	NDC 2: Climate friendly and cleaner path NDC 6: better adapt to climate change
5.5.3	Bio-mining of Legacy waste	National Mission on Sustainable Habitat	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 6: better adapt to climate change NDC 2: Climate friendly and cleaner path
5.5.4	Door-to-Door Municipal Solid Waste management	National Mission on Sustainable Habitat Mission LiFE	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
5.5.5	Integrated Solid Waste Processing & Management System	National Mission on Sustainable Habitat Mission LiFE	SDG 11: Sustainable cities and communities Target 11.6 SDG 12: Responsible consumption and production Target 12.5	NDC 1: To promote healthy and sustainable way of living NDC 2: Climate friendly and cleaner path

Water Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
6.2.1	Upgrade drainage system to manage the runoff in intense rains, especially in the flood prone areas, such as building new and renewing old storm water drains, residential areas that face consistent water logging issues	National Water Mission Mission LiFE	SDG 11: Sustainable cities & communities Target 11.5 SDG 13: Climate Action Target 13.1, 13.2	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.2	Development of Flood Early Warning Systems	National Water Mission National Mission on Strategic Knowledge	SDG 3: Good health and well being Target 3.d SDG 13: Climate Action Target 13.1, 13.2, 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.3	Revamping/retrofitting water supply transmission and distribution network system with the latest technology (water-efficient fixtures)	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change NDC 7: Mobilizing additional funds to bridge the resource gap
6.2.4	Mandatory water meters and audits in high consumption segments/ sectors - industries, hotels, public clubs,	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a	NDC 1: Healthy and Sustainable Way of Living

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
	restaurants, residential complexes, and public buildings		SDG 11: Sustainable cities & communities Target 11.1	NDC 6: better adapt to climate change
6.2.5	Periodic water budgeting to understand the actual demand, usage, and supply of water by sector (domestic + commercial)	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.6	Prohibition/restriction on new borewells	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.7	Metering of groundwater usage by industries and commercial establishments and taxation for over extraction	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: better adapt to climate change
6.2.8	Wastewater treatment plants and use of treated water	National Water Mission Mission LiFE	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1, 11.6	NDC 1: Healthy and Sustainable Way of Living NDC 6: Enhancing investments in developing programmes and vulnerable sectors
6.2.9	Mandatory RWH systems in the public buildings and large houses with periodic audit and check	National Water Mission Mission LiFEs	SDG 6: Clean water and sanitation Target 6.1, 6.4, 6.a SDG 11: Sustainable cities & communities Target 11.1	NDC 1: Healthy and Sustainable Way of Living NDC 6: Enhancing investments in developing programmes and vulnerable sectors

Forest and Wildlife Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	Alignment with SDGs, NDCs, Other National Missions and policies
6.3.1	Promoting increase in tree/green cover in portions of public parks, premises of schools and colleges and community spaces -free distribution of seedlings of various species to the institutions, eco clubs, NGOs & residents of Chandigarh for plantation	National Mission for a Green India Ek Ped Ma Ke Naam LT-LCDS: ES2.6	SDG 15: Life on land Target 15.2 NDC 5: Additional carbon sink Kunming-Montreal Global Biodiversity Framework (GBF): GOAL A GBF Target 11, 12 National Biodiversity Target (NBT): 3, 5 Ek Ped Ma Ke Naam
6.3.2	Demonstration of herbal gardens, bamboosetum, orchids, arboretum along with other means of ex situ conservation	National Mission for a Green India LT-LCDS: ES2.6	SDG 15: Life on land Target 15.2 NDC 5: Additional carbon sink GBF GOAL A GBF Target 11, 12 NBT: Target 11
6.3.3	Replacing invasive and ornamental species by planting native trees in the forest areas, degraded lands and green belts; enhancing biodiversity	National Mission for a Green India Ek Ped Ma Ke Naam LT-LCDS: ES2.6	SDG 15: Life on land Target 15.2, 15.a, 15.8 NDC 5: Additional carbon sink GBF GOAL A Target 6, 11 NBT: Target 4
6.3.4	Developing a city biodiversity index or dashboard for forest health assessment and to inform officials and generate public awareness	National Mission for a Green India	SDG 15: Life on land Target 15.5 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF GOAL C, D GBF Target 14, 21,22 NBT: Target 7
6.3.5	Study on Forest health assessment	National Mission for a Green India	SDG 15: Life on land Target 15.5 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF GOAL C, D GBF Target 14,20, 21,22 NBT: Target 2
6.3.6	To reduce the silt inflow to Sukhna lake through carrying out various kinds of soil conservation works like construction of silt retention dams, masonry check dams, spurs/revetments, desiltation	National Mission for a Green India	SDG 15: Life on land Target 15.1 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal A Target 3, 10 NBT: Target 3, Target 6

