Moreover, Department of Community Medicine and School of Public Health, PGIMER, Chandigarh, examined the seasonal periodicities of airborne pollen spectrum and developed the first Pollen Calendar for Chandigarh city. This helps in identify potential allergy triggers and provide a clear understanding for clinicians as well as allergy sufferers about their causes to help limit their exposure during high pollen loads.

As per the orders of Hon'ble National Green Tribunal (NGT), Chandigarh has to carry out source apportionment study as well as emission inventory. CPCC has almost finalised the tender documents and soon will be floated.

6. State of Noise Pollution

In urban centres rapid industrialization, development of residential and commercial infrastructure and road traffic are leading cause of higher noise levels. Vehicles are the major source of urban noise emission contributing around 55% of the total noise (Banerjee et al., 2008). Noise is regarded as a pollutant under the Prevention and Control of Pollution Act, 1981 of India (MoEF 1981Act). Worldwide, road traffic contributes the most to the production of urban noise. During 2011, the prevalence of hearing loss (Years lived with disability) was estimated as 63 million (6.3%) in India (NPPCD 2011). The growing vehicular population in Chandigarh have aggravated the noise pollution linked with the short term and long term health effects. In the year 2020 and 2021, a total of 7 and 28 hearing aid cases were reported in Chandigarh as shown in Table 23 (Programme officer, NPCCHH, Chandigarh). In Chandigarh, ambient noise monitoring is conducted by the Chandigarh Pollution Control Committee (CPCC) at four different locations (Table 24) to determine the impact of noise levels on a normal day and the day of Diwali celebration. The ambient air quality standards in respect of noise for different zones is prescribed under Rule 3(1) of Noise pollution (Regulation & Control) Rules, 2000 is given in Table 24. The day-time is from 6 AM to 10 PM, while the night time is considered from 10 PM to 6 AM.

Table 23: Hearing aid cases due to noise pollution

Year	No. of Cases
2017	5
2018	8
2019	27
2020	7
2021	28

Source: NPCCHH, Chandigarh

Table 24: Day and night noise limit under different land use category

Category of Zone	Limits in Leq dB(A)	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

Source: CPCC

The ambient noise data for the years 2017, 2018 2019, 2020 and 2021, are shown in Table 25 and Figure 39. It was observed from every monitoring station, the noise level data on Diwali was higher than the normal day and exceeding the permissible limit of 55 dB(A) during the day and 45 dB(A) during the night. In 2017, the highest noise pollution level was recorded in the residential area of sector-22 (84.8 dB(A)) between 9-10 PM on Diwali day while the lower limit was recorded in commercial area (46.7 dB(A)) on normal day between 11 PM and 12 AM. The level of noise pollution was highest between 9-10 PM in the residential area (Sector -22) on Diwali at 87.6 dB(A) and the lowest noise level was recorded between 11-12 AM in the residential area on normal day at 46.1 dB(A) during 2018. Similarly, the level of noise pollution was highest between 9-10 PM in the residential areas on Diwali at 80 dB (A) and the lowest noise level was recorded between 11-12 AM in the same area at 48 dB (A) on normal day during 2019. In 2020, the highest noise level monitored in the residential area between 9-10 PM at 66.6 dB(A) on the day of Diwali while the lowest was recorded in institutional area ((IMTECH, sector-39), within 11-12 AM on normal day at 47.1 dB(A). In the year 2021, the highest noise level was recorded in the institutional area on Diwali, between 9-10 PM at 78.2 dB(A) and the lowest noise level at 48.9 dB(A) on normal day between 11-12 AM in the commercial zone (Sector-17) (CPCC, 2019).

Table 25: Measured ambient noise levels during normal and Diwali day in Chandigarh during the period 2017 to 2021

Location/ Year	Category of Area		2017		2018		2019		2020		2021	
			Normal Day	Diwali Day	Normal Day	Diwali Day	Normal Day	Diwali Day	Normal Day	Diwali Day	Normal Day	Diwali Day
Sector-22	Residential	6 PM-7 PM	55.6	63.8	57.7	59.8	63.4	64.1	54.1	53.5	53.5	55
		7 PM-8 PM	53.3	71.9	56.3	71.1	60.9	66.5	51.9	56	53.6	60.2
		8 PM-9 PM	52.8	80.8	53.8	80.3	54.8	79.7	54.7	63.7	52.4	68.4
		9 PM-10 PM	51.6	84.8	50.6	87.6	52.5	79.8	57.7	66.6	52.1	67.9
		10 PM-11 PM	48.5	75.5	47.5	81	50.9	80	48.1	64.5	57.1	67.2
		11 PM-12 AM	46.8	76	46.1	63.1	48	60.8	47.4	58.9	49.8	52.7
IMTECH, sec-39	Institutional	6 PM-7 PM	59.4	62.2	54.6	54.6	52.2	50.5	56.1	56.2	64.2	65.5
		7 PM-8 PM	63.9	67.5	53.3	61.6	51.2	61.6	55	60.2	64.4	67.6
		8 PM-9 PM	64.4	75.3	55.2	68.8	50.6	68.6	55.5	65.5	62.8	73.8
		9 PM-10 PM	58.2	72.7	55.1	74.4	52.4	63.1	51.9	61.5	61.8	78.2
		10 PM-11 PM	57	62	53.1	69.5	51.6	61.8	56.4	59.7	61.6	69.4
		11 PM-12 AM	54.8	56.1	52.4	58.7	62.4	55.9	47.1	56.7	59.7	64.8
Sector-17	Commercial	6 PM-7 PM	52.6	56.9	53.7	58.1	59.6	59.8	51.2	49.9	53.5	57.2
		7 PM-8 PM	51.8	59.2	53.5	60.3	53.1	62	52.3	54.5	52.6	53.2

		8 PM-9 PM	50.9	63.5	52.5	66.9	53.1	64.8	50.9	55.3	52.9	57.4
		9 PM-10PM	49.3	62.3	51.1	69.7	53.2	66.7	51	55.8	52.8	59.6
		10 PM-11 PM	48	54.9	50.9	59.5	51.6	62.2	50.1	54.1	50	58.4
		11 PM-12 AM	46.7	48.6	51	55.4	49	56.5	49.1	51.2	48.9	49.9
PEC-12	**Silence**	**6 PM-7 PM**			52.6	73.1	66.6	66.8	63.7	52.1	53.3	56.1
		7 PM-8 PM			50	65.2	67.5	59.8	63.6	57.4	59.9	60.8
		8 PM-9 PM			53.9	74.4	60.4	68.2	59.6	57.5	52.7	63.2
		9 PM-10 PM			54	83.1	57.8	65.9	59.5	58.3	59.1	63
		10 PM-11 PM			52.7	75.4	55.4	59.5	60.8	53.2	51.7	58.6
		11 PM-12 AM			49.8	71.1	52.8	52.6	58.6	54.6	51.9	55.6
Standard value: Day time (6 to 10 PM)= 55 dB(A) & Night time (10 to 6 AM) = 45dB(A)												

Source-CPCC

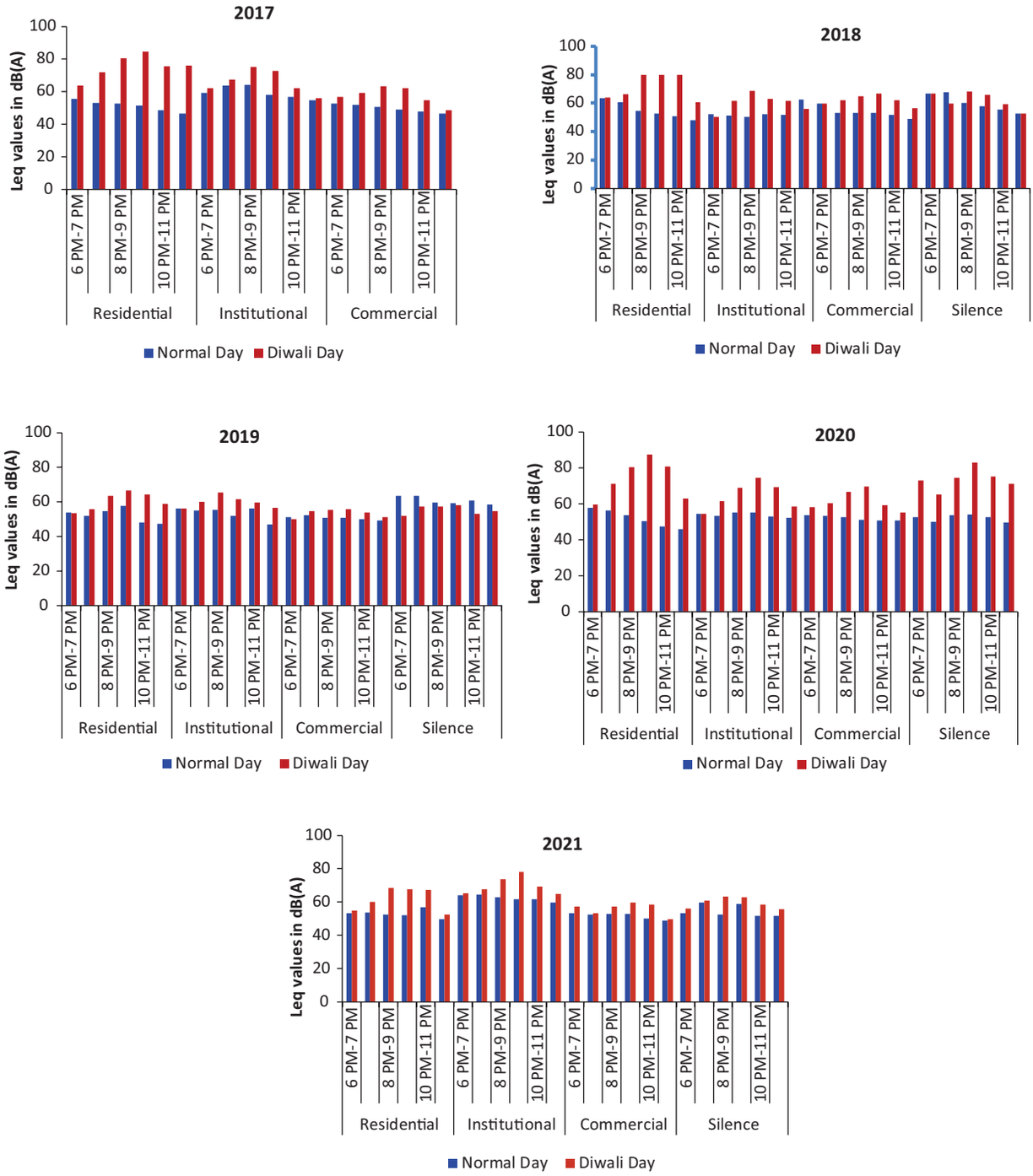

Figure 39: Measured ambient noise levels during normal Diwali day in Chandigarh during 2017 to 2021

Source: CPCC

6.1 Initiatives undertaken by regulatory authority of Chandigarh to control noise pollution

Chandigarh traffic police has been running a campaign titled "Make Chandigarh honk free" since 01.01.2018. The objective of this campaign is to make Chandigarh not pollution free but also noise free. As of now, blowing horn is prohibited in silence zones of Chandigarh which covers Sector-1 (Capital complex including Rajendra Park and Chandigarh Club), Sector-12, Sector-14, the entire area around the lake up to 100 meters from the high water mark, entire North East area of Uttar Marg including Rock Garden and Lake Club. Apart from this, it covers the areas comprising 100 meters periphery of all hospitals, religious places, educational institutions and courts. Also, the campaigning covers the following road safety aspects:

- Prohibit the use of pressure horn.
- No modified silencers in vehicles.
- Do not blow the horns unnecessarily.
- Right of way on roundabouts.
- Lane driving and respecting the rights of pedestrians and cyclists.

Further, the Central Pollution Control Board (CPCB) proposed set of fines for those violating norms restricting to noise pollution. Over the years, several challans have been issued in Chandigarh for violating noise pollution limit. It has been observed that the issuance of sound pollution challans and honking challans remained constant during the period 2012- 2017 (Figure 40). However, in 2018 and 2019 a sudden spike is observed in issuance of sound pollution challans and honking challans.

