U.T. Chandigarh Action Plan on Climate Change

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Chandigarh Administration

United Nations Development Programme

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Executive Summary

There are many challenges ahead for India to combat impacts of climate change particularly on the natural resources and livelihoods. Responding such a challenge India developed its action plan at the national level mostly on the lines of adaptive strategies and directed the states to prepare their own action plan in line with the national guidance. Union Territory (UT) of Chandigarh being an urban conglomerate with adjoining states with urban centers faces a different threat than the rest of India.

Context: Chandigarh, described as "The City Beautiful" is well planned city for comfortable living, built primarily to provide the best amenities. Today Chandigarh has grown beyond expectations in terms of the populations and therefore, the problems also grew at the same proportions. Chandigarh enjoys the picturesque locale with Shivalik hills and wonderful climate, endowed with various natural habitats and many manmade parks. Fortunately, the city also has less number of polluting industries. The domestic electricity consumption and petroleum usage for personal transport is higher in Chandigarh than many other states and therefore, the emission from domestic electricity consumption and transport is high. Given that its area is confined to 114 km^2, (and 25.42 km^2 as Sukhna Wild Life Sanctuary) there is no land area that can be allocated for alternative uses except rooftops. Chandigarh has excellent educational and health facilities. The growth of service industry has been remarkable in IT field. This makes the city Chandigarh a fast developing Union Territory. Furthermore, this growth pattern has increased the pressure from the neighboring states for various infrastructures such as educational institutions, hospitals and other recreational opportunities. This is letting the city beautiful with increased slums, increased traffic congestions and increased population. Thus, Chandigarh experiences a typical urban problem and the climate change action plan is to be addressing both adaptation and mitigation with equal priority.

The vision: Based on the vision of le Corbusier while building Chandigarh, the new master plan builds on accommodating the new and emerging demands and pressures maintaining the quality of life and its urban fabric while rectifying some aberrations. In line with global development on climate change the Chandigarh will strive to reduce urban carbon foot print. Chandigarh will strive to become a model for sustainable water management, use of renewable sources of energy, and protecting the local ecology and environment. The master plan also strives to reduce private vehicle use and increase public transport. As part of the Mission for Sustainable Habitat and Green Code, Chandigarh has been developing Solar City concept to harness solar energy to meet the requirements of power. In addition to address the issue of mitigation of GHG emission from municipal waste, appropriate actions are required through adoption of scientific waste management systems with options for recovery of wealth from waste, *i.e.* compost and energy recovery from solid waste. Improved waste management will not only provide significant GHG mitigation but will also improve public health and environment quality. Some of the frameworks for low carbon urban plan for UT Chandigarh are to build pedestrian city, introducing bicycles as a mode of transport, reducing vehicular congestion, creating awareness among public on various climate change concerns, developing integrated waste

management systems and developing a comprehensive mobility plan to reduce GHG emissions and provide clean habitations for citizens of UT Chandigarh.

Process: A participatory process was followed for drafting the UT Chandigarh Climate Change Action Plan. In tune with NAPCC and its missions the action plan was planned while reflecting the specific needs and contexts of the Union Territory. The Government of UT Chandigarh, in its order dated 26 August 2008 constituted the steering committee to plan and implement the UT Chandigarh Administration polices related to climate. UNDP provided help in compiling relevant information as well as for providing over all technical guidance for the preparation of the report. In order to prepare sectoral action plans, core groups were constituted from members of different departments and expert institutions. For each mission under the NAPCC, nodal agency for the sectoral plan under that mission was identified. As per the necessity of the UT Chandigarh, five Missions were developed and working groups was formed for each mission. These working groups convened number of meetings and developed different chapters for each mission.

Implementation of the action Plan: The action plan will be guided and implemented by the Climate Change Advisory committee in coordination with various departments. The Committee will act as a facilitator to provide a framework for integration, planning, monitoring and assessment. While the overall programme implementation will be facilitated, supervised and monitored by the designated departments according to the missions formed in the action plan, resident associations, eco clubs and various other youth committees, NGOs and other CBOs will have a greater role in implementation of works at field level. Line departments have identified the activities to be carried out by them with assistance from their strategic partner departments such as State Remote Sensing Department, Science and Technology, etc.

Climate Change Impacts on the resources of UT Chandigarh: Analysis of weather data indicates that there is no change in temperatures particularly in the summer months, while there will be increased temperature in winter. The rainfall may not experience any change over time. Forests also may not experience any change though water could be a problem in the future. Given that there are no polluting industries, in UT Chandigarh, pollution from industries is lesser. However, the two major impacts that may cause concern to are the impact of climate change on built up environment and energy production patterns. UT Chandigarh Authorities should aim using less energy and opt for renewable energy to reduce dependence on petroleum based energy products. Overall, it appears that UT Chandigarh may not experience any major impacts due to climate change. Given that Agriculture area is minimal and water sufficiency in UT Chandigarh both in terms of surface and groundwater availability, UT Chandigarh being an urban conglomerate has to address concerns of energy, traffic, sustainable habitation and reducing petroleum product usage.

Strategies to enhance green cover and carbon sequestration: UT Chandigarh administration has been adopting a well planned greening policy with efficient implementation patterns. The Greening

UT Chandigarh Action Plan involves various efforts of governmental and non-governmental institutions and civil society to enhance green cover. The project aims to enhance tree cover through plantation of 6 lac saplings annually apart from enhancing natural regeneration in forested areas and sanctuaries; eco-restoration of degraded lands, reducing forest fragmentation and enhancing awareness among public.

Strategies to reduce energy consumption: UT Chandigarh draws power from the central grid and has no power generation of its own. But yet electricity consumption of UT Chandigarh is increasing by approximately 52 million units every year. Therefore it is imperative that the union territory adapts itself to reduce dependence on the grid electricity and build its own captive generation or switch to renewable power that helps to generate its own power. Furthermore, on the mitigation front, the city should largely focus on reducing green-house gas emissions from reduced electricity consumption that reduces emissions elsewhere and transport sector which is originated in the city itself. While UT Chandigarh boasts of as one of the highest per capita vehicles per family, it also has lowest number of persons per public transport held by the Chandigarh Transport undertaking. Therefore there is a necessity to improve the public transport facilities for people to travel to various destinations within the city in order to reduce dependence on the personal transport that might cause increased per capita emissions.

UT Chandigarh is moving strongly to adopt Solar City plan to reduce dependence on Conventional Energy. As a sustainable city plan, the city is also moving towards adopting electricity reducing measures and solar water heaters in a big way. It is expecting that nearly 15% of total energy consumption is reduced in the next 20 years. Thus, adaptation and mitigation measures are being followed simultaneously. Some of the innovative strategies are to promote bicycles in the city, pedestrian pathways, metros, Bus Rapid Transits, and solar power generation. Energy efficiency building through adoption of building code is another major attempt to reduce energy consumption. Overall, UT Chandigarh is moving towards the low carbon city with various measures though there is a long way to go.

Strategies to improve water use efficiency: UT Chandigarh is receiving water from Bhakra Canal, one of the few cities in the world with canal water supply. Currently Chandigarh is getting nearly 67 million gallons per day from surface water and 20 million gallons per day from tube wells. However, with depleting ground water and possible reduced flow to River, from which the city is drawing water for domestic use, the city administration should aim to reduce water usage through various technologies. UT Chandigarh has a potential to use recycled water. Chandigarh has a capacity to treat 56 million gallons per day, which could be used to irrigate landscapes. Reduce water consumption, is contemplated to gardening, car washing and toilet flushing in all houses measuring more than 500 sq ft. All new buildings can be fitted water efficient fixtures aiming at 25% reduction of water consumption. Replacement of malfunctioning water meters in all houses and commercial buildings. Introducing the conversion of a flat rate water connection into metered connection is

another solution to reduce water consumption. Revision of water tariff will also caution the consumer to use water judiciously. An efficient storm water management through zero drainage of storm water for large development sites that have more than 30 acres; Sustainable urban drainage system on sites with more than 1 ha to implement SUDS technique; Rainwater harvesting structures to be built in all new buildings, commercial complexes and industrial establishments; Existing buildings to install rainwater harvesting structures within next 2 years; Recharging aquifers in all housing complexes and commercial complexes and reduction of paving on unbuilt areas such that paving should not exceed 25% of unbuilt areas where ever possible use of grass pavers should be encouraged.

Strategies for Sustainable habitat: Sustainable habitat mission in Chandigarh is the most important to combat climate change. Some of the reducing energy consumption option in the buildings and low carbon lifestyle need to be implemented as a measure of adaptation to climate change. Some of the strategies are comprehensive mobility plan where metro and rapid transit is being planned. Furthermore, plan to make a city bicycle and pedestrian friendly is under way. Solid waste management is another important strategy for reducing GHG emissions. Currently there are many systems in operation but need to be consolidated and energy generation from solid waste could benefit the city. Municipal authorities in association with medical centres are making efforts to control vector and water borne diseases. Last year, there has been significant reduction in the incidence of malaria in Chandigarh. Integrated Disease Surveillance Programme has been undertaking various measures to collect data and analyze them and adopt appropriate measures to identify and combat the diseases such malaria, dengue and Cholera. Most importantly, there are many steps taken to reduce energy and water consumption in Government official and residential buildings using appropriate technology. In addition, many energy consumption measures have been undertaken in public places such as parks, streets fountains, etc.

Strategies for Strategic Knowledge management: Successful climate change management calls for a new development paradigm that integrates climate change into strategies and plans, and that links policy setting with the financing of solutions. The focus of the mission is to create awareness, monitor progress and coordinate among various missions to share knowledge and implement the action plan towards combating impacts of climate change. A centre will be created to deal with strategic knowledge management towards climate change involving various institutions and reputed individuals in the respective areas. The centre may Department of Environment, Science and Technology, Industries (may be 2 or 3 sectors), Municipal Corporation (1 each from Engineering, Housing, Electricity and Health), Hospitals, Universities, Punjab and Haryana Science and Technology Councils, Housing Board, and Other Appropriate Institutions. In addition the centre may also include eminent scientists from various institutions of Punjab, Delhi, Himachal Pradesh and Haryana etc. It is felt that at least 1% of the total funding for the State need to be provided for Capacity building. The centre will coordinate with various agencies on awareness programmes related to climate change. More specifically, the centre coordinates under the guidance from climate change advisory

committee will undertake monitoring and evaluation of the progress made as per the annual budgets and activities.

Way Forward: Climate Change action plan has been prepared following a participatory approach to address Chandigarh's concerns of climate change. The UT Chandigarh strives to achieve sustainable growth without compromising on the developmental needs. The strategies aspires to the guide the way forward for various departments to integrate and mainstream the climate change concerns in the schemes, projects, programmes, missions and policies to make UT Chandigarh a resilient state to handle the challenges and risks of climate change by making its population to help mitigate carbon emissions and adapt to climate change through low carbon development pathway.

Budget estimates for implementing the Climate Change Action Plan: Based on the climate change strategy developed under each of the sections previously, estimates of expenditure for each of the activities have been made. This is tentative and much more scrutiny is needed for refining the expected expenditures. This only depicts the tentative financial commitment that needs to be provided to undertake UT Chandigarh climate change action plan. The gross expenses are provided in the table given below and the detailed expenditures as per the activities are provided in the following table.

Table E1: Estimated gross expenses under various sectors for UT Chandigarh Climate change action plan.

Sl. No	Sector	Funds required in crores
1	Green India mission including Agriculture, animal husbandry and horticulture	58.75
2	Energy sector (involving solar, electricity and transport)	1714.49
3	Water sector	51.76
4	Sustainable Habitat mission (including health, waste management, comprehensive mobility and biomedical sector)	15641.00
5	Knowledge management mission	1.54
	Total	**17467.54**

A conservative estimate indicates that nearly Rs 17,500 crores of funds are required over a period of 50 years to complete various activities that help UT Chandigarh cope to the climate change impacts and make the life in Chandigarh a habitable one.

UT Chandigarh Action Plan for Climate Change

Introduction

India is facing the challenge of sustaining its rapid economic growth while dealing with the issue of climate change. India is highly vulnerable to climate change, not only because of high physical exposure to climate-related disasters, (65% of India is drought prone, 12% flood prone, and 8% susceptible to cyclones[1]), but also because of the dependency of its economy and majority of population on climate-sensitive sectors such as agriculture, forests, fisheries, tourism, animal husbandry and fisheries. Climate change is expected to increase relative stress on water resources due to the decline in rainfall, with impact on water availability (per capita water availability is expected to decrease from 1820 m^3/yr in 2001 to 1140 m^3/yr in 2050[2]) and agriculture/food security (60% of crop area in India is under rain-fed agriculture). Any adverse impact on water availability due to recession in certain pockets would threaten food security, cause die back of natural ecosystems including species that sustain the livelihoods of rural households, and adversely impact the coastal system due to sea level rise and increased frequency of extreme events. The poor, especially the marginalized groups including women and children, will be the most affected by these changes. In addition, achievement of vital national development goals related to other systems such as habitats, health, energy, and infrastructure would also be adversely affected.[3]

With a view to address the climate change impacts in India, India prepared an action plan. India's National Action Plan on Climate Change (NAPCC) released in 2008[4] outlines its strategy to meet the challenge of Climate Change. NAPCC is guided by the principles of sustainable development (SD) and aligns the environmental and economic objectives. It outlines a national strategy that aims to enable the country adapt to climate change and enhances the ecological sustainability of India's development path. It stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability of the impacts of climate change. There are eight "National Missions" which form the core of the National action plan. They focus on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

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[1] National Institute of Disaster Management, 2007.

[2] *Intergovernmental Panel on Climate Change (2007a). The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge: Cambridge University Press.*

[3] MOEF, India's Initial National Communication to UNFCCC, 2004.

[4] National Action Plan for Climate Change 2008, Govt. of India

As a second step, after the National Action Plan on Climate Change (NAPCC) was announced, all States have been asked to prepare a State level action plan to deal with the challenges of climate change. Broadly the State level action plans are ENVISioned to be an extension of the NAPCC at various levels of governance, aligned with the 8 National Missions. Building on such a need, a National Consultation Workshop was held on 19th August 2010 in New Delhi for discussing the common framework/approach for preparing State level action plans on climate change. During the workshop, it was suggested that States can take their lead from the Mission documents while formulating mitigation/adaptation strategies under the State level strategy and Action plan (SAPCC). It was recommended that all state governments finalize their SAPCC by 31st March 2011. Delhi and Orissa became the first two states in the country to complete and launch their State Action Plans. Although all State governments are implementing climate-friendly strategies (broadly aligned with the missions) as a part of their development programmes, some states have taken specific leads in the matter.

Need for Climate Change Action plan for UT Chandigarh

Chandigarh, described as "the City beautiful" is well planned city for comfortable living. Chandigarh enjoys the picturesque locale with Shivalik hills and wonderful climate. The city is endowed with various natural habitats and many manmade parks. Fortunately, the city also has less number of polluting industries. The domestic electricity consumption and petroleum usage for personal transport is high in Chandigarh than many other states and therefore the emission from domestic electricity consumption and transport is high. The number of personal vehicles is more than 2 per household in UT Chandigarh. Given that there area is confined i.e., 114 km^2 (+25.42 km^2 of Sukhna Wildlife Sanctuary) there is no land area that can be allocated for alternative uses. Chandigarh has excellent educational and health facilities. The growth of service industry has been remarkable in IT field. This makes the city Chandigarh a fast developing Union Territory (UT). Furthermore, this growth pattern has increased the pressure from the neighboring states for various infrastructures such as educational institutions, hospitals and other recreational opportunities. This is letting the city beautiful with increased slums, increased traffic congestions and increased population.

Climate change concerns needs to be internalized into the policy and development planning of UT Chandigarh. Climate change impacts all walks of life and therefore the policy instruments and implementation strategies should be addressed through various sectors such as water, forests, habitats, energy, disaster risk reduction and knowledge management. This necessitates the development of a climate response strategy should be a multi-disciplinary approach with ample vertical and horizontal linkages and feedbacks across sectors, systems and people. Therefore the actions aimed at addressing climate change should not be viewed in isolation and should be an integral part of development planning, action and execution. In the context of UT Chandigarh, and 'right to develop" aspirations of developing societies it is important to pursue both mitigation and adaptation measures to combat climate change, considering the overall socio-economic and

ecological contexts and vulnerabilities, it would be of high importance to focus on adaptation options including Disaster Risk Reduction.

In short, the adaptation interventions are to be designed and designated to maximize the number of avoidable adverse climate change risks that are to be embedded within the overall ambit of sustainable development. Further, adaptation options also needs to be anticipatory (actions taken in advance of serious climate change effects) and responsive (e.g. disaster response) and can include affected individuals' spontaneous responses to climate volatility and change as well as planned responses by Administration or other public or private institutions (effective public warning systems for storm surges). However, in the context of Chandigarh, it may be appropriate to focus on mitigation in addition to adaptation, as the major it is an urban conglomerate with very low agriculture and animal husbandry and much of the occupation is office or industry goers.

Climate change is an evolving multi-disciplinary science. There is large volume of literature generated on this subject at global and regional levels. However, information is conspicuously scanty at the local level. There is very little or no information is available that are specific to UT Chandigarh, being a small Union Territory. Most of the impacts are derived from the studies conducted in the nearby states such as Haryana and Punjab. However, these, as well as climate monitoring systems would need to be strengthened for enhancing the information base. It is important for the UT Chandigarh administration to partner with neighboring states to enhance the understanding of vulnerability of climate change of UT Chandigarh instead of conducting separate research. States of Punjab and Haryana have developed or being developed their climate change action plan, which could be used to derive many impacts and vulnerability of the UT.

Department of Environment and Forest appointed as the Nodal Agency for the preparation of the CAPCC. UNDP's help was solicited to help in compiling relevant information as well as for providing over all technical guidance for the preparation of the report. UNDP appointed consultant participated in various stakeholder consultations, working group deliberations and had meetings with senior officials.

In order to prepare sectoral action plans, core groups were constituted from members of different departments and expert institutions. For each mission under the NAPCC, nodal agency for the sectoral plan under that mission was identified. As the National Mission on Sustaining the Himalayan ecosystem was not applicable to UT Chandigarh. The 5 Missions with the nodal agency are given in Table 1. These working groups convened many meetings amongst themselves as well as with stakeholders.

Table 1 Missions in the CAPCC and the nodal agency for each mission

Mission Name	Nodal Person and Department	Member Departments
Solar Mission and Enhanced Energy Efficiency	Director, Department of Science and Technology	Chandigarh Renewable Energy Science and Technology, Engineering Dept, Municipality Chandigarh, Chandigarh Housing Board, Environment Department,
Mission on Sustainable Habitat	Superintendent Engineer, Construction – I, UT Chandigarh Administration.	Chandigarh Housing Board, Engineering Dept, Deputy Commissioner, Chandigarh Pollution Control Committee.
Sustainable Water Mission	Superintendent Engineer, Public Health, Chandigarh Municipality	Municipality of Chandigarh, Engineering Dept, Chandigarh Housing Board, Chandigarh Pollution Control Committee
Green India Mission (which includes Sustainable Agriculture)	Divisional Conservation of Forests – HQ convener member Department Forests	Department of Wildlife and Forest Department of Environment, Agriculture, Horticulture, Animal Husbandry, Fisheries Departments
Mission on Strategic Knowledge for Climate Change	Divisional Conservation of Forests (Botanical Garden and Nature Parks) Department of Forests	Science and Technology Department, Environment Department, Department of Public Instruction, Department of higher Education, Punjab Engineering College
Transport	General Manager, Chandigarh Transport Undertaking	State Transport Authority, Registering and Licensing Authority, Traffic Police and Chandigarh pollution Control Committee
Health	Director, Health Services, Sector 16, UT Chandigarh	Chandigarh Pollution Control Committee, Municipality of Chandigarh and Department of Environment.

Preparation of the UT Chandigarh Climate Change Action Plan

A participatory process for drafting the UT Chandigarh Climate Change Action Plan is as important as the final product. Maintaining consistency and linkage to NAPCC and its missions while reflecting the specific needs and contexts of the Union Territory are important priorities in the formulation of the CAPCC. The Government of UT Chandigarh, in its order dated 26 August 2008 constituted the steering committee to plan and implement the UT Chandigarh Administration polices related to climate. The committee and its membership is given in Table 2

Table 2: Composition of the State Steering Committee (??)(Notified by UT Chandigarh on vide Order No.45 dated 26.08.2008)

Member	Designation
Administrator, Union Territory Chandigarh	Chairman
Advisor to Administrator, Union Territory Chandigarh	Member
Home Secretary, Union Territory Chandigarh	Member
Finance Secretary, Union Territory Chandigarh	Member
Secretary (Environment), Union Territory Chandigarh	Member
Commissioner, Municipal Corporation Chandigarh	Member
Director, Environment, Union Territory Chandigarh	Member Secretary
Director (Science & technology), Union Territory Chandigarh	Member
Director, Agriculture, Union Territory Chandigarh	Member
Director, Rural Development, Union Territory Chandigarh	Member
Prof. R K Kohli, Coordinator, Centre for Environment & Vocational Studies, Panjab University, Union Territory Chandigarh	Member
Shri Pramod Sharma, Coordinator, Yuvsatta (NGO), Sector 11, Union Territory Chandigarh	Member
Dr. Satish Narula, Senior Extension Specialist (SM), Punjab Agricultural University, Camp office Sec.19B, Union Territory Chandigarh	Member

Organization of the Report

The Report consists of 9 chapters and an Executive Summary. The Chapter 1 describes the setting of the UT Chandigarh, the city beautiful and sets a stage for action plan. Chapter 2 describes the impacts of climate change on various sectors in India as documented by various scientific articles and extrapolates the impacts of climate change in UT Chandigarh. Chapter 3 describes the current status of forest and agriculture in UT Chandigarh and the impact of climate change on them. Chapter 4 documents and explains the situation of energy in UT Chandigarh and measures taken to reduce the reliance on petroleum products and energy consumption reduction measures. Chapter 4 also considers transport sector and reduction of petroleum production consumption consequently reducing GHG emissions. Water situation in UT Chandigarh is described in Chapter 5 and measures to be taken to reduce the impact of climate change on water resources. Chapter 6 describes the Current situation of habitation in UT Chandigarh and steps to undertake sustainable habitat mission. Sustainable habitat mission also includes health, water and other sectors as well. Plan to implement risk reduction of impacts of climate change through Knowledge management is detailed in Chapter 7. Chapter 8 details about the cross cutting issues and integration of the implementing of plan under different sectors and finally sets up the way forward for the action plan, and chapter 9 summarizes the action plan and descries the tentative budget.

Chapter 1: General Profile and Climate of UT Chandigarh:

Chandigarh, "The City Beautiful" is located at the foothills of picturesque Shivaliks was once the home of the Harappans. This city was dreamt as a model urban centre by first Prime Minister, Pandit Jawahar Lal Nehru. The city was planned by the famous architect Le Corbusier. Since the medieval through modern era, the area was part of the large and prosperous Punjab Province which was divided into East & West Punjab during partition of the country in 1947. The city was conceived not only to serve as the capital of East Punjab, but also to resettle thousands of refugees who had been uprooted from West Punjab. In March, 1948, the Government of Punjab, in consultation with the Government of India, approved the area of the foothills of the Shivaliks as the site for the new capital. The location of the city site was a part of the erstwhile Ambala district as per the 1892-93 gazetteer of District Ambala. The foundation stone of the city was laid in 1952. Subsequently, at the time of reorganization of the state on 01.11.1966 into Punjab, Haryana and Himachal Pradesh, the city assumed the unique distinction of being the capital city of both, Punjab and Haryana while it itself was declared as a Union Territory and under the direct control of the Central Government.

1.1 Population Growth in the City

Union Territory Chandigarh has an area of 114 km^2 (+25.42 square km. of Sukhna Wild Life Sanctuary) lying at the longitude 760 47' 14E and latitude 300 44' 14N. The altitude of the region varies between 304-365 meters above MSL with 1% drainage gradient. The current population of UT Chandigarh is about 10.54 lacs as per 2011 census of which the urban population is 10,25,682 (97.25%) and rural population is 29,004 (2.75%) and has recorded population growth rate of about 1.7% between the last two censuses. Literacy rate – 86.77%, sex ratio 81.75 (817 females per 1000 male) and infant mortality ratio is 28 (India's infant mortality rate is 53)

UT Chandigarh was planned for a population of half-a-million. Demographic data indicate that between 1961 and 1971, the population increased by 144.59 %, one of the highest for urban areas in India. According to 1981 census, it grew by another 75.55 %, followed by 42.16 %in 1991 and by 40.33 % in 2001 (with a total population of 900,635). By 2021 the population of Chandigarh is projected to be around 19.5 lacs (at current rate of growth) almost four times for which it was originally built.

1.2 Geology

The Union Territory of Chandigarh is located in the foothills of the Shivalik hill ranges in the north, which form a part of the fragile Himalayan ecosystem. It 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 seasonal rivulets 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 and the other is Choe which initiates at Sector 29.

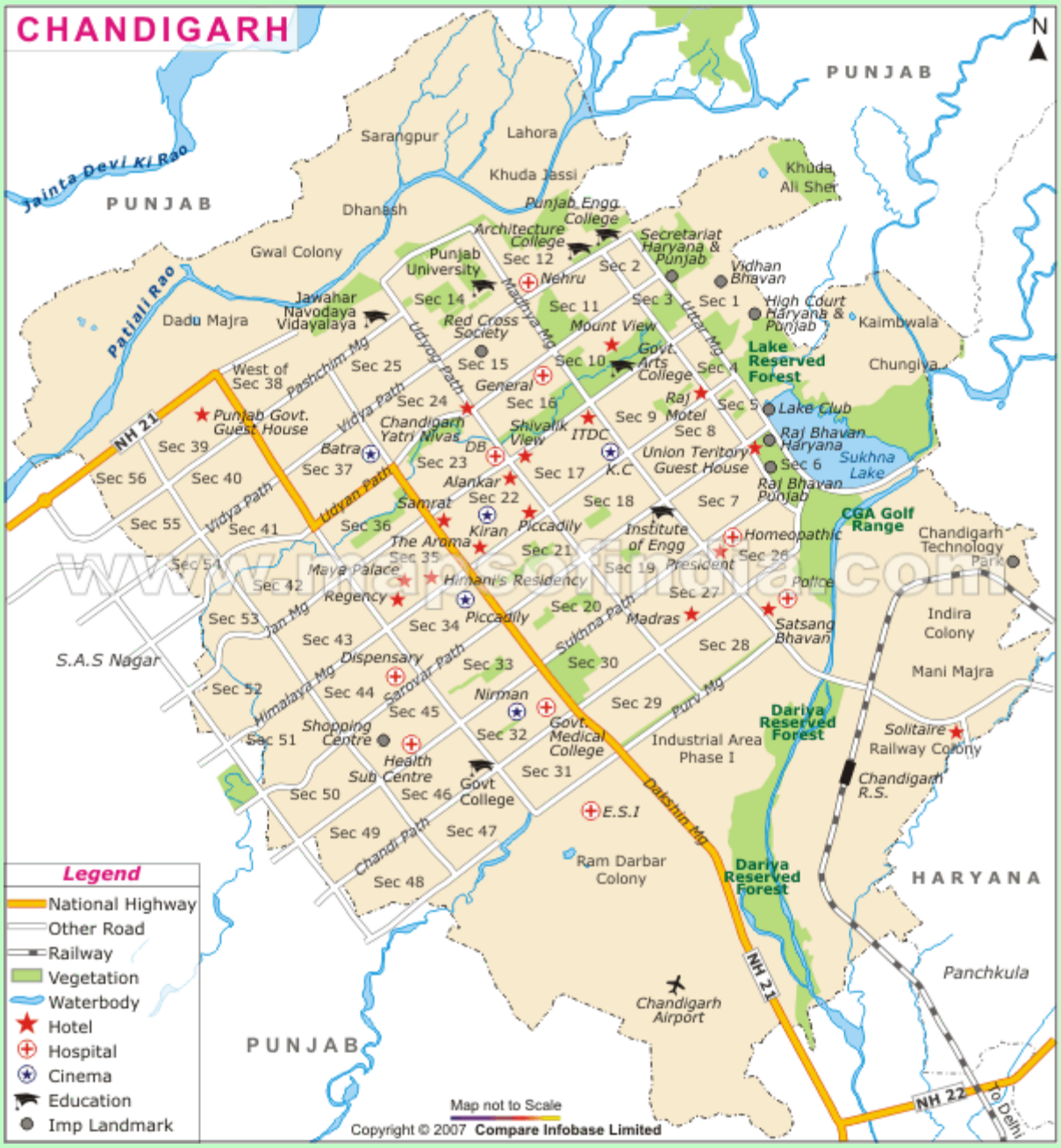


Figure 1.1 Map of UT Chandigarh

1.3 Climate

Chandigarh falls under Koeppen's CWG category i.e. it has cold dry winter, hot summer and sub tropical monsoon. Evaporation usually exceeds precipitation and the weather is generally dry. Chandigarh experiences four seasons: (i) Summer or hot season (mid-March to Mid-June) (ii) Rainy season (late-June to mid-September); (iii) Post monsoon autumn/transition season (mid September to mid-November); (iv) Winter (mid November to mid-March). The dry spell of summer is long but

with the occasional drizzles or thunder storms. May and June are the hottest months of the year with the mean daily maximum & minimum temperatures being about 370C & 250C, respectively. Maximum temperatures can rise up to 44°C. Southwest monsoons with high intensity showers commence in late June. The weather at this time is hot and humid. The variation in annual rainfall on year to year basis is appreciable i.e. 700 mm to 1200 mm. The 20 year average rainfall for UT Chandigarh is 1100.7 mm. January is the coldest month with mean and minimum temperatures being around 23°C and 3.60°C respectively. Winds are generally light and blow from northwest to southeast direction with exception of easterly to southeasterly winds that blow on some days during the summer season.

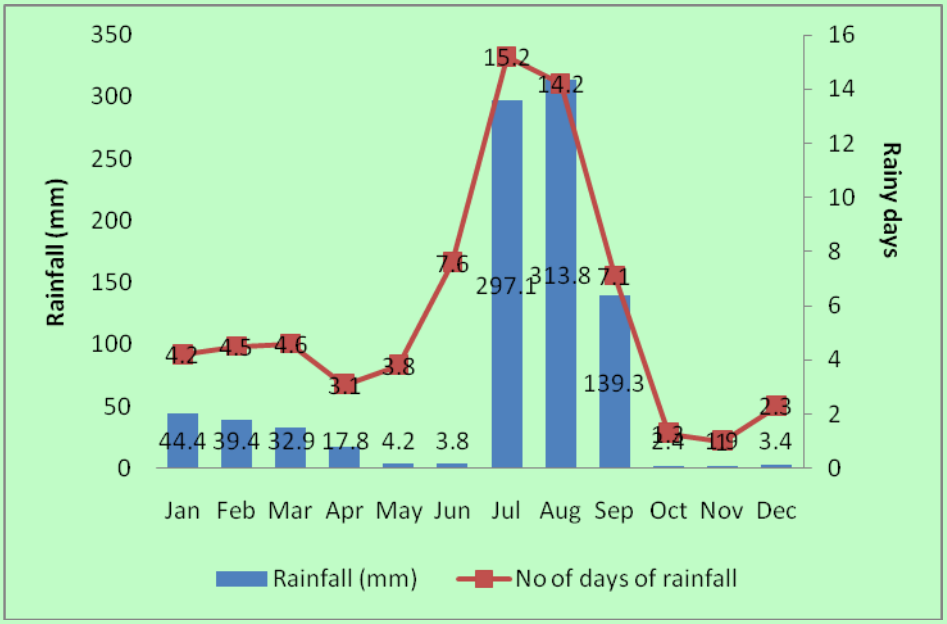


Figure 1.2 Rainfall and number of rainy days in Chandigarh (Source: Air Force Climate Data from 1970-2005)

1.4 Park Areas

Ample areas have been provided in the master plan of the Capital for parks. Out of a total area of 20,000 acres acquired for the first phase, about 2000 acres are meant for development of parks. Leisure Valley, Rajendra park, Bougainvillea Park, Zakir Rose Garden, Shanti Kunj, Hibiscus Garden, Garden of Fragrance, Botanical Garden, Smriti Upavan, Topiary garden and Terraced Garden are some of the famous parks of Chandigarh. Sukhna Lake, Rock Garden, Government Museum and Art Gallery are major tourist attractions of UT Chandigarh. Tree plantation and landscaping has been an integral part of the city's Master Plan. Twenty six different types of flowering and 22 species of evergreen trees have been planted along

Figure 1.3 Rose Garden in Chandigarh

the roads, in parking areas, shopping complexes, residential areas and in the city parks, to ameliorate the harsh climate of the region, especially the hot and scorching summers.

The industrial area comprises 2.35 km^2, set-aside in the Master Plan for non-polluting, light industry on the extreme southeastern side of the city near the railway line, as far away from the Educational Sectors and Capitol Complex as possible.

1.5 Agriculture

The Union Territory Chandigarh has a limited area under agriculture. The agriculture land is being gradually acquired for the expansion of Chandigarh City. The Cultivated area has shrunk from 5441 hectares in 1966 to 1085 hectares in 2011-12. 880 farming families cultivate this area. The main sources of irrigation are deep-bore tube-wells installed by the UT Chandigarh Administration and shallow tube-wells installed by individual farmers. The farmers of UT Chandigarh who keep large number of milch cattle have taken to fodder cultivation to cater the demand of milch cattle. Therefore, the area under food grain crops is decreasing.

1.6 Water Resources

The major source of water for Chandigarh is from Bhakra Main canal which is 27 km away from the City. The transmission mains carry raw water from Kajuali to the water treatment plants located at Sector 39. At sector 39, the water is treated, disinfected and stored at water works. The present water supply service area of MCC is 114 km^2, which includes MCC area 79.34 km^2 and rural area of 34.69 km^2. The villages are provided with 200 tube wells. About 200 tube wells drilled on periphery of Chandigarh and Manimajra are feeding to water works. The average availability of water in Chandigarh is reasonably high at 332 Liters per Capita per Day.

Figure 1.4 Sukhna Lake

The major attraction in UT Chandigarh is Sukhna Lake Located in Sector 1, the Sukhna Lake is an artificial reservoir. There is a walking path, a cafeteria, shops and a mini-amusement park and paddleboats. The Sukhna Lake was created in 1958 by damming the Sukhna Choe, a seasonal stream that flows down from the Shivaliks. This lake harbors many migratory exotic birds.

1.6.1 Ground water resource in UT Chandigarh:

Ground Water Resources of Chandigarh have been estimated for the water table aquifer as on 31.03.2004 by taking into account the following data into consideration:

- The total habitable geographical area of UT Chandigarh is 114 Sq.km. There is no area that is not suitable for ground water recharge.

- The depth to water level in shallow aquifers ranged from 2.79m to 3.13m during Pre-monsoon of 2000-2004 while it was 2.32 to 2.68mduring Post monsoon 2000-2004.
- Specific yield in the zone of water table fluctuation was taken as 12% and Rainfall infiltration factor as 20% (as per norms).
- As per information available, there was no pumpage/ground water draft from shallow aquifers.
- Irrigation was being done by deep Government tubewells only. The net irrigated area was 750 ha only.
- There were 37 irrigation tubewells managed by UT Chandigarh Administration in the various villages of UT Chandigarh. The depth of these wells is in the range of 180m – 250m. These tubewells tap confined aquifers below 78m from ground level. The annual unit draft was 21.74 hectare meters (hams) and gross draft was 804 hams (8.04 MCM).
- There were 175 tubewells for drinking water supply to the rural and urban population. These tubewells tap confined aquifers below 90m from ground level. The depth of these wells ranges from 200-300m. The average unit well draft of these wells was 25.15 hams. The annual draft from these tubewells was 4401 ham (44.01 MCM).