S. No.	Activities	Relevant National Mission/ Schemes& Programme	Alignment with SDGs, NDCs, Other National Missions and policies
	of dams, construction of grade stabilizers.		
6.3.7	Building and maintaining fire breaks and other latest techniques of fire suppression in the forest areas, and training and equipping fire fighters on techniques to control forest fires	National Mission for a Green India	SDG 15: Life on land: Target 15.2 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal A Target 8 NBT: Target 3
6.3.8	Celebration of Wildlife week, world forestry day, world earth day, wetland day; Eco-Clubs; Publication of Chandigarh Greening Action Plan	National Mission on Strategic Knowledge Management for Climate Change	SDG 12: Responsible consumption and production Target 12.8 SDG 13: Climate Action Target 13.2, 13.3 NDC 6: Enhancing investments in developing programmes and vulnerable sectors GBF Goal D GBF Target 11, 20, 22 NBT: Target 1
6.3.9	Building a peoples' biodiversity register (including traditional knowledge)	National Mission on Strategic Knowledge Management for Climate Change National Mission on Sustainable Agriculture	SDG 15: Life on land NDC 8 Building Capacities GBF: Goal A NBT: Target 1

Health Sector

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
6.4.1	Door-to-door awareness generation programmes on mitigating risk of vector- , water-borne diseases, non-communicable diseases (NCDs)	Health Mission Mission LiFE	SDG 3: Good health and well being Target 3.3 SDG 6: Clean water & sanitation Target 6.b SDG 13: Climate Action Target 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.2	Develop online platforms/websites for information dissemination regarding vector and water borne diseases	Health Mission Mission LiFE	SDG 3: Good health and well being Target 3.3 SDG 6: Clean water & sanitation Target 6.b SDG 13: Climate Action Target 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.3	Creating awareness among the people to reduce exposure to dust allergies and air pollution	Health Mission Mission LiFE	SDG 3: Good health and well being Target 3.9 SDG 11: Sustainable cities & communities Target 11.6 SDG 13: Climate Action Target 13.1, 13.3	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.4	Formulation of public protocol in case of severe air quality	National Mission for a Green India Mission LiFE	SDG 15: Life on land Target 15.5	NDC 1: Healthy and Sustainable Way of Living NDC 6: Better adopt to climate change
6.4.5	Real-time surveillance, rapid response teams, and public advisories to combat heatwaves	National Program on Climate Change and Human Health	SDG 3: Good health and well being Target 3.D SDG 13: Climate Action Target 13.1	NDC 6: Better adopt to climate change

Cross Cutting Sectors

S. No.	Activities	Relevant National Mission/ Schemes& Programme	SDG	NDCs
6.5.0	Establish the Programme Cell for the Climate Change Monitoring Committee (CCMC)	National Mission on Strategic Knowledge	All relevant to SAPCC 2.0	NDC 8: Building capacity
6.5.1	Supporting already existing libraries for creating a section on climate change	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.2	Conduct studies on climate change scenarios and impacts specific to Chandigarh and disseminating the information	National Mission on Strategic Knowledge Management for Climate Change	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.3	Training for town planners, architects, administrators on climate change & disaster management	National Mission on Strategic Knowledge Management for Climate Change	SDG 6: Clean water and sanitation Target 6.a SDG 13: Climate Action Target 13.1, 13.2, 13.3	NDC 8: To build capacities,
6.5.4	Distribution of study material related to climate change to students participating in various events	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	SDG 3: Good health and well being Target 3.9 SDG 11: Sustainable cities & communities Target 11.6 SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.5	Organise climate change day	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.6	Seminars/workshops/conferences on thematic areas relevant for or impacted by climate change, such as energy, water, transport, health	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	SDG 13: Climate Action Target 13.1, 13.3	NDC 8: To build capacities,
6.5.7	Extension activity to promote simple and sustainable way of life-style	Mission Life	SDG 13 GBF Goal A NBF Target 1	NDC-1
6.5.8	Develop a dashboard/platform for compiling data and information from different government departments for tracking of climate interventions and developing/publishing cross-sectoral analysis	National Mission on Strategic Knowledge Management for Climate Change Mission LiFE	SDG 13: Climate Action Target 13.1, 13.2, 13.3	NDC 8: To build capacities,