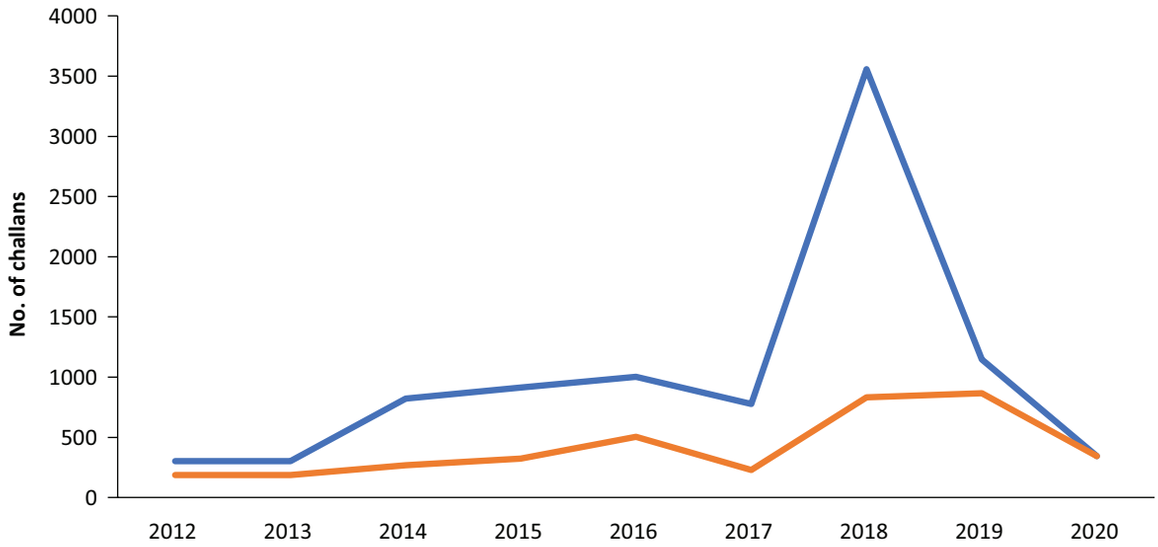

Figure 40: Number of challans issued for honking and exceeding sound pollution limit from 2012 to 2020

Source: CPCC

7. Recommendations for Air and Noise pollution

- The current number of ambient air quality monitoring stations in Chandigarh is sufficient in terms of population as recommended by BIS. However, recommended to enhance this for identification of hotspots in the domain.
- Installation of camera's at hotspot locations and traffic intersections are also recommended for better understanding of the local sources contributing to the air quality of the area which in turn help in adopting precautionary measures for improving the air quality.
- Restrict the entry of vehicles and/or imposing congestion pricing at heavy traffic areas within the city can improve emissions from transport sector.
- Develop roadmap to construct ring road around the city or interstate.
- Scientific study to identity hotspot locations is highly recommended, So far there is no such study carried out in Chandigarh for identification of sources contributing to the prevailing air quality. Therefore Source Apportionment, Emission Inventory and air assimilative carrying capacity study is highly recommended. This will help in providing micro level and regional strategies to control air pollution and also help in understanding the trans-boundary contribution of overall air quality of Chandigarh. Identification of hotspots based on modelling will help in improving the air quality by implementing city specific action plans.
- Source apportionment study needs to be carried out for the whole air shed rather than limiting to city boundary.
- In order to substantially reduce road dust re-suspension, planned landscaping can be done such as paving of roadside belts or planting of vegetation along the roadsides to control pollution from dust. Dust is one of the major sources of air pollution in the city of Chandigarh. Construction activities are one of the sources contributing to the problem. During construction dust particles are expected to be primary concern as dust would be generated with ground levelling and clearing the site. Strict enforcement of construction and demolition rules, better construction practices, such as proper loading and unloading of materials, water sprinkling to construction site to avoid wind-driven fugitive dust, shielding the construction area with barriers, are some of the measures to reduce dust emissions during construction.
- The waste collection and disposal mechanisms in the city must be strengthened.
- Capacity building and training programs for the officials of DOE, CPCC help in bridging the gap and building the capacity within the organizations on various aspects of air pollution including SA, EI, CC, etc.
- Identification of low emissions zones (LEZs) within the city will help in improving air quality.
- Enhancement of electric vehicles (EVs) for public transport by ensuring availability of citywide support infrastructure for EVs (more E buses and cycle track should be developed for cyclists so that cycles do not interfere with regular motor traffic).
- To carry out health impacts studies due to air pollution.

Following noise abatement measures should be undertaken to bring down the levels well below the prescribed limits.

- Installation of continuous noise pollution monitoring station
- Identification of noise hot spots and mapping of noise

- Installation of noise barriers around silence zones (Hospitals, schools).
- Formulation of noise pollution action plan
- Regular monitoring and stringent regulatory measures with high penality especially in no silence zones.

ANNEXURE

Table 26: Revised ambient air quality standards published in 2009 by CPCB

	Concentration in Ambient air			
Pollutants	Time Weighted Average	Industrial, Residential, Rural, and other Areas	Ecologically Sensitive Area (Notified by Central Government)	Measurement Method
Sulphur Dioxide (SO_2) µg/m^3	Annual *	50	20	• Improved West and Gaeke Method • Ultraviolet Fluorescence
	24 Hours**	80	80	
Nitrogen Dioxide, (NO_2), µg/m^3	Annual *	40	30	• Jacob & Hochheiser modified • (NaOH-NaASO2) Method • Gas Phase Chemiluminescence
	24 Hours**	80	80	
Particulate Matter (size less than 10µm) or PM_{10}, µg/m^3	Annual *	60	60	• Gravimetric • TEOM • Beta attenuation
	24 Hours**	100	100	
Particulate Matter (size less than 2.5µm) or $PM_{2.5}$, µg/m^3	Annual *	40	40	• Gravimetric • TEOM • Beta attenuation
	24 Hours**	60	60	
Ozone (O_3) µg/m^3	8 Hours**	100	100	• UV Photometric • Chemiluminescence • Chemical Method
	1 Hour**	180	180	
Lead (Pb) µg/m^3	Annual *	0.5	0.5	• AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper • ED-XRF using Teflon filter
	24 Hours**	1	1	

	Concentration in Ambient air			
Carbon Monoxide (CO), mg/m^3	8 Hours **	2	2	• Non dispersive • Infrared (NDIR) • Spectroscopy
	1 Hour **	4	4	
Ammonia (NH_3), µg/m^3	Annual *	100	100	• Chemiluminescence • Indophenol blue • method
	24 Hours**	400	400	
Benzene (C6H6),µg/m^3	Annual *	5	5	• Gas Chromatography (GC)based continuous analyzer • Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m^3	Annual *	1	1	Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m^3	Annual *	6	6	AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m^3	Annual *	20	20	AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

Source: (CPCB, 2009)

**Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.*

***24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

IV

WATER AND WATER POLLUTION

CHAPTER IV

WATER AND WATER POLLUTION

Introduction

1. Current Status of Water Resources

The Union Territory (UT) of Chandigarh primarily depends on two sources of water i.e. surface and groundwater. The current status and availability of water in the UT have been described in the following sections.

1.1 Surface Water Availability

The Union Territory (UT) of Chandigarh receives rainfall annually during the months of late June to September (southwest monsoon) and occasional winter rains from the Western Disturbance during December to April. An average of 1078 mm of rainfall was received in 2019 while 1070 mm in 2021 (CGWB, 2021). Bhakra dam is constructed across River Sutlej. Bhakra main line canal is located around 27 km from Kajauli and is one of the sources of water for the UT. Chandigarh falls in the Ghaggar basin. There are two significant drains, Sukhna *Choe* and Patiala ki *Rao* that originate from Shivalik hills ranges and form the city's natural drainage. The Sukhna *Choe* flows north to south, drains the eastern part and joins the Ghaggar river. The other important stream is Patiala-ki Rao, which flows northeast to southwest and drains the city's northern parts. Both these streams are temporary and carry high flows during monsoon. The N-*Choe* flows through the leisure valley and drains major parts of the city. It flows from northeast to southwest direction and traverses the north central part of the city.

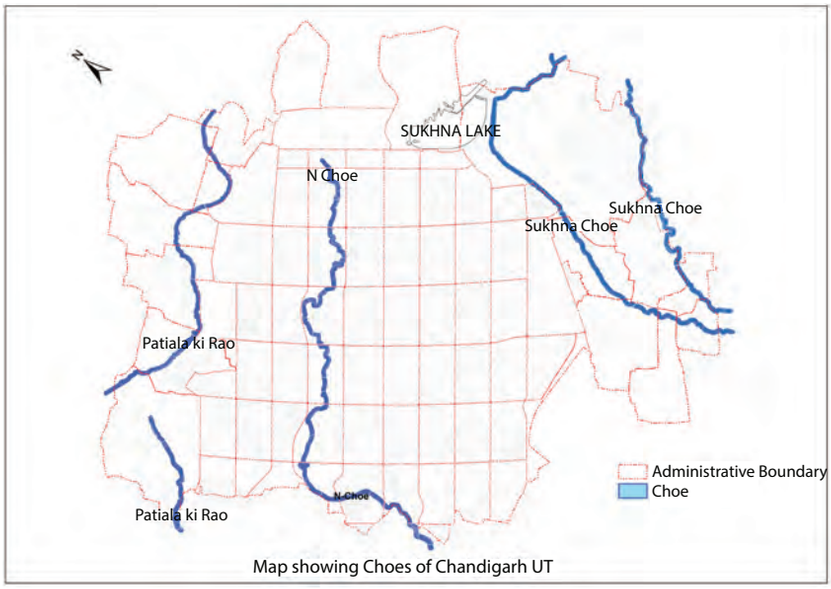

Figure 41: Location of surface water bodies in Chandigarh

Source: Smart City Office, Municipal Corporation, Chandigarh

Another Choe/nalah originates from Sector-31 and drains the southern-most part of the city. The rain fed Sukhna lake was created by damming the Sukhna Choe near sector number six. This lake has an area of 1.63 sq. km. The water holding capacity of Sukhna lake is 5 million cubic meters (CGWB, 2013). The location of the surface water bodies is shown in Figure 41

1.2 Groundwater Availability

Chandigarh is located in the foothills of Shivalik hill ranges in the north, forming a part of the fragile Himalayan ecosystem. The sub-surface formation comprises beds of boulders, pebbles, gravel, sand, silt, clays and some pebbles. As per Central Ground Water Board (CGWB), groundwater in the area occurs under unconfined, confined as well as semi- confined conditions. The pumping test data of the aquifers tested in the city indicates that well confined aquifers occur around Sector 10, 33, 38 and 47, while leaky ones is encountered around Sector 28. One interesting feature is that the aquifers in the southern parts of the city are restricted in aerial extent due to lithological boundaries as deciphered from pumping test data. Groundwater occurs under unconfined conditions down to about 80 m in the Manimajra area. In other regions, the semi-confined conditions prevail up to 20- 30 m below the land surface. Barring the Manimajra area, groundwater below 20-30 m exists under confined conditions. The depth of the shallow aquifer system is less than 30 m below ground level. In contrast, the depth of the deeper aquifer system ranges from 40 to 450 m below ground level of explored depth while in the Manimajra area, confined aquifers occur below 90 m. It was observed that the sediments are coarse-grained down to a depth of 180 m bgl, below which they become finer. The yield of the deeper aquifers is also lesser as compared to the shallower ones. There is a huge dependence on groundwater to meet domestic and irrigation water needs. Groundwater is available in around 289 tube wells. There are dedicated dug wells where groundwater quality is monitored regularly.

2. Water Supply

2.1 Existing institutional mechanisms and arrangements

Chandigarh's primary source of water supply in the past (up to 1983) was only groundwater (tube wells). Later, the supply was augmented via surface water (Bhakra main canal). The present water supply service area of Municipal Corporation Chandigarh (MCC) is 114 sq.km. This includes MCC area of 70 sq.km and rural area of 44 sq. km (Chandigarh Master Plan 2031). The urban area falls under the jurisdiction of Municipal Corporation and water supply system is entrusted to the Public Health Wing of MCC. The rural area comprises 13 villages are also overseen by the MCC. The water supply to the villages is provided with tube wells in and around the villages. Other urban/rural areas have water sources of 58 MGD (Million gallons per day) from the Bhakra main canal, which is 27 km away from Chandigarh and 25 MGD from 250 tube wells located in the city (CGWB, 2021). The water is supplied at the average rate of 245 lpcd (litres per capita per day) approximately for around 9-11 hours a day. As per MCC, the UT of Chandigarh is divided into 6 zones (Figure 42) for water supply based on the slope/gradient of the city. Each zone is fed through independent waterworks, namely Water Works – 39, 12, 26, 37, 52 and 32 (Figure 42). These Water Works are fed from main Water Works – 39 (mother water works), which receives water from Bhakra main canal at Kajuli and various tube-wells spread all over Chandigarh. Keeping in view the geographical location and higher altitutde of Manimajra, i.e., upstream of the entire water distribution system, two additional zones, namely Manimajra-I (MM-I) and Manimajra –II (MM-II) have been included. The details of the areas that they cover have been presented in Table 27. Before the distribution of the water, the canal water is treated at a water treatment plant at Water Works – 39 and 12. Water is being supplied to the slum areas through public stand posts, apart from water tankers.