The ground water resource of shallow aquifer in UT Chandigarh as on 31.03.2004 was as follows:

- Recharge from rainfall during monsoon = 1580 ham
- Recharge from other source during monsoon = 66 ham
- Recharge from rainfall during non-monsoon = 474 ham
- Recharge from other sources during non-monsoon = 135 ham
- Total annual ground water recharge = 2255 ham
- Natural discharge during non-monsoon = 225 ham
- Ground Water Draft as on 31.3.2004 = nil
- Net annual ground water availability = 2030 ham

It has been estimated that the annual replanishable ground water resources (Net Ground Water Availability) of UT Chandigarh were 2030 hams as on 31st March 2004. This estimation is based on the recommendations of the Ground Water Estimation Committee (1997). These are the dynamic ground water resources that are likely to be replenished every year under normal rainfall.

1.7 Engineering

The Engineering Department of UT Chandigarh Administration is responsible for creating entire infrastructure development in the territory of Chandigarh comprising of roads and establishment of Water, providing and laying of water supply system, providing and laying underground sewerage and storm water drainage system, distribution of electric power and construction of various public buildings and housing accommodation for govt. employees of various categories. In addition, most of the buildings as occupied by Punjab and Haryana Governments have been constructed and are

being maintained by the Engineering Department. At present infra-structural services are being maintained by the Municipal Corporation being of public utility but development of these services in sectors covered under Phase- III are being executed by the Engineering Department. To keep up the pace of development in compatibility to population growth of city, the building activity in the city is continuing and adequate funds are being provided under Plan schemes of the Administration.

Construction Circle-I undertakes the maintenance of GMCH, Sector 32, OPD Block Sector 16, Paryavaran Bhawan, extension of Government Schools etc.; repair and maintenance of V1, V2, V3 roads of Northern Sectors.

Construction Circle-II handles the work of maintenance of various Government buildings, repair and maintenance of V1, V2 & V3 roads of Southern Sectors and Horticulture works in UT Chandigarh. Public Health Circle looks after rural water supply, rural sewerage, and development of infrastructural services; providing and laying internal water supply and sanitary system in non-residential and residential building including their maintenance; providing and installation of air-conditioning, fire fighting system including operation and maintenance thereof. In addition this circle also looks at setting up of Govt. Medical College & Hospital, air-conditioning system, fire fighting system, medical gases distribution and solar water heating system are being provided and maintained. Besides above works, the sewerage water supply lines in 3rd Phase Sector i.e. Sector 48 to 52 have also been undertaken. The S.W.D. for area West of Sector 38 has been provided & laying of S.W.D. for sectors 54, 55 and 56 is also under execution. The SWD for the remaining sectors of Phase- III has been planned.

Electrical Circle provides installation of internal electrical services in all the non-residential and residential building including maintenance thereof; electrification works for infrastructural development; modernization and upgradation of ATC signals at various junctions and intersections; works of fire sensing system and passenger lifts in multi-storey buildings including maintenance thereof. Electricity Operation is responsible for arranging power from various sources (as UT Chandigarh does not have its own source) and distribution and transmission thereof to all type of consumers. Power is being purchased from BBMB against 3.5% share of UT; special assistance at global rates from BBMB; from NTPC, NHPC, NPCIL etc. Present power entitlement is 250 MW. The peak demand for last year touched 272 MW and this year it has reached 363 MW.

1.8 Forest & Wildlife

Total forest and other areas managed by Forest Department in UT Chandigarh are 3436 hectares comprising of Sukhna Wildlife Sanctuary 2598 ha, Reserved Forest, Un-classed Forest and other areas. In the city the Horticulture wing of Municipal Corporation and Engineering Department maintains and takes up the plantation on the road side, gardens, parks and other vacant revenue land.

The Forest Department is taking up various activities for improving the green cover of UT Chandigarh, conserving and protecting the Wildlife, creating awareness among the people of Chandigarh about the protection of flora, fauna, preservation & restoration of bio-diversity. To increase green cover in UT Chandigarh, "Annual Greening Chandigarh Action Plan" is being prepared and released for implementation by all greening departments every year. By successful implementation of ongoing schemes like- Forest Conservation & Development, Social & Farm Forestry, Preservation of Wildlife etc the quality and quantity of forest and wildlife has improved significantly over the years, which was acknowledged by the Ministry of Environment & Forest, Government of India by providing the prestigious **Indira Priyadarshini Vriksha Mitra Award-2010** for outstanding work in increasing forest & tree cover in the city. For Ex-Situ and In –Situ Conservation of the flora of Shiwalik region in particular and others in general department of forest is developing a Botanical Garden, spread over in 176 Acre area.

1.9 Health

A total of 678 health care units are available in UT Chandigarh[5]. Of these there are 7 Government hospitals, 452 clinics, 16 nursing homes, 60 dispensaries, 86 pathological labs are available as on 2011. Government Multi Specialty Hospital, Sector 16, Chandigarh earlier known as General Hospital, is the oldest hospital in the city which is well connected by rail, road and air. The hospital is situated on Madhya Marg of the city, just 300 m from the well known Rose Garden, at Sector 16, Chandigarh. This is a patient friendly hospital, known for prompt and efficient services. It caters to the needs of all alike. This 500 bedded hospital has 24 hrs round the clock emergency and indoor facilities manned by specialists.

The city is experiencing continuous rise in temperature from last decade. This rising temperature has a direct impact on the rise in respiratory and cardiovascular diseases. The continuous rise in the motor vehicles numbers and concrete construction has lead to dust storms and free suspended particulate leading to air pollution. Also, the city has green plantation more of the exotic plants which leads to exposure to pollens and aeroallergens that trigger diseases like asthma. With the rising urbanization and better living standards, the city people are more prone to life style diseases. There is rise in number of cases reporting to the Hospitals with Hypertension, Obesity, Cardiovascular diseases. Geographically, the city lies in the high risk earthquakes zone; there is always a risk of disasters to occur. Earlier the city has construction limits of up to three floors of the maximum, but in the recent city has come up with many high rising buildings.

1.10 Urban Planning

The Department of Urban Planning consists of two wings (Architecture and Town Planning). The Architecture Wing deals with the designing of Govt. buildings, Standard designs, architectural and

[5] http://www.chandigarhENVIS.gov.in/beta/aspx/database.aspx

frame control etc. whereas the Town Planning Wing prepares scheme for the implementation of Master Plan, Planning of new areas/Sectors, Zoning Plans, besides identifying land use zones. The technical advices on the projects like structural, public health and electrical are forwarded by the engineering Department to the Chief Architect and overall coordination of the different Engineering Services is done by the Architectural Wing both at the drawing board level as well as in the field. The Department also deals with the concept approval of different categories of buildings/societies, besides scrutiny of building plans. The Department plays a pivotal role in the Plan Advisory Committee (Upper and Lower). The Town Planning Wing deals with the Planning and earmarking of land for the allotment to the Institutions/Societies. The Department also deals with zoning regulations and architectural control and standard design to the public on payment basis. In addition to the normal workload of the Capital projects, the Department also deals with the projects of the others states/Central govt. and public Sector Undertakings as Deposit works.

1.11 Transport

Chandigarh Transport Undertaking (CTU) came in to existence in 1966 with a fleet of 30 buses and at present has a sanctioned fleet of 517 buses (out of which 100 busses are from JNNRUM). Out of these, 250 buses run on local routes, 75 buses runs on Sub-Urban routes,167 buses run on long routes (Interstate routes covering Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Uttrakhand, Rajasthan, Delhi, J&K etc). Chandigarh Transport Undertaking buses travel approx.1.20 lacs. Kms per day and approx.2.00 lacs commuters commutes daily in Chandigarh Transport Undertaking buses that include commuters of Local, Sub Urban and long route buses. However, in addition to the CTU, there are about 1870 busses from other state transport corporations run from the Interstate Bus terminus at Sector 17 and 43[6].

1.12 Industries

There are about 2950 Small Scale and 15 Large and Medium Scale Units in existence in UT Chandigarh[7] as on date. Growth of industry for the last few years has been limited in Chandigarh as it is not an industry led city because of the limited space ENVISaged for industrial development at the time of original planning of the city. However, still keeping in view the fact that industry would provide crucial resource base in the city, a limited area of about 1450 acres was planned for development as industrial area mainly for the development of small scale and pollution free industries. As per Chandigarh Pollution Control Committee there are 193 red, 137 orange and 627 green categories of Industries as per their data during 2011 indicating Chandigarh has large number of environmental friendly industries.

Out of a total of about 2950 small scale industries in Chandigarh about 40% are ancillary units producing components for the major tractor industry around Chandigarh. Light engineering industry

[6] Data provided by Chandigarh Transport Undertaking.

[7] The Pollution Control Committee shows different number as it has to approve for starting of industries. There are differences in number of industries as recorded by Chandigarh Pollution Control Committee.

is heavily represented, other industrial units produce mainly industrial fasteners, electrical / electronic items, machine tools, pharmaceuticals, plastic goods, sanitary fittings, steel / wooden furniture and food products etc. A number of items manufactured here are finding ready markets abroad. The total estimated annual output of industries is to be tune of Rs. 650 crores. Land availability for industries is a major constraint and there little scope for further expansion of industry, apart from the existing Industrial Area Phase-I and Phase-II.

Chandigarh Administration earmarked 1475 acres of land for Industrial Area, Phase-I & II which came into existence during the year 1970. The Administration has also developed Industrial Area, Phase-III in Mauli Jagraon for which an area of 152 acres of land has been earmarked. UT Chandigarh has nearly 2100 small scale industrial units including one large and 7 medium scale units located on the outskirt and separated with a green belt. These units manufacture a wide variety of products with an annual turnover of nearly 1430 crores. 20 units are exporting their products worth about Rs. 151 crores. The Industrial Area in UT Chandigarh has been given the name of Chandigarh Industrial Business Park.

The UT Chandigarh Administration is focusing on promotion of Information Technology (IT) industry which requires lesser space and is also non-polluting. Accordingly, high speed data communication facilities for software development and its export has been arranged by providing a NODE at Punjab Engineering College (PEC), Chandigarh through the Software Technology Parks of India - STPI - (an autonomous Society under the Department. of Electronics, Govt. of India) which has set up an earth station at Mohali for the proposed Software Technology Park / Complex being set up by the Punjab Govt. About 10,000 sq. ft. space has been earmarked in the PEC campus for being rented out to the desirous entrepreneurs at fixed rates.

Several laws govern the functioning of this department. They include:

- The Industrial Development (Regulation) Act, 1956 [For small scale industries registration, the department follows the instructions of the Union Development Commissioner, Small Scale Industries],
- Electrical Wires, Cables, Appliances and Accessories (Quality Control) Order, 1993,
- The Cement (Quality Control) Order. 1995, and
- The Oils and Greases (Processing, Supply and Distribution Regulation) Order, 1987.

1.13 Chandigarh Pollution Control Committee

The Committee is responsible to manage, prevent and control water pollution, air pollution and preservation of the quality of air in UT Chandigarh. The functions of the Committee are specified in detail under section 17(1) and (2) of the water (Prevention and Control of Pollution) Act, 1974 and air (Prevention and Control of Pollution) Act, 1981. Various legislations under which committee is performing functions are:

- The Water (Prevention & Control of Pollution) Act, 1974
- Water (Prevention & Control of Pollution) Cess Act, 1977

- Air (Prevention & Control of Pollution) Act, 1981
- The Environment (Protection) Act, 1986
- Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
- Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro-Organism, 1989
- Bio-Medical Wastes (Management & Handling) Rules, 1998
- Use of Fly Ash Notification 1999
- Noise Pollution (Regulation & Control) Rules, 2000
- Municipal Solid Waste Rules, 2000
- Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008 also referred to e-waste notification under section IV of the rules
- Plastic (Manufacture, Usage and Waste Management) Rules, 2009 Complete Ban on Polythene (2008) under Plastic Rules. e-waste (Management and Handling) Rules, 2011

1.14 Chandigarh Housing Board

The Chandigarh Housing Board was established in the year 1976 with an objective of the Board is to provide reasonably priced, good quality housing for the shelter less persons residing in the Union Territory of Chandigarh. From the beginning, the Board has focused upon the construction and allotment of houses on hire-purchase basis. Till March 2011, the Chandigarh Housing Board has constructed a total of 49,713 houses of various categories. It has been estimated that about 25% of the population of Chandigarh is living in CHB houses. Over time, the Board has maintained a reputation for providing well designed houses with good quality of construction at prices much lower than the market.

1.15 Science & Technology

The Department of Science & Technology was established in UT Chandigarh in the year 1991-92 with an objective was to make use of the most of in-house Scientific and Technical Institutional Infrastructure in the Union Territory of Chandigarh and to prepare Science & Technology Plans relevant to the development of subjects. The work of Non Conventional Energy Sources was also entrusted to the Department. The Department provides financial assistance to various Research Institutions located in UT Chandigarh for the Research & Development purpose. In addition, the department also helps in popularizing the science among students and general public.

Functions of Chandigarh Renewable Energy and Technology also rest with Science and Technology department. Under the new initiative Chandigarh Renewable Energy and Science and Technology Promotion Society (CREST) is undertaking the Solar City Programme in Chandigarh. Chandigarh has been considered as one of the model Solar Cities in India. Some of the non conventional sources of energy programmes undertaken by the Department of Science and Technology are solar water heating systems, Solar Photovoltaic Energy Programme, solar Green-house programme, Solar lighting in forest areas, mass awareness among the public on energy efficiency devices etc. UT Chandigarh is planning to set up Solar photovoltaic Power Plant as it has no power plant of its own.

To introduce battery operated vehicles to reduce impending pollution is also being mooted.

Each of these above mentioned departments have been addressing climate change in their own way. For instance, science and technology department, which is also in charge of the Non Conventional energy, has undertaken solar mission and enhancing the awareness of climate change in Chandigarh. Similarly, Chandigarh Housing Board has been introducing energy efficient instruments in all the newly constructed houses and those that are getting renovated. However, there need to be a policy to integrate the activities of these departments to mainstream climate change into various development departments. This action plan details the integration of these activities and develops a plan that helps mainstream of the climate change.

Chapter 2: Climate Change Impacts on various sectors in India and Chandigarh

India's development agenda focuses on the need for rapid economic growth as an essential pre-condition to poverty eradication and improved standards of living. Meeting this agenda, which will also reduce climate —related vulnerability, requires large-scale investment of resources in infrastructure, technology and access to energy. Developing countries may lack the necessary financial and technological resources needed for this and thus have very low coping capacity to meet threats from climate changes. Only rapid and sustained development can generate the required financial, technological and human resources. In view of the large uncertainties concerning the spatial and temporal magnitude of climate change impacts, it is not desirable to design strategies exclusively for responding to climate change. Rather, the need is to identify and prioritize strategies that promote development goals while also serving specific climate change objectives. It is imperative to identify measures that promote our development objectives, while also yielding co-benefits for addressing climate change effects. Cost- effective energy efficiency and energy conservation measures are of particular importance in this connection. Similarly, development of clean energy technologies, though primarily designed to promote energy security, can also generate large benefits in terms of reducing carbon emissions.

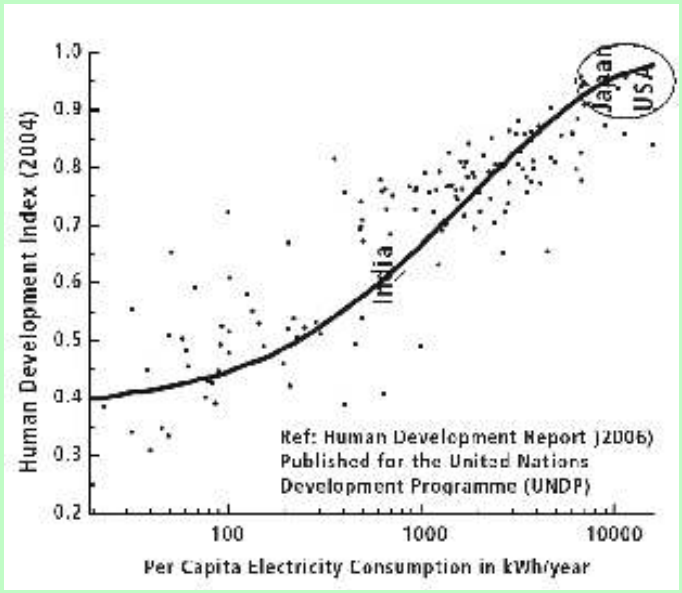


Figure 2.1: Relation between Human development index and Energy Consumption

The impacts of climate change could prove particularly severe for women. With climate change, there would be increasing scarcity of water, reduction in yields of forest biomass, and increased risks to human health with children, women and the elderly in a household becoming the most vulnerable. With the possibility of decline in availability of food grains, the threat of malnutrition may also increase. All these would add to deprivations that women already encounter and so in each of the Adaptation programmes, special attention should be paid to the aspects of gender.

2.1 <u>Relationship between Human Development Index and Energy Consumption:-</u>The strong positive correlation between energy use and human development is well recognized (Figure 2.1). It is obvious

that India needs to substantially increase its per capita energy consumption to provide a minimally acceptable level of well being to its people.

2.2 Current Carbon Dioxide Emissions in India: India's CO_2 emissions per capita are well below the world's average[2]. Per capita carbon dioxide emissions of some regions in the world in 2004 are as follows:

Table 2.1: A comparison of India's per capita GHG emissions with some other countries (India's Second National Communication to UNFCCC 2012)

Country	Per-Capita Carbon-dioxide emissions (metric tons)
USA	20.01
EU	9.40
Japan	9.87
China	3.60
Russia	11.71
India	1.02
World Average	**4.25**

India has a well-developed policy, legislative, regulatory, and programmatic regime for promotion of energy efficiency, renewable energy, nuclear power, fuel switching, energy pricing reform, and addressing GHG emissions in the energy sector. As a consequence of these measures, India's energy intensity of the economy has come down sharply since the 1980s and compares favorably with the least energy intensive developed countries[3].

2.3 Observed Changes in Climate and Weather Events in India: There are some observed changes in climate parameters in India. India's Initial National Communication, 2004 (NATCOM 1)[5] to UNFCCC has consolidated some of these. Some highlights from NATCOM I and others are listed here. No firm link between the documented changes described below and warming due to anthropogenic climate change has yet been established.

2.3.1 Surface Temperature - At the national level, increase of — 0.4° C has been observed in surface air temperatures over the past century. A warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India. However, cooling trends have been observed in north-west India and parts of south India. In the recent report to UNFCCC, it is projected that there may be an increase of 3.5 – 4°C in several parts of India[8].

2.3.2 Rainfall - It appears that there may not be significant decrease in the monsoon rainfall in the future except in some parts of the southern peninsula. Q0, Q1 and Q14 simulations project 16%, 15% and 9% rise respectively in the monsoon rainfall towards the end of the 21st century.

2.3.3 Extreme Weather Events - Instrument records over the past 130 years do not indicate any marked long-term trend in the frequencies of large-scale droughts and floods. Trends are however observed in multi-decadal periods of more frequent droughts, followed by less

[8] Second National Communication to UNFCCC (2012)

severe droughts. There has been an overall increasing trend in severe storm incidence along the coast at the rate of 0.011 events per year. While the states of West Bengal and Gujarat have reported increasing trends, a decline has been observed in Orissa. Goswami[6] et al, by analyzing a daily rainfall data set, have shown (i) a rising trend in the frequency of heavy rain events, and (ii) a significant decrease in the frequency of moderate events over central India from 1951 to 2000.

2.3.4 Rise in Sea Level - It is estimated that sea level rise by 3.5 to 34.6 inches between 1990 and 2100 would result in saline coastal groundwater, endangering wetlands and inundating valuable land and coastal communities. The most vulnerable stretches along the western Indian coast are Khambat and Kutch in Gujarat, Mumbai, and parts of the Konkan coast and south Kerala.

2.4 Possible Impacts of Projected Climate Change

2.4.1 Impact on Water Resources - The majority of river systems show an increase in precipitation at the basin level. Only Brahmaputra, Cauvery and Pennar show marginal decrease in precipitation under MC. The situation under end of the century (EC) improves, wherein all the river systems exhibit an increase in precipitation. The change in evapo-transpiration (ET) under the mid century (MC) scenario exhibits an appreciable increase (close to 10%) for the Brahmaputra, Indus and Luni river basins. All other systems show marginal increase or decrease. Only two river basins - Cauvery and Krishna - show some decrease in ET under the EC. For a majority of the river systems, the ET has increased by more than 40%. The major reason for such an increase in ET is on two accounts: (i) increase in the temperature and (ii) increase in precipitation, which enhances the opportunity of ET.

2.4.2 Impact on Agriculture and Food Production - A rise in atmospheric carbon dioxide to 550 ppm under controlled environment conditions - [Free Air CO_2 Enrichment - FACE, Open Top Chambers (OTC)] -, enhanced the yields of wheat, chickpea, green gram, pigeon pea, soybean, tomato and potato between 14% and 27%. These enhancements were largely due to the increase in the number of storage organs. In most of the crops, this was accompanied by a small reduction (2 to 10%) in the protein content. In plantation crops like coconut, areca nut and cocoa increased CO_2 led to higher biomass.

It is estimated that India loses 1.8 million tonnes of milk production at present due to climatic stresses in different parts of the country. Global warming will further negatively impact milk production by 1.6 million tonnes by 2020 and more than 15 million tonnes by 2050, as per studies conducted by scientific institutions. High producing crossbred cows and buffaloes will be more adversely affected than indigenous cattle.

2.4.3 Impact on Health - Changes in climate may alter the distribution of important vector species (for example, malarial mosquitoes) and may increase the spread of such diseases to new

areas. If there is an increase of 3.8 °C in temperature and a 7% increase in relative humidity the transmission windows i.e., months during which mosquitoes are active, will be open for all 12 months in 9 states in India. The transmission windows in Jammu and Kashmir and in Rajasthan may increase by 3-5 months. However, in Orissa and some southern states, a further increase in temperature is likely to shorten the transmission window by 2-3 months.

2.4.4 **Impact on Forests -** The vegetation distribution simulated by IBIS for baseline and A1B scenario in the simulation grids illustrates an expansion of tropical evergreen forests (IBIS vegetation type 1) in eastern India plateau in the A1B scenario. Similar trend is observed in the Western Ghats. It is interesting to note that there is almost no vegetation type change in the northeast. Further, there is a slight expansion of forests into the western part of central India. Impact on Net Primary Productivity (NPP) and Soil Organic Carbon (SOC): The NPP tends to increase over India for the A1B scenario. It increases by an average of 30.3% by 2035, and by 56.2% by 2085 for A1B scenario. Notably, increase is higher in the northeastern part of India due to warmer and wetter climate predicted there.

2.4.5 **Impact on Coastal Areas -** It is estimated that sea level rise by 3.5 to 34.6 inches between 1990 and 2100 would result in saline coastal groundwater, endangering wetlands and inundating valuable land and coastal communities. The most vulnerable stretches along the western Indian coast are Khambat and **Kutch** in Gujarat, Mumbai, and parts of the Konkan coast and south Kerala. The deltas of the Ganga, Krishna, Godavari, Cauvery, and Mahanadi on the East Coast may be threatened, along with irrigated land and a number of urban and other settlements that are situated in them. The loss of these important economic and cultural regions could have a considerable impact in some states.

2.4.6 **Impact of Climate Change on Energy demand** - Climate change is projected to impact both energy supply and demand. On the supply side, the main effects would be on electricity generation, although oil and gas production would also be affected indirectly due to changes in relative economics of fuels under a climate change regime. Hydropower generation is the energy source that is most likely to be impacted because it is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature (rain or snow, timing of melting). Reduced flows in rivers and higher temperatures reduce the capabilities of electric generation; high temperatures also reduce transmission capabilities. Increased cloudiness can reduce solar energy production despite the availability of generation capacity. Wind energy production would be reduced if wind speeds increase above or fall below the acceptable operating range of the technology. Changes in photosynthesis and growing conditions could affect the production of biomass-based energy. Energy demands would also be similarly affected in sectors, specifically, residential, commercial, and transport. Changes in space cooling and heating requirements, and water pumping needs would be the main drivers of energy demand changes.

2.4.7 **Impact on and off built environment** - Developments in Indian economy have triggered the growth of real estate in the country. Huge investments are being committed in real estate due to increased demand and increasing capacity to invest. Buildings account for more than

60% of all energy use in most high- and middle-income countries of the world, and an increasing proportion in low-income regions. Studies have indicated that both the functionality of the existing built environment and the design of future buildings may need to be altered to cope with the climate change impacts. This would include heat island effects created due to more use of conventional space cooling technologies in future when mean and maximum temperatures rise.

2.5 Analysis of climate in Chandigarh

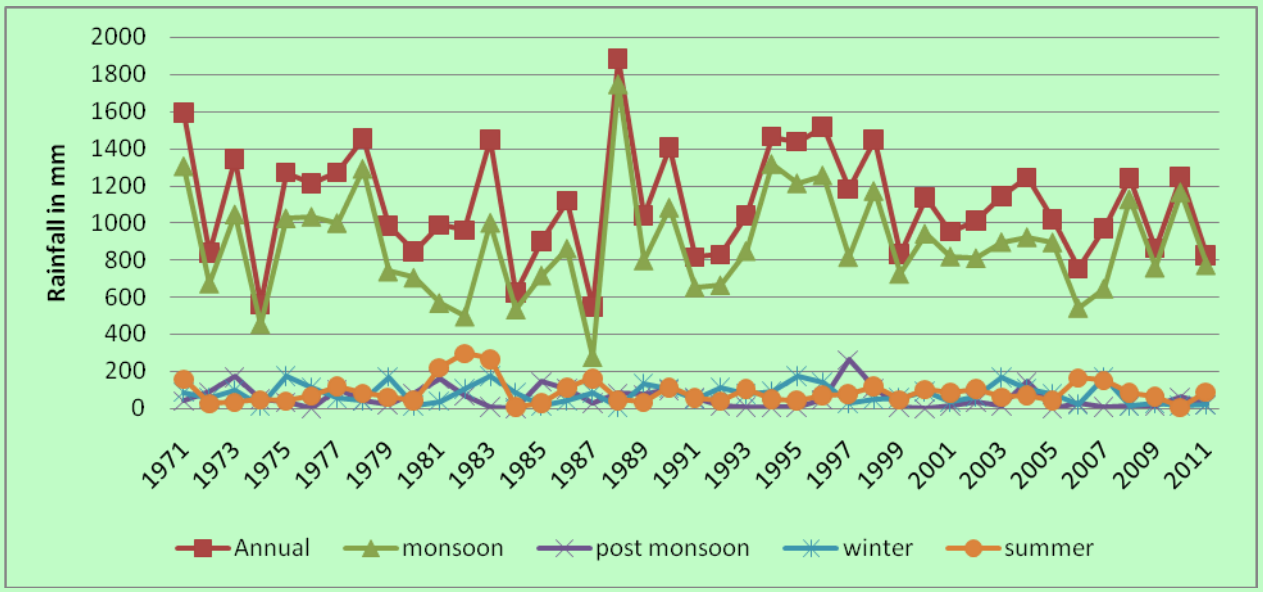


Figure 2.2: Rainfall Pattern in Chandigarh over 40 years.

2.5.1 Average and Variability of temperatures and rainfall - Chandigarh received annual rainfall of the order of 1103.7mm out of which 80% is received in monsoon season, 5% in post monsoon, 7% in winter and 8% in summer. Variability of temperature maximum and minimum temperatures for Chandigarh for the period 1954-2011 is 30.3 and 17.2 respectively (Figure 2.3). The pattern of mean minimum temperature during the months of October – December is increasing, while that of monsoonal temperature does not reflect any change. Temperature during summer is showing a decreasing trend. The increasing temperature during winter months has an implication to rabi crop productivity as the crop may require a specific lower temperatures.

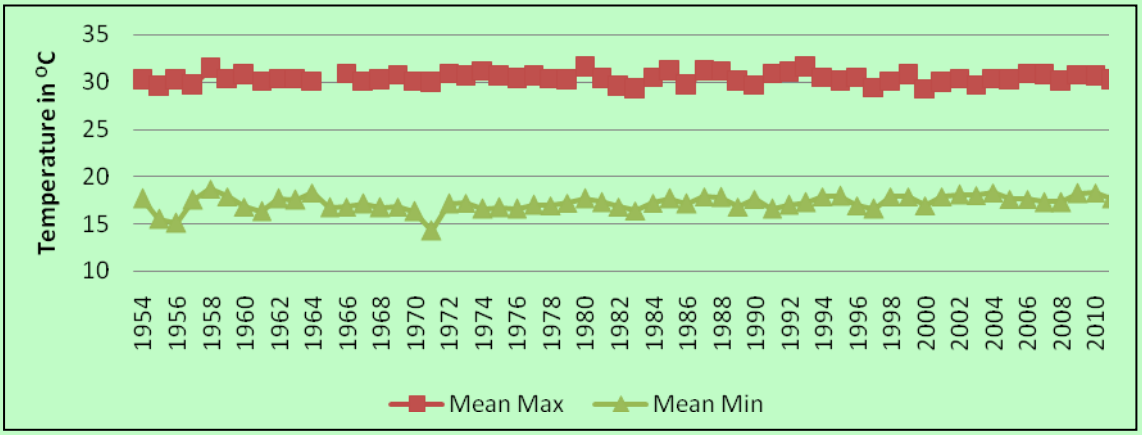


Figure2.3: Minimum and Maximum temperature patterns in Chandigarh.

2.6 Groundwater in Chandigarh: Ground Water Resources of Chandigarh have been estimated for the water table aquifer as on 31.03.2004 by taking into account the following data into consideration:

- The total geographical area of Chandigarh is 114 Sq.km. There is no area that is not suitable for ground water recharge.
- The depth to water level in shallow aquifers ranged from 2.79m to 3.13m during Pre-monsoon of 2000-2004 while it was 2.32 to 2.68mduring Post monsoon 2000-2004.
- Specific yield in the zone of water table fluctuation was taken as 12% and Rainfall infiltration factor as 20% (as per norms).
- As per information available, there was no pumpage/ground water draft from shallow aquifers.
- Irrigation was being done by deep Government tubewells only. The net irrigated area was 750 ha only.
- There were 37 irrigation tubewells managed by Chandigarh Administration in the various villages of UT Chandigarh. The depth of these wells is in the range of 180m – 250m. These tubewells tap confined aquifers below 78m from ground level. The annual unit draft was 21.74 hams and gross draft was 804 hams (8.04 MCM).
- There were 175 tubewells for drinking water supply to the rural and urban population. These tubewells tap confined aquifers below 90m from ground level. The depth of these wells ranges from 200-300m. The average unit well draft of these wells was 25.15 hams. The annual draft from these tubewells was 4401 ham (44.01 MCM).

The ground water resource of shallow aquifer in Chandigarh as on 31.03.2004 was as follows:

1. Recharge from rainfall during monsoon = 1580 ham
2. Recharge from other source during monsoon = 66 ham
3. Recharge from rainfall during non-monsoon = 474 ham
4. Recharge from other sources during non-monsoon = 135 ham

5. Total annual ground water recharge = 2255 ham
6. Natural discharge during non-monsoon = 225 ham
7. Ground Water Draft as on 31.3.2004 = nil

The withdrawal of ground water from Punjab, Haryana, Rajasthan and Delhi has been very high (4 cm per year) over the last 8 years which is equivalent to loss of 109 km^2 of water over these years, which is double the capacity of the largest reservoirs in India[9]. Though the irrigation water is expected to recharge aquifers, but the irrigated water seems to be lost due to run off or due to high evapotranspiration. Thus, immediate steps are to be taken to recharge aquifers to improve the ground water. Similar observations were made by Gosain in Haryana where the climate change scenario indicate higher evapotranspiration and therefore ground water may deplete than at the expected rate.

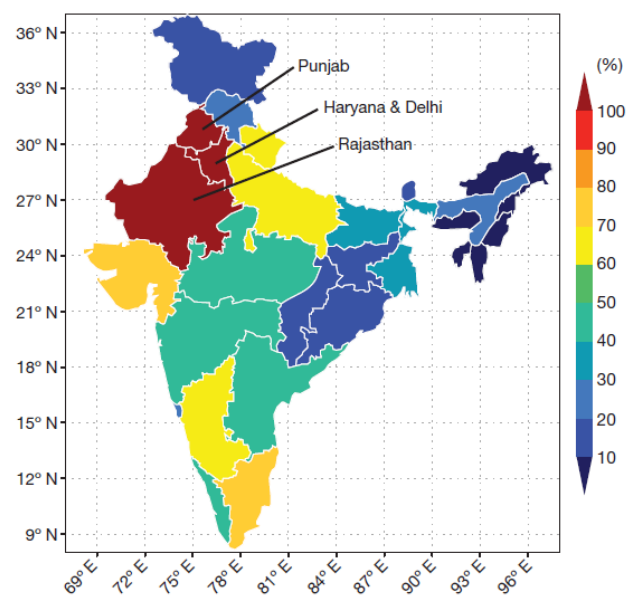


Figure 2.4: ground water withdrawals as percentage of recharge. Source Rodell, M, Velicogna, I, Famiglietti, JS, 2009, Nature, 460: 999-1002

Fortunately there are no big issues related to ground water in the city except for a decline in the piezometric head of the deeper aquifers due to sustained pumping. As mentioned earlier too, the Water Supply Bye Laws of Chandigarh ensure all the water supply is to be met from government tubewells and no private tubewells are allowed to be constructed. Also only the deeper aquifers, below 100 m, are to be exploited and thus at present there is none or negligible withdrawal of ground water from shallow aquifers in Chandigarh city. This is also evident from the fact that whereas there is a heavy decline in the water levels of the deeper aquifers due to sustained pumping, there is hardly any decline in water levels of the shallow aquifers (except in the central parts where the decline in the last five years can be attributed to leaky confined conditions). Another interesting observation is that while the water levels of the deeper aquifer are in the range of 15 to 70 meter below ground level (mbgl), those in the shallow aquifer are in the range of 2 to 17 mbgl. The water levels are especially quite shallow in the southern sectors (and Mohali - where in certain areas water logged conditions exist and dewatering had to be resorted to while constructing multi-storied buildings). It is notable that the chemical quality of ground water of all the aquifer systems in Chandigarh is within the permissible limits prescribed by BIS (1991) for drinking water except at a couple of locations where water sample drawn from hand

9 Rodell, M, Velicogna, I, Famiglietti, JS, 2009, Satellite-based estimates of groundwater depletion in India, Nature, 460: 999-1002

pumps that are about 15 m deep, the iron concentration was higher than the prescribed limits. This may also be due to corrosion in the delivery pipes.