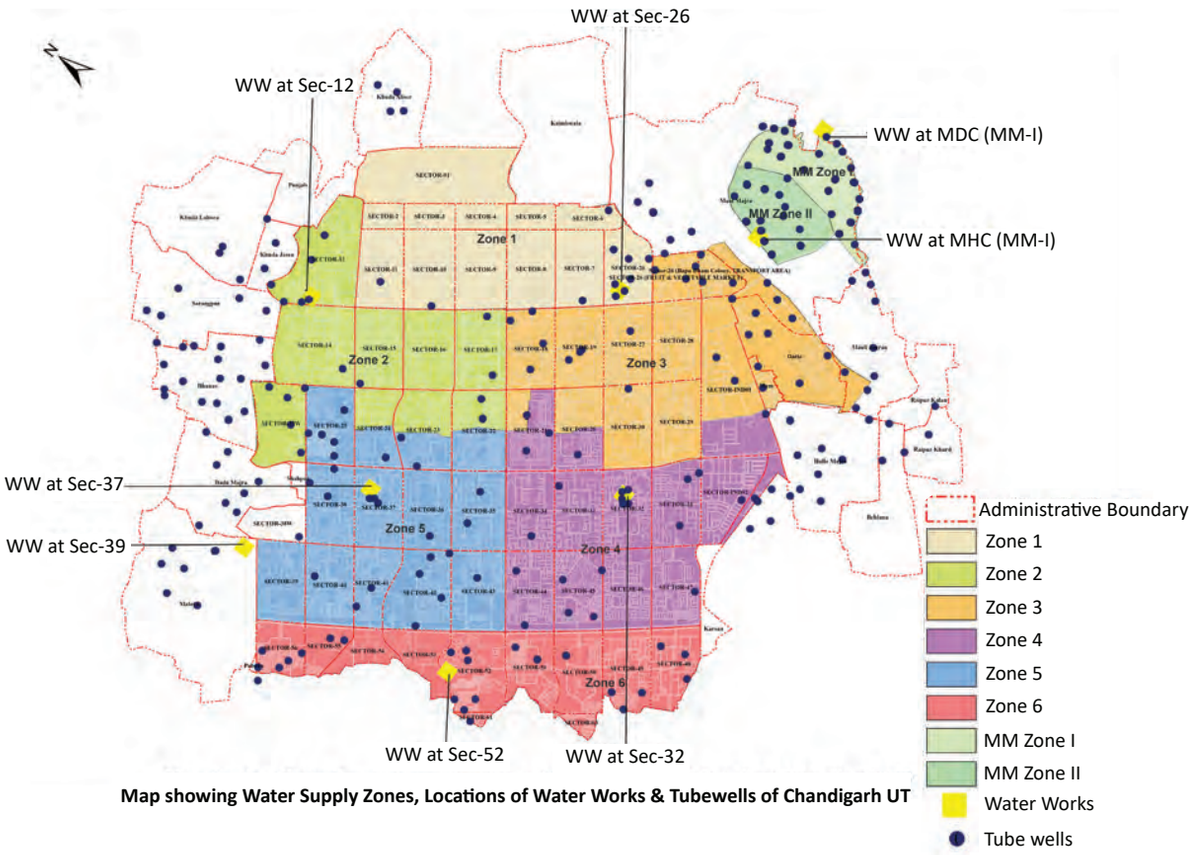

Figure 42: Chandigarh water supply zones, location of water works and tube wells

Source: Smart City Office, Municipal Corporation, Chandigarh

Table 27: Details of water supply across Chandigarh

Zone #	Location of Waterworks	Sectors Covered
1	Water works 12	12, 14, 15, 16, 17, 18-22-A&B, 21-A, PGI, Punjab University, 25
2	Water works 26 (Kirloskar side)	1 to 11 and Secretariat, High Court, Rock Garden
3	Water works sector 26 (Jyoti Side)	19, 26, 27, 28, 29, Industrial Area Phase –I (Part), 20-A& B, 21-B, 30-A&B, Bapu Dham colony, colony No.4, Sanjay Colony
4	Water works sector 32	31, 32, 33, 34, 43, 44, 45, 46, Industrial area phase- 1(Part), Industrial Area Phase-II, 20-C& D, 21-C &D, Burail
5	Water works sector 37	22-C&D, 23, 24, 25, 35, 36, 37, 38, 39, 40, 41, 42 and 43, Attawa, Butrela, Badheri
6	Water works – 52	48-61, Kajheri
7	Manimajra -I	Water is distributed to the old abadi of Manimajra Town
8	Manimajra-II	Feeding to modern housing complex Manimajra

Source: Municipal Corporation of Chandigarh, 2017

2.2 Quantum of water supplied

To examine the change in the volume of water supplied over the years, the quantity of water that was supplied in 2016 and 2020 has been depicted in Figure 43. As can be seen there is an increase in the water demand.

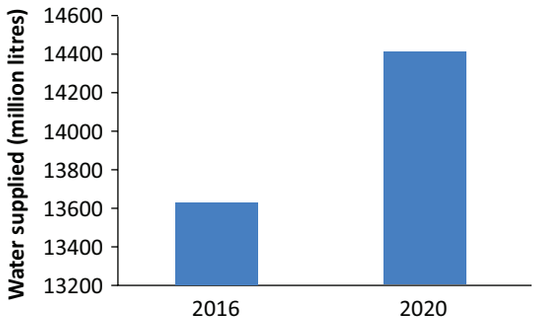

Figure 43: Total volume of water supplied

Source: *Smart City Office, Municipal Corporation, Chandigarh*

As per MCC and (CGWB, 2020) the groundwater draft or extraction during the year 2020 has been as follows:

1. **Domestic Draft:** Around 3483 Ha m/year of groundwater was pumped for drinking/domestic water supply. These tube-wells tap confined aquifers below 90 m from ground level. The depth of these wells ranges from 200-300 m. The average unit well draft of these wells is 15.54 (hectare-meter) ha-m/year.
2. **Industrial Draft:** There are 32 nos. of commercial tube-wells for industrial water supply and out of which total 20 tube-wells are actual in use. These tube-wells tap confined aquifers below 90 m from ground level. The depth of these well ranges from 200-300 m. The average unit well draft of these wells is 8.67 ha-m / year.
3. **Agriculture Draft:** Total 30 nos. of irrigation tube-wells in Chandigarh UT are in actual use. These tube-wells tap confined aquifers below 90 m from ground level. The depth of these wells ranges from 200-300 m. The average unit well draft of these wells is 31.69 ha- m/year.

2.3 Service Level Benchmarks

As per the Ministry of Housing and Urban Affairs (MoHUA), Government of India guidelines, the status of water supply in a state or union territory is assessed using standard service level indicators. The ranking of these service level indicators for the UT of Chandigarh is presented in Table 28. As seen from the table, Chandigarh met the benchmark for five out of nine indicators. The extent on non-revenue water is more than the benchmark indicating the need for plugging of leakages. Further, free water supply to slum areas contributes to unaccounted for water (UFW) thereby negatively affecting the extent of non- revenue water. The cost recovery in water supply services and efficiency in addressing consumer complaints needs improvement. The quality of water supplied was per the required standards. The per capita water supply of 245 lpcd exceeds the benchmark of 135 lpcd. This rate does not apply to institutional and irrigation water supply. This rate of water supply could be checked to save or conserve water.

Table 28: Status of Service Level Benchmarks for water supply sector

S.No.	Indicator (Unit)	Standard Benchmark	Existing as of 2020-21
1	Coverage of water supply (%)	100	100
2	Per capita supply of water (lpcd)	150	245
3	Extent of Metering of water connections (HSC), %	100	100
4	Extent of Non-Revenue Water (%)	15	32 - 38
5	Continuity of water supply (hours per day)	24	4-5 hours in morning and 4-5 hours in evening
6	Quality of water supplied (%)	100	100
7	Cost recovery in water supply services (%)	100	52
8	Efficiency in collection of water supply related charges (%)	90	92.25
9	Efficiency in addressing customer complaints (%)	80	78

Source: Smart City Office, Municipal Corporation Chandigarh

A Driver, Pressure, State, Impact, and Response (D-P-S-I-R) framework has been adopted for further analysis. This has been described in the next section (figure 44).

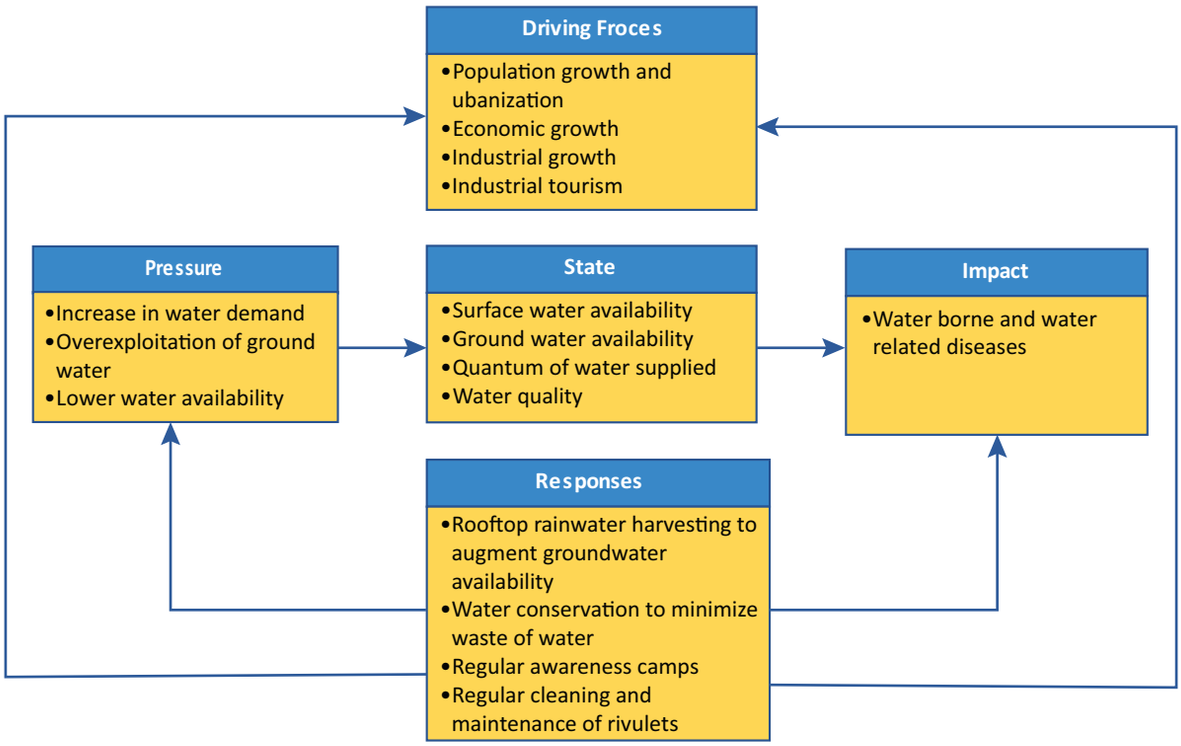

Figure 44: Diagram illustrating each component of DPSIR Framework

3. Drivers and pressures on water resources

The key drivers that exert pressure on the water resources of the region include increase in population, urbanization, industries and tourism. During the last six decades (1951-2011), Chandigarh has witnessed a population increase of more than forty-four times with the absolute population increasing from 24, 261 in 1951 to 10, 55, 450 in 2011 (Statistical Abstract of Chandigarh, 2020). As per the Master Plan 2031, the projected population of Chandigarh in 2021 is 13.5 to 14.5 lakhs. The current rate of urbanization is 79%. There are about 2950 small scale and 15 large and medium scale industrial units in existence in Chandigarh. There has been consistent increase in tourism. Around 9, 58, 719 domestic and international tourists visited Chandigarh in 2012 while in 2019 the number increased to 16, 07, 927 (Statistical Abstract of Chandigarh, 2020). The floating population of 2019 was higher than the projected population of that year which has influenced the water consumption and this has led to an increase in the water demand. Further, variability in rainfall affects the water availability and puts pressure on the water resources.

4. State and Impact

A continuous increase in the water demand has been exerting pressure on the existing water resources thereby leading to its overexploitation and lower availability of water. As mentioned earlier, there is a huge dependence on groundwater. The latest estimates on the existing draft and stage of groundwater development have been presented in Figure 45. Based on the latest estimates (CGWB, 2020), the stage of groundwater development in Chandigarh is 80.60% and falls under the 'Semi-Critical' category. Hence, efforts are being taken to limit excess use of groundwater.

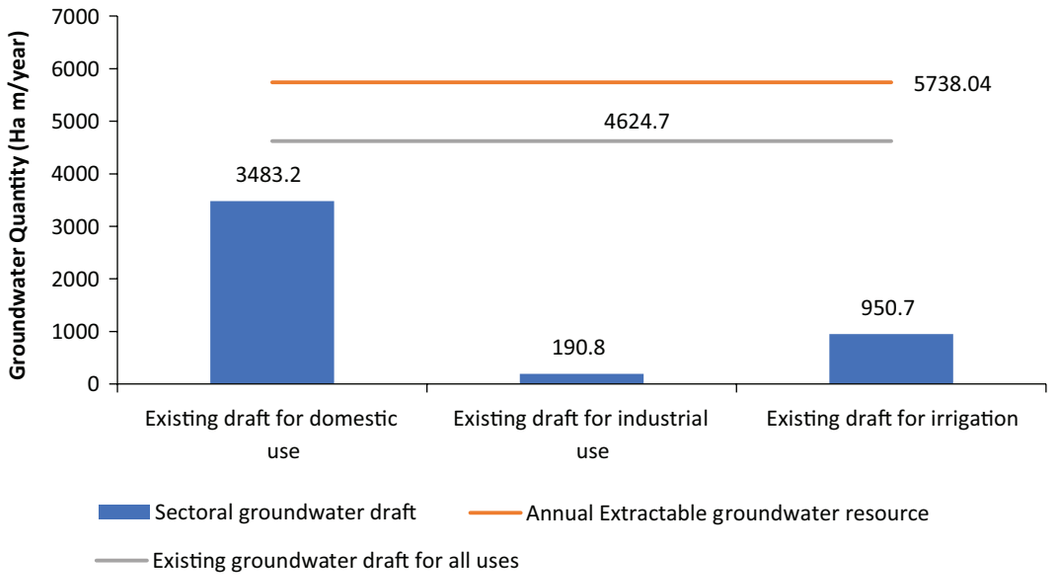

Figure 45: Stage of groundwater development as on the year 2020

Source: Central Ground Water Board, 2020

At present, there are 289 deep tube wells in the UT, which form the ground water reserves. Out of these, around 250 tube wells are used for water supply to the tune of 25 MGD. The water requirement in the year 2021 is projected to be 355.25 MLD whereas the total availability projected is 395.5 MLD (Smart City, Chandigarh).

The variability in rainfall affects water availability. A deviation in actual annual rainfall from normal rainfall for UT Chandigarh for more recent years has been depicted in Table 29. This is IMD grid data that is available at India Water Resources Information System (IWRIS), Ministry of Jal Shakti, Government of India. It was observed that except for 2018 other years witnessed a decrease in the average annual rainfall as compared to the normal average rainfall.

Table 29: Deviation in actual annual rainfall from normal rainfall

Year	Normal Rainfall (mm)	Actual Rainfall (mm)	% Deviation from normal
2015	1078	824	-24
2016	1078	575.4	-47
2017	1078	858	-20
2018	1078	1086	1
2019	1078	940	-13
2020	1078	867	-20
2021	1078	819	-24

Source: IMD data available at IWRIS

Considering the current state of groundwater development and variability in the rainfall, immediate intervention for its conservation and replenishment is warranted.

5. Response

The demand for water is growing in direct proportion to the city's growth. In order to meet the future water demand, water conservation and recharge measures are required. This section describes the actions taken by the government towards conservation of water.

A master plan for artificial recharge to groundwater in India – 2020 has been prepared by the Central Ground Water Board. This plan states that Chandigarh is highly urbanized and hence rooftop rainwater harvesting can be ideal technique to augment the groundwater availability. There is abundance of green area and some water bodies can be effectively utilized for recharging the rainfall runoff. In Chandigarh, there are two distinct aquifer systems – shallow and deep. Shallow aquifer occurs under unconfined and semi-confined conditions and exists down to 20 to 30 m below land surface. Deep aquifers below 40 m are under confined conditions. The aquifer in the area is under semi-confined to confined conditions. It is evident from the fact that the ground water extraction for drinking purpose through 250 tube-wells is mainly from deeper aquifers (200m), however the decline in shallow water table can be observed. Hence, recharging of shallow aquifer can also induce recharge of deeper aquifer due to head difference. The scope for artificial recharge in the UT of Chandigarh is shown in Table 30.

Table 30: Scope for Artificial Recharge (AR) of groundwater in UT of Chandigarh

Area (Sq.km)	Area identified for AR (sq.km)	Volume of unsaturated zone (MCM)	Available sub-surface space for AR (MCM)	Water required for recharge (MCM)
114	114	455	55	73

Source: *CGWB, 2020*

There are initiatives taken by the Chandigarh administration towards construction of stormwater harvesting and groundwater recharge structure. These include some roads, rooftops of residential areas, shopping areas, and public institutions. Owing to Chandigarh's well laid out drainage system, tapping storm water and progressive channelling it into recharge trenches has a potential to harvest 70% of the rain. Legal frameworks have been laid down by the administration to make provisions for rain water harvesting mandatory vide notification dated 16-10-2008 while granting additional covered area to buildings with size above 500 sq km (Department of Environment, Chandigarh Administration, 2019).

Some of the water conservation and harvesting activities that have been undertaken by the Public Health Department includes: (i) Amrit Sarovar in village Kaimbwala; (ii) Pond in Sarangpur village; (iii) Pond in Khuda Ali Sher village; (iv) Jal Shakti Abhiyan, Catch the Rain at four locations under Chandigarh administration and three locations under MCC.

6. Water Quality

6.1 Water Treatment

The raw water is treated at the water treatment plant (Water Works – 39 and 12) before its distribution. The treatment includes alum dosing, flocculation, settling, filtration, and chlorination. The water is tested using scientific methods for standard physico-chemical and bacteriological parameters before its distribution.

6.2 Sewage Treatment

The city of Chandigarh has a well-planned underground network of pipes for the disposal of sewage generated in the city. It is a decentralised system. It is mandatory for every residential/ establishment or society to have a proper sewage disposal system. The sewage system of the city has been designed by taking into account the natural slope of the city, which is from north to south. The sewage of the city flows under gravity in various pipes of different diameter ranging from 6" to 18" S.W. Pipes and 24"x36" to 66" diameter circular brick sewer. The total length of the sewer lines in the city is 1108 km. There are six sewage treatment plants. There are few pockets in the city which are at lower level and thus the sewage of these pockets cannot be discharged by gravity into the sewage system of the city. The sewage of these pockets is pumped into the sewage system and thereafter it flows under gravity to the STP. The increase in the population and increasing water supply has resulted in increased sewage flow. This has necessitated augmentation of sewage treatment plant. There are many unauthorized settlements and rehabilitates colonies in the city. To check the residents of these settlements from defecating in the open areas, the community toilets and mobile toilet vans have been provided in these areas. The public health department of the MCC also deals with sewage services within Chandigarh. The service is designed in such a way that there is no intermittent pumping required. Trunk sewer lines have been designed for

2.2 times the peak flow which is more than what the manual on sewage specifies. The amount of sewage generated in Chandigarh is around 52.86 MGD which includes both sewage from domestic and industrial sector. To treat the sewage generated, there are currently six sewage treatment plants in Chandigarh with an overall capacity of 53.9 MGD. The treated effluent from the tertiary treatment plant is used in gardening etc. The details of the STPs have been given in Table 31 and their locations are shown in Figure 46.

Table 31: Details of Sewage Treatment Plants (STPs)

S.No.	Location of STP	Capacity (MLD)	Capacity (MGD)
1	Diggian	136	30
2	Raipur Kalan	22.5	5
3	3 BRD	50	11
4	Dhanas	7.5	1.65
5	Maloya	22.5	5
6	Raipur Khurd	5.6	1.25

Source: Municipal Corporation Chandigarh, 2021

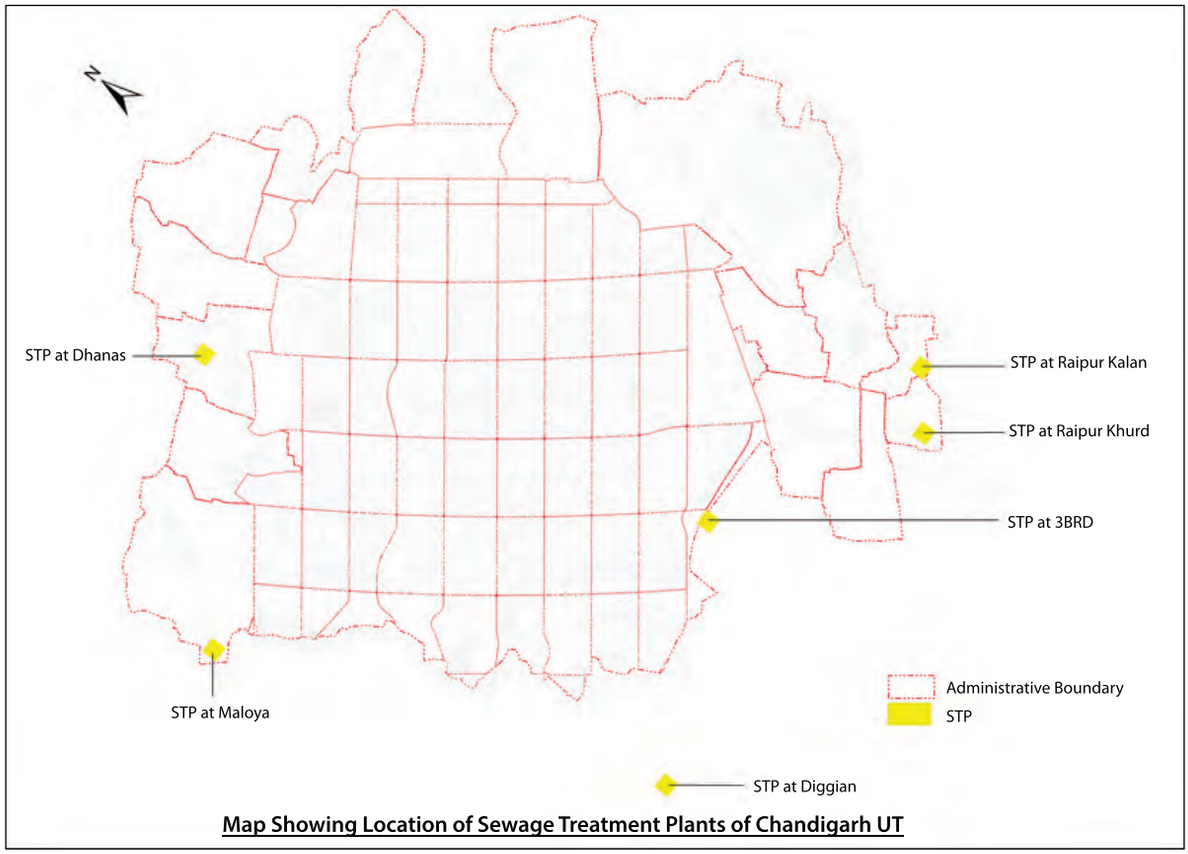

Figure 46: Locations of Sewage Treatment Plants

Source: Municipal Corporation of Chandigarh

There are two more STPs at Raipur Kalan (1.25 MGD or 4.73 MLD), and Kishangarh near Sukhna lake (0.44 MGD or 1.66 MLD) that were proposed in 2020 and expected to be in operation by 2022. The mode of disposal of treated effluent is to natural Choe except for Diggian.

6.3 State or status of water quality and related infrastructure

The service-level indicators in Chandigarh related to sewage services highlight that the current system is functioning reasonably well (Table 32). As can be seen for Table 32, Chandigarh has achieved the required benchmark for most of the indicators. There is just a slight gap in efficiency treatment which needs to be addressed in near future.

Table 32: Status of service-level indicators for sewage services

Indicators	Existing Service Level (%)	Benchmark (%)
Coverage of toilets (individual/community)	100	100
Coverage of sewage network services	100	100
Efficiency of collection of sewage	100	100
Efficiency in treatment: Adequacy of sewage treatment capacity	99.7	100

Source: *Municipal Corporation of Chandigarh, 2020*

The annual volume of wastewater treated at the two STPs (Diggian and 3BRD) has been increasing consistently over the years (Figure 47) indicating the increased generation of wastewater and/or improvement in its collection and treatment. The total volume of sewage treated in the 2020 at various STPs is depicted in Figure 48.

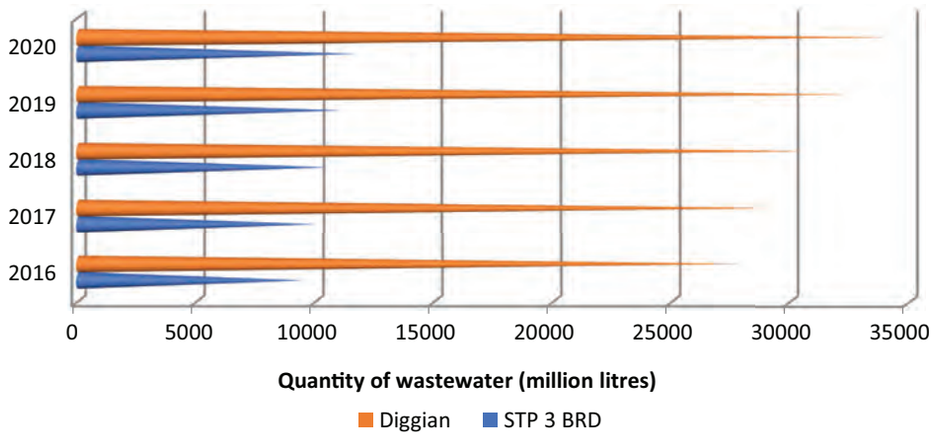

Figure 47: Annual volume of wastewater treated at two sewage treatment plants

Source: Municipal Corporation of Chandigarh

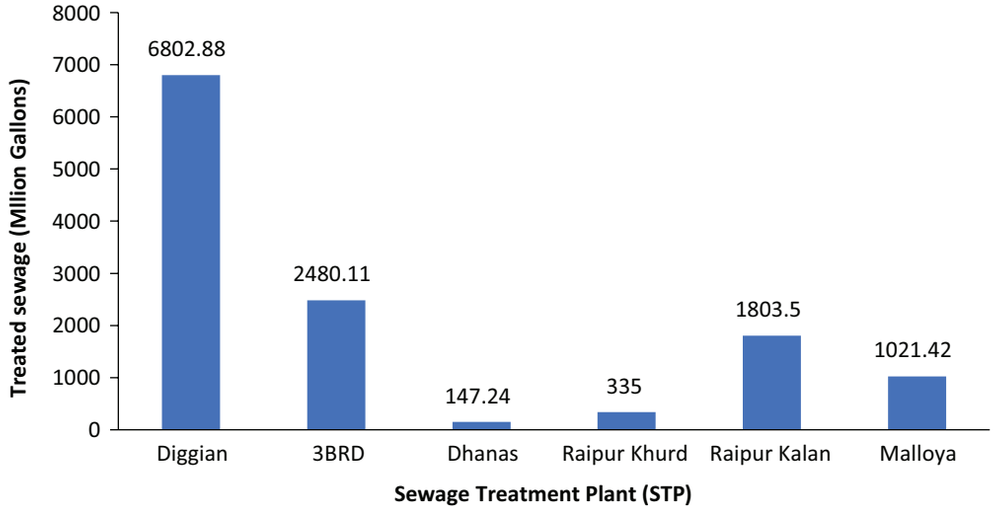

Figure 48: Annual volume of sewage treated in 2020

Source: Municipal Corporation of Chandigarh

As required by the Central Pollution Control Board (CPCB), the water quality data of the treated sewage from the outlets of various STPs was examined with the Inland Surface Water standards (CPCB, 2020). The water quality data (for the year 2020) from the outlets of various STPs has been presented in Table 33 to Table 38. The parameters that exceeded the standard limit have been indicated in '**bold**' font. As seen from the data, the COD and BOD values exceeded the limit for STP at Raipur Khurd, Raipur Kalyan, and Dhanas. Occasional exceedance of BOD value was observed for STP at Diggian and STP 3 BRD.