2.7 Health – incidence of vector and water borne diseases- The National Vector Borne Diseases Control Programme deals with Prevention and Control of six Vector Borne diseases like Malaria, Filaria, Dengue, Japanese Encephalitis (JE), Kala – Azar and Chikungunya. The programme objectives are (i) to prevent Morbidity due to Malaria, Dengue, Chikungunya, JE and Kala – Azar and (ii) To prevent deaths due to Malaria and other vector borne diseases. In addition Integrated Disease Surveillance Programme was also launched in Chandigarh during 2006. The purpose of the implementation of IDSP is to detect early warning signals impending outbreaks. The main objectives

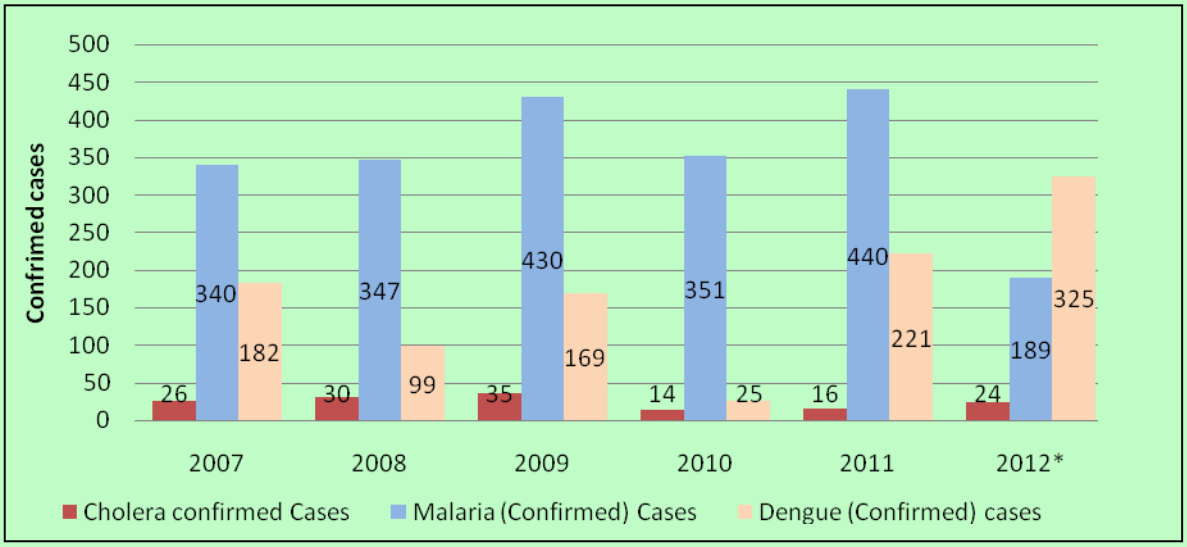


Figure 2.5: Incidence of Vector and Water Borne Disease in Chandigarh

*** indicates that the data for Malaria was up to September 2012; Dengue and Cholera was up to November 14, 2012**

of the project are (i) To establish a decentralized state based system of surveillance for communicable and non-communicable diseases, so that timely and effective public health actions can be initiated in response to health challenges in the country at the state and national level; (ii) To improve the efficiency of the existing surveillance activities of disease control programs; (iii) to establish a public Health Laboratories and (iv) To provide a secure online data management system.

The data collected by IDSP indicates that the vector borne disease such as Malaria and Dengue has been fluctuating over the years. Last year there has been a decrease in malaria incidence. This is in line with the pattern of malaria breakout elsewhere in India. Similar patterns are observed for incidence of dengue as well. Water borne diseases such as cholera has been reported almost at the same frequency over the years.

Impact on the Forests: India's second communication to UNFCCC[10] indicates that there would be no change in area and type of future of the forests particularly in the northwestern India. Chandigarh, being a part of northwestern India may not experience any change in the forest type or area. Thus, there is no concern for any immediate steps to be taken. Higher carbon dioxide in the atmosphere could enhance the Net Primary Productivity in the region. The studies specifically aimed at Haryana[11] indicate that there will be no change in the northern parts of Haryana. Chandigarh being in the northern parts and in the foothills of Shiwalik may not experience any change in the forest type.

Overall, it appears that Chandigarh may not experience any major impacts due to climate change. Given that Agriculture area is minimal and water sufficiency in Chandigarh both in terms of surface and groundwater availability. Chandigarh being an urban conglomerate has to address concerns of energy, traffic, sustainable habitation and reducing petroleum product usage. Thus, the Chandigarh Authorities must aim making livable habitations with reduced energy usage and opt for renewable energy options to reduce dependence on petroleum based energy products. In the forthcoming chapters, details of various options and strategies will be discussed.

[10] Ministry of Environment and Forests, 2012, India: second national communication to United National Climate Change Convention, Government of India

[11] Haryana State Action Plan on climate Change, Draft, 2012

Chapter 3: Green India mission: Climate Change Action Plan for Chandigarh; Forest, agriculture and Animal Husbandry[12]

"A plan arranges organs in order, thus creating an organism. The organs posses' distinctive qualities- lungs, heart, stomach."-I am claiming Sun, Space and green surroundings for everybody and striving to provide you with an efficient 'Circulation'-The great new word in architecture and planning" - Le Corbusier, the architect of Chandigarh.

3.1 Baseline Scenario

Forest and wildlife: Total forest and other areas managed by Forest Department in UT Chandigarh are 3436 hectares comprising of Sukhna Wildlife Sanctuary 2598 ha, Reserved Forest, Un-classed Forest and other areas (Figure 3.1). In the city the Horticulture wing of Municipal Corporation and Engineering Department maintains and takes up the plantation on the road side, gardens, parks and other vacant revenue land.

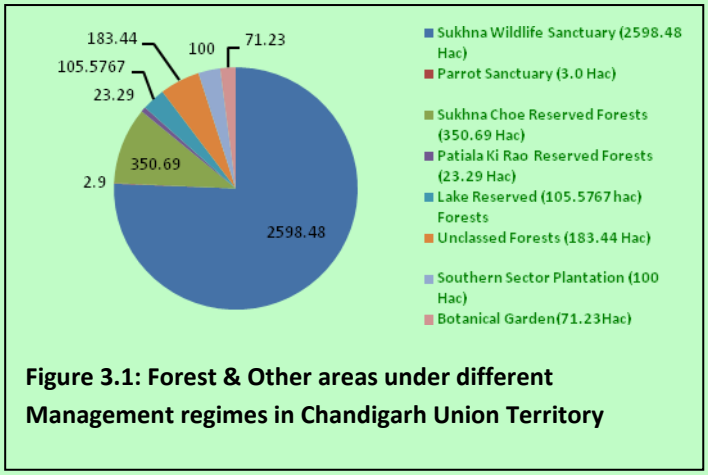


Figure 3.1: Forest & Other areas under different Management regimes in Chandigarh Union Territory

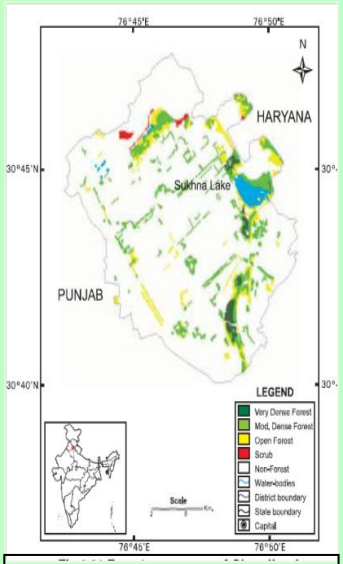


Figure 3.2: Green cover of Chandigarh UT (Source Forest Survey of India

The Forest Department is taking up multifarious activities for improving the green cover of UT Chandigarh, Protection & Conservation of Wildlife, and its Habitat, Restoration of Bio- diversity, Scientific Management of the forest area, Establishment of Botanical Garden in 176 Acre area for Ex-Situ and In- Situ Conservation of flora of the region, Research, Recreation and Study, Development of Butterfly Park, City Forest etc. To increase green cover in UT Chandigarh, "Annual Greening Chandigarh Action Plan" is being prepared and released for implementation by all greening departments.

[12] Notes presented here are based on consultation of various official documents of the Forest Department, Chandigarh Administration and discussions held as a part of preparation of action plan held at DCF (HQ)'s office at Forest Department with Department of Agriculture, Horticulture, Animal Husbandry and Fisheries, Municipal corporation authority officials.

All the Greening agencies – Forest department, Horticulture Wing of Engineering Department, UT and Municipal Corporation have achieved successfully plantation targets since 2001 to 2011. Details of plantation taken up by greening agencies in UT is placed at Annexure -3

The institutions namely Forest Department, Municipal Corporation, Engineering Department, Chandigarh Unit of Punjab Agriculture University, NGO's, Resident Welfare Associations, Educational Institutions and above all, the strong will and farsightedness of the Administration contributed a lot towards the success of this programme. The contribution, dedication and genuine concern of the proud citizens of the 'City Beautiful' to make the city greener needs special mention.

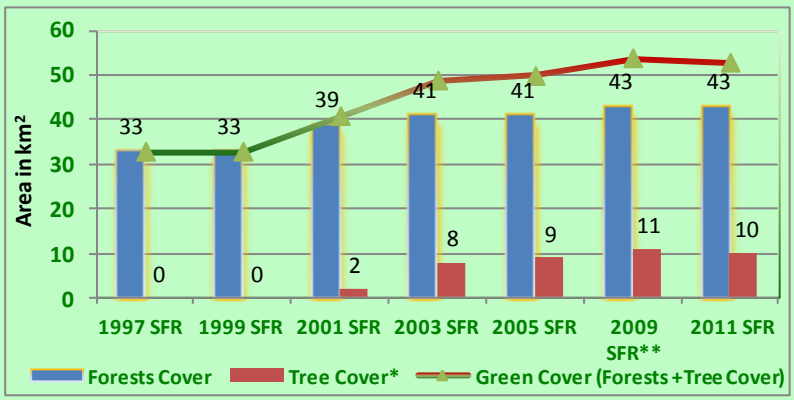


Figure 3.3: Trend of Increase in Green Cover (Forests & Tree Cover) of Chandigarh UT

*Estimation of tree cover started only during 2001 therefore no date prior 2001

** 2007 onwards Government of India started printing the year of publication rather than the year of assessment. Therefore year 2007 is not indicated and 2011 is the data of assessment of year 2009

As per the India State of Forests Report -2011[1] (ISFR) of Forests Survey of India (FSI), the forest cover in UT Chandigarh is 43[1] km^2 and another 10 km^2 area is under tree cover. Thus, the total green cover (forest cover + tree cover) of Chandigarh as per 'ISFR-2011' is 53.0 km^2 which amounts to 37.8% the total geographical area.

Several schemes and projects have been launched to improve the forest cover of the Chandigarh UT. They are:

3.1.1 **Forest Conservation & Development Scheme**: The main objective of this scheme is to reduce the silt inflow to Sukhna Lake by carrying out various kinds of soil conservation works. The works like construction of silt retention dams, masonry check dams, spurs/revetments, desiltation of dams, construction of grade stabilizers, planting of live-hedge and opening of Choe bed etc. are being undertaken under this scheme. Various engineering measures followed by vegetative measures have resulted in development of excellent vegetation in the Sukhna Wildlife Sanctuary.

[13]Forest Survey of India, 2011, State of Forest, Ministry of Environment and Forests, Dehradun

[14] As per forest survey of India forest and tree cover of Chandigarh is 26.78 km, while it does not consider Sukhna Wildlife Sanctuary which is outside union Territory borders but controlled by Chandigarh administration. Therefore 26 km is added to the total forested areas so as to depict. Thus, the % cover increases to 37.8 as against 26.78km indicate by Forest Survey of India.

3.1.2 **Plantation Scheme:** The main objective of this scheme is to provide a carpet of vegetation in open patches/hill tops to reduce soil erosion by planting/sowing of seeds. Plants raised in the newly acquired land as well as the southern Sectors are also being maintained. The works like plantation, patch-sowing & installation of tree guards etc. are being undertaken under this scheme.

3.1.3 **Greening of City Beautiful Scheme:** Main objective of this scheme is to raise plantation in and around city to provide pollution free environment to the people of the city beautiful. Mixed plantations raised in southern sectors along Vikas Marg are also being maintained under this scheme. Seedlings are being supplied to the institutions/ NGO's & public free of cost from following Nurseries :

i) Hallomajra Nursery on Ambala –Chandigarh National Highway
ii) Nursery at Forest Rest House in front of Railway Station
iii) Kishangarh Nursery at Kishangarh village.
iv) Forest Nursery in Patiala-ki-Rao Forests (behind Panjab University) Saplings are distributed during all working days.
v) Forest Nursery near Boat Club
vi) Medicinal Plants Nursery at Chandigarh Botanic Garden, Sarangpur

3.1.4 Chain link fencings **are being provided around forest area to avoid encroachment. The works like** plantation in lake & Patiala-ki-Rao forest & Sukhna choe forests, chain link fencing, removal of lantana-parthenium in forest area & environmental up gradation of sukhna Choe etc. are being undertaken. Apart from maintaining Lake reserve forest, Sukhna choe reserve forest and Patiala-Ki-Rao forests, department is maintaining plantations over 100 hectares of land in southern sectors & brick kiln area. It is appropriate to mention that Chandigarh UT was bestowed with **Indira Priyadarshini Vriksha Mitra Award-2010** for outstanding work in increasing forest & tree cover in the city. The forest cover in UT Chandigarh is 43 km^2 and another 10 km^2 area in under tree cover as shown in the Figure 3.3.

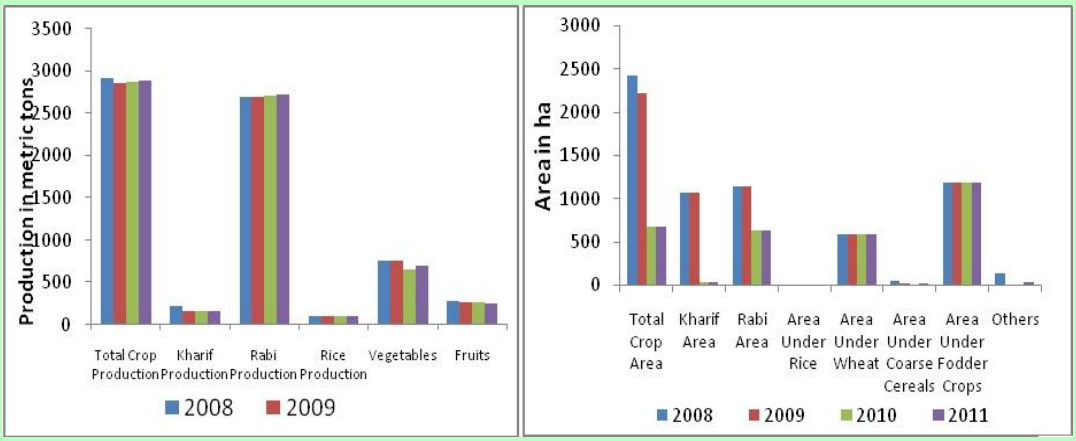


Figure 3.4: Area and production of agricultural crops in Chandigarh

3.2 Agriculture

The Union Territory, Chandigarh has a limited area under agriculture. The Cultivated area has shrunk from 5441 hectares in 1966 to 1085 hectares in 2011-12. 680 farming families cultivate this area. Of the 680 families, 468 (68.82%) families hold less than 1 acre of land, 187 (27.5%) families hold between 1 and to 2.5; 17 families (2.5%) hold 2.5 to 5 acres of land and the remaining 8 families (1.17%) hold more than 5 acre of agriculture land. The main sources of irrigation are deep-bore tube-wells installed by the Chandigarh Administration and shallow tube-wells installed by individual farmers. The farmers of Union Territory, Chandigarh who keep large number of milch cattle have taken to fodder cultivation to cater the demand of milch cattle. The milk production has stabilized over the years (Figure 3.5) though the cattle population is decreasing (Figure 3.6). Current data indicates that there are only 18574 cattle in the Chandigarh UT area[13]. Therefore the area under food grain crops is decreasing (Figure 3.4). The main food grain is wheat and its sown nearly in about 600 hectares and the fodder is sown nearly in about 1200 hectares in three seasons.

Emissions from agricultural lands are quite low, but due to the nature of its vastness, the emissions are larger. Nitrate emission from agricultural land is 1.25 kg/ha/year[14] and the global warming potential of Nitrate gasses are 310 times more than that of carbon dioxide. Application of external fertilizer results in nitrate emissions. With the current 1880 ha of agricultural land, total nitrate

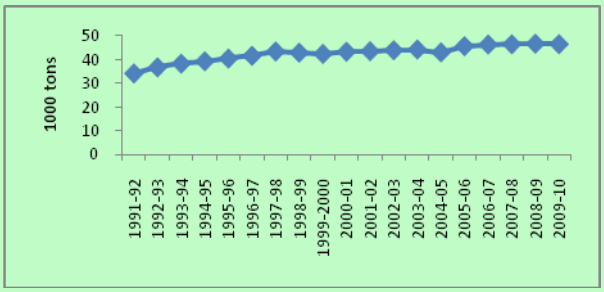


Figure 3.5: Annual Milk production in Chandigarh UT over the last 20 years (in 1000 tons)

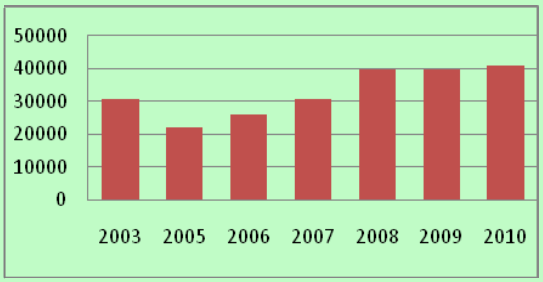


Figure 3.6: Variation in the livestock number (poultry excluded)

emissions equivalent to carbon dioxide are 728 tonnes per year. Organic agriculture can reduce this potential emission.

3.2.1 Organic Cultivation of Horticultural Crops

Chandigarh is a growing and developing City because of its importance as Union Territory is the Capital of two states namely Punjab and Haryana. Much of the union territory's area is urban and it

[13] Discussion with Dr Lovelesh Gupta, a meeting held on 8 June 2012 at office of DCF at Chandigarh.
[14] Pathak, H, 1999, Emissions of nitrous oxide from soil, current science, 77(3):359-369

depends a lot on outside help for the supply of fruits and vegetable. In view of the above, it is proposed to cultivate fruits and vegetables in the hinterland to cater to the requirements of the city population and also to utilize the back yard space of the houses for growing vegetables/fruits plants. Keeping in the felt needs as mentioned above, the Horticulture Department has already set-up a nursery near Lake Club for supply of fruits, ornamental plants, seeds and seedlings to urban and rural people. The Department intends to develop the nursery on large scale for supply of fruit/ornamental plants to the rural as well as urban people. The plant Nursery near Lake Club was established to supply quality seeds/seedlings of flowers and vegetables on reasonable rates. The ecological problems caused by using anti-eco-chemical has local national and global consequences, protection of environment and conservation of natural resources are the prime duty of each and every person. To provide good environment and technical guidance, the Kitchen Garden Nursery be strengthened on large scale, with plenty of ornamental and fruits plants, apart from supplying pesticides, seeds and seedlings of flowers and vegetables on reasonable rates. The object of this scheme is to maintain and provide good environment to city residents. The nursery at lake is open to all for purchase of plants, seeds, seedling and availing the faculty of know-how.

Since the majority of farmers in Union Territory, Chandigarh are small/marginal, the individual efforts to purchase small quantity of new high yielding seeds of wheat are not fruitful and farmers face difficulty on this account. It is therefore, proposed to procure the wheat seed of latest varieties and to supply the same to the farmers on 25% discount, in order to popularize the use of high yielding seeds of wheat crop and to get maximum production.

3.3 Assessment of Vulnerability to Climate Change in Chandigarh

3.3.1 Impact on Forest: The dynamic vegetation model outputs in Haryana[15] show that during the short-term period of 2030s, out of the 14 forested grids, 4 (28.57%) will be impacted by climate change. The number of currently forested grids projected to be impacted by climate change remains the same towards 2080s. It is also assessed that any afforestation programme undertaken in future, in the districts of Karnal, Panipat, Jind, Bhiwari, Sonepat, Gurgaon, etc., could be vulnerable to future climate impacts. The vegetation grids near Chandigarh such as Panchkula did not show any change due to climate change impacts. In this respect Chandigarh is not likely to face any climate change impacts.

Table 3.1: Details of saplings planted by various Departments in Chandigarh Administration (for details see Annexure 2)

Department	2006-07	2007-08	2008-09	2009-10
Municipal Corporation Chandigarh	19,699	11,445	26,290	38887
Horticulture	24,446	15,172	36,250	69,595
Forest Department	71,708	246,806	51,000	33,500
Engineering Department		15,000		
Total	115,853	288,423	113,540	141,982

[15] Haryana State Climate change Action Plan (draft)

3.3.2 Impact on Agriculture: Likely Impacts of Climate Change on Agriculture projects that with short periods of exposure of wheat crops to temperatures of 28°C to 32°C result in significant decrease in yield by 20% or more. Unpredictable moisture deficits during crop growth are a major constraint to 2 PRECIS (Providing Regional Climate for Impact Studies) is the Hadley Centre portable regional climate model[16], developed to run on a PC with a grid resolution of 0.44° x 0.44°. PRECIS simulation datasets is provided by the Indian Institute of Tropical Meteorology, Pune, Sclerotinia stem rot may become a serious threat to the successful cultivation of Indian mustard.

3.3.3 Impact on Livestock: The environmental conditions that induce heat stress on dairy animals may exacerbate and may lead to decline in milk productivity and may impair reproductive functions and efficiency of livestock species[17].

3.3.4 Impact on poultry[18]: As the ambient temperature reached 34°C the mortality due to heat stress was significantly high in heave meat type chickens (8.4%) as compared to light layer type (0.84%) and native type (0.32%) chickens. Feed consumption decreased from 108.3 g/bird/day at 31.6°C to 68.9 g/bird/day at 37.9°C. Egg production also decreased both in broiler (by 4.5%) and layer (6.4%) breeders as compared to their standard egg production. The body temperature increased from 41°C to 45°C as the shed temperature rose from 28°C to 42°C and the critical body temperature at which the birds succumbed to death was 45°C, which was observed at the shed temperature of 42°C. Naked neck birds performed significantly better than the normal birds with respect to thermo tolerance, growth, feed efficiency and immunity at high temperatures.

3.4 Agricultural water stress indicator

Agriculture faces water stress if the water requirements of crops are not met. To detect the severity and spatial occurrence of water stress in the basin, the relative evapotranspiration (ETrel) expressed as the ratio of actual evapotranspiration (ETa) over potential evapotranspiration (ETp) has been used. For relative evapotranspiration, it is generally recommended that this ratio does not drop below 0.70 throughout the year[19]. Bastiaanssen et al., 2001[20] used an 'operational range' and an 'acceptable range' for this indicator. If the indicator remains within the operational range, crop yield will deviate less than 10% from the target value. If the indicator moves out of the acceptable range yield reductions of over 20% occur. For ETrel, the operation range was set at 0.8-1, and the acceptable range at 0.7-1. The relative evapotranspiration (ETrel) is calculated for the basins of

[16] In the absence of any specific studies in Chandigarh, the closest study in Haryana state is referred to indicate the possible climate Change Scenarios.

[17] http://www.icar.org.in/files/reports/icar-dare-annual-reports/2010-11/climate-change-AR-2010-11.pdf

[18] http://www.icar.org.in/files/reports/icar-dare-annual-reports/2010-11/climate-change-AR-2010-11.pdf

[19] Bos, M. G.; Burton, M. A.; Molden, David J. 2005. Irrigation and drainage performance assessment: Practical guidelines. Wallingford, UK: CABI. viii, 158p

[20] Bastiaanssen, W.G.M., Brito, R.A.L., Bos, M.G., Souza, R., Cavalcanti, E.B. and Bakker, M.M. (2001) Low cost satellite data applied to performance monitoring of the Nilo Coelho irrigation scheme, Brazil. Irrigation and Drainage Systems 15, 53–79

Yamuna and Indus lying within Haryana on seasonal basis. The results of seasonal agricultural water stress are indicates that water stress is higher in winter and season. The agriculture water stress is going to exacerbate towards end century. Chandigarh is in the Northern part of Haryana experiences lesser stress during summer months, while the stress will be high winter months. This will indicate that wheat and other winter crops are expected to experience severe water stress conditions.

3.5 Climate Change Strategy

3.5.1 Review of existing policies and strategies to identify priorities

3.5.1.1 Forest and Wildlife: Chandigarh's Forest and wildlife department is prominently dictated by the national policies and programmes. First and the foremost is the conservation of forest and wildlife through formation of wildlife sanctuaries and national Parks. UT Chandigarh has few prominent wildlife sanctuaries and reserve forests. These are the permanent spaces of green cover in the UT which is unlikely to be disturbed.

3.5.1.2 Forest Conservation and Development: The primary goal of this programme is to reduce or arrest the siltation of the Sukhna Lake, the lifeline of Chandigarh. Several measures of soil and water conservation measures have been taken and various soil and moisture conservation structures have been constructed in the hilly catchment to check the silt erosion and to reduce siltation of Sukhna lake.

3.5.1.3 Plantation Scheme: One of the major programmes of the forest department involving the other departments to enhance the green cover of Chandigarh.

3.5.1.4 Greening the City beautiful: The aim of this programme is to raise plantation in and around city to provide pollution free environment to the people of the city beautiful. Plantations are raised in various vacant places in and around the city, particularly in the education institutions, hospitals, office buildings and avenues. Chandigarh administration is undertaking large scale plantations to reduce the impacts of climate change through carbon capture. Carbon capture was calculated conservatively using the following assumptions[21]:

1. Assuming a tree density of 200 per hectare
2. Converting the number of seedlings distributed or planted into number of hectares
3. Assuming a annual biomass accumulation of 1.5 tons per ha
4. Assuming that 20% of the biomass produced is used by people or wasted.

The biomass accumulated with these number of seedlings distributed or planted was calculated. The total biomass at the end of 2010 according to the above assumptions is 4077 tonnes.

[21] Ravindranath and Hall (1993), Biomass in India, Oxford University press.

3.5.1.5 Agriculture Department: Agriculture is very minor component in Chandigarh and the production is diminishing over the last several years. In order to reduce reliance on other cities for vegetables and fruits Department of Agriculture is encouraging cultivation of organic practices to reduce pollution and enhance the soil carbon accumulation. Soil organic accumulation is one of the important ways of capturing the atmospheric carbon. In addition to climate change adaptation, soil organic carbon and organic cultivation improves the soil water retention capacity and improves crop yield. One of the major issues is reduction of cost of cultivation as the plant protection chemicals involve high cost. All India level pesticides use in Punjab is nearly 0.23 kg per ha of crops while it is 0.75 per ha in Chandigarh (calculated from the data provided in annexure 1). Organic agriculture would help to reduce even this usage. If agriculture in Chandigarh were to continue, there are various steps to be taken by the agriculture department as the water stress is expected to improve (Figure 8[22]).

3.5.2 Strategies to Enhance Green cover in Chandigarh

Green cover in Chandigarh will be enhanced through Greening Chandigarh Action Plan (GAP) through the following interventions.

1. Motivating people to plant Trees: Motivating people and creating awareness among the local community through print and electronic media. A new initiative called Partnership Initiative Programme (PIP) has been launched to motivate people to drive them towards greening Chandigarh. As a part of this programme 98 NGOs have been registered with the Forest Department tree plantation drive. Forest Department distributes free saplings of various species such as medicinal, ornamental species to these NGOs and the NGOs organize frequent plantation drives in various colonies and blank places. Adequate monitoring mechanisms have been set up in place for enhancing post plantation care and to ensure higher survival rates
2. Eco-Clubs: 125 eco clubs have been initiated in Chandigarh as a part of National Green Corps. Eco clubs are primarily initiated to impart the knowledge of importance of nature among the student community; generate awareness towards protection of nature, wildlife and natural resources; and to sensitize the students for sustainable way of living.
3. Plantation by Municipal Corporation: Municipal Corporation with the help of various resident associations develops and maintains the green belts under the jurisdiction of the Corporation. The municipal corporation visits the plantations or parks maintained by the resident welfare associations and provide technical cooperation through the Horticulture department. The local councilor will be the prime mover of this programme.
4. Forest department's programme on the protecting and maintaining the vegetative cover in the natural habitats are done through the following activities:
    a. Replacing dead and fallen trees in the parks and avenue trees

[22] In the absence of any studies in Chandigarh, the closest state where such studies have been taken is referred.

b. Planting for the future replacement
c. Removal of *Lantana, Partnenium* and *Cuscuta* (Amarbel)
d. Selection of species to be planted under the electric and telephone poles
e. Control of pest and disease attack on trees
f. Composting / vermicomposting to stop burning of leaves
g. Recharging of ground water aquifers
h. Mulching leaves for protection of saplings.

3.6 Climate Change Action Plan

Table 3.2: List of measures (short and long term) needed to implement these strategies (including natural, engineering and locally suitable solutions), including timeframe and sequence for implementation

Sl. No	Category of Interventions	Proposed activities / projects	Target 2020	Target 2030	Target 2050
1	Increasing tree cover in urban and peri-urban Areas. Funds will be arranged through ongoing schemes of forest Department, Municipality of Chandigarh and Engineering Department. Other schemes under horticulture and agriculture department will also be continued.	• Free distribution of seedlings of various species to the institutions, eco clubs, NGOs & residents of Chandigarh for plantation	• 3 lacs (approx 40,000 plants per annum) 1044 tons of biomass or 522 tons of carbon	• 6 lacs (2214 tons of biomass or 1107 tons of carbon	• 15 lacs Under the projects city beautiful, research and extension scheme, forest conservation and development
		• Creation of Eco clubs in schools & colleges of UT Chandigarh	• 150 schools	• All schools & colleges	• All schools & colleges
		• Increase in green cover (forest + tree cover)	• 40%	• 42%	• 45%
2	Promotion of natural regeneration and mixed species planting	• Patch sowing	• 3 lacs per annum in Sukha wildlife sanctuary (1044 tons of biomass or 522 tons of carbon)	• All the hill slopes of Sukhna lake to be covered	All the hill slopes of Sukhna lake to be covered under forest conservation programme
		• Plantation of fruit bearing species	• 10,000	• 1,00,000	• 3,00,000
3	Protected areas (PA) management securing corridors for species migration	Acquisition of land for the purpose of establishment of wildlife corridor or effective management		450 acres	450 acres
4	Reduced forest fragmentation by conserving contiguous forest	Fencing of forest boundaries at species locations to check encroachment on forest	8 km	Complete boundary wall fencing around the	Complete boundary wall fencing around the

	patches (use of landscape /sub-landscape approach)	land		forest area in UT Chandigarh	forest area in UT Chandigarh under greening city beautiful, social and farm forestry project
5	Eco-restoration of degraded lands	Lantana, parthenium removal and biodiversity plantations	Botanical garden at Sarangpur to be free from such weeds	All the reserve forest areas to be free from Lantana	All the reserve forest areas to be free from Lantana. Forest conservation and development scheme
6	Awareness generation	• Creation of nature interpretation centres at Botanical garden • Celebrations of Wildlife Week • Celebration of world forestry day • Celebration of world earth day • Celebration of wetland day • Publication of Chandigarh greening action plan	75 eco clubs will be associated with one or the other activity	All the eco clubs will be associated with one or the other activity with the help of Engineering Department, Forest Department and Science and technology Department, Environment Department and National Social Service	All the eco clubs will be associated with one or the other activity

3.6.1 Potential areas available for greening in UT Chandigarh

3.6.1.1 Enrichment Plantation in the Catchment area of Sukhna Lake:

a) Plantation of indigenous & palatable variety of trees & shrubs on gentle slopes & plain area of Wildlife sanctuary.

b) Hill tops & slopes of Sukhna Wildlife Sanctuary will be enriched with green cover by seed sowing in patches by contour trenching and trench-cum-ridge method.

c) Plantation of stem cuttings of soil conserving species like Arundo-donax along Choe banks to reduce erosion of Choe banks by rain water runoff.

3.6.1.2 Enrichment plantation in the city forest area - Reserved and Unclassed Forests in & around the city are Lake Reserved Forest, Sukhna Choe Reserved Forest, Patiala-ki-Rao Reserved Forest,

Unclassed forests in Sukhna Choe, Lake & Patiala- ki- Rao. As per the India State of Forests Report-2011, density of these forests ranges from dense to moderately dense and at places open forests patches are also present. Enrichment plantation will be carried out in the open forests area to improve the quality and the biodiversity of the forests area. Fruit bearing & palatable species of trees and shrubs will be planted here as wildlife is in abundance in these forests.

3.6.1.3. Plantation within the city

- Plantation of trees & shrubs in parks and greenbelts under the jurisdiction of Municipal Corporation and Engineering Departments
- Vacancy filling by planting along the roads, green belts etc, by Municipal Corporation and Engineering Department.
- Enrichment plantation in southern sectors
- Development of Parks & green belts in southern sectors
- Establishment of new Theme Parks like Garden of Palm, Garden of Silence, Garden of Conifers, Valley of Springs etc.

3.6.1.4 Plantation in Schools, Colleges, Offices and residential houses and other vacant spaces - A massive campaign for plantations on private lands, complexes of Schools, Colleges, University, Hospitals, Police Lines and Residential Complexes and offices may be undertaken in collaboration with students, Resident Welfare Associations, Market Associations, Environmental N.G.O.'s etc. Every unutilized & abandoned patch of land will thus be brought under tree plantations.

3.6.1.5 Strategy to Improve the Forest and Green Cover: Increasing pollution level and subsequent degradation of the city environment, particularly by vehicular pollution, highlights the need for immediate remedial measures to combat pollution. Though the best way to reduce pollution at source is by adoption of clean technology and clean fuel, proper maintenance of roads & vehicles, maximum use of bicycles, strict enforcement of Air (Prevention and Control of Pollution) Act, 1981, Water (Prevention and Control of Pollution) Act, 1974 and the Environment (Protection) Act, 1986 etc., yet another effective way to reduce air and noise pollution is through a well planned and realistic strategy for afforestation. Apart from giving shade, aesthetic beauty, recreational spots and playing host to a wide variety of birds and insects, the forests and trees play an important role in amelioration of environment due to their tremendous potential to act as organic sponges to absorb gaseous pollutants through their leaf stomata (the tiny pores on the leaves) and breaks them down into less harmful molecules during the photosynthesis; storehouse of Carbon dioxide by assimilating the carbon dioxide in form of sugar; supplier of much needed vital oxygen; aid in soil and water conservation. In addition trees have significant effect in improving the microclimate of the area. Green Cover significantly affects the building heating budget. Vegetation helps in reducing the noise pollution to the acceptable level. Specifically Ficus, Mango, Neem also act as good dust collectors. Well laid out gardens and parks with selected ornamental and shady trees provide good recreational

spots and enhance the beauty of the city. Well-designed green belts prove to be very effective wind break and help in soothing the microclimate of the surroundings.

A need based appropriate model dovetailing environmental considerations will have to be adopted by all Greening Agencies in their plantation drives. The selection and quality of species play most important role in the success of greening and improving the survival percentage of the plantations. Therefore, the selection of species has to be judicious for which a number of indicators have been short-listed. They (i) are (i) Location of plantation site (ii) Site conditions like, soil, ground water table (iii) Climatic conditions like rainfall, temperature (iv) Ornamental and aesthetic requirement (v) Environmental considerations like pollution abatement and (vi) Distance of the plantation site from the residential building, public utility services

To ensure greater survival percentage of saplings planted, ***salient requirements*** have been identified which are as follows:-

- Proper identification of area requiring afforestation,
- Selection/choice of species,
- Raising of healthy seedlings,
- Planting of healthy and tall saplings,
- Area treatment according to its edaphic and climatic condition,
- Protection from grazing by providing tree guards or proper fencing,
- Post plantation care particularly the maintenance and watering up to three years,
- Monitoring and concurrent evaluation,
- Soil and water conservation including water harvesting

It has to be recognized clearly by all greening agencies that every effort should be made for horizontal expansion of the forest cover/ green cover in & around Chandigarh. Simultaneously, all efforts have to be made as well for vertical expansion of existing green areas by way of developing them into multi-strata forest to increase efficiency and effectiveness of forest areas as carbon sink and green lungs of the city.