The water quality is also being monitored at two Choe/drains namely Sukhna Choe/drain and Attawa Choe/drain. The monthly water quality data for these two drains has been shown in Table 39 and Table 40 respectively. This data was also examined against the inland water quality standard limits as prescribed by the CPCB. The values for BOD and total suspended solids for Sukhna drain surpassed the standard limit. Similarly, the BOD values were found to be more for AttawaChoe/drain. This calls for intervention, monitoring and strict compliance.

Table 33: Water quality at STP Diggian outlet

S.No	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not exceed 5°C above the receiving water temperature	18	18.1	--	27	27	29	28.5	28	29	25	24	20.2
2	pH	5.5 - 9.0	7.6	7.3	--	7.2	7.2	6.9	7.2	7.2	7.3	7.2	7.3	7.3
3	DO, mg/l	-	5.9	4.7	--	4.4	4.6	5.7	5.9	4.4	4.9	4.2	1.7	1.5
4	COD, mg/l	250	93	112	--	151	41	37	41	50	42	73	69	120
5	BOD, mg/l	30	29	62	--	55	14	12	16	29	18	24	27	47
6	TSS, mg/l	100	28	48	--	28	6	14	12	29	10	20	41	60
7	NH_3-N, mg/l	50	15	31	--	18	18	17	12	26	16	26	31	27
8	PO_4-P, mg/l	5	4.99	2.51	--	2.43	2.56	3.15	2.49	2.29	2.29	2.62	1.83	2.64
9	Total Coliform, MPN/100ml	-	2.78 × 106	3.45 × 106	--	--	2.4 × 106	-	1.41 × 106	3.48 × 106	2.2 × 106	7.6 × 104	5.42 × 105	1.2 × 106
10	Faecal Coliform, MPN/100ml	-	7.0 × 105	2.21 × 106	--	--	3.3 × 105	-	9.0 × 104	1.3 × 106	1.4 × 105	1.8× 104	1.3 × 105	1.4 × 105

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: Chandigarh Pollution Control Committee (CPCC)

Table 34: Water quality at STP 3BRD final outlet

S.No Limit*	Parameters	Permissible	2020											
			Jan	Feb	March	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2	pH	5.5 - 9.0	7.6	7.1	--	7	8	6.8	6.8	7.4	7.2	7.4	7.1	7.9
3	DO, mg/l	-	4.6	2.7	--	5.8	--	6.9	10.8	5.1	6.6	6.5	2.9	5.4
4	COD, mg/l	250	--	53	--	25	19	16	13	14	8	12	32	19
5	BOD, mg/l	30	80	27	--	9.6	9.8	9	5	6.4	3.1	4.8	8.7	6.5
6	TSS, mg/l	100	51	69	--	10	19	10	3	13	9	4	5	4
7	NH_3-N, mg/l	50	2.15	2	--	1.6	1.2	0.37	0.68	2.12	0.73	0.38	1.89	0.78
8	PO_4-P, mg/l	5	2.03	1.89	--	1.35	1.18	0.58	2.34	0.61	2.04	1.71	1.08	1.62
9	Total Coliform, MPN/100ml	-	2.4 × 106	5.42 × 106	--	--	2.4 × 103	2.4 × 103	7.9 × 104	3.45 × 104	1.3 × 105	1.2 × 105	3.45 × 105	7.6 × 104
10	Faecal Coliform, MPN/100ml	-	7.9 × 105	1.09 × 106	--	--	2.3 × 102	4.9 × 102	1.7 × 104	1.72 × 104	5.4 × 104	4.0 × 104	4.9 × 104	4.0 × 103

*Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: *Chandigarh Pollution Control Committee (CPCC)*

Table 35: Water quality at STP Raipur Khurd outlet

S.No Limit*	Parameters	Permissible	2020											
			Jan	Feb	March	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2	pH	5.5 - 9.0	6.4	7	--	7.3	7.2	6.9	7.3	7.7	7.7	7.6	7.7	7.3
3	DO, mg/l	-	NIL	NIL	--	2.4	2	0.7	0.5	2	3.4	3.2	1.8	0.3
4	COD, mg/l	250	309	383	--	157	168	161	107	80	72	120	205	226
5	BOD, mg/l	30	123	119	--	87	101	101	86	48	26	39	65	84
6	TSS, mg/l	100	83		--	66	58	102	63	66	53	75	105	137
7	NH_3-N, mg/l	50	32	33	--	24	35	13	23	9	11	14	15	12
8	PO_4-P, mg/l	5	4.84	6.47	--	5.84	2.17	3.05	0.99	0.37	0.59	1.97	1.86	1.96
9	Total Coliform, MPN/100ml	-	9.4 × 106	4.9 × 106	--	--	3.5 × 105	7.9 × 106	--	7.9 × 105	2.7 × 106	7.6 × 106	2.78 × 106	1.41 × 107
10	Faecal Coliform, MPN/100ml	-	1.7 × 106	1.7 × 106	--	--	2.4 × 105	4.9 × 106	--	1.7 × 105	6.9 × 105	1.8 × 106	1.41 × 106	4.9 × 106

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: *Chandigarh Pollution Control Committee (CPCC)*

Table 36: Water quality at STP Raipur Kalan outlet

S.No.	Parameters	Permissible Limit*	2020										
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not exceed 5°C above the receiving water temperature	18	23	--	27	27	27	29.5	29	29	27	23.5	16.5
2	pH	5.5 - 9.0	7	7.2	--	7.3	7.1	6.9	7	7.2	7.2	7	7	7.3
3	DO, mg/l	-	NIL	NIL	--	NIL	NIL	NIL	9.4*	2.5	0.83	NIL	NIL	0.9
4	COD, mg/l	250	190	145	--	164	132	90	77	108	102	140	121	335
5	BOD, mg/l	30	104	60	--	84	69	59	38	64	46	87	63	172
6	TSS, mg/l	100	25	40	--	47	45	23	46	55	28	47	27	177
7	NH_3-N, mg/l	50	8	11	--	16	33	28	10	10	6.4	4.4	5.9	5
8	PO_4-P, mg/l	5	4	4.54	--	3.03	2.65	3.53	3.47	3.2	2.99	1.37	1.81	2.1
9.	Total Coliform, MPN/100ml	-	7.0 × 106	4.0 × 104	--	--	5.4 × 105	1.09 × 106	1.3 × 105	1.72× 107	7.6 × 105	1.4 × 106	2.78 × 106	2.21× 107
10	Faecal Coliform, MPN/100ml	-	1.1 × 106	1.7 × 104	--	--	2.4 × 105	4.6 × 105	4 × 103	2.1 × 106	1.8 × 105	2.2 × 105	2.2 × 106	1.3× 107

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: *Chandigarh Pollution Control Committee (CPCC)*

Table 37: Water quality at STP Dhanas outlet

S.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not Exceed 5°C Above the receiving water temperature	17.4	20.5	--	27	28	29	28.5	31.3	30.5	30.5	24	20
2	pH	5.5 - 9.0	7.6	7.7	--	7.3	7.4	7.3	7.2	7.2	7.7	8.1	7.6	7.2
3	DO, mg/l	-	4.9	2.2	--	3.4	0.8	3.6	5.8	4.9	3.9	8.6	4.3	4.4
4	COD, mg/l	250	198	328	--	140	108	18	23	13	10	8	28	24
5	BOD, mg/l	30	82	87	--	40	38	10	10	8	3	2	12	8
6	TSS, mg/l	100	47	183	--	44	33	6	9	3	9	5	11	8
7	NH_3-N, mg/l	50	26	35	--	23	30	21	5	1.09	0.83	0.63	0.83	1.58
8	PO_4-P, mg/l	5	2.28	2.14	--	0.37	3.1	2.4	1.33	2.3	2.93	2.04	0.83	2.93
9	Total Coliform, MPN/100ml	-	7.9 × 106	--	--	--	3.45 × 106	7.9 × 104	33	23	280	7	<2	33
10	Faecal Coliform, MPN/100ml	-	1.7 × 106	--	--	--	2.21 × 106	7 × 103	13	13	110	2	<2	13

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: Chandigarh Pollution Control Committee (CPCC)

Table 38: Water quality at STP Maloya outlet

S.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not Exceed 5°C Above the receiving water temperature	18	20.6	--	26	28.5	31	29	30.1	30.5	30.5	24	20.5
2	pH	5.5 - 9.0	7.4	7.4	--	7.1	7.3	7.2	7.1	7.3	7.3	7.2	7.2	7.1
3	DO, mg/l	-	5.3	3.6	--	3.4	1.7	3.9	3.2	2.5	2	2.4	3.07	2.3
4	COD, mg/l	250	36	22	--	10	12	10	12	8	9	16	15	25
5	BOD, mg/l	30	6.9	7.4	--	<1	2.1	2.9	1.3	1.2	1.96	3.3	2.6	4.9
6	TSS, mg/l	100	17	12	--	3	7	10	4	5	10	6	10	6
7	NH_3-N, mg/l	50	0.09	1.1	--	1.1	1.7	0.83	1.98	4.5	3.08	0.96	0.46	1.77
8	PO_4-P, mg/l	5	2.03	1.35	--	1.08	0.29	0.06	0.65	1.35	0.79	0.48	0.35	0.12
9	Total Coliform, MPN/100ml	-	7.9 × 105	--	--	--	5.42 × 105	--	2.78 × 105	--	--	--	--	--
10	Faecal Coliform, MPN/100ml	-	3.3 × 105	--	--	--	2.40 × 105	--	4.6 × 104	--	--	--	--	--

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: Chandigarh Pollution Control Committee (CPCC)

Table 39: Water quality at SukhnaChoe/Drain

S.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not exceed 5°C above the receiving water temperature	17.5	23.2	--	28	27.5	26.5	28	28.1	29	26.5	23.5	16.5
2	DO, mg/l	-	NIL	NIL	--	NIL	0.5	NIL	NIL	1	NIL	NIL	NIL	NIL
3	pH	5.5 - 9.0	7.4	7.5	--	7.2	7.2	7.3	7.1	7.4	7.4	7.4	7.4	7.4
4	Conductivity, µs/cm	-	990	932	--	944	910	853	872	781	901	1025	1055	1099
5	BOD, mg/l	30	193	202	--	187	192	155	117	113	125	125	177	186
6	NO_3-N, mg/l	10	2.5	4.7	--	BDL	3.5	3.2	3	3.2	4.1	0.76	3	3.7
7	Total Coliform, MPN/100 ml	-	1.41 × 107	5.42 × 106	--	--	3.5 × 105	2.21 × 106	3.48 × 106	2.21 × 107	1.2 × 106	5.4 × 106	7.0 × 106	1.41 × 107
8	Faecal Coliform, MPN/100 ml	-	2.2 × 106	3.3 × 105	--	--	2.4 × 105	3.4 × 105	3.4 × 105	4.9 × 106	4.0 × 105	1.4 × 106	4.6 × 106	7.0 × 106
9	Turbidity, NTU	-	130	138	--	120	147	166	178	197	153	143	178	184
10	P-Alkalinity, mg/l	-	NIL	NIL	--	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
11	Total alkalinity, mg/l	-	390	372	--	376	370	408	374	272	422	408	398	412