Forest department has been receiving funds from the Government of India under various programmes on wildlife conservation, afforestation etc. Forest department in Chandigarh will be planning to use these funds to allocate accordingly to afforestation, desiltation and other works programmes as part of the climate change action plan. Apart from the Central Government, the Forest department, Chandigarh, also receives funding from other sources such as Municipal Corporation facilitates other agencies to help them plant appropriate species at appropriate time. This integrated plantation works will help increasing the green cover in the city of Chandigarh.

3.6.1.6 Animal Husbandry: There are over 27,000 approximately livestock in Chandigarh UT. One of the most important contributions of livestock on climate change is enteric methane production,

which has 23 times more global warming potential than CO_2. At the current livestock population the annual methane production is 628 tons, which is equivalent to14, 457 tonnes. Given the small size of the UT Chandigarh, this is a large amount. Therefore the UT administration or the animal husbandry department needs to take a special initiative to reduce the methane emissions.

There are several measures with which the methane reduction can be reduced with small efforts. Protein supplementation in the ration helps in increasing milk production and also reduces methane emission. Specific protein supplements need to be fed to the cattle for reducing methane production. Most of the farmers are providing the stall fed cattle with various grains and pulses instead of fodder alone, which supplements protein and may help in reduction of enteric methane emissions.

Chapter 4: Energy consumption and Climate Change

4.1 Baseline Scenario:

Chandigarh is a small union territory area with 114 km^2 land area. Chandigarh does not have any provision of power generation of its own and is totally dependent on the neighboring states for its power supply. The increase in population along with the ever-increasing per capita consumption of electricity is making it difficult for the city to meet the demand. This in turn leads to power cuts and discontinuous power supply to both residential and non-residential areas including the industrial area as a consequence of which the productivity is being affected.

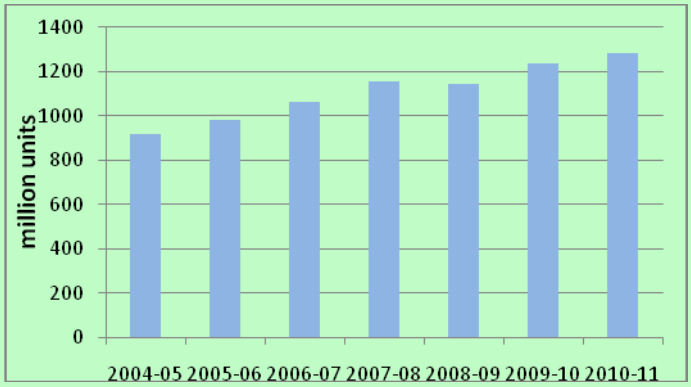


Figure 4.1: Electricity consumption in Chandigarh UT (in million units)

4.1.1. Electricity consumption: At present the city is receiving 52% of its power through Mohali (PSEB), 40% through Nalagarh and remaining 8% through Dhulkote (BBMB). The average power requirement is around 40-45 lakh units per day. UT has an allocation of 140-190 MW of power from different Central Generating Stations during different hours of the day against an entitlement of 236 MW of power. Per capita consumption of electricity in Chandigarh has increased from 253 kWh in 1967-68[23] to 1217 kWh in 2009-10 and accordingly electricity consumption has increased from 1.38 (lakh Unit) LU per day to 35.6 LU per day in 2011-12. All the 22 inhabited villages in UT Chandigarh have already been electrified. Current power consumption for the year 2010-11 is 1301.47 million units (Figure 4.1). Over the last seven years, the consumption on an average is increasing at 52 million units annually. Chandigarh Administration is maintaining around 20,000 street light points. Sector wise energy consumption (Figure 4.2) indicates that nearly 39% of the electrical energy is consumed in the domestic sector followed by commercial sector (30%). Though Chandigarh has no electricity

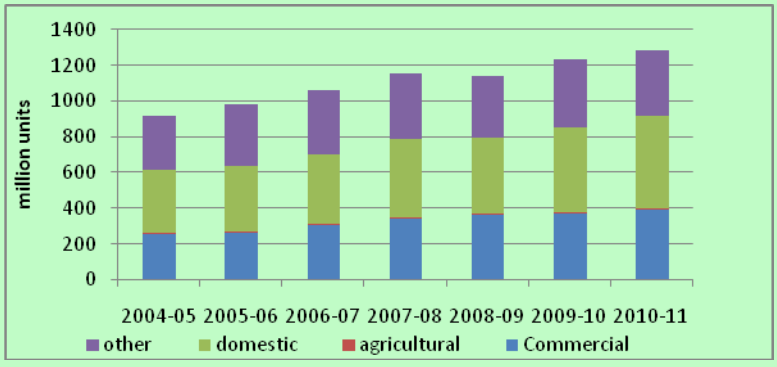


Figure 4.2: Sector wise electricity consumption in million units

[23] TERI study on Solar master plan Report No 2008RT03

generating (such as hydro or thermal power plants) units, but indirectly it contributes to Green House Gas emission through consumption. Considering this, domestic sector is the major Green House gas emitter and therefore there is a possibility to reduce consumption of electricity at the domestic sector. Energy consumption from agriculture sector is negligible. Among the domestic sector, most of the usage of energy is for fans (34%), lighting of the houses (28%), room heaters/coolers (7%) and refrigeration (13). The remaining are coolers, TV and other appliances.

4.1.2: Vehicular Density: Number of vehicles registered has been steadily increasing in Chandigarh, (Figure 4.3) and the percentage of cars among the vehicles registered is about 40% and the number of two wheelers is about 58%. Thus, the total number of cars and two wheelers constitute 98% of the vehicles in the UT. Over all there are over 730,000 vehicles plying in the Chandigarh UT and with the given number of over 351,000 households, the average vehicle holding per household is 2.08 (Table 4.1). Though the vehicle density may appear high, but there have been

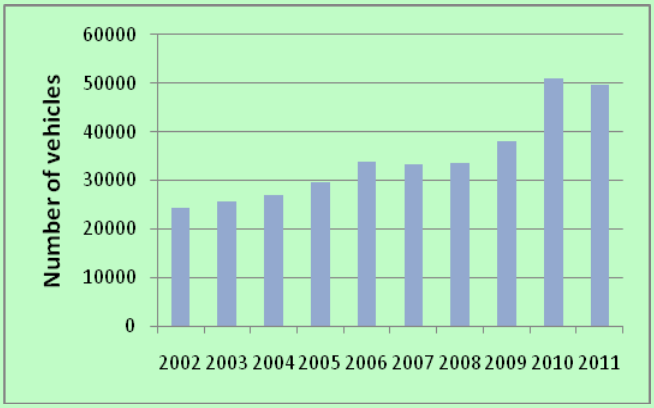


Figure 4.3: Number of vehicles registered in Chandigarh

Table 4.1: Number of vehicles, households and vehicles to households ratio in UT Chandigarh.

Year	2003	2004	2005	2006	2007	2008	2009
Total number of vehicles registered in Chandigarh	537049	563845	593326	626868	659850	693124	730386
Number of households	218181	266007	280407	295998	312903	331263	351230
Vehicles to household ratio	2.46	2.12	2.12	2.12	2.11	2.09	2.08

restrictions on the vehicles older than 15 years and therefore, the number may be less. However, there is difficulty in obtaining such data on actual vehicle density.

4.1.3 Petroleum product consumption in Chandigarh: Chandigarh is having a high vehicular density among the cities in India, and also catering to the petroleum product of the neighboring states, being a capital city of Haryana and Punjab, has higher consumption of petroleum products as well. Furthermore the consumption gets accentuated due to the status of Chandigarh as Union Territory attracts less tax on some products. Volume of sales of petroleum products indicate that 72,872 metric tonnes of diesel was sold during 2011-12 while 88,419 tons of petrol was sold during the same year. Similarly, other product sales can be seen in table 3.2 and it is noticed that during the year 2010-11 most products were sold at higher quantities than the current and previous years.

4.1.4 Green house gas emissions: Emissions from different petroleum products was calculated from the factors provided in the article[24] and emissions from the electricity consumption was calculated from the book published by the Ministry of Power, Government of India[25]

Table 4.2: Sale of various petroleum products from Chandigarh City (in metric tonnes).

Product	Liquid Petroleum Gas	Motor Spirit	Aviation Turbine Fuel	Superior Kerosene oil	High speed diesel	Light Diesel Oil	Low Sulphur heavy stock	Bitumen	Lubes
2009-10	39428	84294	36750	7255	74846	379	15341	6375	1452
2010-11	43050	91152	38646	7307	76641	288	42988	6894	1417
2011-12	44582	88419	46252	5797	72872	373	35184	4478	1650

Data source: ENVIS website.

Green House Gas emissions from various sectors

Green house gasses are emitted from various sectors in Chandigarh. The major emissions are from the electrical use and use of petroleum products from the transport of personal and public vehicles. Though there is no electricity generation, but the electrical energy is met from the northern grid. Sector wise electricity consumption indicates that the domestic sector is large than the other sectors. The other emission sources are from the enteric methane emissions from cattle and nitrification from the agricultural fields due to fertilizer application. As area under agriculture is low and nitrate emissions from the agricultural fields are 728 tons of CO_2e and that of enteric emissions (forms 0.06% of total emissions) are 14,457 tons of CO_2e annually (forms 1.3% of emissions annually). Therefore contributions from these two are not being discussed here in this section. These have been separately discussed in the section on agriculture.

4.1.1 Domestic energy use - Emissions from domestic energy use such as kerosene and Liquefied Petroleum Gas (LPG) have been the major source of GHG emission in Chandigarh apart from electricity. The total LPG use for cooking purposes is 340,000 kg annually and 444,000 liters of kerosene annually. Together the emissions from LPG and kerosene are 16,038 and 18,907 tons respectively. Together the domestic consumption constitutes 11% of the emission from the petroleum products.

4.1.2 Transport System in Chandigarh - Public transport system is overseen by Chandigarh Transport Undertaking (CTU) in the city. The city is provided with a daily average fleet of about 517 including

[24]SEI, 2008, Energy in Ireland 1990-2007, Report 2008. Available at: www.sei.ie. And also at http://cmt.epa.ie/global/cmt/emission_factor_sources.pdf

[25] Emissions from electricity consumption were calculated based on the northern grid emissions as referred in Government of India, 2011, CO_2 Baseline database for Indian Power Sector, User Guide, Version 6, Central Electricity Authority, Ministry of Power, Sewa Bhavan, RK Puram, New Delhi110066 available at http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver6.pdf

(100 JNNURM) buses consuming approximately 32,000 liters of diesel per day travelling a distance of about 115,000 km[26]. Consuming 32,000 liter diesel daily the emission amounts to 31,320 tons forming 11% of the total emission from petroleum products in Chandigarh. Over 200,000 passengers travel everyday in CTU buses. Consumption of petroleum from other vehicles such as 1870 busses plying from Chandigarh has not been estimated here and therefore the actual emission of GHG is more than indicated here.

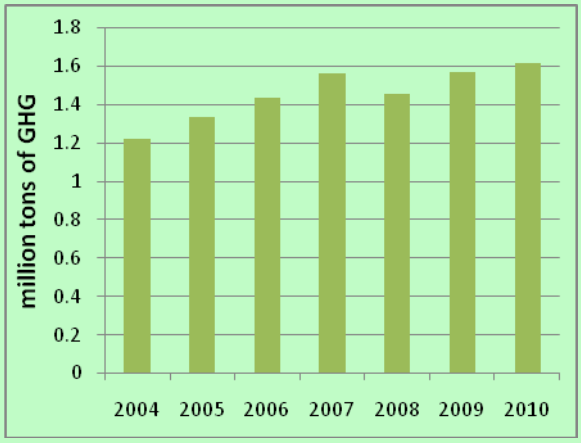


Figure 4.4a: Total emissions in Chandigarh UT.

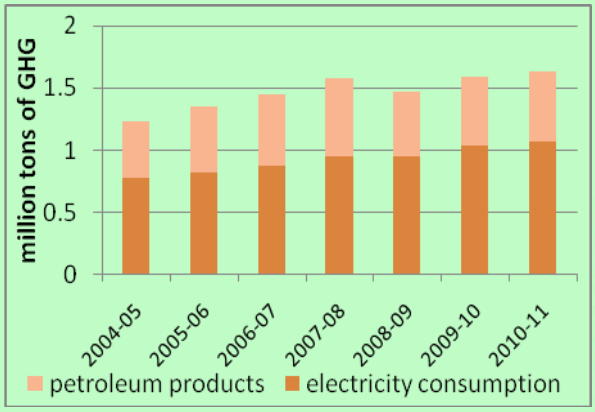


Figure 4.4b: Emissions from electricity consumption and vehicular emissions petroleum products

To reduce pollution and to improve the passenger comfort, CTU is planning to procure euro IV standard buses that reduce nearly 30% of nitrous oxide and 50% of Suspended particulate matter (SPM). The plan is to replace the current fleet with the high technology low emission buses. The estimated cost is about 50 crores annually. A comprehensive transport plan has been developed by Chandigarh Administration along with the Government of Punjab and Haryana, which has been detailed in chapter 6. It may be advisable that other state transport corporations also are procure euro IV standard buses to reduce pollution in Chandigarh.

4.2 Climate Change impacts on Energy development situation

Climate change is projected to impact both energy supply and demand. On the supply side, the main effects would be on electricity generation, although oil and gas production would also be affected indirectly due to changes in relative economics of fuels under a climate change regime. Hydropower generation is the energy source that is most likely to be impacted because it is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature (rain or snow, timing of melting). Reduced flow in rivers and higher temperatures reduce the capabilities of electric generation; high temperatures also reduce transmission capabilities. Increased cloudiness can reduce solar energy production despite the availability of generation capacity. Wind energy

[26] Chandigarh ENVIS database accessed on 10 June 2012

production would be reduced if wind speed increases above or fall below the acceptable operating range of the technology. Changes in photosynthesis and growing conditions could affect the production of biomass-based energy. Energy demands would also be similarly affected in sectors, specifically, residential, commercial, and transport. Changes in space cooling and heating requirements, and water pumping needs would be the main drivers of energy demand changes.

In the situation such a Chandigarh, which is an urban conglomerate and has great deal of influence from the neighboring states to its infrastructure, faces a different threat on energy sector. Chandigarh UT has no generation electricity on its own and has to depend on the central grid power supply. Increasing power shortage situation in the neighboring states may have influence on the UT in terms of its quota of power though currently it is sufficient but increasing at alarming rate of 52 million units annually. Therefore it is essential that UT resort to renewable sources of energy to fulfill its partial energy through solar, wind and other sources.

4.3 Climate Change Strategy

Chandigarh has no power generation of its own, and yet it is increasing its use by 52 million units every year. Considering that there are strong impacts on water flows to the two generating stations from which the state is drawing power, there is possibility of reduced power supply in future. Therefore it is imperative that the union territory adapts itself to reduce dependence on the grid electricity and build its own captive generation or switch to renewable power that helps to generate its own power. Furthermore, on the mitigation front, the city should largely focus on reducing green house gas emissions through reduced electricity consumption that reduces emissions elsewhere and transport sector which is originated in the city itself. While Chandigarh boasts of as one of the highest per capita vehicles per family, it also has lowest number of persons per public transport held by the Chandigarh Transport undertaking[27]. Therefore there is a necessity to improve the public transport facilities for people to travel to various destinations within the city in order to reduce dependence on the personal transport that might cause increased per capita emissions.

Some of the strategies planned to reduce the GHG emissions from the Chandigarh Administration are:

4.3.1 Chandigarh – A move towards Model Solar City - MNRE has identified 60 cities in the country to be developed as solar city by 2012 as part of the National Mission of Solar Energy with Chandigarh being one of them in the northern region. This concept will prove extremely beneficial for Chandigarh, which is located in the sunny belt of the country and receives a good amount of solar radiation over the year. The Chandigarh Administration has got a Master plan for implementation of solar city program prepared from TERI approved by Government of India. The underlying philosophy

[27] Review of performance of State Road Transport Undertakings (SRTUs) (Passenger services for April 2010-March 2011, Ministry of Road Transport, Government of India

of the concept of the Solar City is to ensure that Chandigarh's energy demand is met in affordable, technologically advanced, and environmentally friendly manner. It means that after cost effective efficiency and demand response, the city relies on renewable sources of power and distributed generation, to the extent possible. It is proposed that Chandigarh will generate its own power by harnessing solar energy for which the following has been proposed setting up of

- 10 MW solar PV based roof top power plant
- 5 MW solar PV based power plants in landfill site of the city (this has of late has been ruled out due to capping of site which prohibits use of the site for grass).
- 25 MW large solar PV based power plant in '**Patiala ki Rao**' area of Chandigarh.

The report[28] has also suggested utilizing Central Government schemes and that CREST/Municipal Corporation/Engineering Department may initiate installation of solar-based LED traffic lights, solar street lights, building integrated solar PV, and other relevant solar products on a priority basis. In order to showcase Chandigarh City as a Solar City, the following may be taken up on priority:

4.3.1.1 State/UT level energy Park: One state/UT level energy park is being established in Botanical Garden Sarangpur as an inviting place for social gatherings and to provide public education about issues of sustainable energy in a friendly, non-technical atmosphere.

4.3.3.2 Paryavaran Bhawan: A new Energy Efficient Green Building name Paryavaran Bhawan has been constructed housing the offices of Forest Department, Environment Department, Science and Technology Department, Pollution Control committee, the offices of CREST and Solar City Cell in sector 19B of Chandigarh. The building has been constructed in accordance with ECBC and other efficient/green building concepts. The roof top of 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.

Figure 4.5: Paryavaran Bhawan, Sector 19 B

Provision of solar powered lights and fountains in the prominent public gardens and parks in the city (such as Botanical Gardens, Bougainvillea Garden, Rajendra Park, Rock Garden, Rose Garden, Shivalik Garden, Shanti Kunj, Leisure Valley etc.,) thereby spreading the Solar City message. Solar powered displays as well as battery operated vehicles for intra-complex transportation. CREST along with PSEB and power utilities may begin engaging the public through sustained awareness campaigns

[28] TERI study on Solar master plan Report No 2008RT03

about the benefits of energy conservation and renewable energy; including local elected representatives and school children. Need to initiate creation of accredited certifiers who can be engaged by the house owners/builders/developers for obtaining the energy conservation compliance certificates.

4.3.3 Propagate Energy Efficient Appliances, which include 'Energy Star' appliances - To replace traffic signals having incandescent lamps with those with energy saving LEDs, along with solar controllers. Similarly, CFL based streetlights; lights in the parks, gardens, and roundabouts may be replaced with solar lights. To encourage adoption of energy conservation, energy efficient equipment/appliances, as well as renewable energy system; CREST may introduce specific, time-bound financial incentives for Chandigarh.

4.3.4 Popularizing Non-Conventional Energy Sources: Regularly popularising non-conventional energy sources in the form of solar driven cookers, vehicles, water heating systems, solar lights etc. have been introduced. Subsidies to battery operated vehicles and alternate sources of energy are being granted.

4.3.5 Use of Solar Water Heaters - Chandigarh Administration has mandated the provision of Solar Water Heating in all new and existing institutional, public buildings, e.g. hotels, industrial & residential plots above one Kanal plots, where usage of hot water is anticipated.

4.3.6 Special Area Demonstration Project Scheme - In order to promote renewable energy in the city, the Chandigarh Administration has launched the Special Area Demonstration Project Scheme in which various prestigious buildings like Raj Bhawan, State Assembly premises, Secretariats of States and UTs, Institutions like school, medical colleges including hospitals shall be covered in different categories for the demonstration and renewal energy system. Under the scheme Grid Interactive Solar Voltage Power Plant (GISVPP) will be installed in the buildings. The above buildings and the government houses shall be providing Solar Water Heating System. In conjunction, provisioning for Solar Photovoltaic Energy Programme may be initiated by installing solar powered lights in new upcoming sites, and any replacement in the existing outdoor lighting will be made by Solar Powered Lights.

4.3.7 Bachat Lamp Yojana - Lighting accounts for nearly 20% of the total electricity consumed in Chandigarh. The majority of lighting systems use incandescent light which generates heat using 9-% of the electrical power and only10% of the power is used for light. Bachat Lamp Yojana (BLY) is an innovative CDM based initiative by the Central Government to enhance lighting efficiency in the household sector by making CFL available at prices of Rs. 15 which is comparable to that of ICL (Incandescent Lamp). The public private partnership between the GOI, private sector CFL manufactures/Traders/investors and State Level Electricity Distribution Company (DISCOM) provides a framework to distribute high quality CFL to the households. All the expenditure in this project is

made by the investors. The rate of carbon credit rating is very low (~3.7 dollar per ton of carbon) private sector is hesitating to invest in BLY project.

4.3.8 Construction of Green Buildings - The Chandigarh Administration has constructed its first green building – the Paryavaran Bhawan. The design was been prepared by the Department of Urban Planning incorporating the green concept and includes solar passive elements, down draught ventilation etc. on the basis of advice taken from Green Consultant, M/s TERI. The Chandigarh Housing Board is planning its office having approximately 153,000 square feet covered area as a **green and intelligent building.** The Nehru Centre for Performing Arts, a project of the Chandigarh Administration, and which is proposed to be constructed in the Sub City Centre, Sector 34, has also been targeted for green rating. The activities undertaken by the Engineering Department of Chandigarh administration is provided as Annexure 6.

4.3.9 Energy Audit of Buildings - The Engineering Department, of the Chandigarh Administration has got energy auditing done for few buildings –including the Punjab and Haryana High Court Building to assess the present day consumption and thereafter to suggest measures to reduce the same.

4.3.10 Creating Self Sustaining Neighborhoods in terms of Power, Water and Sewage Disposal - Le Corbusier's concept of the neighborhood now needs to be strengthened and extended to function as communities which in addition to providing the daily needs -, schools, medical facilities, community facilities within easy walking distance, aim towards self sufficiency in terms of their requirements for power, waste water management, sewage disposal .These green communities will thus aim at zero emissions so as to help reduce the pressure on the landfill sites and the power grid. Today advanced technology has made available compact Sewage Treatment plants which can be accommodated within a neighborhood and will thus eliminate the need of first carrying the sewage down south to the STP Plants at Diggian, and thereafter of pump up to rainy water for its usage of irrigation etc. Similarly, photo-voltaics which are grid interactive to harness the energy for use within neighborhood building and the surplus power generated to be thrown back to the grid. The existing well planned layouts, manageable size of the sector, along with the active participation of the councilors, the residents, the shopkeepers, Resident Welfare Association and the other stake holders can make this possible.

Chandigarh Administration is proposing to develop one sector (residential area) on the above concept by taking the help of an expert/consultant to act as a role model to be emulated by others. Each sector should therefore generate its own power, treat its sewerage and use the treated waste water for generating tertiary water, which can be used for non-potable uses. The concept of rewarding the best sector would also motivate each sector for its proper maintenance and upkeep. With a view to encourage whole hearted public participation, it is proposed that each sector be given an option to project the best option for implementation of the above proposal by appointing experts/consultants at their own level. The best model would be rewarded suitably.

4.3.11 Chandigarh as Pedestrian City - A comprehensive proposal for making the city pedestrian friendly should be part of the Master Plan of Chandigarh under preparation. This concept is easily achievable in a compact city like Chandigarh, which is already consciously planned on the neighborhood concept designed with the pedestrian in mind. The predominance of vehicles on internal roads, the missing pedestrian paths and underpasses across major roads, have not made it comfortable for the pedestrian so far. Though the city may have the highest walkability index as compared to other Indian cities, there is still need to provide for well defined comfortable, lively pedestrian environment.

4.3.12 Promote Bicycle as a Mode of Transportation in the City: The compact size of the city, due to which most of the Living, Working, Care of Body and Spirit functions are within easy distance and the orderly pattern of the city fabric make this aim achievable. The concept of cycle tracks was in built into the original plan of the city however the same has not been implemented. Only a few cycle tracks have been laid. It is proposed that a plan for the same needs to be worked out in a comprehensive manner. Presently only the lower income strata of the society uses bicycles – however if the concept of bicycles is promoted and proper bicycle parking areas, bicycle rental schemes/nodes are put in place then bicycle can become an important mode of transportation. This mode is not only economical, eco- friendly, energy efficient, but has zero green house, noise and air pollution. The concept will also help achieve inclusive planning. The new and proposed cycle tracks need to be made comfortable with shady trees and landscaping so that cycling becomes a joyful experience.

4.3.13 To reduce car use/ownership in Chandigarh - Car purchase to be regulated to ensure the same is commensurate with the availability of parking spaces within the city. The car ownership should be maintained at the current level, the same to be achieved by imposition of heavy registration and tax on cars and certification by Registering Authority about availability of parking space. To discourage the use of cars and encourage use of public transport, congestion Tax may be imposed in congested areas such as Sector 34, High Court and Commercial areas of Sec-22, Manimajra etc.

4.3.14 Treatment of Electronic Waste Facility - Setting up of an electronic Waste Treatment facility to address the electronic waste generated due to increasing use of computers and other electronic products.

4.3.15 Chandigarh as a City promoting Clean Technologies Industrial activity is permitted only within the industrial area of the city and as a matter of policy only non obnoxious industries are allowed therefore the quality of air is not adversely affected. Chandigarh should encourage only Industries supplying Clean Technologies offering incentives such as tax rebates, subsidies etc.

4.3.15 Eco-friendly transport system within Sites: All large campus, housing complex sites shall be provided with eco-friendly modes of intra site transportation. The new construction must have footpath for the streets longer than 100 m and bicycling tracks for the streets longer than 200 m. Public mode of electric driven vehicles within the site for the elderly people and people with disability should be provided. In the area in case of new construction/re development of such sites it is recommended that planning should be on the concept of cluster development and linear layouts are to be avoided since it leads to large vehicular lengths. Parking should be as per norms and provision of convenient and well distributed free battery charging facilities should be made within the site premises.

4.3.17 Outdoor Lighting - It shall be mandatory to enhance the outdoor lighting system efficiency to meet the minimum allowable luminous efficacy (as per lamp type) and make progressive use of renewable energy –based lighting system.

Table 4.3: Targets of Energy consumption reduction

Description	Target		
	Short Term (till 2015)	Medium Term (till 2017)	Long Term (till 2022)
1. Energy Conservation*	Reduction in present energy consumption		
1.1 Residential sector	10%	15%	20%
1.2 Commercial sector	10%	15%	20%
1.3 a Municipal sector (Water pumping)	1.5%	3.0%	4.0%
1.3 b Municipal sector (Street lighting)	1.5%	3.0%	4.0%
2. Coverage of solar water heating systems (as a proportion of total heating demand in residential and commercial sectors)	10%	25%	45%
3. Roof Top solar energy based electricity generation	2.5 MW	5 MW	10 MW
4. Large solar energy based electricity generation at Landfill Site	3 MW	5 MW	5 MW
5. Large solar energy based electricity generation at Patiyala ki Rao site	5 MW	15 MW	25 MW
GHG emission reduction (tCO_2/annum)	90973	214051	404969

** As a percentage of reduction in energy consumption over projected consumption in Business As usual scenario*

4.3.18 Use of solar lights for lighting the external campuses - At present it is mandatory for all residential and non-residential campuses to provide a minimum of two solar lights in the campuses. In future it shall be made mandatory that 50-100% of outdoor lighting should be of solar photovoltaic lights or in combination with other renewable sources of Energy, i.e., bio-mass, fuel cell, wind energy etc.

Based on the resource potential current use possible strategy the following Targets for energy conservation generation and green house gas emission reduction has been planned as a part of Solar City programme in Chandigarh (Table 4.3).

Table 4.4 Summary of strategies for climate change adaptation for energy sector

Sl. no	Strategy	Proposed Activities
1	Enhancing energy efficiency and emission reduction transport system	Replace all the current fleet of vehicles to CNG or Euro IV standard to reduce emissions and increasing the number of vehicles to improve public transport.
2	Bachat Lamp Yojana	Replacing all conventional incandescent lamps with CFL or LED in Residential Buildings
3	Energy Park	Energy-cum-Science Park to be established in a central locality of Chandigarh
4	Promotion of Green Buildings	Buildings are built using ECBC codes to reduce energy consumption such as solar passive elements, down draught ventilation. Currently the Nehru Centre for Performing Arts, Sub City Centre, Sector 34 and eventually all public buildings and at least 50% of new buildings to be certified under new ECBC rules
5	Energy efficiency options in public places	Solar powered lights and fountains in prominent parks and gardens. Initially to implement in Botanical Gardens, Bougainvillea Garden, Rajendra Park, Rock Garden, Rose Garden, Shivalik Garden, Shanti Kunj, Leisure Valley
6	Propagate 'Energy Star' and other energy efficient appliances	• Replace all traffic signals with those with energy saving LEDs. Encourage adoption of energy efficient equipment/appliances, as well as renewable energy system. • Introduce time-bound adoption of energy efficient appliances and introduce financial incentives.
7	Solar water heaters in Government houses	Installation of solar water heaters in Government residential areas and Government buildings that are maintained by Chandigarh Administration
	Solar water heaters in residential buildings	Incentives proposed for residential buildings adopting solar water heaters
8	Special Area Demonstration Project Scheme	Installation of Grid Interactive Solar Voltage Power Plant Public buildings, schools and colleges

9	Energy Conservation in Residential sector	• Solar water heating system 824500 liter capacity per annum with 5% increase every year. • Promotion of LPG and Microwave stoves Reducing 10% reduction in current electricity consumption • Promote use of alternate lighting systems such as SPV systems in villages to reduce kerosene consumption • Promote energy conservation through promotion of energy efficient devices (CFL, air conditioners, microwaves, Washing machines, TV, etc) Primarily awareness creation
10	Energy Conservation in Residential sector	• Promotion of energy efficiency through awareness creation achieve 10% share of energy efficient devices in the city • 100% replacement of existing ballasts with efficient ballasts in all street lights • Replacement of 250 booster water pumps of 10 HP capacity in drinking water schemes with energy efficient pumps • Promotion of solar water heating systems in industries, hotels, hostels etc 100000 lit per day capacity systems in three years • Promotion of roof top systems in commercial /government, institutional and industrial buildings Total 10 MW capacity solar systems
11	Power generation	Solar PV power plants capacity 25 Mega watts
12	Awareness creation	Establishment of 'Chandigarh Solar City Cell'

To achieve the above targets (table 4.4), several departments have already started implementing the programme particularly to reduce electrical consumption. The engineering department (Electricity - maintenance) of Chandigarh Administration (please see annexure 6), The Chandigarh housing board (please see annexure 3) and Electricity Department (distribution) of Chandigarh Administration has taken various steps (Annexure 4). The Chandigarh Electricity (maintenance) Department has replaced many incandescent bulbs to CFLs and is replacing others. Similarly street lights have been changed to LEDs and low energy consumption type of bulbs. Chandigarh housing Board has installed various solar devices to reduce electricity consumption. Similarly Engineering Department (Maintenance) has initiated Restructured Accelerated Power Development and Reforms (R-APDRP). The new R-APDRP programme is expected to reduce AT&C losses; identification of high loss areas, improved customer satisfaction, increased revenue collection, automation of business processes and real time monitoring of electrical energy and other data.

Chapter 5: Water Resource Management for Climate Change

"In every glass of water we drink, some of the water has already passed through fishes, trees, bacteria, worms in the soil, and many other organisms, including people...Living systems cleanse water and make it fit, among other things, for human consumption" - ELLIOT A. NORSE, in R.J. Hoage, ed., Animal Extinctions, 1985

The National Water Mission[29], as part of National Climate Change Action Plan, aims to ensure integrated water resource management to help conserve water, minimize wastage and equitable distribution both across and within states. The Mission will take into account the provisions of the National Water Policy and develop a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. More specifically, it seeks to ensure that considerable share of the water needs of urban areas are met through recycling of waste water. The National Water Policy would be revisited to enhance both above and below ground storage, rainwater harvesting, coupled with equitable and efficient management structures. The Mission seeks to optimize the efficiency of existing irrigation systems, including rehabilitation of systems that have been run down and also expand irrigation, where feasible, with a special effort to increase storage capacity. Incentive structures will be designed to promote water-neutral or water-positive technologies, recharging of underground water sources and adoption of large scale irrigation programmes which rely on sprinklers, drip irrigation and ridge and furrow irrigation.

The National Mission for Sustainable Habitat also highlights the importance of Water Resource Management and stresses the need to explore new sources of water. It states "water reclamation, recycling and reuse represent significant components in the hydrological cycle in urban, industrial and agricultural uses. The reclaimed water can be used for non potable uses such as toilet flushing, construction, ground water recharge, recreation, horticulture etc." It further states that "water needs to be used more efficiently across all sectors. Measures to be taken include water efficient irrigation techniques and water saving appliances, reduced leakage in supply systems, and water recycling and rain water harvesting. Low water use technologies like ecological sanitation also reduce demand for water and could provide sustainable alternatives". Consistent with the National Water Mission, Chandigarh Administration also aims to reduce water consumption in various ways. In this chapter various activities planned to circumvent the various climate change scenarios will be discussed.

[29] National Action Plan for Climate Change, 2008

5.1 Baseline scenario

5.1.1 Water Supply: The present water supply service area of MCC is 114 km^2, which includes MCC area 79.34 km^2 and rural area of 34.69 km^2. The urban area falls in jurisdiction of Municipal Corporation. The water supply system is entrusted to Public Health wing of MCC. The rural area comprises of 13 villages overseen by the Engineering Department. The water supply to the villages is provided with tube wells in and around the villages. Other urban/rural areas have water source of 67 MGD from Bhakra Main Canal which is 27 km away from Chandigarh and 20 MGD from 210 tube wells located in the city. The transmission mains carry raw water from Kajuali to the water treatment plants located at Sector 39. At sector 39, the water is treated, disinfected and transmitted to 7 No. subsidiary water works located in Sectors 12, 26, 32, 37, 52 and Manimajra.

The average availability of water in Chandigarh is reasonably high at 332 Liters per Capita per Day (LPCD), stands second in the country after Goa (343 LPCD). Chandigarh gets 14.5 million gallons per day (MGD) water as its share from each phase of Kajauli water supply scheme. Chandimandir cantonment and Haryana is in process of installing its infrastructure for treatment and transmission of water. The net available water will be only 78.0 MGD if Haryana and Chandimandir Cantonment starts drawing it share of raw water from Chandigarh.

5.1.2 Distribution of Water Supply:

The City has been divided into 7 zones for the purpose of distribution including town of Manimajra. The total installed capacity of water from the four phases of surface source is about 67 MGD. Apart from the piped supply, about 20 MGD is also abstracted through deep bore wells with power pumps. 85% connections are metered and flat rate connections are given to rehabilitated colonies. Besides there are 800 stand posts in the city 332 LPCD water is 10-12 hours.

Table 5.1: Estimates of Deficit in water supply over the years

Year	Projected Population (In lacs)	Water Demand (in MLD)	Present water Availability (in MLD)	Deficit (MLD)
2016	12.79	520.57	396.72	123.85
2021	13.71	588.38	396.72	191.66
2025	14.46	620.57	396.72	223.85
2031	15.59	669.07	396.72	272.35

Source: 1. The Future Population of India, Population Reference Bureau, August 2007 http://www.prb.org/pdf07/futurepopulationofindia.pdf)
2. Ground Water Scenario in Major Cities of India, CGWB, 2011. (http://cgwb.gov.in/documents/GW-Senarioin%20cities-May2011.pdf)

5.1.3 Water Demand and Deficit

Chandigarh's current estimated demand stands at 110 MGD. However, the current availability is 87 MGD. The estimated ground water extraction that supplements water supply is 20 MGD, which accounts to only around 29% of supply.

According to Bureau of Indian Standards (BIS) code 1172-1993[30] the per capita water requirement for the cities with habitations more than 100,000 with full flushing systems require 150-200 Liters per day. This may come down to 135 Liters per capita for Economically Weaker section of the society. In this context, Chandigarh is providing more water per capita than required.

Current Water demand based on the current population is around 492.93 MLD as indicated in the annexure 5. This includes 164.7 MLD for domestic consumption, 34.91 MLD for commercial or industrial demand, 55 MLD for community institutional demand, 16.47 MLD for standpost lavatory blocks and a wastage of water nearly 22%) stands at 59.71 MLD. In addition horticultural water demand is 161.8 MLD. The annexure indicates that the population at 2006 is 10.98 lacs, while according to 2011 census population of Chandigarh is 10.54 lacs. Therefore, the projections may need to be revised based on the current population and projections.

5.1.4 Non-Revenue Water - Non-Revenue water (NRW) due to commercial losses and physical loses in the system, leads to loss of revenue. The water system has high NRW levels averaging to 28% in MCC area; the efforts have been made to replace transmission losses. These compounded by commercial losses due to approximately flat rate connections; public stand posts and inefficiencies in billing and recovery.

5.1.5 Status of storm water drainage in Chandigarh - The drainage system in Chandigarh is comprised of a hierarchy of natural and man-made drains and water bodies which ultimately discharge surface run-off into 'N' Choe. Numerous 'N' Choe constituting the major storm water drainage system for the area drain the City. The 'N' Choes are the major carriers of storm water. Currently, storm water drains in the city are constructed and maintained by the Municipal Corporation. Mainly storm water lines have been laid in more than 90% of the UT area. Mainly discharge of rain water is disposed of in 'N' Choe near Sector 47. With the construction of railway line from Morinda to Ludhiana, barrier has been created around eastern southern area of Chandigarh because filling has been done to construct the railway track over right of way. The size of storm water drain varies from 12" size to 96" size including brick drain and RCC box channels. The total length of storm drain is 713 Km. A study undertaken by MC recommended deepening, widening and providing retaining walls at critical sections to reduce the problems of flooding.

One of the key issues is the silting of the N-Choe and the Sukhna Choe has ultimately affected the efficiency of drainage system during torrential rains. All storm water drains are held up for longer period; thus causing flooding of roads and low lying areas. This is primarily due to the planning of water drainage system based on the slope of the city from north east to southwest. Chandigarh has a natural slop of 10 from east north towards south which helps in naturally drainage and cleansing. There are certain low altitude areas like sector 11, 24, part of sec 15 and 35, Mauli Jagran, and

[30] http://xa.yimg.com/kq/groups/23711357/994160094/name/1172.pdf

Gobindpura of Manimajra. Chandigarh is having a closed drainage system, therefore no prominent impact on Environment. In addition to this, the work of up-gradation/construction of STP's are under progress to mitigate sewage treatment needs of Chandigarh. It was initially designed for a rainfall intensity of half an inch per hour. However, because of increased green areas and open spaces coming under construction, the run-of has increased tremendously. This has resulted in overloading of storm drain areas resulting in flooding of low lying areas of the city. The administration has attempted to address this problem by laying additional pipelines, constructing additional rain water harvesting structures along the storm drains which helped the rainwater endowment of the city. The MC has undertaken a study to prepare a storm water drainage master plan to alleviate the problems of flooding by providing adequate measures. The study has recommended deepening, widening and providing retaining walls at critical sections.

5.2 Climate Change Scenarios

Studies of Gosain, 2011 indicate that Indus basin SWAT (Soil and water analysis tool) analysis projects an increase in annual precipitation of about 9% (72 mm) by mid century, this results in 46% (33 mm) increase in runoff to the stream flow and 7% (5 mm) increase in base flow, negligible decrease in the ground water recharge is projected. Evapotranspiration is projected to increase by 39% (28 mm). During the monsoon months (June-July-August-September) increase in precipitation is projected to be about 10% (64 mm) and increase in evapotranspiration by 11% (17 mm). The indication is that in parts of the basin surface runoff would be increased under the A1B mid century scenario. Similarly during the Rabi season, precipitation is projected to increase by 23% (17 mm) resulting in increase in runoff by 48% (8 mm) and negligible change in ground water recharge. Evapotranspiration is projected to increase by 25% (4 mm) and baseflow is projected to increase by 17% (3 mm).

5.3 Initiatives by Administration for conservation of Water

5.3.1 Rainwater Harvesting made Compulsory for Private Buildings: To reduce dependence on ground water a short term legal frame work has been laid by the Administration to make provisions for rain water harvesting mandatory while granting the additional covered area to all plots above 500 m^2 area.

5.3.2. Recycle and Reuse of Water: Under the JNNURM, the MCC has already set in motion a process to treat and reuse sewage water for horticultural purposes. Chandigarh is unique because it has huge demand for water for horticulture purposes. The total water demand for horticulture purposes is 20 MGD. To reduce its pressure for fresh water, a tertiary treatment (TT) plant was set up in Diggian in 1991. Distribution system has been laid to distribute this treated water for the green areas in Sectors 1-12 and Sector 26. At present 7 MGD of TT water is being distributed through pipe lines to green areas in Sectors 1-12 and Sector 26.

Chandigarh administration aims to achieve reduced dependence of ground water by 50%.

5.3.3 Water Harvesting for Chandigarh - The demand for water is growing in direct proportion to the city's growth. Rain water harvesting is one of the ways to protect and sustain its water resources. The Ministry of Urban Development had appointed CSE (Centre for Science and Environment) to prepare a plan for rain water harvesting at city level for Chandigarh. A report has been submitted titled "Capturing Rainwater: A way to augment Chandigarh's water resources**."**

5.3.4 Rainwater harvesting potential of Chandigarh - The rainwater harvesting potential of Chandigarh, with an area of 114 km^2 (assuming a co-efficient of 50%) with an average annual rainfall of 1059.63 mm is 60380.1 million Liters. This is more than the water pumped out of aquifers and therefore, harvesting and recharging rainwater will go a long way in contributing towards sustainability of water supply. The report suggested two main ways to undertake rainwater harvesting in the city;

a) By recharging the deep, confined aquifers

b) By storing water in tanks or ponds and water bodies

Some of the Key findings are:

- The city taps groundwater from the deep confined aquifers, which do not get naturally recharged**.** Hence recharging these aquifers is should be undertaken**.**
- Tube wells are located all across the city. Harvesting rainwater from the storm water drain network to recharge the confined aquifer, through structures all along the network is a simple solution to access the city's endowment of rainwater**.**
- Chandigarh has the unique advantage of having a planned and well-maintained storm water drain network. The

Table 5.2: Sewage Treatment Plants in the City with their capacity.

Sl No.	Name of the installation	Capacity
1	STP at Diggian, Mohali	45 MGD
2	STP at Raipur Kalan	5 MGD
3	STP at 3 BRD	5 MGD
4	STP Raipur Khurd	1.25 MGD
	Total Sewage Treated	**56.25 MGD**
STP under Construction likely date of completion 30 September 2012		
1	STP at 3 BRD	10 MGD
STP proposed to be constructed		
1	Maloya	5 MGD

network receives more than 70% of the total rainfall received in the city. Thus, this will be an effective way to augment the city's water resources.

- The quantum of water that will be available for recharge annually is 6736 million gallons or 18.46 MGD.

4.3.5 Tertiary treated water supply for irrigation of gardens, green belts and houses up to 1 kanal - In order to conserve the fresh water, tertiary treated water could be used for irrigation purposes for gardens, green belts etc. A project Tertiary Water Supply for irrigation of green belts in Chandigarh City was conceived in the late 80's & the first 10 MGD Tertiary Treatment Plant for treating sewage already treated up to secondary level to Tertiary level was commissioned in year 1991. Under this project, Pre-stressed Pipes (PSC) was laid from STP at Diggian (Phase XI, Mohali) to Rajindra Park, Sector -1 Chandigarh for carrying Tertiary Treated water to City for irrigation of gardens, green belts & lawns. Along with this skeleton distribution network for supplying Tertiary treated water to multi kanal houses in about 10 Sectors was laid. Initially, the requirement of the water in these Sectors was limited to 3 to 5 MGD as limited pipe network was laid. In order to utilize 10 MGD capacity of Tertiary treated water, a 2nd Project for Tertiary Treated Water Supply line was ENVISaged and executed in the year 2005 and the same was completed in the year 2007.

5.3.6 Sewerage System and Sewage Treatment in Chandigarh - Chandigarh city is fully covered with sewerage facility. Out of 87 MGD water being supplied to the residents of the city, 67 MGD sewage effluent is being generated. It is on the way of becoming the only city in India with 100% sewage treatment in the near future. Presently, the capacity of Sewage Treatment Plants (STP) in the city is 56.25 MGD and another 10 MGD STP is under construction which is likely to be commissioned by this year ending 2012.

5.4 Climate Change Strategies for Chandigarh

Several strategies have been developed to combat climate change to reduce ground water use, reduce water use and to improve infiltration of storm water in the union territory.

4.4.1 Use of Re-cycled Water – some of the strategies to use re-cycled water are as follows:

- The use of potable domestic water should be restricted to kitchen uses including drinking, bathing and washing clothes and other similar uses. Recycled water, if available, should be used for non-potable uses such as watering parks, gardens landscapes, golf courses, use for construction, laundry, industrial process, flushing, washing roads etc.
- Use of recycled water will be compulsory for all non-potable uses for all large buildings with an area of more than 2000 sq. m. in all new developments. If such water is not supplied by

the MC then the building should set up water treatment plant within its premises for reuse of waste water.

- For all buildings or properties located in plots with area equal to or more than 2000 sq. m the MC or water agency should not sanction potable water connections for uses other than that meant for human consumption, if suitable recycled water is not available.

All apartments or group housing complexes with more than 20 tenements and commercial, institutional and industrial complexes with an area of more than 2000 m^2 should make plumbing and infrastructure provision for enabling localized sewage treatment, use of recycled water for flushing, washing and for watering gardens.

5.4.1.1. Plan for Implementation – it is suggested that all building plans and land development plans with an area of more than 2000 sq. m. should indicate the onsite wastewater treatment and disposal arrangements and water reuse infrastructure including the plumbing plans etc. Separate systems should be provided for sewage and sludge to facilitate reuse of sludge water for gardening and washing purposes. This may require suitable storage facilities that are to be indicated on the building plans.

5.4.2 Reduce Consumption of Water - Consumption of potable water in all new buildings can be reduced by using water efficient fittings**.** At least 25% reduction in Water consumption can be achieved from all sources.

5.4.2.1 Water efficient fixtures: There have been technological innovations in many of the water fixtures with the aim of reducing water consumption. Some of the most common fixtures that have improved efficiencies of use are:

5.4.2.2 Flush toilets: Low flush toilets use 6 Liters per flush as against 14-15 Liters of conventional flush toilets and Ultra low-flush toilets use 3 Liters per flush. There are also dual flush toilets that use between 3 to 6 Liters per flush depending on half or full flush. The savings in water use can be upto 40-50% by switching over to low flush toilets. More than one-third of total water use is used for toilet flushing in urban centres. Switching to water efficient flush toilets will make a great impact on the total water consumed in urban buildings.

5.4.2.3 Urinals: There is an ongoing process of technological improvements to make urinals more water efficient or completely waterless. Several types of water efficient and waterless urinals are being developed as pilot projects. The censor/push cocks should be provided at the urinals in place of old water cisterns. This will ensure use of water only when required. This can save upto 10% of the total water consumption in the toilet blocks.

5.4.2.4 Water efficient faucets and showerheads: conventional faucets have a flow rate of about approximately 11-19 Liters per minute (LPM) and water efficient faucets have a flow rate of 7.5 LPM. Installation of pressure reducing devices such as aerators can reduce the flow further. In addition, there are sensor taps that automatically shut off. One of the simplest ways to improve efficiency is to switch from compression type faucets which require you to turn the faucet to open or close tap to cartridge type faucets that requires you to turn the handle for vertical or lateral movement. There are also self-closing faucets which will automatically close after a set time to reduce the potential for taps to be left running too long or not turned off. Today there are a variety of produces available that can be attached to existing taps to reduce water flow.

5.4.2.5 Plan for Implementation - The Administration is phasing out programme to replace old flush toilets and faucets with new low-flush and water efficient taps. This must be phased out in public institutional buildings and large commercial buildings as well.

Currently the Ministry of Urban Development is undertaking a study to initiate a programme of labeling of water efficient fixtures similar to the star rating system for electrical appliances. This will greatly help in motivating consumers to switch over to the use of water efficient fixtures.

5.4.2.6 Leakage Control Management: There is lot of wastage of water due to leakage in pipes. Regular monitoring of supply pipes will help of save water to larger extent.

5.4.2.7 Mal-functioning of Water Meters: Some of the measures are as follows: (i) Unauthorized water connections and mal functioning of water meters should also be checked regularly to avoid illegal and excessive use of water. (ii) All flat rate water connection is required to be converted into metered connections to avoid unnecessary wastage of water. (iii) Revision of water tariff is also one way to reduce wastage of water. The high tariff of water will stop the users to waste water. Moreover this will also help the Department to recover the losses.

5.4.3 Landscape Water Conservation: Landscape forms an important part of the building environment a large amount of water is utilized for landscaping purposes and garden watering. Much of this water is used to maintain traditionally high water-demanding landscapes, or it is simply applied inefficiently.

To improve the efficiency of water use for landscape the following shall be mandatory:

- If grey water recycling or waste water treatment is undertaken on the site, the total landscape water requirement per day should not exceed the total amount of treated water available per day.

- If no grey water or waste water treatment is undertaken on site, the total landscape water requirement per annum (as calculated using the Landscape water calculator) should not exceed the total amount of rainwater collected per annum.
- If no grey water or waste water treatment or rainwater collection is undertaken on site not more than 25% of the total vegetated area should be covered by lawns, exotic or ornamental plants which require more water and high maintenance and lawn areas should not have a slope of greater than 25%.
- At least 50% of the total landscaped area in the site should use water conserving vegetation such as Native species or Xeriscape.
- At least 40% water savings should be achieved in all sites with vegetated area > 50sqm by using efficient irrigation equipment. Water savings have to be calculated using the
- It is proposed that incentives should be given to those complying with the above.

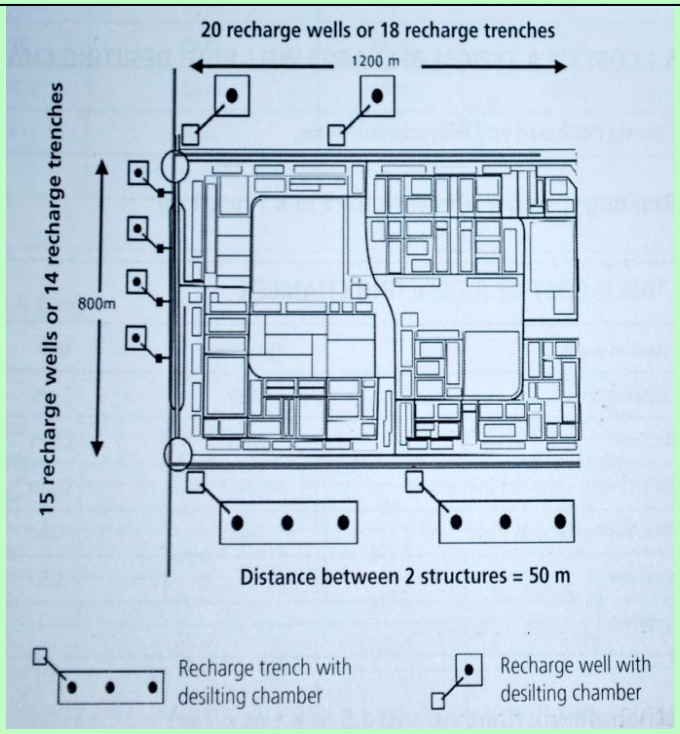


Figure 5.1: Diagram of Typical Sector for Recharge Wells

5.4.4 Water Audit for Existing Buildings - Water use audits are an important initiative toward understanding a building's water use and how it can be reduced. A comprehensive water use audit would examine all of the major aspects in which a building uses water, including sanitation, maintenance, mechanical systems, building processes, landscaping etc. These aspects can broadly be classified into seven categories viz., landscaping/external use, bathrooms, toilets, laundry, kitchen, taps/leaks and water source. The details on the components, scope, processes and essential tasks to be carried out in water audit needs to be outlined.

5.4.6 Tertiary treated water supply for irrigation of gardens, green belts and houses up to 1 kanal - In order to conserve the fresh water, tertiary treated water could be used for irrigation purposes for gardens, green belts etc. A project Tertiary Water Supply for irrigation of green belts in Chandigarh City was conceived in the late 80's & the first 10 MGD Tertiary Treatment Plant for treating sewage already treated up to secondary level to Tertiary level was commissioned in year 1991. Under this

project, Pre-stressed Pipes (PSC) was laid from STP at Diggian (Phase XI, Mohali) to Rajindra Park, Sector -1 Chandigarh for carrying Tertiary Treated water to City for irrigation of gardens, green belts & lawns. Along with this skeleton distribution network for supplying Tertiary treated water to multi kanal houses in about 10 Sectors was laid. Initially, the requirement of the water in these Sectors was limited to 3 to 5 MGD as limited pipe network was laid. In order to utilize 10 MGD capacity of Tertiary treated water, a 2nd Project for Tertiary Treated Water Supply line was ENVISaged and executed in the year 2005 and the same was completed in the year 2007.

Further treatment of tertiary treated water for drinking is being contemplated. The Chandigarh Administration while developing 3rd Phase Sectors, laid a DI pipe line of various diameters in the range of 300mm to 200mm from Sector 47/48 to Sector 43/52 along with skeleton network of PVC pipes for supply of tertiary treated water to the gardens & green belts of Phase III sectors. Another Project for supply of Tertiary Treated Water was conceived in the year 2007 for funding under JNURM. Out of 4 phases of work 2 has been completed and 2 will be completed by June 2012. After the completion of these 2 phases, all the gardens, green belts, open spaces, institutions and houses of area having 1 Kanal and above will be covered with Tertiary water supply for irrigation thus conserving 10 to 15MGD of fresh water.

5.4.7 Developing Water Recharge Structures The planning for a typical sector measuring 1200m x800m have been detailed out. In some of the sectors there are storm water drains on all four sides and in some, only on three sides. Assuming that recharge structures are made at an interval of 50m there can be a minimum 55 recharge wells and 50 recharge trenches and a maximum of 70 recharge wells and 64 recharge trenches for a sector. Areas suitable for rainwater harvesting in the city as follows:

5.4.7.1. Roads and Roundabouts: Recharge along storm water drains to both recharge rainwater as well as prevent flooding.

5.4.7.2. All green areas: Recharge where suitable and store where hydrogeology is not suitable. Stored water can be used for horticulture. Ponds can be constructed to harvest and use rainwater as in Botanical Garden.

5.4.7.3. Institutional areas such as Punjab University, Capitol Complex: Recharge where suitable and store where hydrogeology is not suitable. Stored water can be used for horticulture.

5.4.7.4. Commercial areas: Store in underground tanks for non-potable use.

5.4.7.5. School, colleges and religious places: Store and recharge stored water can be used for horticulture and other non-potable uses.

5.4.7.6. Industrial areas and airport: Water from roof top catchments to be stored and can be used for industrial purposes. Overflow of rooftop water can be recharged. Water from rooftops and hangers to be harvested in storage tanks to be used for non-potable purposes.

The Chandigarh Administration has already initiated the process of implementing the above mentioned report of CSE through the public health wings of the Engineering Department and Municipal Corporation, Chandigarh.

5.4.8 Storm Water Management

5.4.8.1 Zero Drainage of Storm water for Large Development Sites (>30 acre) - All the large developments, housing and institutional campuses etc. with a total site area >30 acres must adhere to Zero storm water runoff from the site. This infers that all the storm water flowing from various surfaces should be effectively collected and managed onsite. The collected storm water must be reused for different applications after appropriate filtration as may be possible. The remaining storm water must not be discharged outside the site but has to be managed within the site by means of creating detention basins, retention ponds and/ or wetlands so that it can act as the local ground water recharge basin. The possibility of implementing this in existing campuses such as P.G.I, C.S.I.O., IMTECH, P.U., PEC, GMCH, Sector 17, Sector 34 also needs to be explored and if found feasible, steps taken to implement them as early as possible."

5.4.8.1 Integrated Implementation of Sustainable Urban Drainage Systems (SUDS) - Many existing cities storm water is damaging the environment and is not sustainable for long term. To reduce these effects techniques have been developed with the ideals of sustainable development and collectively referred as Sustainable Drainage System.

Some of the components of the SUDS are:

- **Pervious Paving** -Surfaces that allow inflow of rainwater into the underlying construction or soil.
- **Green Roofs** - Vegetated roofs that reduce the volume and rate of runoff and remove pollution.
- **Filter Drains** - Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
- **Filter Strips** - Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
- **Swales** - Shallow vegetated channels that conduct and retain water and may also permit infiltration; the vegetation filters particulate matter.
- **Detention Basins & Retention Ponds**- Areas that may be utilised for surface runoff storage as well as to provide water quality treatment.

- **Infiltration Devices** - Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soak-ways.
- **Pipes and Accessories** - A series of conduits and their accessories normally laid underground that convey surface water to a suitable location or treatment and/or disposal. (Although sustainable, these techniques should be considered where other SUDS techniques are not practicable.
- **Constructed Wetlands** - Constructed Wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wild life habitat.

5.4.8.1 Plan for Implementation of Drainage systems - Sustainable Urban Drainage Systems in an integrated approach shall be implemented to manage storm water on-site and achieve runoff volume reduction aggravated by construction development. This shall be based on the local climatic and geological conditions prevailing and also be specific to the site/ neighborhood conditions being planned for any particular project. Site-specific adherence criteria shall be as follows:

- Sites with area lesser than 10,000 m^2 shall implement Rain Water Harvesting and SUDS Source control and Infiltration instruments such as green roofs, permeable paving, infiltration trenches, infiltration basins, etc.
- Larger sites (area greater than 10,000 m^2) shall implement integrated SUDS techniques as feasible that would effectively reduce runoff.
- Still larger sites (with area greater than 20 acres) should go for Soil Infiltration rate testing before implementing SUDS Infiltration devices & passive treatment techniques to enable successful implementation of “zero” storm water drainage from the site.

The current construction practices need to be modified to accommodate the implementation of SUDS on-site. In particular, the construction of basement beyond the building line, which has become a regular practice for the want of increased space for parking, shall not make it feasible to utilize the ground cover to implement various SUDS techniques.

Apart from depending on artificial means of light and ventilation, the basements particularly extending further away from the building line into the site area also defeats the practical purpose of implementing SUDS for storm water management. This is because SUDS essentially integrates the geology/ natural site soil conditions into managing storm water in the most ecological ways possible, which also includes collection and storage of storm water at several points on the site that finally allow for percolation into the aquifer, thus completing the water cycle. Such infiltration- based SUDS

techniques cannot be designed where basements extend too much beyond the building lines, sometimes until the site boundary, where the top soil cover is only a landscape feature and does not have any additional hydro-geological utility value.

It should hence be mandatory that the Site geology be undisturbed from its natural conditions to the maximum extent possible. Practically, site excavations for structural requirements and various infrastructure requirements of the proposed building will be necessary, but extensions beyond the building line should be completely avoided, leaving the mandatory un-built site area in its most natural state. This is essential for implementing SUDS in its true principles.

5.4.9 Measures to Increase Infiltration of Storm Water

5.4.9.1 Reduction of Paving on the Un-built Site Area: In order to reduce the Urban Heat Island Effect (UHIE) adverse impact and to increase storm water attenuations and infiltration the following shall be mandatory for all new constructions.

A. The total paved area of the site under parking, roads, paths, or any other use should not exceed 25% of the unbuilt site area *or* net imperviousness of the unbuilt site should not go beyond the imperviousness factor as prescribed by the National Building Code of India, Bureau of Indian Standards, 2005; Part 9(Plumbing Services) Section 5.5.11.2.1, whichever is more stringent.

B. At least 50% of the paved area should be provided with pervious paving or open grid pavement or grass pavers.

2. Hard paving on site should be reduced and adequately shaded to reduce Urban Heat Island Effect as defined below.

A. At least 50% of the paved area including parking should be shaded by a vegetated roof or pergola with planters.

B. At least 50% of the paved area including parking should have a surface finish with an SRI>0.5 (solar reflectance index). OR; At least 50% of the total un-built site area should have any of the above combinations (shaded paved area or area with SRI >50%), where common area having two or more strategies can be calculated only once.

5.4.9.2 Plan for Implementation of strategies for enhancing infiltration of Storm Water

- Site plan with area statements clearly showing all the paved areas (paved areas labelled as per use) e.g., walkways, drive-ways, parking, sit-out, etc. Demarcation of areas having pervious paving, vegetated roof and corresponding details needs to be depicted. In case high reflectance surface is provided, submit details of reflectance of surface finish.

- Certificate by the Architect validating that the total surface parking does not exceed the permissible limit as per Revised Parking norms.

Specifications of the permeable paving material being proposed, with its infiltration potential and sections of the proposed installation systems, with dimensions and details of joints & layers with a justification narrative on the applicability of proposed material for the decided location onsite from practical, utilitarian & maintenance point of view.

At present the city has 394.98 MLD of water which includes 20 MGD from 180 tubewells and also utilizing 6 MGD and 3 MGD water share of Haryana and Chandimandir respectively. The water after storage and sedimentation is filtered and chlorinated at various water works located in the city. As per the CDP submitted by M.C. to Ministry of Urban Development, by 2011, the requirement of the water would be 519.47 MLD, which would grow up to 800 MLD by 2035[31].

Moreover, the spring level of the tubewells is depleting very fast that has gone deeper from 230' to 290' ranging from Northern Sectors to Southern Sectors. In Manimajra area also the situation is similar because Panchkula & Chandimandir are also exploiting the deep aquifer by drilling deep tubewells in the absence of surface resource. This has resulted in reducing the lifespan of tubewells from 12-15 to 7-8 years & also increasing the consumption of power by lifting water from the greater depth which in turn has increased the generation cost. Keeping in view the deep aquifer, *MC now proposes to draw only 10 MGD ground water through deep tube wells to improve the spring level of city Chandigarh.*

5.4.10 Reducing Siltation of Sukhna Lake - The catchment area of the Choes feeding the lake has rugged terrain, steep slopes, plenty of gulleys, very deep water table and the soils are predominantly alluvial sandy embedded with layers of clay and are highly susceptible to soil erosion by water run-off action. The impact of rain drops, quick flow of run-off and exposed soil coupled with hill denudation due to deforestation and animal grazing, are ideal conditions in the area for soil erosion. Naturally, the water flowing into the lake is heavily loaded with silt. The situation is accentuated by the fact that on an average 50% of the total rain in the Shivalik ends in run-off (Misra *et al.,* 1978). Thus due to higher run-off there is accelerated pace of erosion in the catchment areas of the seasonal stream tributaries of Sukhna Choe resulting in the higher rate of sedimentation in the reservoir of Sukhna Lake and stream beds. The silt deposited year after year in the lake bed reduces the water storage capacity, depth; water spread area and submergence area at lake level.

[31] source –Chief Engineer, Municipal Corporation

5.4.11 Mandating Rainwater Harvesting

Chandigarh Administration has mandated the provision of Rain Water Harvesting in all Commercial, Institutional, Public, Hotels, Industrial & Residential plots above One Kanal[32]. All existing buildings shall install rain water harvesting system to recharge the ground water within 2 years of the date of Notification.

Moreover, the spring level of the tubewells is depleting fast that has gone deeper from 230' to 290' ranging from Northern Sectors to Southern Sectors. In Manimajra area also the situation is similar because Panchkula & Chandimandir are also exploiting the deep aquifer by drilling deep tubewells in the absence of surface resource. This has resulted in reducing the lifespan of tubewells from 12-15 to 7-8 years & also increasing the consumption of power by lifting water from the greater depth which in turn has increased the generation cost. Keeping in view the deep aquifer, MC now proposes to draw only 10 MGD ground water through deep tube wells to improve the spring level of city Chandigarh.

Rainwater harvesting at the landscape level may have disadvantages such as pollutants may be passed on to the water while passing through the drain, agriculture land and other industrial areas. However, there are techniques made available by the Central Pollution Control board[33] for effective rainwater harvesting for different situations.

Table 5.3 Summary of Strategies for Climate Change for water conservation

Strategy	Activities and targets
Reduce water consumption	• All new buildings can be fitted water efficient fixtures aiming at 25% reduction of water consumption • Leakage Control Management • Replacement of malfunctioning water meters in all houses and commercial buildings
Landscape water conservation	• Use partially treated water for irrigation in all parks
Water audit for existing buildings and various landscapes	Assessment of use for various typology of water such as toilets, cooking, and others in all commercial and residential buildings; and landscapes such as parks and reserves
Use of tertiary treated water	Use of water for non potable purposes such as gardening, car washing and toilet flushing in all houses measuring >500 sq ft

[32] 1 Kanal = 5,000 sq ft

[33] http://www.ecacwb.org/editor_upload/files/Concepts%20and%20Practices%20for%20Rainwater%20Harvesting.pdf

Storm water management	• Zero drainage of storm water for large development sites that have > 30 acres • Sustainable urban drainage system on sites with more than 1 ha to implement SUDS technique • Rainwater harvesting structures to be built in all new buildings, commercial complexes and industrial establishments. Existing buildings to install rainwater harvesting structures within next 2 years • Recharging aquifers in all housing complexes and commercial complexes • Reduction of paving on unbuilt areas such that paving should not exceed 25% of unbuilt areas, where possible use of grass pavers

Chapter 6: Sustainable Habitat mission – Climate Change action plan for UT Chandigarh

The good building is not one that hurts the landscape, but one which makes the landscape more beautiful than it was before the building was built. – Frank Lloyd Wright

A National Mission on Sustainable Habitat[34] was launched to improve energy efficiency in buildings, manage solid wastes and modal shift to public transport. The Mission aims to promote energy efficiency as an integral part of urban planning and urban renewal through three initiatives: (i) The Energy Conservation Building Code, which addresses optimization of building energy demand; (ii) Recycling of material and Urban Waste Management with a special focus on producing power from waste, biochemical conversion, waste water use, sewage utilization and recycling options wherever possible and others; (iii) Better urban planning and modal shift to public transport to ensure efficient and convenient public transport. In addition, the Mission will address the need to adapt to future climate change by improving the resilience of infrastructure, community based disaster management, and measures for improving the warning system for extreme weather events. Capacity building would be an important component of this Mission.

As part of the Mission for Sustainable Habitat and Green Code for Chandigarh, detailed action plan and guidelines have been prepared by the Ministry of Urban Development (MoUD) which could be City's vision for sustainability. Chandigarh is a part of the Mission for model solar energy to harness solar energy to meet the requirements of power. In addition to address the issue of mitigation of GHG emission from municipal waste, appropriate actions are required through adoption of scientific waste management systems with options for recovery of wealth from waste, *i.e.,* compost and energy recovery from solid waste. Improved waste management will not only provide for significant GHG mitigation, but will also improve public health and environment quality.

The Ministry of Urban Development (MoUD) has formulated benchmarks for service delivery in the areas of water supply, sewerage, solid waste management and storm water drainage. The bench mark is given in Annexure 8. The Purpose of formulating these benchmarks is to shift the focus from infrastructure creation to service delivery. The benchmarks[35] incorporate various concerns related to mitigation such as coverage and per capita availability of water and sewerage, as well as concerns related to adaptation such as reuse of recycled water, cost recovery, recycling of waste, reduction of non-revenue water etc.

6.1 Baseline Scenario

Chandigarh is one of the planned cities in the world, but over the years, as the city started growing, it had encountered many problems. Some of them are as follows:

[34] National Action plan on Climate Change 2008.
[35] Benchmarks given as Appendix 2

6.1.1 Green Belt given away to Urbanization - Le Corbusier's concept of the green belt around the city to provide an environmental belt to control spread of urbanization besides the purpose of meeting the basic daily needs-vegetables, fruits, milk and milk products, poultry etc. has been given away to extensive urbanization in this area as a result of bifurcation. The city thus has to depend on far flung areas for its day-to-day needs –resulting in additional transportation costs and thereby increase in the price of essential commodities.

A detailed account of greening the city beautiful and its targets with various departments are listed in the Green India mission chapter. Given that the pollution is increasing over the last several years in Chandigarh and therefore there is an urgent need to develop a strategy to reduce pollution and absorb pollutants through specific tree plantations. The knowledge management mission should take up appropriate research or adopt research already undertaken elsewhere.

6.1.1.1 Dependence of Neighborhood States on City's Infrastructure - The development of the satellite towns of Mohali and Panchkula in the vicinity and their dependence for schools, hospitals, institutional, cultural and commercial areas has put great pressure on the city's infrastructure, increasing regional traffic through and city, adding to noise, air, pollution thus impacting the overall environment and carbon footprints of the city.

6.1.1.2 Disfiguring the anatomy of the city - The disposition of various land uses of the city, which was earlier ideal, today, seems misfit in the present scenario *e.g.,* industrial area, the grain market, the Timber and Wholesale market. These uses which were intentionally kept on the city's periphery are today sandwiched between the towns causing traffic congestion and traffic jams thus disturbing the functioning of the town. The anatomy and performance of the organism created by Le Corbusier has been totally disturbed.

6.1.2 Inadequate transportation system – Though the city has a well planned road network and with public transportation system in mind, yet public transport system is inadequate. The city has the highest per capita car ratio in the country and the predominant mode of transport is private transport. The large volumes of intra and inter city traffic on the roads has resulted in saturating the carrying capacity of the roads leading to traffic congestions, traffic jams, noise and air pollution and consumption of huge quantum of fossil fuels. There is thus an urgent need to reduce the traffic congestion of the roads.

6.1.3 Power / Energy Inadequacies - The city does not have any provision of power generation of its own and is totally dependent on the neighbouring states for its power supply. The increase in population along with the ever-increasing per capita consumption of electricity is making it difficult for the city to meet the demand. This has lead to power shortages affecting the productivity.

6.1.4 Water problems - At present the city has 87 MGD of water which includes 20 MGD from 210 tubewells and also utilizing 6 MGD and 3 MGD water share of Haryana and Chandimandir respectively. As per the CDP submitted by Municipal Corporation to Ministry of Urban Development, by 2011, the requirement of the water would be 137.23 MGD, which would grow up to 211 MGD by 2035[36]. The spring level of the tube wells is depleting very fast that has gone deeper from 230' to 290'. This has resulted in reducing the lifespan of tube wells from 12-15 to 7-8 years & also increasing the consumption of power by lifting water from the greater depth which in turn has increased the generation cost. Keeping in view the deep aquifer, MC now proposes to draw only 10 MGD ground water through deep tube wells to improve the spring level of city Chandigarh. In spite of the acute shortage of water in the city and due to non availability of tertiary water, potable water is being used for irrigation, watering of lawns, for construction, washing of cars etc which is further aggravating the shortage of potable water.