S.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
12	Chloride	-	60	48	--	42	46	42	55	43	55	49	55	67
13	COD, mg/l	-	326	400	--	328	340	264	216	193	198	208	414	499
14	TKN, mg/l	-	40	33	--	39	--	--	--	--	26	43	--	--
15	NH_3-N, mg/l	-	34	45	--	37	35	37	28	36	22	35	37	41
16	TH as $CaCO_3$, mg/l	-	220	194	--	202	210	188	214	190	236	220	240	286
17	Ca as $CaCO_3$, mg/l	-	184	150	--	114	110	122	130	110	118	135	171	227
18	Mg as $CaCO_3$, mg/l	-	36	44	--	88	100	66	84	80	118	85	69	59
19	Sulphate, mg/l	-	41	47	--	43	50	42	44	39	47	33	27	40
20	Sodium, mg/l	-	79	69	--	57	78	57	80	46	82	169	95	70
21	TDS, mg/l	-	466	482	--	484	522	384	214	330	464	464	526	516
22	TFS, mg/l	-	288	444	--	426	488	354	207	294	434	428	426	420
23	TSS, mg/l	100	116	174	--	69	255	183	185	166	188	132	232	236
24	Phosphate, mg/l	5	4.14	3.7	--	4.18	2.85	3.18	3.21	2.3	3.99	3.04	4.58	4.92
25	Boron(B), mg/l	-	BDL	BDL	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Potassium, mg/l	-	18	15	--	6	16	15	14	17	15	BDL	34	44
27	Fluoride, mg/l	2	0.18	0.33	--	0.06	BDL	0.1	0.24	0.16	0.11	0.12	0.1	0.1

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: *Chandigarh Pollution Control Committee (CPCC)*

Table 40: Water quality at AttawaChoe/Drain

Sr.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Temp, °C	Shall not exceed 5°C above the receiving water temperature	18.2	19.1	--	28	28	29	28	28.2	28.5	25.5	24.5	20.2
2	DO, mg/l	-	Nil	Nil	--	Nil	Nil	Nil	Nil	0.6	Nil	Nil	Nil	<1
3	pH	5.5 - 9.0	7.3	7.5	--	7	7	7	6.8	7.3	7.4	7.3	7.3	7.5
4	Conductivity, µs/cm	-	586	637	--	608	642	667	589	587	612	636	556	587
5	BOD, mg/l	30	99	155	--	210	110	38	98	51	43	44	33	46
6	NO_3-N, mg/l	10	4.2	3.7	--	0.8	1.7	1.5	2	2	3	2	3.3	2.1
7	Total Coliform, MPN/100 ml	-	2.21 × 106	3.45 × 107	--	--	3.5 × 106	9.4 × 105	1.75 × 107	3.45 × 106	5.4 × 106	4.0 × 105	1.3 × 106	3.8 × 105
8	Faecal Coliform, MPN/100 ml	-	1.09 × 106	7.9 × 106	--	--	1.1 × 106	2.2 × 105	3.2 × 106	1.41 × 106	9.3 × 105	1.2 × 105	2.2 × 105	9.3 × 104
9	Turbidity, NTU	-	85	93	--	107	115	54	83	60	48	36	29	34
10	P-Alkalinity, mg/l	-	NIL	NIL	--	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
11	Total alkalinity, mg/l	-	208	284	--	248	228	268	206	218	270	230	206	228
12	Chloride	-	36	38	--	28	31	35	35	34	41	36	30	38
13	COD, mg/l	-	203	292	--	428	184	108	174	94	71	91	63	91

Sr.No.	Parameters	Permissible Limit*	2020											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
14	TKN, mg/l	-	19	29	--	--	--	--	16	10	11	15	9	15
15	NH_3-N, mg/l	-	14	23	--	30	37	23	16	3.6	3.7	7.3	3.4	3.7
16	TH as $CaCO_3$, mg/l	-	184	224	--	170	190	200	190	190	205	166	182	194
17	Ca as $CaCO_3$, mg/l	-	120	162	--	90	130	116	128	130	115	103	134	143
18	Mg as $CaCO_3$, mg/l	-	64	62	--	80	60	84	62	60	90	63	48	51
19	Sulphate, mg/l	-	47	54	--	50	52	54	43	48	52	60	43	44
20	Sodium, mg/l	-	45	51	--	37	33	56	32	33	40	21	101	33
21	TDS, mg/l	-	286	374	--	380	336	362	268	250	322	298	294	324
22	TFS, mg/l	-	202	282	--	344	238	170	182	228	258	238	276	282
23	TSS, mg/l	100	74	78	--	70	45	38	118	41	60	33	25	37
24	Phosphate, mg/l	5	2.9	3.38	--	3.02	2.46	2.25	2.15	1.32	1.95	1.92	1.06	1.88
25	Boron(B), mg/l	-	BDL	BDL	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Potassium, mg/l	-	12	14	--	16	10	15	16	13	10	14	12	8
27	Fluoride, mg/l	2	0.18	0.22	--	0.22	0.08	0.07	0.18	0.2	0.28	0.2	0.2	0.22

* Schedule - VI General Standards for Discharge of Environmental Pollutants - Inland Surface Water Standard limit # Parameters that exceeded the standard limit have been indicated in 'bold' font

Source: *Chandigarh Pollution Control Committee (CPCC)*

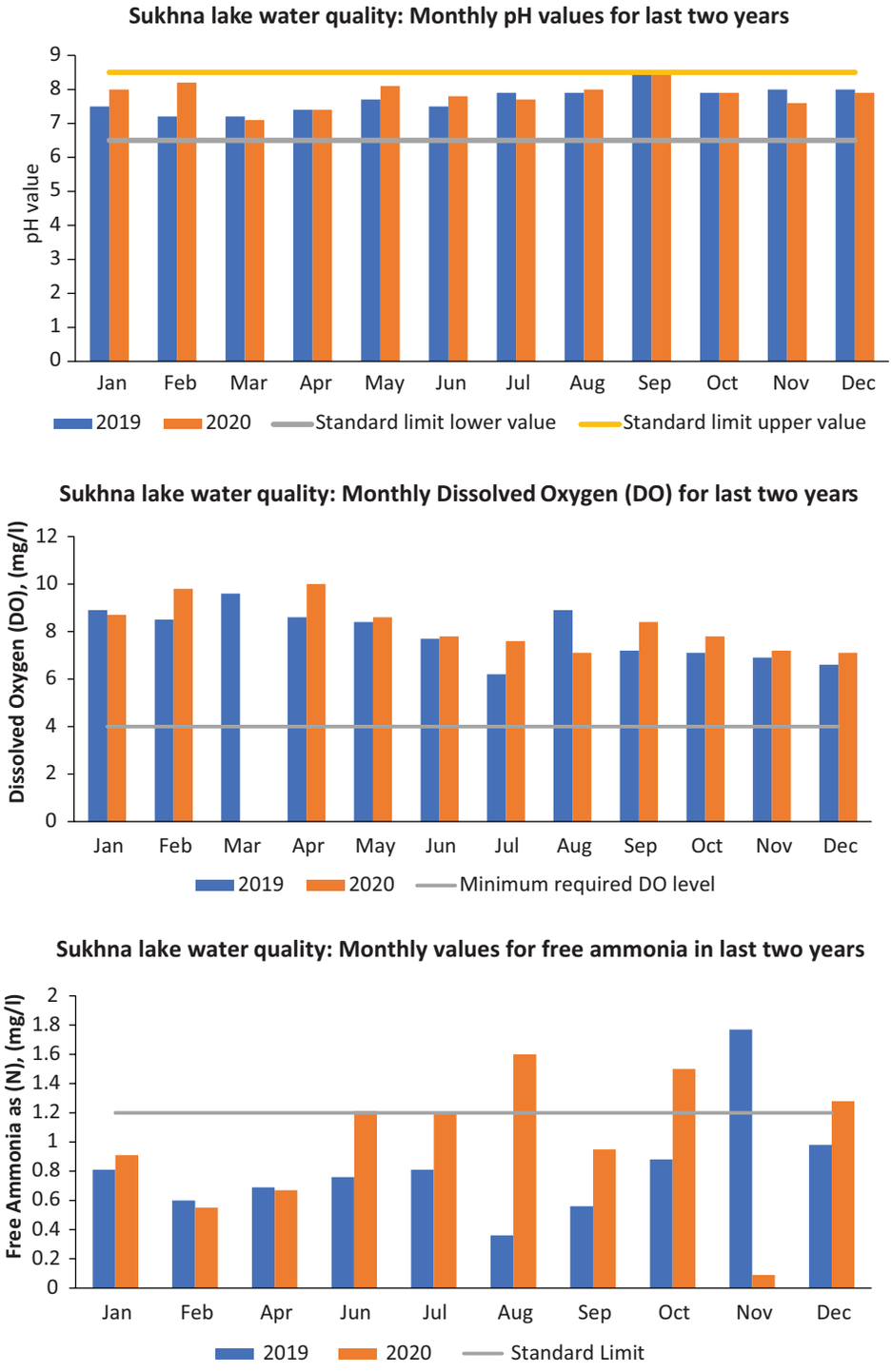

Figure 49: Sukhna lake water quality

Source: CPCC

Sukhna Lake water Quality: Under the National Water Monitoring Programme (NWMP), Chandigarh Pollution Control Committee (CPCC) monitors water quality. The values for different water quality parameters have been given in the Table 41. As per the CPCB guidelines for designated best use water

quality criteria for surface water, Sukhna lake falls under 'D' class of water. The designated best use is for 'propagation of wild life and fisheries'. The stipulated criteria or permissible limit for Class 'D' is pH between 6.5 to 8.5, dissolved oxygen (DO) 4 mg/l or more and free ammonia (as N) is 1.2 mg/l or less. The trends in these three parameters have been depicted in Figure 49. The pH and DO values were within the prescribed limits; however the values for free ammonia exceeded the standards indicating possibility of pollution. Ammonia can enter the aquatic environment via direct means such as municipal effluent discharges and excretion of nitrogenous wastes from animals and indirect means such as nitrogen fixation, air deposition, and runoff from agricultural lands. When ammonia is present in water at higher enough levels, it is difficult for aquatic organisms to sufficiently excrete the toxicant, leading to toxic build-up in internal tissues and blood, and potentially death.

Table 41: Water quality of Sukhna lake in 2020

2020														
S.No	**Parameters**	**Unit**	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1	Temp	°C	18.1	23	--	26	27	27.5	29.5	30.1	29	27.5	23.5	16
2	DO	mg/l	8.7	9.8	--	10	8.6	7.8	7.6	7.1	8.4	7.8	7.2	7.1
3	pH	-	8	8.2	--	7.4	8.1	7.8	7.7	8	8.5	7.9	7.6	7.9
4	Conductivity	µs/cm	274	288	--	274	274	283	246	235	215	218	234	275
5	BOD	mg/l	<1	1.9	--	1.1	2	2.6	2.6	2.2	2.9	2	3.3	3.6
6	NO_3-N	mg/l	2	1.8	--	2.7	2.4	0.9	1.9	1.9	BDL	0.52	4	1.6
7	Total Coliform	MPN/100 ml	7.9 × 103	79	--	--	7.9 × 103	1.75 × 103	3.2 × 104	5.4 x 102	8.0 × 104	3.0 × 104	7.0 × 103	2.78 × 104
8	Faecal Coliform	MPN/100 ml	9.0 × 102	33	--	--	2.3 × 103	9.4 × 102	2.0 × 103	1.3 x 102	4.5 × 103	5449	2.1 × 103	2.0 × 102
9	Turbidity	NTU	45	40	--	32	48	49	59	64	35	58	55	37
10	P-Alkalinity	mg/l	Nil	6	--	14	8	10	6	6	8	8	6	4
11	Total alkalinity	mg/l	124	128	--	120	122	144	114	96	92	106	106	116
12	Chloride	mg/l	10	9	--	8	12	12	11	12	12	11	13	10
13	COD	mg/l	12	12	--	8	9	14	17	8	15	13	21	29

2020														
S.No	Parameters	Unit	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
14	TKN	mg/l	BDL	--	--	12	--	6	--	--	1	2	10	5
15	NH_3-N	mg/l	0.91	0.55	--	0.67	1.25	1.21	1.2	1.6	0.95	1.5	0.09	1.28
16	TH as $CaCO_3$	mg/l	124	118	--	116	120	112	106	102	88	81	112	139
17	Ca as $CaCO_3$	mg/l	88	80	--	74	96	90	74	66	64	58	79	103
18	Mg as $CaCO_3$	mg/l	36	38	--	42	24	22	32	36	24	23	33	36
19	Sulphate	mg/l	18	20	--	14	22	16	22	23	17	13	10	15
20	Sodium	mg/l	16	13	--	13	16	16	14	14	10	16	96	10
21	TDS	mg/l	128	178	--	190	176	150	134	120	116	116	142	120
22	TFS	mg/l	36	88	--	95	104	130	108	108	74	94	124	106
23	TSS	mg/l	28	24	--	12	33	35	47	51	31	29	40	32
24	Phosphate	mg/l	0.08	0.07	--	0.04	0.09	0.06	0.08	0.1	0.08	0.15	0.18	0.08
25	Boron(B)	mg/l	BDL	BDL	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
26	Potassium	mg/l	6	20	--	10	7	8	14	11	6	28	30	12
27	Fluoride	mg/l	0.25	0.25	--	0.3	0.28	0.3	0.5	0.37	0.34	0.3	0.25	0.25
28	Colour	Hazen	<5	<5	--	<5	<5	<5	<5	<5	<5	<5	5	<5

Source: Chandigarh Pollution Control Committee (CPCC), 2021

Groundwater Quality: The results of groundwater quality monitored in 2019 by CGWB are presented in Table 41. The results of chemical analysis of ground water sample (Table 42) reveals that it is alkaline in nature with pH from 7.87 to 8.66 and moderately mineralized with EC ranging from 235 to 735 µS/cm at 250C. Among anions, carbonate ion is found to vary between 0 and 14 mg/l whereas bicarbonate concentration ranges from 98 to 279 mg/l. The chloride values range from 14 to 71 mg/l, while the sulphate values vary from 2 to 51 mg/l. Nitrate concentrations are found to range between <0.20 to 85 mg/l. The fluoride content is low and maximum concentration is 0.44 mg/l which is below the desirable limit of 1 mg/l. The cations such as calcium and magnesium are present in low concentration and their highest values are 34 mg/l and 36 mg/l respectively. The sodium concentration varies between 4 to 91 mg/l. The maximum potassium concentration reported is 5 mg/l. Total hardness of water sample expressed as $CaCO_3$ is found to range between 84 and 210 mg/l. The groundwater is suitable for domestic use as all parameters are within the permissible limits of drinking water quality standards prescribed by BIS-2012. The suitability of groundwater for irrigational uses is determined by considering the values of salinity (EC), sodium adsorption ration (SAR) and residual sodium carbonate (RSC). Based on highest reported values for EC (735 µS/cm), SAR (4.33) and RSC (3.37), it can be concluded that groundwater of Chandigarh is suitable for irrigation except one location.