6.1.5 Choking Sewage System - As per the report prepared by the Municipal Corporation on this title, the brick trunk sewers laid more than 30 years ago in Phase I and Phase II sectors have outlived their life. This report also brings out that only some of the sewage after treatment is recycled back to the city for the purpose of irrigation, watering lawns etc, however the same has not yet been distributed throughout the city. There is a proposal to do so to ensure that the remaining parts of the city would also have supply of tertiary water supply.

6.1.5.1 Solid Waste Management - Rapid urbanization, increasing population and changing lifestyles have resulted in a quantum leap in the waste generated in the city. From the population of 1 million, the municipal solid waste generation per capita per day is 400 grams in Chandigarh and is likely to increase over the years.

6.1.5.2 Lack of Waste Segregation - At present the waste is collected from door to door and then deposited in Sehaj Safai Kendras in the sectors. It is the responsibility of the Municipal Corporation to treat and dispose of the segregated waste in a sustainable manner. However, source segregation is almost absent.

6.1.5.3 Inadequate Landfill Sites - Large quantities of non- bio-degradable waste is generated but there is not enough land filling sites. The existing landfill site has been exhausted and finding space for additional landfills has become a great challenge. There is therefore an urgent need to manage municipal solid waste-which includes waste from residential buildings and complexes, commercial buildings, industrial waste, biomedical waste from health facilities, hospitals, construction and demolition waste, in a more holistic, integrated and sustainable manner.

[36] Chandigarh Administration

6.1.5.3 Setting up of De-Skinning/Carcasses Utilization Centre - At present there is no suitable place for de-skinning of the dead animals and with a view to undertake this work in sanitary conditions, there is thus need to identify a suitable site for the same.

6.2 Current National and State policies towards Sustainable Habitat

6.2.1 The National Mandate – Mandatory Compliance with ECBC: The Ministry of Power, Government of India has launched ECBC 2007 on 27 May 2007 for its implementation in commercial buildings on voluntary basis all over India, with a view to make this mandatory in the next couple of years depending upon the experience gained during the voluntary period. This code as prepared by the BEE under the Ministry of Power and helps to make air-conditioned buildings Energy Efficient.

6.2.2 ENERGY EFFICIENCY IN BUILDINGS: The following are part of the agenda directed towards energy efficiency:

6.2.2.1 Adoption of Green Building Concepts in the Building Designs of the City: 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. The green building codes have been detailed in annexure 4. The features of the code are site selection and parameters for conservation of efficient utilization of Resources.

6.2.2.2 Pre-construction Measures: Some measures are timing of construction, Preservation of existing vegetation, preservation of top soil and spill prevention and control.

6.2.2.3 Measures during construction: This stipulates that soil erosion, sedimentation control plan be submitted prior to construction. Sedimentation basin –this necessitates the construction of a temporary dam or basin at the lowest point of the site for collecting, trapping and storing sediments produced by the construction activities, together with a flow detention facility. Apart from this, the measure also takes care of soil and water conservation, vegetative measures to reduce top soil erosion, rainwater harvest structures[37], infiltration techniques and water reuse measures especially for drinking purposes.

6.2.2.4 Plantation Design Consideration: Planting design consideration lays emphasis on the sensitive decisions based on various aspects, ecology, botany, horticulture, aesthetic value, growth and survival, environmental considerations. For service Utilities in Landscape areas paved surfaces with hard paving should be reduced or to be provided with shade.

[37] Rainwater harvest has been extensively dealt in the water sector. Therefore the readers may refer appropriately if more details are needed.

6.2.2.5 Solar Passive design: Passive architectural design strategies can help in reducing the annual electricity consumption of buildings by 5 to 20%. At present most buildings consume non renewable resources. Energy consumption in buildings in India is about 35% of total electricity produced. By designing solar passive buildings the load on conventional systems on HVAC (Heating Ventilation and Air Conditioning) and artificial lighting reduces.

6.2.2.6 Landscaping: Landscaping by vegetation is one of the most effective ways of altering micro climate for better conditions. Natural cooling without air conditioning can be achieved by locating trees to channel cool breeze inside the buildings. Additionally, the shade created by trees, reduces air temperature of the micro climate around the building through evapotranspiration. Properly designed roof gardens help to reduce heat loads in a building. Water has a moderating effect on the air temperature of the micro climate. It possesses very high thermal storage capacity much higher than the building materials like Brick, concrete, stone. A large body of water in the form of lakes, rivers, fountains moderates air temperatures in the micro climate. Water evaporation has a cooling effect in the surroundings. It takes up heat from the air through evaporation and causes significant cooling especially in hot season of Chandigarh.

6.2.2.7 Orientation: In solar passive buildings, orientation is a major design consideration, mainly with regard to solar radiation, daylight and wind. The orientation of the building should be based on whether cooling or heating is predominant requirement in the building. The Orientation also plays an important role with respect to wind direction.

6.2.2.8 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 roof top and roof treatment to reduce heat gain.

6.2.2.9 Thermal insulation for exposed walls: Thermal performance of walls can be improved by increasing wall thickness, providing air cavity between walls, hollow masonry blocks and applying insulation on the inside of external walls. Air cavity within walls or an attic space in the roof ceiling combination reduce solar heat gain factor, thereby reducing space conditioning loads.

6.2.2.10 Evaporative Cooling: Evaporative cooling lowers indoor air temperature and is effective in hot & dry climate zones when the atmospheric humidity is low. In evaporative cooling the hot air is used to evaporate the water, thereby releasing energy and air gets cooled, which in turn cools the indoor living spaces. Increase in contact between air and water increases the rate of evaporation. Water bodies like ponds, lake or fountains in the landscape help to

reduce micro climate air temperature around the buildings. In Chandigarh evaporative cooling is used to cool the hot breeze. Water is used commonly to reduce local temperatures by evaporative cooling, to humidify the air and also to clean the air by capturing dust particles.

6.2.2.11 Passive downdraught cooling: In this system, wind catchers guide outside air over water filled pots, which causes evaporation and a significant drop in temperature before the air enters inside the interiors. Such wind catchers can also define the architecture of the building. Passive down drought cooling is particularly very effective in hot & dry climate zones. Results from existing buildings in India where P.D.D.C system is working indicate that internal temperatures are 10 to 15^{o}C below the peak external air temperature. This system could be installed in multi-storey buildings. Direct evaporative cooling process entails evaporation of water in warm dry ambient air at a high level of the building. The evaporation process lowers the air temperature and raises its moisture content while maintaining a constant wet bulb temperature. It is a very attractive means of cooling as the installation is cheap as well as consumes very little energy.

6.2.2. The Green Building Code: A code offers a broad, subjective set of recommendations and means to achieve a certain end. The end in this case is a Green City or a structure that has a minimal negative impact on the environment and consumes minimal resources (Water, Energy, Power etc) during its construction, operation and demolition stages.

6.2.3 Green Rating Systems: There are rating systems such as the Leadership in Energy and Environmental Design (LEED) rating system. This system is developed by the United States Green Building Code (USGBC) and now adapted by Indian Green Building Council (IGBC). In India, TERI has developed its independent rating system called the Green Rating for Integrated Habitat Assessment (GRIHA) rating system, which has been endorsed by the Ministry of New and Renewable Energy (MNRE). MNRE has initiated schemes
which offer incentives to architects, planners, who achieve a 3 star GRIHA green rating. The MNRE has also launched a set of guidelines for energy efficiency measures in commercial and residential buildings. Financial assistance is being offered by MNRE for encouraging awareness efforts, for organizing seminars and disseminating knowledge.

6.2.4 Schemes to encourage use of Solar Photo Voltaic: To encourage the use of Solar Photovoltaic various schemes have been launched. The Chandigarh Administration through the CREST has already initiated the process of installing Solar Voltaic in institutional campuses.

There is a target of installing 2.5 MW roof top based solar photovoltaic power plant till 2015 and 10 MW till 2022. The details of SPV power plants being installed is depicted in table

6.3 Climate change impact on built environment

Table 6.1 Average Respirable Suspended particulate matter and Suspended Particulate Matter found over 5 sites in the last 5 years (in ppm) (Source: ENVIS Chandigarh)

Year	RSPM	SPM
2005	99	252.6
2006	104.8	191.8
2007	102.4	220.2
2008	95.6	199.8
2009	81	165

Developments in Indian economy have triggered the growth of real estate in the country. Huge investments are being committed in real estate due to increased demand and increasing capacity to invest. Buildings account for more than 60% of all energy use in most high- and middle-income countries of the world, and an increasing proportion in low-income regions. Studies have indicated that both the functionality of the existing built environment and the design of future buildings may need to be altered to cope with the climate change impacts. This would include heat island effects created due to more use of conventional space cooling technologies in future when mean and maximum temperatures rise.

6.4 Environmental Degradation

Table 6.2: Forecast by Class of Vehicle Populations in India (In Millions)

Population	2015	2025	2035
2-Wheeler	87.7	174.1	236.4
3-Wheeler	5.3	8.8	13.1
HCV	4.6	9.1	16.1
LCV	5.7	12.5	26.9
Car, SUV	18.0	41.6	80.1
Total	**121.3**	**246.1**	**372.7**

6.4.1 Air Pollution - Ambient air quality of Chandigarh is under pressure. Respirable Suspended Particulate Matter in the city is crossing its permissible limits (Table 6.1). The fleet of vehicles is over 2 per household. Chandigarh has the highest density of vehicles in India. The other major contributor of air pollution are activities like transport, industries, burning of dry leaves, litter from trees & gardens in the city, and operation of generator sets in certain areas. Pollution would be on the rise as the forecast of new vehicles in the forthcoming years in Chandigarh is high (Table 6.2). The composite pollution index provided for over 85 countries across the world indicates that Chandigarh is one of the least polluted cities (6.3). The highly polluted city in the world Jakarta has a composite pollution index of 146, while Chandigarh has only about 12.07.

6.4.2 Noise Pollution - Chandigarh has taken many measures such as, ban on movement of heavy vehicles on internal roads, a carefully segregated industrial area, a dense vegetation cover, etc., but still in some areas noise level exceed the noise pollution limits.

6.5 Solid Waste Management

Solid waste management now has widely been recognized as a resource for the generation of energy in an environmentally sustainable manner. Most of the urban centres in the country lack system of scientific management of municipal solid waste. Presently in urban areas municipal waste is rarely segregated at source instead mixed waste is dumped into low lying areas. Municipal Solid Waste generally comprises of 30-35% of bio-degradable matter, 20-35 % inert matter and 5-15 % recyclable matter[38]. Bio-degradable matter can be profitably converted into useful energy like compost for manure, methane gas for cooking, heating, lighting etc. While biomethanation, refuse derived fuel and incineration are the most common technologies; pyrolysis and gasification are also emerged as preferred options. The major benefit of recovery of energy from urban waste is reduction in land requirement by 60-90% as well as transportation, reduction in pollution besides generation of energy.

Table 6.3: Pollution index of various cities in India (http://www.numbeo.com/pollution/rankings.jsp)

City	Pollution Index	Exponential Pollution Index
Jakarta, Indonesia	146.25	208.78
Kolkata	145.50	210.58
Mumbai	125.00	172.83
Delhi	115.71	160.17
Hyderabad	110.62	153.12
Chennai	103.57	144.91
Nagpur	101.25	146.21
Kochi	91.67	130.27
Bangalore	72.84	96.67
Pune	71.67	99.39
Nasik	62.50	97.60
Chandigarh	**12.07**	**48.75**[1]

[1] http://www.numbeo.com/pollution/city_result.jsp?country=India&city=Chandigarh

6.5.1 Status of Solid Waste Management in Chandigarh: Both neighborhood level and building level interventions to manage solid waste in a more scientific manner has been attempted. Door to door collection of waste is promoted wherever possible. An attempt has also been made to deal with the increasing electronic waste, popularly known as e-waste. Efforts are being made to involve different stakeholders often overlooked at policy level such as rag-pickers/recyclers. For the purpose of collection, the corporation has allotted about 1/5th of the city area to private entrepreneurs for providing sanitation services and has outsourced to 373 safaiwalas.

The garbage is collected in the wheel barrows/small cycle carts during the road sweeping by the safaiwalas of the corporation and is collected from house to house in large cycle carts by the Resident Welfare Associations and NGOs through the cart pullers. The Municipal Solid Waste so collected is deposited in the community bins/Sehaj Kendras from where it is transported to the dumping ground regularly through hydraulic fitted fast moving vehicles.

[38] Green Code Chandigarh

6.5.2 Treatment of Garbage with EM solution and Dumping of Disposal: The Corporation has started the treatment of city garbage at the dumping ground with Effective Micro Organism Solution (EM Solution) with effect from 2005. This treatment if helpful in the acceleration of decomposition process of the garbage, reduction in volume of gas discharge with the result that foul smell has substantially minimized, minimization of larva of flies & mosquitoes, reduction in suspended dust particles, reduction in the volume of waste and fermentation period. EM solution is still being sprayed on the dumping ground. The city corporation has earmarked 45 acres of land fill sites in Sector 38. The garbage transported to dumping ground is compacted with heavy chain dozer, treated with EM solution, is covered with a thick layer of earth on daily basis as per MSW Rules 2000.

6.5.3 Garbage Processing Unit: Garbage processing unit has been set up by Jaiprakaash Associates Ltd on BOOT (Build, own, operate and Transfer) basis in the name of Green-Tech Fuel Processing Plant. In this plant municipal solid waste has been converted into refused derived fuel (RDF) which is further used as a fuel in various industrial processes.

6.5.4 Central Pollution Control Board's Sponsored Demonstration Project - The Central Pollution Control Board has allotted one 'Demonstration Project' to the city Corporation of Chandigarh for the management of Municipal Solid Waste and to project the implementation of Municipal Solid Waste (Management & Handling) Rules, 2000. The project covers works relating to road sweeping, its collection, storage and disposal as per norms. The municipal Corporation has purchased mechanical road sweeper and no of cycle carts, dust bins, garbage containers, vehicles etc.

Figure 6.1: Project Sahyog carriages

Project Sahyog for 'Waste to Wealth' was started by Chandigarh Administration along with Chandigarh Animal Welfare and Eco-development Society involving the Municipal Corporation, Municipal Councilors, Residents Welfare Associations, NGOs and all major institutions in the city like big hospitals, colleges, hotels and universities for locally managing the waste generated by them. The main plank of the Project 'Waste to Wealth' is the Sehaj Safai Kendras (SSK) and/or Khad Banao Kendras (KBK) which are set up within the institutional areas, as in the case of GMCH-32, GH-16, GCG-11, PEC, Hotel Parkview etc. The project first started by diverting segregated waste generated in hostel kitchens etc. in institutions and treating it in composting/vermi pits. The waste generated in the institutional area soon got converted into rich organic compost which immediately impressed the residents with its excellent qualities and potential for vegetable, fruit and flower cultivation. In the second stage, the programme formulated that each sectors will have its own garbage or waste

management centres minimizing transportation of garbage and also minimize the load on the landfill site as well as decentralize the entire process.

6.6 Climate Change strategy

Chandigarh is preparing its master plan to develop a sustainable city.

6.6.1 Chandigarh City Vision – the vision of the new master plan is to build upon and reinforce the original vision of le Corbusier while providing a framework for accommodating the new and emerging demands and pressures in a manner which preserves the quality of life and its urban fabric while rectifying some aberrations which have crept in. In line with global on climate change the Chandigarh will strive to reduce urban carbon foot print. Chandigarh will strive to become a model for sustainable water management, use o renewable sources of energy, protecting the local ecology and environment. The master plan also strives to reduce private vehicle use and increase public transport. For a low carbon urban plan the following are some of the plans for Chandigarh:

6.6.1.1. The pedestrian City: Le Corbusier gave due emphasis on the pedestrian. The aim of the master plan is to strengthen the lively and comfortable pedestrian movement through city's green pathways. This could reduce up to 5% of the carbon emissions from the traffic.

6.6.1.2. Introduction of bicycles as a mode of transport: The park and ride concept model used world over is being considered for the Chandigarh UT to reduce the traffic congestion in many parts and also to reduce carbon foot print. This could reduce up to 10% of the carbon emissions from the traffic.

6.6.1.3. Slum free city: In recognition to effectively rehabilitated the urban poor Chandigarh has been conferred "JNNURM award" during the year 2009-10 by the Hon'ble Prime Minister. However, much of the work needed to be undertaken by the Chandigarh UT to improve the condition of slum dwellers in the city. The master plan seeks cooperation from the neighbouring states to improve the conditions of Chandigarh.

6.6.1.4. Reduced vehicular congestion: per capita vehicle per family in Chandigarh is high and as a result there has been increased vehicle density in the city. In addition the neighbouring states and tourist vehicles passing through the city to access other state capitals such as Haryana, Punjab and Himachal Pradesh. Therefore a plan to develop appropriate bye-pass roads to relieve vehicle congestions need to be thought. Furthermore, increased public transport to various access points may ease the congestion of city vehicles. Chandigarh Transport Undertaking may be strengthened to improve the busses to enhance frequency of busses plying between various points. It is also important to increase awareness among the public to use public transport than using the private vehicles.

6.6.1.5. Tourism Development: Tourism is an important aspect of Chandigarh UT. Therefore adequate measures need to be given to sustainable tourism. Chandigarh has a number of

places for tourist visits. One of the being the Sukhna Lake. Sustainable or Ecotourism in and around Sukhna Lake would be an ideal option. Reducing the siltation of Sukha Lake, developing tree line in the catchment areas and such other measures would help Sukha Lake tourism prospects.

6.5.1.1. Creating awareness among Public: One of the important aspects of vision of Green Chandigarh is awareness building among the public. Chandigarh has already taken a leap towards this by preparing Green Code for Chandigarh and also preparing a master plan for Chandigarh. As a part of these two programmes, Chandigarh is creating awareness among the public to use appropriate technologies for reducing pollution and reducing carbon emissions and ultimately to develop Chandigarh as a low carbon city. Several eco clubs and resident association committees have been engaged for greening Chandigarh.

6.6.2 Integrated Solid Waste Management– several plans have been made to improve the living conditions of the city and to reduce pollution and subsequent reduction of GHG to inch towards low carbon city.

6.6.2.1 At Sector Level: All residences other than the apartments and small neighborhood shops are required to store segregated waste (biodegradable and non-biodegradable) and hand over to the waste-collector (door-to door collection by Municipal Corporation for disposal in the ward-level/Sector level waste processing/segregation place against a certain fee. This guideline is targeted at efficient management of generated residential solid waste on the principles of Integrated Solid waste Management.

It is proposed to encourage public-private alliances between the local bodies, NGOs, RWA's and CBO's for innovative models for managing solid waste at neighborhood level. OSI, Bio-sanitizer, Compositing, vermin-composting, compositing with bio culture method, are the recommended methods**.**

6.6.2.2 Waste Management in Apartments & Societies: It is proposed that Group Housing Societies with more than 20 households and apartments with similar strength in each sub-sector shall provide segregated Solid Waste Management facilities within the site in a sustainable manner[39]. A secondary storage space at community level has to be provided for each (existing and new) dwelling unit for treating recycling and collection by the Municipal Corporation. For this the space requirements are to be calculated @ 2.6 kg of waste per household for a family of 4% with the density of the given type of waste. The enclosure for the communal storage has to be at least 2 m high with provision for washing down and draining the floor into a system suitable for treating the polluting effluents. It should

[39] Chandigarh Green Code


preferably be covered and secure to prevent access by animals. The biodegradable part of the waste shall be treated in a common treatment plant. An area of 1.2m x 1.2m in new buildings will be planned which should be sufficient to provide storage of waste containers for all category /types. There are a number of treatment options available for treating bio-degradable waste at a smaller scale such as composting and biomethanation.

The Management of Solid Waste on the basis of various *functions of the building* has been enlisted below for implementation:

- By commercial waste it is meant by-products and materials consumed during business activities, building management and maintenance. All commercial buildings should have arrangement for storage of segregated waste.
- All market waste (coming from fish/slaughterhouses/vegetable/fruit/flower markets) should have arrangements for composting of the organic waste.
- All hotels and restaurants should have in-house arrangements for treating biodegradable waste.
- All offices should have arrangements for recycling of items such as paper and cardboards, toner cartridges, batteries, mobile phones and e-waste.

6.6.2.3 Annual Waste Audit Report of Commercial Buildings: It is proposed that an annual waste audit report should be made mandatory for all commercial, Offices, Restaurants, Hotels, Educational Institutions etc., to be submitted to the MOH/ Municipal Corporation.

6.6.2.4 The Management of Biomedical Waste As per the Environment Report 2008[40], biomedical waste in Chandigarh is collected and treated with 100% efficiency. Biomedical waste approximately forms 0.4% of the total municipal waste generated in Chandigarh. All the health care units in Chandigarh are following the Bio-Medical Waste (Management & Handling) Rules, 1998. Major Hospitals like PGIMER, Govt. Medical College and Hospital (Incinerable waste is being treated in PGIMER/ GMSH-16), Govt. Multi Speciality Hospital and Primary Health Centre, Manimajra are having their own treatment facility and rest all the Govt./private health Care Units are taking the facility of Govt. Sector for disposal of bio-medical waste.

It should be made mandatory to form a Waste Management and Recycling Plan for construction and demolition projects for all new buildings and refurbishments of existing buildings with intent to minimize the generation of waste due to construction activity and manage the generated waste in a sustainable manner.

The below measures are a compulsory requirement for plan approval.

[40] State of Environment Chandigarh -2008, ENVIS Centre, Chandigarh


- In case of demolition projects, a minimum of 20% of the existing structure (walls, roofs and floors, windows, doors, etc. excluding the hazardous materials) if reused shall be given incentive/rebate.
- A minimum of 20% of the construction waste generated should be reused/recycled.
- A minimum of 4% of the total site area should be allocated for storage of the waste. This storage area should be covered and the pollutants from the waste should not affect the surrounding.
- A document with the confirming the contents of wastage need to be submitted to the concerned authority along with plan approval documents.

An estimate of the reduced GHG emission and cost required to implement the above need to be worked out.

6.6.3 Comprehensive mobility plan: Urban transport strategy plays an important role in tackling urban problems, traffic congestion constraints and business efficiency which degrades the quality of life. Urban Transport projects can reduce journey time and its unpredictability resulting in savings in travel time and vehicle operating costs thus improving economic and social potential. This is expected not only to enhance efficient traffic movement and reduce time to travel; most importantly this improves the reduction of petroleum product use such as petrol diesel etc., which directly contributes to reduction of emission. A comprehensive mobility plan has been prepared by **RITES**[41],[42] in consultation with Governments of UT Chandigarh, Haryana and Punjab which proposes the following infrastructure development:

1. Provision of high capacity mass transport corridors along trunk corridors and extension of mass transport system to provide wide coverage and transport integration with other modes of transport
2. Provide substantially large network of medium level mass transport systems such as BRT to cover the areas beyond metro network on overloaded corridors.
3. Land use adjustments and densification of corridors along mass transport corridors where possible.
4. Provision of commuter rail system up to Ambala, Pinjore-Kalka, Ludhiana and Baddi-Nalagarh
5. Rationalization of local bus system and its augmentation
6. Improvement in traffic management through TSM measures.
7. Special facilities for pedestrians within the network especially in the core areas; provision of pedestrian subways, foot paths and road furniture along the roads where necessary.
8. Developing V – 6, V-7 roads as pedestrian and cycle pathways across sectors to facilitate their movements across two adjoining sectors

[41] RITES, 2009, Comprehensive Mobility Plan for Chandigarh Urban Complex, Draft Final Report, Rites Ltd. http://chandigarh.gov.in/advt/cmp-mrts100809.pdf

[42] Delhi Metro, 2012, Final Detailed project report on Metro Rail in Chandigarh Urban Complex, Chandigarh Administration, Govt of Haryana and Govt of Punjab.

9. Diverting through traffic bye-passes, providing transport hubs at the periphery of Chandigarh Urban Complex
10. Improving primary, arterial and other important roads (particularly radial and ring road) by providing grade separation in the form of underpass, junction, improvements, adding missing links widening and other road side facilities.

6.6.3.1 Traffic and Transportation Plan for Chandigarh: On the basis of projected traffic, an integrated multi-modal mass transport system plan on various corridors has been suggested in order to cater to cater to traffic up to 2041. The mass transport system has been proposed on various corridors considering expected traffic demand by 2041, available road right-of-ways and system capacity. The balance traffic should be carried by road system in order to satisfy the normal bus system and other modes such as two wheelers, cars, bicycles, trucks, pedestrians etc. The proposed comprehensive mobility plan for Chandigarh Urban Complex contains the following types of proposal, which will cater to requirements of the projected travel demand up to 2041.

6.6.3.1.1 Short term measures - Traffic engineering and management measures have been finalized in the light of problem identification and included in this report. The schemes consist of the following measures:

- Traffic engineering management measures
- Intersection improvement (Corridor improvement by traffic circulation measures such as ban on certain turning movements, one way streets, providing channelizes, underpasses at junctions etc.)
- Provision of automatic multi level parking lots
- Schemes non motorized modes

6.6.3.1.2 Medium and Long Term Tariff and Transportation Plan

Within Chandigarh Urban Complex

- Mass transport system
  - Metro System
  - Bus Rapid Transport (BRT) system
- City Bus System
  - Augmentation of Bus Fleet
  - Bus shelters
  - Additional Depots
- Inter-city Bus terminal
  - Road Infrastructure
  - Parking Facility
  - Inter modal Interchanges

- Integrated Freight complexes

Outside Chandigarh Urban Complex

- Road infrastructure
  - Bypasses
  - Road Widening
- Commuter Rail System
- Bus Rapid Transit System

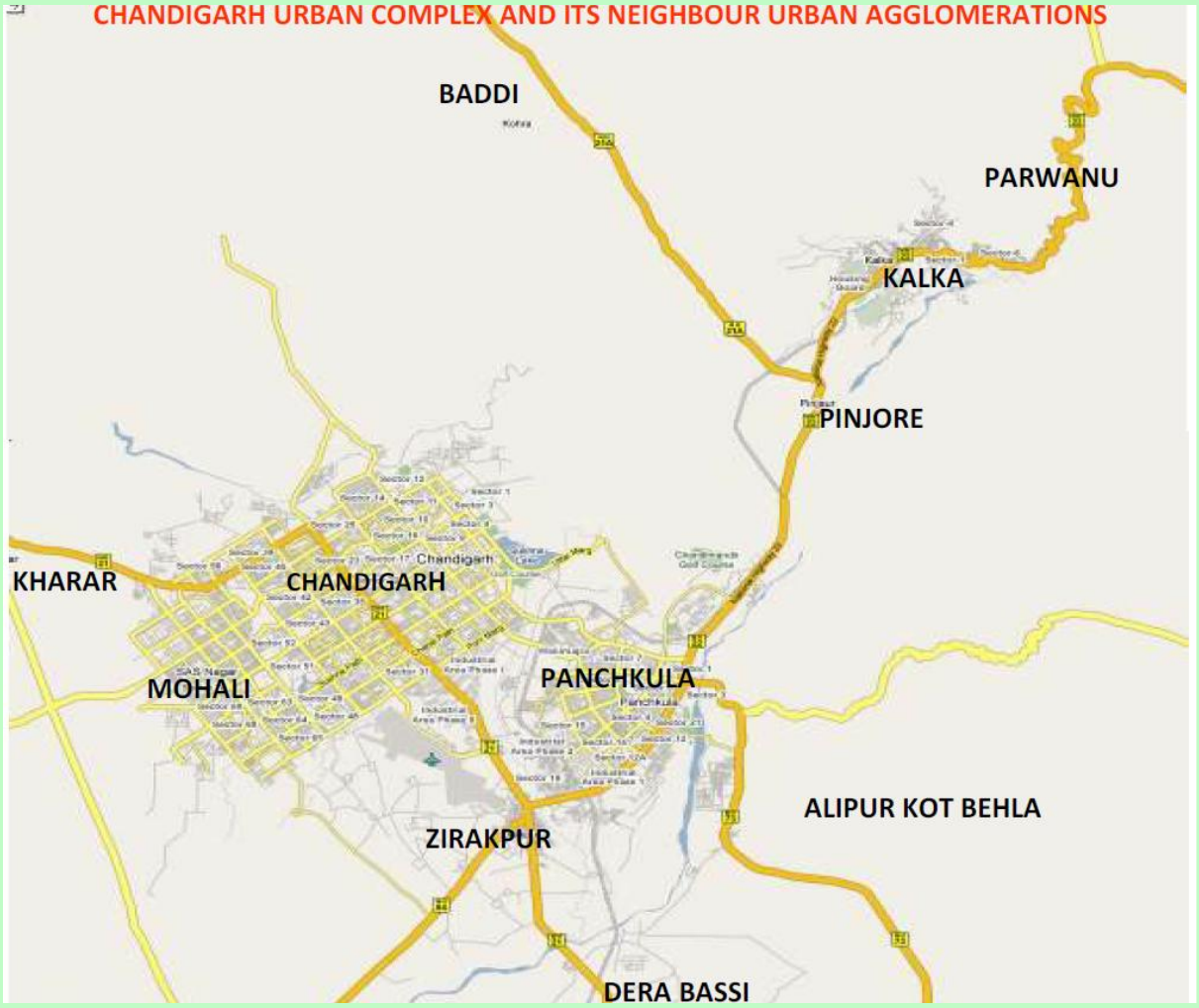


Figure 6.2: Chandigarh urban complex and its neighbor urban conglomerate

Proposed Mass transport Corridors

Metro Corridor

1.	Khuda Lahora – IT Park (Madhya Marg)	16.1 km
2.	Sector Sector 43 Bus Terminal – Sector 52 (Himalaya Marg)	10 km
3.	Sector 26- sector 38 Dadu Majra (Purv Marg/Vikas Marg0	14.6 km
4.	Chandigarh Sectro 52 – Mohali Sector 104	12 km
5.	Housing Board Chowk – sector 21 Panchkula	5 km

Bus rapid Transit (BRT) Corridor

1.	Police Housing Complex – Zikarpur (Along dakshing Marg)	18 km
2.	Sukhna Lake – Sector 49 – Kharar (along Sukhna path Via sector 62 SAS Nagar	20 km
3.	PGI Pocket F SAS Nagar (Along Vidya Path)	11 km
4.	Zirakpur-dera Basi (Along dakshin Marg)	8 km
5.	Kharar – Bannur	18 km
6.	Pocket F SAS nagar – Chatbir	20 km
7.	Sector 28 Panchkula extension – Mansa Devi Complex Via sector 5 city centre Panchkula	23 km
8.	Housing Board Chowk – Sector 1 Panchkula – Zirakpur	14 km
9.	Industrial area phase 2 Panchkula – Dakshin Marg (along Route no 2)	4 km
10.	Sector 49 – Sector 87 City Centre Mohali	9 km
	Total	**145 km**

Commuter Rail Corridors

1.	Ambala – Kalka	70 km
2.	Chandigarh – Mohali – Ludhiana	90 km
3.	Pinjore – Baddi – Nalagrh	35 km
	Total	**195 km**

The above measures are expected to reduce travel time, improve the travel conditions and reduce the energy consumption in terms of electricity, petrol, diesel etc. At this junction, it is not estimated the amount of GHG emissions the proposals may reduce due to the above measures, once fully operational.

6.7 Climate Change and Health sector

Changes in climate may alter the distribution of important vector species (for example, malarial mosquitoes) and may increase the spread of such diseases to new areas. If there is an increase of 3.8 °C in temperature and a 7% increase in relative humidity the transmission windows i.e., months during which mosquitoes are active, will be open for all 12 months in 9 states in India. The transmission windows in Jammu and Kashmir and in Rajasthan may increase by 3-5 months.

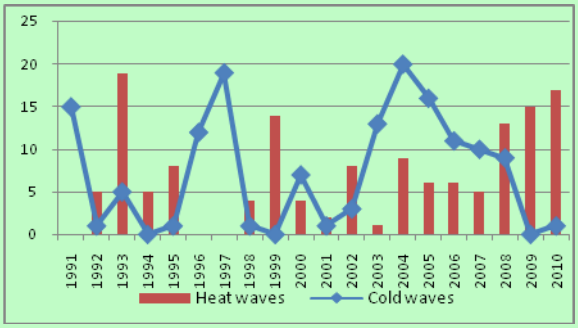


Figure 6.3: Frequency of heat and cold waves in Chandigarh in the last 20 years

However, in Orissa and some southern states, a further increase in temperature is likely to shorten the transmission window by 2-3 months[43].

6.6.1 Heat waves and human health - Heat waves are normally associated with the high average temperature and the number of consecutive hot days. Heat exhaustion is the most common response to prolonged exposure to high outdoor temperature; it is characterized by intense thirst, heavy sweating, dizziness, fatigue, fainting, nausea or vomiting, and headache. If unrecognized and untreated, heat exhaustion can progress to heatstroke, a severe illness with a rapid onset that can result in delirium, convulsions, coma, and death. Heatstroke has a high fatality rate. Non-fatal heatstroke can lead to long-term illness. In India, 18 heat waves have been reported during the period between 1980 and 1998, with a heat wave in 1988 affecting 10 states and causing 1300 deaths. Heat waves in Orissa in 1998, 1999, and 2000 caused an estimated 2000, 91, and 29 deaths, respectively, and heat waves in 2003 in Andhra Pradesh caused more than 3000 deaths. In India, the frequency of hot days and multiple-day heat waves has increased in India in the past century[44]. In particular, El Niño years are more prone to get frequent heat waves, whereas heat wave occurrences are fewer during La Niña years. In Chandigarh, there has been frequent heat and cold waves observed (Figure5. 1). During 1993, highest numbers of heat waves were noticed followed by 2008 and 2009, while 996 and 1997 experienced frequent cold waves[45]. This indicates that Chandigarh may experience frequent cold and hot waves due to climate change impacting on the health of inhabitants of Chandigarh City.

6.7.2 Likely Impacts of Climate Change on Human Health - Some of the fundamental impacts of climate change as indicated on human health are listed below[46]:

- Extreme air temperature leading to heat waves is a direct contributor to deaths from cardiovascular and air pollution to respiratory disease, particularly among elderly people. High temperatures also raise the levels of ozone and other air pollutants that exacerbate cardiovascular and respiratory disease, and pollen and other aeroallergens that trigger asthma.
- Floods, droughts and contaminated water raise disease risk as more variable precipitation is occurring, with an increase in the frequency and intensity of both floods and droughts. At the same time, higher temperatures are hastening rates of evaporation of surface waters and melting the glaciers that provide fresh water for many populations. Lack of fresh water compromises hygiene, thus increasing rates of diarrheal disease. In extreme cases, water scarcity results in drought and famine. Too much water, in the form of floods, causes contamination of freshwater supplies and also creates opportunities for breeding of disease carrying insects such as mosquitoes.

[43] India: Second National Communication to the United Nations Framework Convention on Climate Change (2012)
[44] IPCC Report 2007 (Assessment Report 4)
[45] Graph generated based on the data from ENVIS, Chandigarh (http://chandigarhENVIS.gov.in/beta/asp/header.asp?page=index.asp)
[46] WHO 2009, Protecting health from climate change – Connecting Science Policy and People

- Rising temperatures and changing patterns of rainfall are projected to decrease crop yields, stressing food supplies. This is deleterious for small and marginal farmers as they are unlikely to have enough income to buy food. This situation is expected to translate directly into wider prevalence of malnutrition. In turn, malnutrition and under nutrition increase the severity of many infectious diseases, particularly among children.
- Expected increases in the frequency and severity of flooding and storms will result in the destruction of homes, medical facilities and other essential services, impacting particularly on people in slums and other marginal living conditions.
- Many of the major infectious diseases transmitted by water and contaminated food, and by insect vectors are highly sensitive to climatic conditions and weather extremes. Climate change threatens to slow, halt or reverse current progress against many of these infections.
- Many vector control measures as prescribed by the national vector borne disease control board[47] will be taken up such as Chemical control; biological control; community participation and awareness; individual prophylactic measures; environmental management and source reduction measures.

6.7.3 Impact of climate changes on the Health in Chandigarh:

- The city is experiencing continuous rise in temperature from last decade. This rising temperature has a direct impact on the rise in respiratory and cardiovascular diseases. The continuous rise in the motor vehicles numbers and concrete construction has lead to dust storms and free suspended particulate leading to air pollution. Also, the city has green plantation more of the exotic plants which leads to exposure to pollens and aeroallergens that trigger diseases like asthma.
- With the rising urbanization and better living standards, the city people are more prone to life style diseases. There is rise in number of cases reporting to the Hospitals with Hypertension, Obesity, Cardiovascular diseases.
- Waste management and disposal now a day is a major issue. With the rising population and strictness in the Biomedical waste management (rules and regulations), the disposal of the waste has become a major health issue. Also, with the advancement of information technology, the city will face problems in the management of E-waste.
- From the last few years, there is an alarming increase in the number of vehicles plying on the city roads. This continuous rise in the motor vehicles has led to the rise in the vehicular accidents over the years.
- Geographically, the city lies in the high risk earthquakes zone; there is always a risk of disasters to occur. Earlier the city has construction limits of up to three floors of the maximum, but in the recent city has come up with many high rising buildings.

[47] http://nvbdcp.gov.in/malaria11.html

- From the recent times there is increase in the menace of stray animals in various city areas. The stray animals move on the roads or else and have become the source of road accidents. The monkeys are the source of menace in the city southern sectors. There has been rise in the dog bite cases in the city from recent times.

Integrated Disease Surveillance programme (IDSP) was launched in Chandigarh in 5th April, 2006. The basic purpose of the implementation of IDSP is to detect early warning signals impending outbreaks. The main objectives of the project are (i) to establish a decentralized state based system of surveillance for communicable and non-communicable diseases, so that timely and effective public health actions can be initiated in response to health challenges in the country at the state and national level; (ii) to improve the efficiency of the existing surveillance activities of disease control programs; (iii) to establish a public Health Laboratories; and (iv) To provide a secure online data management system.

As a part of IDSP, weekly disease surveillance report is being developed and early warning signals and outbreaks have been detected. A toll free number 1075 has been established to inform any type of outbreak ad other relevant information in respect of communicable and non communicable diseases to the Government authorities. IDPS unit has been carrying out for Prevention and Control of Communicable & Non Communicable Diseases like Swine Flu, Cholera, and Dengue etc through distribution of Banners, Pamphlets and other IEC materials amongst the general public for creating awareness. IDPS laso has established a EDUSAT network at State Surveillance Unit, GMCH sector -32, and at PGIMER Sector 12.

6.7.4.1 Strategies to manage the climate change impact:

6.7.4.1.1. Short term plans:

- An assessment needs to be carried out to understand the extent of the disease burden that may occur due to climate change and develop plans for the risk reduction of the diseases.
- Awareness programs/campaigns need to be launched to raise the public awareness on climate changes and its impact.

6.7.4.1.2 Long term plans:

- Adequate preparations to address various epidemics caused due to various vectors will be undertaken. More specifically to address spread of dengue.
- Heat stress tolerance concerns will be prepared

- The city has to have an integrated waste management facility, where waste of all types' viz. general waste, infectious waste or biomedical waste can be disposed. Also, the measures to manage the E-waste, Radioactive waste and nuclear waste has to be planned.
- Presently, the city hospitals are catering to patient load of major areas of the North India, which are already overloaded. There city has to have Hospital in the southern sectors to cater to the rising patient load. The existing health facilities has to be upgraded with better infrastructure and well trained manpower to manage every type of disastrous situation.
- Life style diseases have to be managed by imparting knowledge and training about health life style and exercises.
- There is need to develop a mechanism for management of slaughter houses in the city.
- Green house concept has to be introduced in the upcoming newer and existing buildings to minimize the energy utilization. The methods of water conservation and solar energy conservation have to be planned.
- The strategies like pooling of the vehicles, staff vehicles to ferry the staff etc. need to be developed to manage this uprising problem. The possibility of Metro railway connecting the city with near towns can be given emphasis in the near future times.

Table 6.4 Summary of strategies and Actions for Sustainable habitat sector

Strategies	Activities and Targets
Energy efficient building construction	• Pro construction Measures • Measures while constructing buildings • Solar passive designs • Planting design of plantations • Landscaping • Orientation • Passive downdraught cooling • Thermal insulation of exposed walls • Green Roof Concept • Evaporative cooling
Pedestrian City	Pavement along the streets
Introducing bicycles as a mode of transport	Dedicated lane for bicycles
Slum Free City	Providing houses to the slum dwellers
Tourism development	Eco-tourism around Sukhna Lake


Comprehensive mobility Plan	• Metro rail system of 57.7 km • Bus Rapid Transit System of 145 km • Bus Depots – 8 • Bus Shelters – 836 • Bus terminals -7 • Low Floor Buses – 2570 • Integrated Freight complex – 4 • Parking facilities (No of car spaces) - 7500 • Pedestrian and cyclist pathway or paths- 328 km • 14 Grade Separators Roads • 2 Intersection improvement • 2 Rail Over Bridges • New Road Links 10.9 km • Road Improvement 18.8 km
Solid waste management	• Biomedical waste management • Waste management at apartment / society level • Waste management due to construction to reduce 20% construction waste
Reducing diseases caused due to pollution and pollen allergies	• Creating awareness among the people to reduce exposure to allergies • An assessment to plans for the risk reduction of the diseases.
Reducing the life style diseases incidence	• Creating awareness among the people to reduce proneness to life style diseases
Improving the preparedness to risk of rising instances of accidents and vector borne diseases	• Creating awareness and taking steps to preparedness • Assessment needs study to develop plans for the risk reduction of the diseases. • Preparations to address various epidemics caused due to various vectors
Reducing the density of stray animals	• Appropriate steps to reduce stray animal density such as sterilization and rehabilitation


Chapter 7: Strategic Knowledge Mission – UT Chandigarh Climate Change Action Plan

National Climate Change Action Plan emphasizes that the strategic knowledge mission help facilitate the technology innovation and transfer of appropriate technology among vulnerable countries. Within the country, it would be appropriate for the states to cooperate on sharing the technologies that are environmentally benign and cost effective. Climate change poses a serious threat to development and poverty reduction in the poorest and most vulnerable regions of the world. An establishment's knowledge management system and skill development is the collection of information technologies used to facilitate the collection, organization, transfer and distribution of knowledge between departments/institutions/offices about the climate change strategy. Impact of climate change on various sectors will alter the distribution and quality of natural resources and adversely affect the livelihood of the people dependent on the respective resources. The national action plan lays down various existing State Policies/Programs and Rules/Regulations include that may facilitate the process of preparation of action plan:

- Scientific studies to recommend specific vulnerability reduction measures suitable for different vulnerable areas.
- Existing/Scope of Research and Development capabilities on climate science and vulnerability reduction measures.
- Vulnerability to the impacts of climate change is a function of exposure to climate variables, sensitivity to those variables, and the adaptive capacity of the affected community
- Use of modern data sources such as Satellite data, total Station, GIS software, and other hardware, software & latest technologies.
- Pattern of Land & Water Uses.
- Technical capacity and Adaptation capabilities of the state/departments to handle the climate change impacts.
- Current Documentation/Database management system of various departments.
- Identifying critical areas which need to be addressed and prioritizing.
- Identifying Area of Research
- Existing Information/knowledge Dissemination channels etc.
- Identification and documentation of technologies both within the country and abroad.
- Gender specific impacts, inclusiveness and impacts of climate change on different socio-economic categories.

Successful climate change management calls for a new development paradigm that integrates climate change into strategies and plans, and that links policy setting with the financing of solutions. A centre may l be created to deal with strategic knowledge management towards climate change involving various institutions and reputed individuals in the respective areas. The centre may be

based out of Science and Technology Department. The other departments include Science and Technology, industries (may be 2 or 3 sectors), and Municipal Corporation (1 each from engineering, housing, electricity and health), hospitals, universities, Housing board and other appropriate institutions. In addition the centre may also include eminent scientists from Chandigarh or from the institutions of Punjab and Haryana (Punjab Agricultural University for example). It is felt that at least 1% of the total funding for the State need to be provided for Capacity building. Climate change Strategy and Action Plans under Strategic Knowledge Mission proposes:

- Assist UT Chandigarh Administration to support implementation of Action Plan for Climate Change through creating a cell on knowledge management. The constitution of the cell and roles and responsibilities are provided in table 7.1

Table 7.1 Summary of Strategies for Knowledge Management.

Strategies	Activities with Targets
Knowledge management cell secretariat	Recruitment of Secretariat staff
Awareness Programmes	• Awareness Campaigns (Schools and Colleges, Resident colonies, Government offices and Corporate offices, policy makers) 1 campaign per year for each group for 10 years • Targeted seminars for different groups (Agriculture, animal husbandry, forestry, general public on water, health, electricity etc) • Posters, leaflets, audio visuals and other communication materials to be distributed at various occasions (10,000 posters, leaflets, Video CDs etc on impact of climate change on water, health, agriculture etc)
Capacity Development	• Setting up a library or supporting already existing libraries on climate change issues • Brain storming session on thematic areas such as agriculture, water, health on impact of climate change • Initiating or supporting studies on climate change scenarios and impacts specific to Chandigarh. • Study on identification of capacity gaps of Government institutions to address climate change impacts • Training to town planners, architects, administrators on climate change disaster management • Creation of Centre of Knowledge management on climate change – a secretariat in S&T department • Website management, networking and others
Monitoring and Evaluation	• Setting up the protocol for monitoring and evaluation of climate change action plan • Data collection and analysis on various parameters – annually • Supporting Climate Change steering committee on various aspects of monitoring, evaluation and reviews

- Define activities and monitor various actions under different missions set up for climate change action in the Government of Chandigarh.
- Prepare and implement various actions under the State Strategic Knowledge Mission

Some of the focus areas include:

- Develop priority areas for research specific to Chandigarh based on the projected impacts of climate change under various sectors. In First instance Research will help us to understand the scenarios of climate change impacts and secondly it will help us to address the adaptation measures needed to cope with the impacts.
- Promote a multi disciplinary research on the aspects of GHG emission reduction as well as waste utilization engaging various institutions within UT Chandigarh and outside.
- Help the rural and urban communities and the Government with updating appropriately with environmental status reports with special emphasis on climate change.
- Facilitate Environmental Impact Assessment of development projects critical to climate change i.e. power, housing, waste management etc.
- Create climate change related databases and identify newer responses to climate change.
- Facilitate research into identification of alternative means of livelihood in view of the impending climate change impacts.
- Help the Government Departments to adopt innovations into new and cost effective alternate energy options.
- Prepare communication and dissemination strategies.
- Help or facilitate documentation on Industry best practices that reduces energy consumption and other resources.

7.1 Awareness of Climate Change: Creating awareness for different stakeholders is important as different communities need to be sensitized differently. In this regard, the knowledge missions should collate information that need to be targeted at different stakeholders. Knowledge mission will coordinate with various academic institutions and development agencies to specifically develop curriculums to impart required knowledge to various stakeholders. Activities proposed under creating awareness for Climate Change are:

- Act as a storehouse of knowledge to gain and provide information on climate change and act as one stop window to access and share learning.
- Identification of technical experts for creation of awareness for different target groups.
- Dissemination of Climate Change Information aimed at different stakeholders and different kind of information.
- Massive awareness campaign on climate change and its impact.
- Communicate climate change issues to growers, policy makers and all stake holders.
- Impart training to students and teachers in school and college on climate change, impacts, adaptation and mitigation. Most importantly, to train the students, how they could help teach


their parents and neighbours on climate change to bring about large scale change through horizontal diffusion of knowledge.

- Organize targeted seminars, conferences and workshops on Climate Change for different stakeholders.
- Create Climate Change awareness centers at prominent public places.
- Publicity through print and electronic media.
- Environmental education, Training and awareness programme by celebrating World Environment day, International Bio Diversity day, International Ozone Layer Conservation day, Organization of Environmental Training programs.

7.2 Capacity Development: Activities proposed under capacity development are:

- Facilitate identification of priorities for Research and Development in UT Chandigarh.
- Identify the capacity gaps of various departments and based on the necessity and priority such gaps that are critical need to be removed.
- Providing training and Capacity building among town planners and architects so that they can use latest technique for preparation of various Development Plans and build energy efficient buildings.
- Training the Officials of State Development Departments on the steps and approaches to handle the climate change impacts on various sectors and to build scientifically the adaptations options to be considered by the policy makers and the society.
- Sensitize the importance of Climate Change and its inter-linkages with development options.
- The adaptation programming is to improve the adaptive capacity and reduce the vulnerability of human populations and the natural and economic systems on which they depend, to climate change and its impacts, and therefore contribute to the realization of the Adaptation.
- Learn about relevant climate information.
- Communicate to appropriate stakeholders and the Government about scientifically based information on observed climate trends.
- Skill Development to address climate change adaptation technologies or behaviors both at formal and informal level.
- Creation of a Centre for Knowledge Management & Skill Development on climate change.
- The mission will also create, maintain and update a portal on the subject.
- Identification of State Govt. Departments having the capability to execute the recommendations finalized in the SAPCC

7.3 Brief monitoring and evaluation framework

- Creating a database: In order to benefit from the experience of development agencies in monitoring and evaluating their activities, there is a need to organize a data source and convert into database.
- Integrate conventional data sources with modern data sources to develop GIS database.
- Constant monitoring of climate change signals/climate variability and creating meteorological database/forecasting for decision support system in all the districts and providing competitive incentives to the better performing districts.


- A high power committee for supervision and review of policies.
- Constitution of Climate Change Advisory Committee in the UT may be considered aiming, at coordination among various departments.

It may be good to mention the number of institutions Chandigarh has in terms of universities, engineering colleges, research institutions and other useful agencies that help the strategic knowledge management can co opt to work with and a brief description of those institution as an appendix.

1. Panjab University, Chandigarh – specifically Department of Environmental Sciences, Botany, zoology, and geology.
2. Punjab engineering College, Chandigarh
3. Medical College, Chandigarh
4. Punjab Agricultural University (centres in Chandigarh, if any)
5. ICAR institutions such as Soil and Water conservation, Animal or plant breeding centres
6. Forestry institutions –ICFRE institutions
7. Any other autonomous institutions

Box 7.1 Knowledge Management Centre and Secretariat for Climate Change Advisory Committee

Chairman – Additional Director of Environment / Member Secretary Chandigarh Pollution Control Committee
Coordinator – Deputy Conservator of Forests (Botanical garden and Nature Reserve), Chandigarh Administration
Members

- Nodal Officer– Department of Environment
- Nodal Officer – Department of Health
- Nodal Officer – Department of Higher Education
- Nodal Officer – Public Health, Municipal Corporation
- Nodal Officer – Superintendent Engineer, Construction
- Nodal Officer – Chandigarh Housing Board
- Nodal Officer – Science and Technology Department
- Nodal Officer – Chandigarh Disaster management Cell
- Nodal Officer – Pollution Control board
- Nodal Officer – Transport Department
- Director– Meteorology Centre, Chandigarh

Roles and Responsibilities

1. The centre works as a secretariat for various activities of the Climate Change Advisory Committee and coordinates the activities of other missions. However, this works under the guidance of Strategic Knowledge Management mission.
2. Assist the Government of Chandigarh to prepare a framework of State Action Plan for Climate Change
3. The centre meets thrice every year to monitor the progress of the action plan
4. The centre helps to develop monitoring and evaluation protocols for each of the
5. The centre appoints the review committee for technical review of the action plan for every three years and directs action plan according to the review observations
6. The centre facilitates to integrate various missions at critical juncture and liaise with various agencies when necessary.
7. Seeks guidance from Climate Change Advisory Committee or Authority on various matters from time to time.
8. Maintains the data base and the knowledge products developed by various missions
9. Supports other missions towards knowledge dissemination activity
10. The Centre undertakes training programmes for various missions, organize lectures and other activities that aim to disseminate knowledge on climate change sector
11. The centre works as a store house of knowledge products that are generated from various missions and from outside the state and country
12. The centre may support or undertake studies or research that are critical to the climate change action plan implementation through funding from Government or other allied agencies
13. The centre supports other academic and research agencies to undertake research that are directly related to Chandigarh Climate Change Action Plan

Chapter 8: Integrated Approach, Cross Cutting Issues and the Way forward

The State has already recognized a large number of issues critical to the management of climate change. Some of the critical areas recognized and the areas of research that need to be taken up are:

- Identification of species tolerant to climate change.
- Identification of technology options for handling industrial and domestic sewage.
- Handling of municipal solid wastes.
- Handling of air pollution from industrial, domestic, transportation sources.
- Alternative energy options
- Utilization of CDM benefits.
- Creating data base and identifying trends and Climate responses.
- Strengthening the nodal agencies and creation of human resource.

Apart from these critical issues, there are many cross cutting issues that need to be identified and taken up as part of knowledge management. One of the issues of integration and cross sectoral policies that are working cross purposes need to be identified. Strategic knowledge management would identify these policy barriers and appropriate measures will be taken up.

8.1 Areas of research:

Priority areas for research should include:

- Promote research in multi-disciplinary aspects of environmental pollution as well as waste utilization.
- Undertake carrying capacity assessments in critical/aquatic stretches and air polluting areas.
- Prepare and upgrade environmental status reports with special emphasis on climate change.
- Develop effective and low cost technology for pollution control.
- Conduct EIA of development projects critical to climate change i.e. power, housing, cement etc.
- Create climate change related databases and identify responses to climate change.
- Research into low and alternative energy options.
- Preparing communication strategies.
- Gender mainstreaming focusing on the impacts of climate change on gender and different sections of the society.

The above intent is not an easy affair and needs a strategic planning and implementation to get the desired results.

8.2 Need for Integrated approach

As mentioned above, If the climate change adaptation has to be adequately and comprehensively addressed then the interconnectivity of other sectors has to be understood. In the context of Chandigarh, which is mainly urban ecosystem, the major concern is reducing energy consumption both electrical and petroleum products. Though various programmes are being planned and being implemented, these actions should get integrated into each other. For instance, the housing department can take up all possible actions to reduce energy consumption at the household level. The city planning department may take up actions that help reduction the traffic congestion and provide options to low carbon development technologies. Therefore there is a framework necessary to integrate the sectors of development. Chandigarh being a small UT may well experiment with this framework. This framework, once available, could be used by all the line departments and updated by the relevant departments which have designated areas of jurisdiction.

Box 8.1 Climate Change Advisory Committee

Chairman – Advisor, Chandigarh Administration

Coordinator – Conservator of Forests and Director Environment, Chandigarh

Members

- Secretary – Department of Environment
- Secretary – Department of Health
- Secretary – Department of Higher Education
- Commissioner – Municipal Corporation
- Chief Executive Officer – Chandigarh Housing Board
- Director – Science and Technology Department
- Deputy Commissioner, Chandigarh
- Member Secretary, Chandigarh Pollution Control Committee
- Director, Indian Meteorological Department, Chandigarh
- Chief Engineer, Chandigarh
- Chief Architect, Chandigarh
- Deputy Inspector General (police), Chandigarh

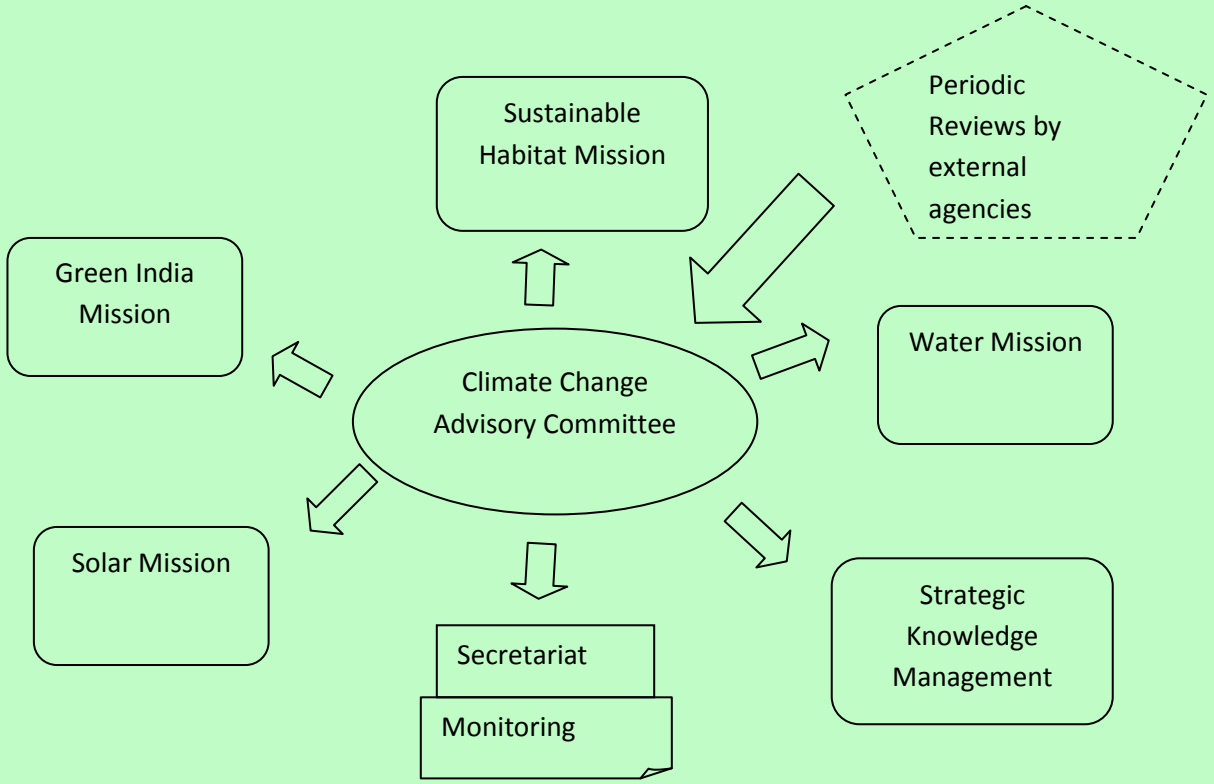
Roles and Responsibilities

1. The committee oversees the activities of various missions of Climate Change and provide guidance for effective functioning
2. The committee meets twice every year to review the progress of the action plan
3. The committee approves the annual action plan on climate change
4. The committee appoints the review committee for technical review of the action plan for every three years and directs action plan according to the review observations
5. Review the progress of the action plan based on the monitoring protocol developed by the monitoring and evaluation cell
6. Guides the monitoring and evaluation cell for development of the monitoring protocol
7. Seeks guidance from the National Action Plan for climate change on various technical matters from time to time.
8. Recruits various missions and members under the mission of the state action plan as and when necessary
9. Seeks financial support for state action plan from the central government or other donor agencies when necessary
10. Facilitates inter- ministerial/departmental coordination for effective

8.3 Institutional arrangements

Setting up of a Climate Change Advisory committee in State may be initiated to coordinate among various departments. The Authority will act as a facilitator to provide a framework for integration, planning, monitoring and assessment. While the overall programme implementation will be facilitated, supervised and monitored by the designated departments according the missions formed in the action plan. Resident associations, eco clubs and various other youth committees, NGOs and other CBOs will have a greater role in implementation of works at field level. Line departments have identified the activities to be carried out by them with assistance from their strategic partner departments like State Remote Sensing Department, Science and Technology, etc. The following is the structure of the climate change advisory committee (Box 8.1). The institutional arrangements are depicted in the Figure 8.1

Figure 8.1 Institutional Structure for the Implementation of Climate change Action Plan



8.4 Monitoring and Evaluation

Monitoring and evaluation (M&E) framework need to be developed by the knowledge management section to measure and assess performance of the identified key strategies. The strategic knowledge management unit may involve other Research Institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections. Line departments to have their inbuilt monitoring mechanism which may take care of monitoring and evaluation once trained.

8.5 Review and Continuous Improvement

The climate change authority will have the role of review and continuous improvement. A periodic

monitoring and 3 year review could be set up by the authority with external experts who would review and suggestion future steps based on the new technologies and novel approaches in the area of climate change. Limitations in terms of data, knowledge on climate change/gaps in available studies on impact and vulnerability on sensitive sectors and the nature of arriving at approximate costs of the suggested actions were the learning experience.

8.6 Capacity building

Capacity building is critical for the success of mitigation and adaptation. The capacity building has many aspects. They are enhancing the technical capacity of the concerned departments to handle the climate change impact assessment and adaptation capability, monitoring, awareness creation among the public and financial management. Many impacts of climate change are not neutral and there orientation of the implementing officers to address the issues of gender balance while implementing the programmes. Some of the activities under capacity building are:

- Environment impact assessment methodologies, primarily in relation to biodiversity and water quality
- Monitoring and evaluation The impact assessment methodologies on, socio-economic improvement, energy consumption, green cover improvement, improved transport systems, water resource, enhanced capacity and enhanced risk reduction capacities etc.
- Capacity improvement of administrators, technocrats and other stakeholders involved carbon management
- Corporate / Industrial sector that are known for high GHG emissions
- Universities and Research institutions for enhanced awareness on technology and indigenous technology development
- Capacity building of different sector specialists and Government partners on gender concerns, inclusiveness and participatory approaches while addressing climate change.

The way forward: Climate Change action plan has been prepared following a participatory approach to address Chandigarh's concerns of climate change. The Union Territory strives to achieve sustainable growth without compromising on the developmental needs. The strategies aspires to the guide the way forward for the state departments to integrate and mainstream the climate change concerns in the schemes, projects, programmes, missions and policies to make Chandigarh a resilient state to handle the challenges and risks of climate change by making its population to help mitigate carbon emissions and adapt to climate change through low carbon development pathway.

Chapter 9: Summary of Climate Change Action Plan and Budget

Based on the climate change strategy developed under each of the sections previously, estimates of expenditure for each of the activities have been made. This is tentative much more scrutiny is needed for refining the expected expenditures. This only depicts the tentative financial commitment that needs to be provided to undertake climate change action plan for Chandigarh UT. The gross expenses are provided in the table 9.1 below and the detailed expenditures as per the activities are provided in the table 9.2.

Table 9.1 Estimated gross expenses under various sectors for Chandigarh Climate change action plan.

Sl. No	Sector	Funds required in crores
1	Green India mission including Agriculture, animal husbandry and horticulture	58.75
2	Energy sector (involving solar, electricity and transport)	1714.49
3	Water sector	51.72
4	Sustainable Habitat mission (including health, waste management, comprehensive mobility and biomedical sector)	15642.66
5	Knowledge management mission	1.54
	Total	**17469.16**

A conservative estimate indicates that nearly Rs 17,500 crores of funds are required over a period of 50 years to complete various activities that help Chandigarh cope to the climate change impacts and make the life in Chandigarh a habitable one.

Table 9.2: Strategies to implement climate change and action plan for Chandigarh by different missions, their activities and budgets

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
Forestry Programmes								
1	Increasing tree cover in urban and peri-urban Areas.	Free distribution of seedlings of various species to the institutions, eco clubs, NGOs & residents of Chandigarh for plantation	Raise approximately 40,000 lacs seedlings/ annum, covering 150 Eco clubs	0.15	0.20	0.25	0.60	Plantation scheme of Forest and wildlife Departments
		Creation of Eco clubs in schools & colleges of UT Chandigarh	All schools and colleges	0.05	0.075	0.75	0.20	Environment Department UT Chandigarh
2	Promotion of natural regeneration and mixed species planting	Patch sowing in the hill slopes of Sukhna lake to be covered under forest conservation programme	3 lacs per annum in Sukhna wildlife sanctuary	0.15	0.20	0.25	0.60	Plantation scheme (hilly area of forest and Wildlife Department)
		Plantation of fruit bearing species	10,000 trees of different fruit bearing species	0.50	0.60	0.90	2.00	Plantation scheme (hilly area of forest and Wildlife Department)
3	Protected areas (PA) management securing corridors for species migration	Acquisition of land for the purpose of establishment of wildlife corridor or effective management	450 acres - Amount will be worked out as per present value of the land by Land Acquisition Officer of UT Chandigarh					Capital head (4406) of the Department of Forest and Wildlife
4	Reduced forest fragmentation by conserving contiguous forest patches (use of landscape /sub-landscape approach)	Fencing of forest boundaries at species locations to check encroachment on forest land	2 km / annum	3.5			3.5	Social and Farm forestry scheme of Forest and wildlife Department
5	Eco-restoration of degraded lands	Lantana, parthenium removal and biodiversity plantations	Botanical garden and all the reserve forests to be free from weeds	0.60			0.60	Social and Farm forestry scheme of Forest Department
6	Awareness generation	Creation of nature interpretation centres at Botanical garden	All the eco clubs will be associated with one or the other	10	15	25	50	Research and Extension Scheme of Forest and Wildlife

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
			activity with the help of Engineering Department, Forest Department and Science and technology Department, Environment Department and National Social Service					Department
		Celebrations of Wildlife Week		0.25	0.35	0.40	1	Research and Extension Scheme of Forest and Wildlife Department
		Celebration of world forestry day						
		Celebration of world earth day						
		Celebration of wetland day						
		Publication of Chandigarh greening action plan						
	Total			**15.2**	**16.425**	**26.875**	**58.5**	
Agriculture, Horticulture and Animal Husbandry								
1	Promoting organic agriculture / horticulture	Creating awareness among horticulturists to change to organic farming	One study tour and training camp for farmers during 2012-13	0.10			0.10	Under the state sector plan scheme "extension and farmer study tours/ training camps Funds are available
	Promoting cropping patterns that are suited to arid situation	Awareness building among agriculturists to adopt appropriate varieties and crops that are adapted to arid conditions and increased carbon dioxide concentrations	100 beneficiaries are covered under the plan scheme for supply of wheat and fodder seeds	0.12			0.12	Under the state sector plan scheme "supply of wheat and fodder seeds at 50% discount.
	Measures to reduce enteric emissions	Awareness building among dairy owners to provide appropriate dietary schedule for cattle	No specific agenda	0.05			0.05	Current plan on farmers training and camps
	Total			**0.25**			**0.25**	
Solar Mission / Energy mission								
1	Enhancing energy efficiency and emission reduction transport system in Chandigarh	Replace the current fleet of vehicles to Euro IV standard to reduce emissions and increasing the number of vehicles to improve public transport. (more details are provided under Sustainable habitat comprehensive mobility low floor buses)	Replacing all the vehicles to Euro 4 and CNG (CNG is yet not available in Chandigarh therefore these are tentative) low floor buses that are fuel efficient and low emission	100	200	200	500	JNNURM, Chandigarh Administration

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
2	Bachayat Lamp Yojna	Replacing all conventional incandescent lamps with CFL or LED in Government and residential Buildings	There are nearly 2 lakh households and approximately 4 CFLs to each households equal to 8 lakh lamps	8.0			8.0[48]	Plans to set up a CDM project
3	Promotion of Green Buildings	Buildings are built using ECBC codes to reduce energy consumption such as solar passive elements, down draught ventilation	The Nehru Centre for Performing Arts, Sub City Centre, Sector 34 an eventually All public buildings and at least 50% of new buildings to be certified under new ECBC rules	1.25			1.25	BEE, JNNURM
4	Energy Conservation in Residential sector	Solar water heating system	824500 litre capacity	150	250	387.64	787.64	Jawaharlal Nehru National solar Mission (JNNSM)
		Promotion of LPG and Microwave stoves	Reducing 10% reduction in current electricity consumption	0.30			0.30	Oil companies and other corporate sources
		Promote use of alternate lighting systems such as SPV systems in villages to reduce kerosene consumption		0.75			0.75	JNNSM
		Promote energy conservation through promotion of energy efficient devices (CFL, air conditioners, microwaves, Washing machines, TV, etc)	Primarily awareness creation	0.75			0.75	BEE/ State Energy Conservation Fund; private industry
5	Energy Conservation in Residential sector	Promotion of energy efficiency through awareness creation	achieve 10% share of energy efficient	1.25			1.25	BEE/ State Funds; private industry

[48] As per the document http://220.156.189.23/about_bee/documents/tender_notices/tender/EOI-BLY.pdf

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
			devices in the city					
		Replacement of existing ballasts by efficient ballasts in all street lights	100%	11			11	JNNURM
		Replacement of booster water pumps in drinking water schemes with energy efficient pumps	Replacement of 250 pumps each of 10 HP Capacity	1.08			1.08	JNNURM
		Promotion of solar water heating systems in industries, hotels, hostels etc	100000 lit per day capacity systems in three years	0.22			0.22	MNRE-GEF, JNNSM
		Promotion of roof top systems in commercial /government, institutional and industrial buildings	Total 10 MW capacity solar systems	40	60		100	MNRE, JNNSM
6	Power generation	Solar PV power plant	25 MW	100	150		250	Private investment, JNNSM
			5 MW	50			50	
7	Awareness creation	Establishment of 'Chandigarh Solar City Cell'		2.25			2.25	MNRE, UT Chandigarh
	Total			**466.85**	**660.0**	**587.64**	**1714.49**	
Water mission								
1	Reduce water consumption	All new buildings can be fitted water efficient fixtures	25% reduction of water				TBD	
		Leakage Control Management	Strict Monitoring	5			5	
		Replacement of malfunctioning water meters	All houses and commercial buildings					
2	Landscape water conservation	Use partially treated water for irrigation	All parks and reserves	15	21.72		36.72	JNNURM
3	Water audit for existing buildings and various landscapes	Assessment of use for various typology of water such as toilets, cooking, and others	All commercial and residential buildings; and landscapes such as parks and reserves	4	6		10	
	Total			**24**	**27.72**		**51.72**	
Sustainable Habitat Mission								
1	Comprehensive mobility Plan[49]	Metro system	57.7 km	500	5000	5875	11375	
		Bus Rapid Transit System	145 km	645	772	448	1865	

[49] Based on RITES, 2009, Comprehensive Mobility Plan for Chandigarh Urban Complex, Draft Final Report, Rites Ltd. http://chandigarh.gov.in/advt/cmp-mrts100809.pdf report

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
		Bus Depots	8 numbers	36			36	
		Bus Shelters	836 nos	100	25		125	
		Bus terminals	7 nos	100	55		155	
		Low Floor Buses	2570 nos	250	350	428	1028	
		Integrated Fright complex	4 no	140			140	
		Parking facilities (No of car spaces)	7500 nos	150	225		375	
		NMT facilities (Pedestrian and cyclist pathway or paths)	328 km (approx)	50	114		164	
		Grade Separators – Road	14 nos	50	100	136	286	
		Intersection improvement	2 nos	2			2	
		Rail Over Bridges	2 nos	20	20		40	
		New Road Links	10.9 m	10	20		30	
		Road Improvement	18.8 km	16			16	
		Total					15637	
	Total			**2069**	**6681**	**6687**	**15637**	
Health Mission								
1	Reducing diseases caused due to pollution and pollen allergies	Creating awareness among the people to reduce exposure to allergies		0.25	0.35	0.40	1.0	
		An assessment to plans for the risk reduction of the diseases.		0.50			0.5	
2	Reducing the life style diseases incidence	Creating awareness among the people to reduce proneness to life style diseases		0.50	0.50		1.0	
3	Improving the preparedness to risk of rising instances of accidents and vector borne diseases	Creating awareness and taking steps to preparedness		1.0	1.5	0.66	3.16	
		Assessment needs study to develop plans for the risk reduction of the diseases.						
		Preparations to address various epidemics caused due to various vectors						
	Total			**2.25**	**2.35**	**1.06**	**5.66**	
Strategic Knowledge Management Mission								
1	Knowledge management cell secretariat	Recruitment of Secretariat staff	2 secretarial staff	0.54			0.54	UT Administration
		Website management, networking and		0.25			0.25	

Sl. No	Category of Interventions	Proposed activities	Targets	Funds required in crores				Source of funding
				2020	2030	2050	Total	
		others						
2	Monitoring and Evaluation	Setting up the protocol for monitoring and evaluation of climate change action plan		0.25			0.25	
		Data collection and analysis on various parameters – annually		0.25			0.25	
3		Supporting Climate Change Authority on various aspects of monitoring, evaluation and reviews		0.25			0.25	
	Total			**1.54**	**0**	**0**	**1.54**	
	Gross Total			**2579.09**	**7387.495**	**7302.575**	**17469.16**	

ANNEXURES

Annexure 1 – Agriculture

(Information provided by Department of Agriculture, Chandigarh)

Area and Production under various Crops for the year 2011-12

Crop	Area (Hectares)	Production (Tonnes)	Yield (Quintal per hectare)
Kharif Cereals			
Paddy	20	103	51.50
Maize	25	55	22.00
Rabi Cereals			
Wheat	600	2725	45.41
Total Cereals	645	2883	
Vegetables			
Potato	10	165	165.00
Onion	2	35	175.00
Other Vegetables	20	500	250.00
Total Vegetables	32	700	
Fruits			
Kinnow	1	8	80.00
Mango	6	140	233.33
Guava	4	75	187.50
Bair	1	14	140.00
Peach	1	15	150.00
Total Fruits	13	252	

Consumption of Chemical Fertilizers for the year 2011-12

2011-2012	About 40 to 45 M.T. fertilizer (in terms of Material) is being brought by the farmers from neighboring villages of Punjab & Haryana States.