Table 42: Groundwater quality monitored in 2019-2020

Location	Parameter					
	pH	EC in µS/cm	CO_3, mg/l	HCO_3, mg/l	Cl, mg/l	SO_4, mg/l
Sector 46	8.12	260	0	112	21	4
Sector 37	8.23	310	0	140	21	15
IMD Sector 39	8.23	310	0	126	36	8
Sector 39D	7.92	395	0	168	36	30
Maloya	8.26	735	0	210	71	17
Sector 38	7.87	560	0	210	43	51
Sector 10C	8.21	350	0	126	28	24
Leisure Valley	8.24	285	0	98	14	43
Sector 31D	8.66	550	14	279	21	2
Burail	7.99	235	0	122	21	5

Source: Central Ground Water Board, 2020

7. Impacts of water pollution

Water borne and water related diseases: A major hazard due to water logging is that of manholes and electrocution. Such incidences lead to instant death of an individual and hence needs to be minimised as much as possible. In addition to such fatalities, water logging also leads to water borne diseases such as cholera, diarrhoea, etc. This makes it a serious threat to the health and well-being of the population residing in areas that face the issue of water logging. The areas that face persistent issues of water

logging in the UT are residential areas such as Manimajra. The recent year 2020 was especially bad with the UT recording about 81, 625 cases of vector borne diseases (Ministry of Statistics and Programme Implementation, 2020).Vector borne diseases arise due to stagnant water which provides a breeding ground for most of the vectors (mosquitoes). The cases of water-borne diseases that were reported in last three years are presented in Table 43. As can be seen, the numbers of such cases were increasing and needs attention and proper intervention.

Table 43: Water related diseases reported during 2015-2018

Vector Borne Diseases			
Period	**Dengue**	**Malaria**	**Chikungunya**
2015-16	968	151	1
2016-17	1247	158	309
2017-18	1953	113	19
Water Borne Diseases			
Period	**Diarrhea**	**Cholera**	**Hepatitis (A and E)**
2015-16	-	66	222
2016-17	-	57	389
2017-18	-	12	634

Source: Anti Malaria Officer-Cum-Nodal Officer (IDSP) NVBDCP, U.T. Chandigarh

8. Response to combat water pollution

- The STP at Diggian has a treatment capacity of 30 MGD and presently receives 22 MGD. Around 5-6 MGD of this treated wastewater is supplied for gardening after tertiary treatment.
- Bulk generators and even houses where tertiary water supply is available are encouraged to use as much tertiary treated water as possible to reduce the fresh water consumption.
- Hon. National Green Tribunal (NGT) has ordered the residential societies with an area greater than 10, 000 sq.m to install an onsite STP.
- Regular awareness camps are organized by the health department to apprise general public about the ill effects of improper disposal of wastewater.
- Regular cleaning and maintenance of N-Choe, Sukhna Choe and Patiala-ki- Rao is done by the Engineering Department of Chandigarh Administration.
- River Ghaggar originates in Dagshai village in Himachal Pradesh and flows through Punjab and Haryana. It traverses around 7 km far from Chandigarh. Owning to the deterioration of river water quality, NGT has ordered (OA No. 138 of 2106) to implement corrective measures to stop pollution of river Ghaggar. To address this, an Action Plan for Control of Pollution in River Ghaggar has been formulated by the Chandigarh Pollution Control Committee (CPCC). Corrective measures have been taken and an executive committee has been formed to monitor the water quality of river Ghaggar.

9. Policy Recommendations

- The per capita supply of water requirement is 150 lpcd whereas currently 245 lpcd is being supplied. There is a window of opportunity to conserve water that Chandigarh administration should explore.
- Measures towards leak detection and plugging should be implemented to reduce the extent of non-revenue water
- Checks and systems should be enhanced to improve the cost recovery in water supply services. The unaccounted for water should be curtailed.
- As per the recent guidelines issued in 2021 by the Central Ground Water Authority, Ministry of Jal Shakti, Government of India, the authorised tankers drawing groundwater from areas that fall under 'Semi Critical' category are permitted to withdraw only up to 100 m^3/day. Compliance of this rule should be strictly followed in UT Chandigarh to preserve groundwater.
- The city extracts groundwater from deep confined aquifers which do not get recharged naturally. Hence recharging these aquifers is necessary. Tube wells are located all across the city. Harvesting rainwater from storm water drain network to recharge confined aquifers through structures all along the network could be a simple solution.
- Chandigarh generates around 52.86 MGD of wastewater every day and has a treatment capacity of 53.9 MGD. Occasional exceedance in the BOD and COD values as compared to the prescribed limit was observed. Proper operation and maintenance of these STPs should be done on regular basis to adhere to the prescribed limit and avoid water pollution.
- The incoming wastewater from industrial area (Phase – I and II) could be diverted to a separate Effluent Treatment Plant (ETP) in order to reduce the incoming BOD levels and other chemical waste to the existing STPs.
- The tertiary treated wastewater should adhere to the required permissible limit and provision should be made to make this treated water available to bulk consumers such as industries. This will help conserve water and reduce the dependence on groundwater.
- The water quality results of Sukhna choe and Attawa choe showed that the values for BOD exceeded the standards indicating the possibility of pollution. Man-made encroachments/slums along the choe and discharge of untreated sewage maybe the reason for water pollution. Strict action to plug these point and non-point sources of pollution is warranted. Regular monitoring should be encouraged.
- The value for total suspended solids for Sukhna Choe was above the standard limits indicating the possibility of silting from the catchment areas. Vegetative buffer strips along the choe should be maintained to curtail erosion and silting.
- Proper intervention is required on regular basis to avoid water logging and restrain the spread of vector borne and water borne diseases
- To combat water pollution, preventive measures should be taken before, during and after the various festivals. Awareness campaigns on do's and don'ts should be undertaken along the water bodies.

V

AGRICULTURE AND ALLIED SECTORS

CHAPTER V

AGRICULTURE AND ALLIED SECTORS

1. Introduction

To a large extent, food security and sustainability depend on the management of ecological foundations of agriculture, viz., land, water, biodiversity, forests and atmosphere. The economic growth and the increasing population growth rate have increased the pressure on natural resources. Depleting natural resources such as water and land poses a potential threat to sustainable food security. Further, agriculture is dependent on weather and climate. The rising concentration of carbon dioxide in the earth's atmosphere may have severe consequences for agriculture and, in particular, for regional food security in some regions.

In India, agriculture sector contributes to about 17.8% of country's Gross Value Added (GVA) for year 2019-20, with a share of 9.4% of crops and 5.1% of livestock. Agricultural products have a substantial share at around 11.9% of India's total export earnings. About 70% of rural households in India depend on agriculture for their livelihoods, with a large proportion (86%) of resource-constrained small and marginal farmers (MoAFW, 2020). At the same time, land degradation affects one-third of the country's land, costing about 2.5% of the country's Gross Domestic Product (GDP) (TERI, 2018). Government of India took several measures for development of agriculture sector in a sustainable manner. Initiatives were taken to improve the income of the farmers in the country and to mitigate the risk in this sector, a Yojna named 'Pradhan Mantri Fasal Bima Yojana (PMFBY)' was also introduced in 2016. Many other schemes were also introduced for the betterment of the farmers such as formation and promotion of about 10, 000 FPOs & the Agriculture Infrastructure Fund created for benefitting the agriculture sector.

The Union Territory Chandigarh has a limited area under agriculture (around 1797 hectares of total cropped area) and a limited section of the population is involved with agriculture as its primary occupation (about 918 farming families), having approximately 97% of operational land holding up to 2.5 hectares. Further, there has been an increase in farm animals and dairy business; consequently, fodder cultivation has picked up in the region over the years. Owing to the smaller agricultural area, the consumption of various agrochemicals, including fertilizers, insecticides, pesticides and herbicides, is lower. The main food grain is wheat, which is nearly 546 hectares and fodder is sown nearly in about 1000 hectares in both seasons. It has a minimal area under fruit and vegetable cultivation.

The growth in agriculture and allied sector can have considerable implications on livelihoods and the state of the environment. This chapter adopted the Driver, Pressure, State, Impact and Response (DPSIR) approach to describe and analyze India's agriculture and allied sector (See, Figure 50). The framework characterizes the current means of agricultural production as a basis for identifying response interventions. The nature and magnitude of important crop and livestock systems and agrarian production concerning the use pattern and size of the land holdings provide information on the importance of different farming

systems and crop and livestock enterprises. Identification of environmental impacts associated with the predominant crop and livestock systems is ascertained by the agricultural management practices such as nutrient management, pest and disease management and water management.

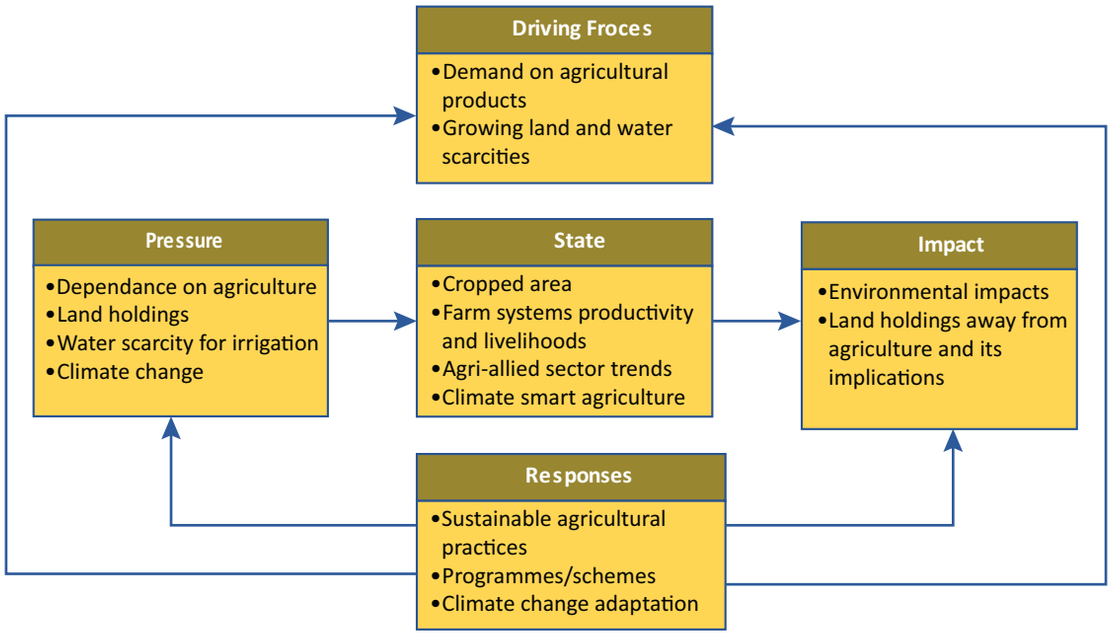

Figure 50: Diagram illustrating the contents of each step for the components of the DPSIR framework

2. Pressure

2.1 Dependence on agriculture

There has been an increase in the share of farm employment in total employment from 0.79% in 2001 to 1.06% in 2011.