Consumption of Pesticides (in Metric Tonnes)

Year	Quantity (Technical Grade)	Area Covered (In Hectares)
2011-2012	0.27	360

Tube wells for Irrigation (In cumulative Numbers Cum.)

Year	Diesel Operated	Electric Operated	Total
2011-12	8	50	58

Annexure 2 – Forest

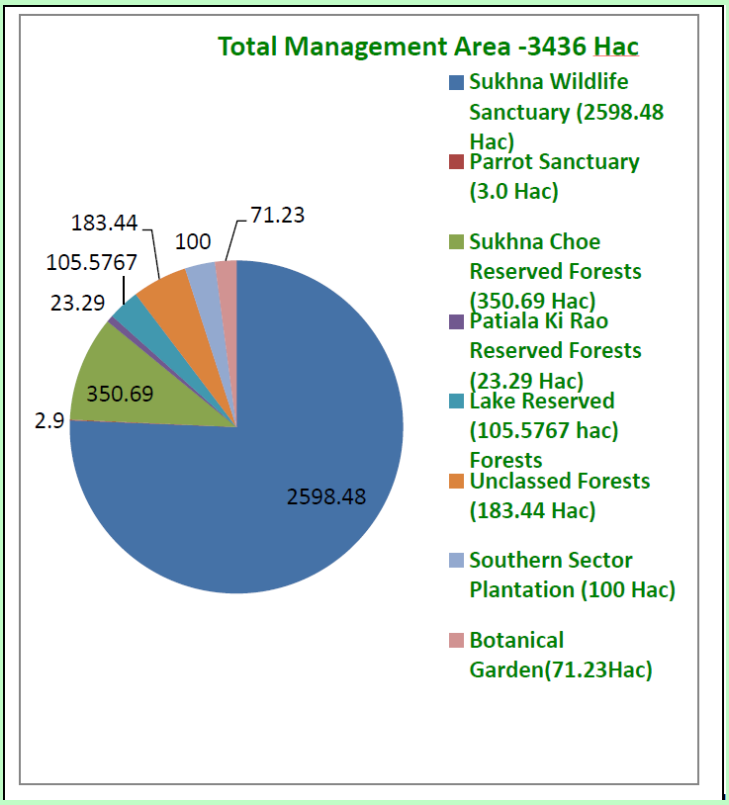
(Information provided by the Forest Department, Chandigarh)

Role of the Forests in Amelioration of the Environment

Rising pollution level and degrading environment of the city particularly by vehicular pollution highlights the need for remedial steps to combat pollution. Though the best way to reduce pollution at source is by adoption of clean technology and clean fuel, proper maintenance of roads & vehicles, maximum use of bicycles, strict enforcement of Air (Prevention and Control of Pollution) Act, 1981, Water (Prevention and Control of Pollution) Act, 1974 and the Environment (Protection) Act, 1986 etc., yet another effective way to reduce air and noise pollution is through a well planned and realistic strategy for afforestation. Apart from giving shade, aesthetic beauty, recreational spots and playing host to a wide variety of birds and insects, the forests and trees play an important role in amelioration of environment due to their tremendous potential to act as:

1. Organic sponges to absorb gaseous pollutants via their leaf stomata (the tiny pores on the leaves) and breaks them down into less harmful molecules during the photosynthesis
2. Storehouse of Carbon dioxide by assimilating the carbon dioxide in form of sugar
3. Supplier of much needed vital oxygen
4. Nature's air conditioners as well as purifier of air
5. Soil and water conservation

Forests/ Trees in the city enhance its visual character by adding variety and richness to urban landscape with their different foliage and blossoms. They provide habitat for the wildlife. They have significant effect in improving the microclimate of the area. Green Cover significantly affects the building heating budget. Vegetation helps in reducing the noise pollution to the acceptable level. Plants play an important role in both, reducing the environmental pollution load as well as serve as pollution indicator. Vegetal cover is, therefore, a pollution scavenger as it absorbs gases and gathers particulate matter through leaves having large surface areas. The green portion of the trees and plants has the capacity to filter dust, smoke and other pollutants in the air. Some species like Ficus, Mango, Neem etc. also act as good dust collectors. Well laid out gardens and parks with selected ornamental and shady trees provide good recreational spots and enhance the beauty of the city. Well-designed green belts prove to be very effective wind break and help in soothing the microclimate of the surroundings.



Forest area:

Total forest and other areas managed by the forest department in UT Chandigarh are 3436.00 hectares as shown in the pie diagram.

In the city the Horticulture wing of Municipal Corporation and Engineering

Department maintains and takes up the plantation on the road side, garden, parks and other vacant revenue land.

Greening Chandigarh Action Plan:

To increase green cover in UT Chandigarh, "Annual Greening Chandigarh Action Plan" is being prepared and released for implementation by all greening departments every year.

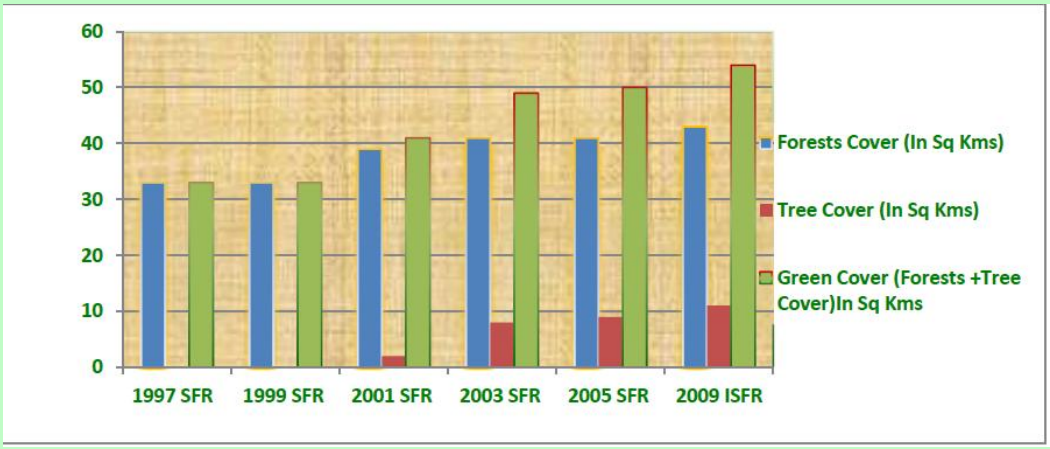
All the Greening agencies – Forest department, Horticulture Wings of Engineering Deptt, UT and Municipal Corporation have achieved successfully plantation targets since 2001 to 2011. Details of plantation taken up by greening agencies in UT is placed at Annexure -3

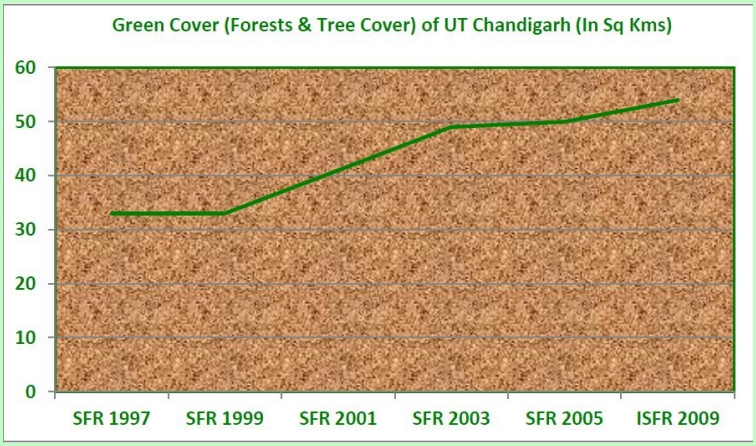
The institutions namely Forest Department, Municipal Corporation, Engineering Department, Chandigarh Unit of Punjab Agriculture University, NGO's, Resident Welfare Associations, Educational Institutions and above all, the strong will and farsightedness of the Administration contributed a lot towards the success of this programme. The contribution, dedication and genuine concern of the proud citizens of the 'City Beautiful' to make the city greener needs special mention.

Green Cover of UT Chandigarh:

As per the India State of Forests Report -2009 (ISFR) of Forests Survey of India (FSI), the forest cover in UT Chandigarh is 43 km^2 and another 10 km^2 area is under tree cover. Thus, the total green cover (forest cover + tree cover) of Chandigarh as per 'ISFR-2007' is 53 km^2 which form 37.8% of its total geographical area.

Trend of Increase in Green Cover (Forests & Tree Cover) of UT Chandigarh





Chandigarh bestowed with Indira Priyadarshini Vriksha Mitra Award-2010

Union Territory of Chandigarh was presented the prestigious **Indira Priyadarshini Vriksha Mitra (IPVM) Award** for States and Union Territories (Category: Union Territories) for the year 2010 for outstanding work in increasing forest & tree cover in the city. The forest cover in UT Chandigarh is 43 sq km and another 10 sq km area in under tree cover.

The MoEF, GOI has been giving IPVM Award since 1986 under various categories for outstanding achievement in the field of afforestation. During the year 2008, GOI decided to institute IPVM Award biennially to the State and Union Territories for outstanding works in increasing forest and tree cover within their boundaries based on the last two State of Forest Reports.

Annexure 3 - Plantation

Plantation Details of UT Chandigarh of Last Ten Years Carried Out by Forest Department, Horticulture Wing of Municipal Corporation, Chandigarh & Engineering Department

S.N.	Year	Target	Achievement
1.	2002-03	1,10,364	1,36,672
2.	2003-04	92,800	1,24,387
3.	2004-05	95,896	1,06,656
4.	2005-06	1,02,205	1,61,355
5.	2006-07	1,20,648	1,36,173
6.	2007-08	1,09,170	1,49,723
7.	2008-09	2,64,130	2,44,216
8.	2009-10	1,57,987	1,92,982
9.	2010-11	1,90,072	2,27,291
10.	2011-12	2,30,897	2,23,740
11.	2012-13	2,07,878	--

POTENTIAL AREAS AVAILABLE FOR GREENING IN UT Chandigarh

Enrichment Plantation in the Catchment area of Sukhna Lake:

1. Plantation of indigenous & palatable variety of trees & shrubs on gentle slopes & plain area of Wildlife sanctuary.
2. Hill tops & slopes of Sukhna Wildlife Sanctuary will be enriched with green cover by seed sowing in patches by contour trenching and trench-cum-ridge method.
3. Plantation of stem cuttings of soil conserving species like Arundo-donax along Choe banks to reduce erosion of Choe banks by rain water runoff.

Enrichment plantation in the city forest area

Reserved and Unclassed Forests in & around the city are:-

1) Lake Reserved Forest,
2) Sukhna Choe Reserved Forest
3) Patiala-ki-Rao Reserved Forest
4) Unclassed forests in Sukhna Choe, Lake & Patiala- ki- Rao

As per the India State of Forests Report-2011, density of these forests ranges from dense to moderately dense and at places open forests patches are also present. Enrichment plantation will be carried out in the open forests area to improve the quality and the biodiversity of the forests area. Fruit bearing & palatable species of trees and shrubs will be planted here as wildlife is in abundance in these forests.

Plantation within the city

1. Plantation of trees and shrubs in Parks and greenbelts under the jurisdiction of Municipal Corporation and Engineering Department.
2. Vacancy filling by planting along the roads, green belts etc. by Municipal Corporation and Engineering Department.
3. Enrichment plantation in southern sectors.
4. Development of Parks & green belts in southern sectors.

5. Establishment of new Theme Parks like Garden of Palm, Garden of Silence, Garden of Conifers, Valley of Springs etc.

Plantation in Schools, Colleges, Offices and residential houses and other vacant spaces

A massive campaign for plantations on private lands, complexes of Schools, Colleges, University, Hospitals, Police Lines and Residential Complexes and offices may be undertaken in collaboration with students, Resident Welfare Associations, Market Associations, Environmental N.G.O.'s etc. Every unutilized & abandoned patch of land will thus be brought under tree plantations.

STRATEGY TO IMPROVE THE FOREST AND GREEN COVER

A need based appropriate model dovetailing environmental considerations will have to be adopted by all Greening Agencies in their plantation drives. The selection and quality of species play most important role in the success of greening and improving the survival percentage of the plantations. Therefore, the selection of species has to be judicious for which a number of indicators have been short-listed as indicated below:-

- Location of plantation site,
- Site conditions like, soil, ground water table,
- Climatic conditions like rainfall, temperature,
- Ornamental and aesthetic requirement,
- Environmental considerations like pollution abatement.
- Distance of the plantation site from the residential building, public utility services

To ensure greater survival percentage of saplings planted, ***salient requirements*** have been identified which are as follows:-

- Proper identification of area requiring afforestation,
- Selection/choice of species,
- Raising of healthy seedlings,
- Planting of healthy and tall saplings,
- Area treatment according to its edaphic and climatic condition,
- Protection from grazing by providing tree guards or proper fencing,
- Post plantation care particularly the maintenance and watering upto three years,
- Monitoring and concurrent evaluation,
- Soil and water conservation, including water harvesting measures

It has to be recognized clearly by all greening agencies that every effort should be made for horizontal expansion of the forest cover/ green cover in & around Chandigarh. Simultaneously, all efforts have to be made as well for vertical expansion of existing green areas by way of developing them into multi-strata forest to increase efficiency and effectiveness of forest areas as carbon sink and green lungs of the city.

Annexure 4 – Energy Efficient Programme

Guidelines for Implementation of Energy efficient Solar/green building Programme

Background

Energy efficient solar buildings are constructed based on the techniques of solar passive design with a view to provide comfortable living and working conditions, both in winter and in summer. These buildings can be integrated with renewable energy and energy conservations devices and systems and can save over 30 to 40% of conventional energy that is used for lighting, cooling or heating. Such buildings have been tried out in a few States as a result of the initiatives taken by the Ministry. Finding the concept of solar buildings useful, the state governments of Himachal Pradesh, Punjab, Haryana and Nagaland have already made it mandatory to construct all new buildings in government and public sectors on this concept. Necessary G.O.s has been issued and the development authorities have been asked to approve building plans for construction only if the designs incorporating solar passive features are certified by approved architects or the experts. Over 40 experts/architects are presently involved in the country in practicing energy efficient solar buildings. Bureau of Energy Efficiency (BEE) have recently introduced Energy Conservation Building Code (ECBC) which includes energy efficient design features. National Building Codes have also been developed by the Bureau of Indian Standards (BIS) which incorporates some of the concepts of energy efficient solar buildings. Sufficient literature/publications are also available for design of such buildings.

Efforts are now being made to construct Green Buildings all over the country which not only take care of energy conservation but also look into water and waste management, environment impact, minimum destruction of natural resources and various other aspects in an integrated way. Building Rating Systems have been quite effective in raising awareness and popularizing energy efficient and green building design. Most of the internationally devised rating systems have been tailored to suit the building sector of the country where they were developed. In India, a US based LEED(Leadership in Energy and Environmental Design) Rating System is under promotion by CII-Godrej Green Business Center (GBC) which is more on energy efficiency measures in AC Buildings. A couple of other Rating systems suitable for Indian conditions e.g TERI-GRIHA and Eco-Housing System have also been developed by TERI and Pune Municipal Corporation respectively and are under promotion in the country.

Keeping in view our climatic conditions, and in particular the construction of non-AC buildings, a National Rating System GRIHA (Details available at MNRE website: www.mnre.gov.in) has been developed which is suitable for all types of buildings in different climatic zones of the country. The Rating System was initially conceived and developed by The Energy & Resources Institute, TERI. It has been modified as a National Rating System after incorporating various suggestions by a group of architects and experts. It takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 and other IS codes, local bye-laws, etc. Through various qualitative and quantitative assessment criteria, GRIHA would be able to 'rate' a building on the degree of its 'greenness'. It will operate on a 100 point marking system with 70 to 80 points to be obtained for 3 star rated buildings and 81-90 points for 4 star rated buildings. The rating would be

applied to different types of new and existing buildings, whether commercial, institutional or residential.

A Memorandum of Understanding has been entered into between the Ministry and TERI towards development and operationalization of the National Rating System 'GIRHA' for Green Buildings. A National Advisory Council (NAC) has been constituted to provide advice and directions to the National Rating System. A Technical Advisory Committee (TAC) has also been constituted to provide technical oversight towards modifications and constant up-gradation of the GRIHA framework. GRIHA will be operated through GRIHA secretariat which will be hosted by TERI. It is understood that large scale promotion of GRIHA will help in getting the new buildings constructed on the concepts of Green Building design suitable for Indian conditions.

Financial Provisions

A. **GRIHA Secretariat -** GRIHA Secretariat will act as an independent autonomous body. It will be registered by TERI under Society's Act. A seed funding of up to Rs. 1 crore will be made available to the Society for its establishment and infrastructure facility as non-recurring grant based on the proposal received from TERI with details of the budget required. However, till the society is formed by TERI the Secretariat will function from the office of TERI at Delhi.

B. **Buildings rated under National Rating System –GRIHA -** The scheme is presently confined to commercial and institutional building including housing complexes with minimum built area of around 2500 m2. All the houses in a complex will be considered as single project. Individual houses are not covered in the Scheme.

C. **Registration-cum-Rating Fee -** 90% of the fee as given below for projects rated 3 star having built area up to 5000 m^2 and for projects rated 4 star having built area above 5000 m2 will be reimbursed by MNRE. Owners of building under design and construction, interested to be rated under GRIHA will get their buildings registered with GRIHA Secretariat as per the procedure given at GRIHA/MNRE. Website, Registration-cum-Rating Fee for the projects registered under GRIHA will be as per blow which will be paid to GRIHA Secretariat by the owners at the time or registration.

Project size (total built up area)	**Rating cum registration fee**
<=5000 m^2	Rs. 3,14,000 (Rs. 2,50,000 fixed cost for registration and secretariat fees + Rs. 64,000 for evaluation)
>5000 m^2	Rs. 3, 14,000 (fixed cost for projects up to 5000 m^2) + Rs. 3.75 / m^2 over and above 5000 $m^2$of built area.

Release of Registration-cum-Rating Fee to the owners will be made by MNRE on reimbursement basis through GRIHA Secretariat after validation of Star Rating Post – Construction by the National Advisory Council.

> Incentive to Architects/Design Consultants

To encourage Architects and consultants to design buildings on Green Architectural concepts and get them rated under GRIHA, and incentive as per below will be available from MNRE.

- Rs. 2.50 lacs for projects upto 5000 m^2 built-up area with minimum 3 star rating
- Rs. 5.0 lacs for projects > 5000 m^2 built up area with minimum 4 star rating.

Procedure for release of incentives to architects/design consultants and settlement of account with MNRE will remain same as given in Para A above.

Capital subsidy for SPV installations

One of the criteria under GRIHA is to meet 1% of total connected load for interior lighting and space conditioning through solar photovoltaic. It has been decided to support such photovoltaic system through capital subsidy which will be made available under Ministry's scheme on Solar Photovoltaic Systems/Devices for Urban Areas.

D. Other Item

Promotional Activities: A financial support of up to Rs.2.00 lakh for each activity could be provided for organizing workshops/seminars/training programmes/meetings of NAC/publications/awareness campaigns etc to implementing agencies including GRIHA Secretariat.

Submission for proposals and Release of Funds**:** The proposals on promotional activities could be generated by SNAs/Municipal Corporations/Govt. bodies/Reputed NGOs/GRIHA Secretariat etc and submitted to MNRE in the prescribed format**.** 80% of the CFA sanctioned will be released in advance on merit and rest on progressive achievements/completion of the activities with detailed reports and utilization certificates/SOE received in the Ministry**.** To private bodies, the funds will be released on reimbursement based or on the basis of the bond submitted to the Ministry.

Incentives to Urban Local Bodies: A one-time incentive of Rs 50 lacs to Municipal Corporation and Rs. 25.00 lacs to other Urban Local Bodies will be available to those who (i) announce rebate in property tax for energy efficient solar/green buildings rated under GRIHA, (ii) make it compulsory to get the new buildings under Govt. & Public Sector rated under GRIHA and (iii) sign an MOU with GRIHA Secretariat in presence of MNRE for large scale promotion of Green buildings in their area.

Submission of proposals & release of funds: To avail the incentive, Municipal Corporations/Municipalities/Urban Local Bodies will submit an application to the Ministry with a copy marked to SNA giving details of notifications/orders announcing rebate in property tax for energy efficient solar buildings and mandatory provisions of new Government/Public Sector Buildings rated under GRIHA. Release will be made directly to them in two parts, one immediate after receiving the application complete in all respect and other after receiving the progress report of Green Buildings after a period of one year.

Institution of Awards/Incentive: Annual awards to green buildings rated 5 Star under GRIHA will be given away by the Ministry in the form of Shields/Certificates. Cash incentive of Rs. 50 lacs to

Municipal Corporation and Rs. 25 lakh to municipalities/other Urban Local Bodies (one each to them) will also be given away that perform the best in promoting Green Buildings in their areas from 2011-12 onwards.

Other Activities – Funds for other activities as felt necessary by GRIHA Secretariat to promote as large scale in the country may also be considered by MNRE with the approval of NAC subject to availability.

Annexure 5 – Water Requirement

Water Requirement													
Year	Population in Lacs	Domestic Requirement @150 LPCD In MLD	Industrial Commercial @ 4000 gallon/ Acres/Day Area in Acres	Industrial Commercial Requirement in MLD	Community Institutional @ 4000 gallon/Acres/ Day Area in Acres	Community Institutional Requirement in MLD	Requirement For Stand Post Lav Blocks MLD	Wastage Water Leakage %	Total Leakage MLD	Total Requirement	Horticulture Requirement @ 5400 Gallon /Acres /Day Area in Acres	Horticulture Requirement in MLD	Gross Requirement MLD
2006	10.98	164.70	1921.63	34.91	3048.50	55.34	16.47	22	59.71	331.13	6600	161.80	492.93
2009	12.36	185.40	1921.63	34.91	3048.50	55.34	17.00	15	43.90	336.55	6600	161.80	498.35
2011	13.38	200.70	1921.63	34.91	3048.50	55.34	20.07	15	46.65	357.67	6600	161.80	519.47
2016	16.29	244.35	1998.50	36.27	3170.44	57.56	24.43	8	29.00	391.61	6600	161.80	553.41
2021	19.85	297.75	2078.44	37.72	3297.25	59.88	29.77	8	34.00	459.12	6600	161.80	620.92
2026	24.19	362.85	2161.60	39.27	3429.15	62.28	36.29	8	40.05	540.74	6600	161.80	702.54
2031	29.46	441.90	2248.00	40.82	3566.32	64.76	44.19	8	47.33	639.00	6600	161.80	800.80
2036	35.91	538.65	2338.00	42.46	3709.00	67.35	53.86	8	56.19	758.51	6600	161.80	920.31

Annexure 6 – Energy Conservation Measures

The main energy conservation measures taken by Electrical Circle, UT Chandigarh are as under:

1 A. Work Already Executed by Electrical Circle, UT Chandigarh:

Replaced all Incandescent lamps with CFL in all Govt. buildings under Chandigarh Administration.

Replaced all FTL tubes (2x40 watt) with Energy Efficient T5 lights (14 W / 28 W) at following Govt. buildings that will result to saving of Energy.

i) Deluxe buildings, U.T, Sectt, Sector-9 D, Chandigarh.

ii) Addl. Deluxe Building Sector-9, Chandigarh.

iii) Estate Office(D.C Office), Sector-17, Chandigarh.

iv) Extension to Govt. School Block I&II at Manimajra.

v) Primary Health Centre (Additional Block) at Manimajra.

vi) New OPD Block at GMSH Sector-16, Chandigarh.

vii) Judicial Academy Sector-43, Chandigarh.

viii) I.T Block of Govt. College for Girls, Sector-42, Chandigarh.

ix) 16 Nos. Additional Court Building in Punjab & Haryana High Court, Chandigarh.

x) Multi Level Parking in Punjab & Haryana High Court, Chandigarh.

xi) Central Library Sector-17, Chandigarh.

xii) UT Guest House (Block) at Sector-6, Chandigarh.

xiii) Govt. Senior Secondary School, Sector-54, Chandigarh.

xiv) Govt. Senior Secondary School, Sector-53, Chandigarh.

xv) Govt. Senior Secondary School, Sector-50, Chandigarh.

xvi) LED Electrification in Rose Garden, Sector-16, Chandigarh.

B. Energy Efficient Street light at JAN MARG:

The work for replacement of approx. 240 Nos. 250 Watt mercury lights by Energy efficient LED light is completed on the following roads.

i) V-3 road between Sector-3 & 4

ii) V-3 road between Sector-9 & 10

iii) V-3 road between Sector-16 & 17

iv) Partially between V-3 road of Sector-22 & 23

C. Investment Grade Energy Audit (IGEA):

With the support from Bureau of Energy Efficiency (BEE) the Chandigarh Administration has conducted Energy Audit of 12 Nos. Government Buildings as Detailed below:-

i) Punjab & Haryana High Court

ii) BBMB , Sector -19
iii) Punjab Police Head Quarter, Sector 9
iv) Panjab University , Sector 14
v) P.G.I.M.E.R, Sector 12
vi) GMCH Sector 32
vii) Telephone Exchange Building sector 17
viii) Telephone Exchange Building sector 34
ix) Hotel Mount View, Sector 10
x) Institute of Microbial Technology , Sector 39, Chandigarh
xi) Passport Office , Sector 34
xii) Accountant General Punjab

D. Solar Power Plant

i) (3 Nos.) of 6.30 KW, 4.5 KW & 3.8 KW capacities have been installed for Bollard & parking lights at Rose Garden, Sector-16, Chandigarh.

ii) Solar based ATC signal has already been installed at three different locations i.e. Inter Section of Sector-27 & 28, Inter Section of Sector-29 & 30 and Inter Section of Ind. Area & Sector-31 in Chandigarh.

iii) 50 KW Solar Power Plant Installed at UT Sectt. Building, Sector-9, Chandigarh.

E. Instruction have been issued for Mandatory purchase of BEE Star labeled products for Government purchases and CFL of good quality with minimum power factor of 0.85 or more and 10000hrs glow hrs life.

F. 60 Nos. ATC signals are replaced with LED's which resulted to annual Saving of Energy.

2. A. Work to be Executed by Electrical Circle, UT Chandigarh:

The work of replacement of all FTL tubes (2x40 watt) with Energy Efficient T5 lights (14 W / 28 W) at following Govt. buildings shall be carried out in this financial year.

i) CCET, Block-I, Sector-26, Chandigarh.
ii) 4 Nos. Court, Punjab & Haryana High Court, Chandigarh.
iii) 6 Nos. Court in Punjab & Haryana High court, Chandigarh.
iv) Renovation of 2nd & 3rd Floor, Police Head quarter, Chandigarh.
v) 55 Nos. Barracks in Village Sarangpur, Chandigarh.
vi) Extension of Various Govt. Schools, Chandigarh.
vii) Library Building Sector-34, Chandigarh.
viii) Library Block, Punjab & Haryana High Court, Chandigarh.

B. Solar System:

i) Providing Solar System in 6 Nos. Judges Houses, Sector-24, Chandigarh
ii) Providing Solar System in 3 Nos. Judges Houses, Sector-19, Chandigarh

C. The work of replacement & providing of LED Energy Efficient fitting is being taken in place with HPSV/HPMV Lamp fitting on the following road in the financial year.

i) V-3 road between Sector-34 & 35.

ii) V-3 road between Sector-35 & 36.

iii) V-3 road between Sector-22 & 23 (Balance Work).

iv) Campus Lighting District Court Sector-43, Chandigarh.

v) Campus Lighting on Paryavaran Bhawan, Sector-19, Chandigarh.

D. Energy Audit is in Progress in the following buildings:-

i) Chandigarh Housing Board Sector 9

ii) Principal Controller of Defense Account Sector 9

iii) Punjab & Haryana Civil Sectt. Building Sector -1

iv) Govt. Multi-Specialty Hospital Sector 16, Chandigarh.

E. Solar based automatic traffic control (ATC) signal at various location in the city has been proposed & under process.

Annexure 7 – R-APDRP

Restructured Accelerated Power Development and Reforms Programme (R-APDRP)

Introduction

The Govt. of India has proposed to continue R-APDRP during the XI Plan with revised terms and conditions as a Central Sector Scheme. The focus of the programme shall be on actual, demonstrable performance in terms of sustained loss reduction. Establishment of reliable and automated systems for sustained collection of accurate base line data, and the adoption of Information Technology in the areas of energy accounting will be essential before taking up the regular distribution strengthening projects.

Programme Coverage

It is proposed to cover urban areas - towns and cities with population of more than 30,000 (10,000 in case of special category states). In addition, in certain high-load density rural areas with significant loads, works of separation of agricultural feeders from domestic and industrial ones, and of High Voltage Distribution System (11kV) will also be taken up.

Further, towns/areas for which projects have been sanctioned in X Plan R-APDRP shall be considered for the XI Plan only after either completion or short closure of the earlier sanctioned projects.

Proposed Scheme

Projects under the scheme shall be taken up in Two Parts. Part-A shall include the projects for establishment of baseline data and IT applications for energy accounting/auditing & IT based consumer service centres. Part-B shall include regular distribution strengthening projects. The activities to be covered under each part are as follows:

Part-A: Preparation of Base-line data for the project area covering Consumer Indexing, GIS Mapping, Metering of Distribution Transformers and Feeders, and Automatic Data Logging for all Distribution Transformers and Feeders and SCADA / DMS system (only in the project area having more than 4 lacs population and annual input energy of the order of 350 MU). It would include Asset mapping of the entire distribution network at and below the 11kV transformers and include the Distribution Transformers and Feeders, Low Tension lines, poles and other distribution network equipment. It will also include adoption of IT applications for meter reading, billing & collection; energy accounting & auditing; MIS; redressal of consumer grievances; establishment of IT enabled consumer service centres etc. The base line data and required system shall be verified by an independent agency appointed by the Ministry of Power. The list of works is only indicative.

Part-B: Renovation, modernization and strengthening of 11 kV level Substations, Transformers/Transformer Centers, Re-conductoring of lines at 11kV level and below, Load

Bifurcation, feeder separation, Load Balancing, HVDS (11kV), Aerial Bunched Conductoring in dense areas, replacement of electromagnetic energy meters with tamper proof electronics meters, installation of capacitor banks and mobile service centres etc. In exceptional cases, where sub-transmission system is weak, strengthening at 33 kV or 66 kV levels may also be considered.

Funding Mechanism

1). GOI will provide 100% Loan for part A of the R-APDRP schemes which shall include projects for establishing Base Line data and IT applications for energy accounting/auditing and IT based consumer services etc.

2). GOI will provide up to 25% (90% for special category States) Loan for Part B of the R-APDRP schemes which shall include regular distribution strengthening projects.

3). The entire loan from GOI will be routed through PFC/REC (FIs) for the respective schemes funded by them.

4). The counterpart funding will be done by PFC/REC (FIs) as per its prevailing policy.

5). PFC / REC will be the prime lender for funding these schemes. In case of default by the utility the commercial loan of PFC / REC will be recovered first (being the primary Lender) before that of any other lender for funding such schemes.

Conversion of GOI Loan to Grant:

1). The entire amount of GOI loan (100%) for part A of the project shall be converted into grant after establishment of the required Base-Line data system within a stipulated time frame and duly verified by TPIEA.

2). Up to 50% (90% for special category States) loan for Part-B projects shall be converted into grant in five equal tranches on achieving 15% AT&C loss in the project area duly verified by TPIEA on a sustainable basis for a period of five years.

3). If the utility fails to achieve or sustain the 15% AT&C loss target in a particular year, that year's tranche of conversion of loan to grant will be reduced in proportion to the shortfall in achieving 15% AT&C loss target from the starting AT&C loss figure

Annexure 8 – Bench Marks

Bench mark for various service deliveries

Water Supply		
Sr. no.	**Proposed indicator**	**Benchmark**
1.	Coverage of water supply connections	100 percent
2.	Per capita supply of water	135 LPCD
3.	Extent of Non-Revenue Water	15 Percent
4.	Extent of metering	100 per cent
5.	Continuity of water supplied	24 hours
6.	Efficiency in redressal of customer complaints	80 per cent
7.	Quality of water supplied	100 percent
8.	Cost recovery	100 percent
9.	Efficiency in collection of water supply related charges	90 percent
Sewerage		
1.	Coverage of toilets	100 percent
2.	Coverage of Sewerage network	100 percent
3.	Collection efficiency of sewerage network	100 percent
4.	Adequacy of sewage treatment capacity	100 percent
5	Quality of sewage treatment	100 percent
6.	Extent of reuse and recycling of sewage	20 percent
7.	Extent of cost recovery in waste water management	100 percent
8.	Efficiency in redressal of customer complaints	80 percent
9.	Efficiency in collection of sewage water charges	90 percent
Solid Waste Management		
1.	Household level coverage	100 percent
2.	Efficiency of collection of solid waste	100 percent
3.	Extent of Segregation of MSW	100 percent
4.	Extent of MSW recovered	80 percent
5.	Extent of scientific disposal of MSW	100 percent
6.	Extent of cost recovery	100 percent
7.	Efficiency in collection of SWM charges	100 percent
8.	Efficiency in redressal of customer complaints	80 percent
Storm Water Drainage		
1.	Coverage	100 percent
2.	Incidence of water logging	0 numbers