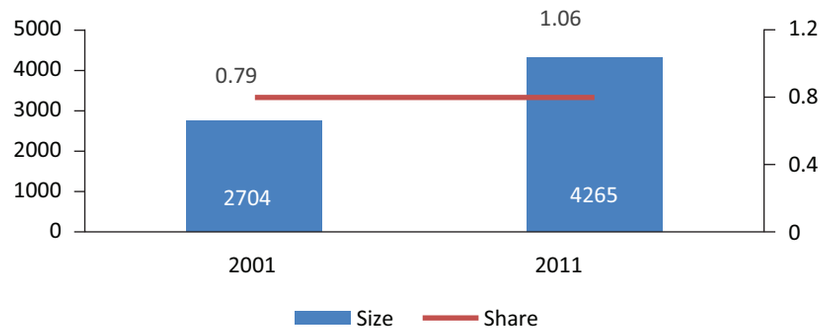

Figure 51: Size and share of employment in the farming sector in Chandigarh, U.T

Source: Census 2001, 2011

2.2 Land Holdings

The small and marginal farmers dominate the agricultural landscape of Chandigarh. Of the 911 farm households, 648 households (71%) own less than 1 hectare of land, 235 households (26%) hold 1 to 2.5 hectares of land the remaining 28 households (3%) hold 2.5 to 5 hectares of agricultural land. The holdings-wise details of farming families' is provided in Table 44.

Table 44: Number of operational holdings by size group

Size Class of Land Holding	Unit	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Less than 1 Hectare	Nos.	563	656	651	653	656	648	648
1 to 2.5 Hectare	Nos.	221	239	238	237	236	235	235
2.5 to 5 Hectare	Nos.	27	28	27	28	28	28	28
5 to 10 Hectare	Nos.	-	-	-	-	-	-	-
10 to more Hectare	Nos.	-	-	-	-	-	-	-
Total		**811**	**923**	**916**	**918**	**920**	**911**	**911**

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

2.3 Water and Energy use for Irrigation

The extent of the area equipped for irrigation or the size of customarily irrigated crops enables an assessment of the general pressure on water resources from agricultural demand. The whole agrarian land irrigated is facilitated by deep-bore tube wells installed by the Chandigarh Administration and shallow tube wells established by individual farmers. Most tube wells are electrically operated, with few diesel-operated tube wells (see Table 45). As per the Report on Dynamic Ground Water Resources of Chandigarh (UT), as of March 2020, 30 numbers of tube wells are used for irrigation use, and the complete draft of these wells is 5.73 MGD (950.80 ham/year) (see, Figure 52) (Chandigarh Administration & Municipal Corporation and CGWB, 2021).

Table 45: Tube wells for irrigation (In No. Cum.)

Year	Diesel Operated	Electric Operated	Total
2015-2016	8	50	58
2016-2017	8	50	58
2017-2018	8	50	58
2018-2019	8	50	58
2019-2020	8	50	58
2020-2021	8	50	58

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

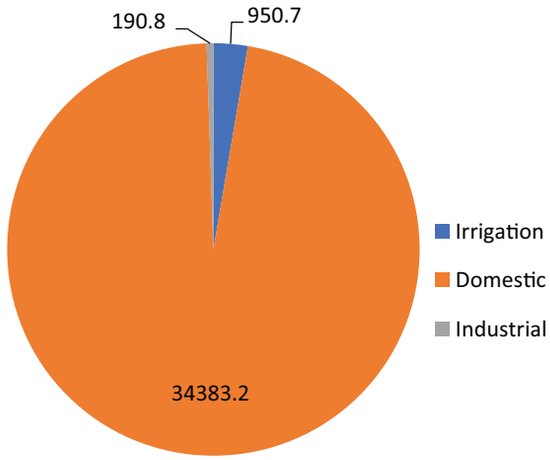

Figure 52: Groundwater extraction for different uses in Chandigarh, U.T in 2020 (ham/year)

Source: Chandigarh Administration & Municipal Corporation and CGWB, 2021

3. State

3.1 Area and production of agriculture and horticultural crops

The area and production under food grain crops are decreasing. However, in recent years there has been an increase in the area and production of Kharif cereals (see, Figure 53 and Figure 54). The prominent food grain is wheat, sown nearly in about 546 hectares. There has been a steep decline in area under paddy cultivation, from 45 hectares between 2010-2011 to 4 hectares in 2017-18. However, paddy cultivation's size increased from 80 hectares in 2018- 19 to 88 hectares in 2019-20. Further, farmers have again started maize cultivation in an area of 8 hectares in 2019-20 (see, Figure 54). Fodder is sown nearly in about 1000 hectares in both season. A slight increase in area under vegetables and their production was observed during 2016-2018. However, the size and production of vegetables have declined during 2018-2020. The area under fruits has remained the same during this period with a slight increase in its production (see, Table 46).

Out of the total sown area, cultivation of two main crops has been practiced in Chandigarh, namely Rice and Wheat. In contrast, fruits and vegetables count for a negligible part of the total cultivated area. Fruit varieties grown in the city include native species such as Kinnow, Mango, Guava, Bair, and Peach, involving a total area of 12 hectares during 2019-20 (see Table 46). Similarly, the cultivation of seasonal vegetables, including potato, and onion, is also performed on a small scale comprising 28 hectares during 2019-20 (see Table 47).

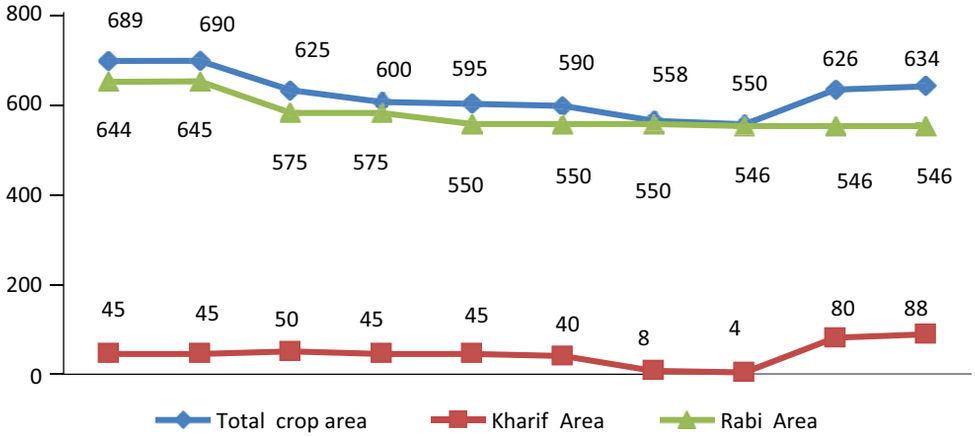

Figure 53: Area under principal crops (kharif & rabi) in Chandigarh (in Hectares)

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

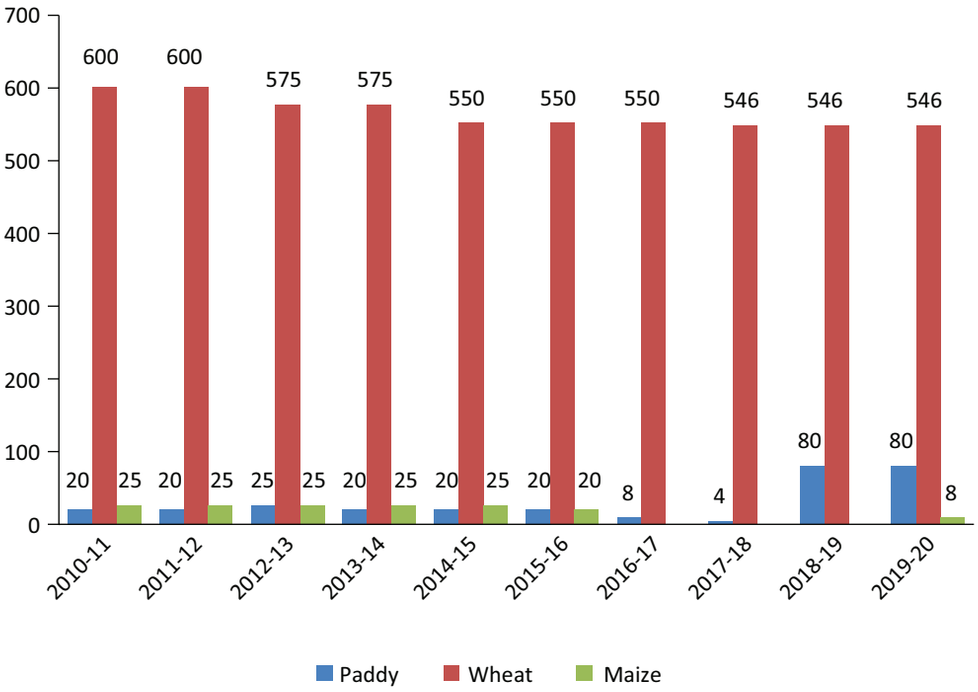

Figure 54: Area under rice and wheat in Chandigarh (in Hectares)

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

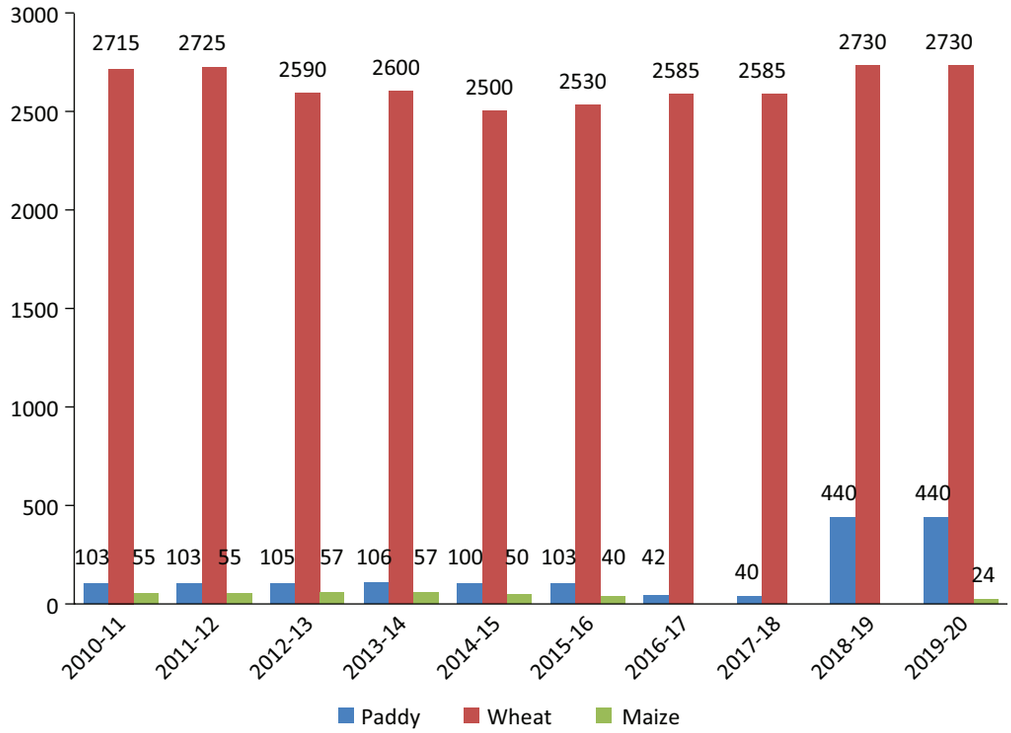

Figure 55: Production of major crops in Chandigarh (in tons)

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

Table 46: Area and Production under different fruits

Crop	2015-2016		2016-2017		2017-2018		2018-19		2019-20		2020-21	
	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)
Kinnow	1	8	1	8	1	8	1	8	1	8	24	168
Mango	5	130	5	135	5	135	5	135	5	135	27	675
Guava	4	70	4	75	4	75	4	75	4	75	28	504
Bair	1	10	1	8	1	8	1	8	1	8	16	112
Peach	1	13	1	12	1	12	1	12	1	12	15	165
Others	-	-	-	-	-	-	-	-	-	-	5	-
Total Fruits	12	231	12	238	12	238	12	238	12	238	115	1624

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

Table 47: Area and Production under different vegetables

Crop	2015-2016		2016-2017		2017-2018		2018-2019		2019-2020		2020-21	
	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)	Area (Ha.)	Production (Tons)
Potato	10	155	12	188	12	188	10	160	10	160	9	135
Onion	3	60	4	84	4	84	3	63	3	63	2	40
Other Vegetables	20	525	20	528	20	528	15	390	15	390	14	364
Total Vegetables	33	740	36	800	36	800	28	613	28	613	25	539

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

3.2 Livestock and Fisheries related Activities

The farmers of Union Territory Chandigarh keep a large number of milch cattle and there has been an increase in the population of bovines and goats over the different livestock census rounds (see, Table 48). To cater to the feed demand of milch cattle, farmers have taken to fodder cultivation. Therefore, the area under different crops is decreasing and there is a demand for quality seeds of fodder crops to get better yields, given the pressure on arable land. The U.T. administration has been offering seeds of wheat and fodder crops at a discount. The total area under fish culture, fish seed production, and fish production has been depicted in Table 49. There are 27 small concrete ponds constructed at Fish Seed Farm.

Table 48: Livestock population (in numbers)

Livestock category	2007	2012	2019
Cattle	6505	8962	13378
Buffaloes	19568	14034	12177
Total Bovines	26073	22996	25555
Sheep	54	66	-
Goat	655	805	998
Horses & Ponies	440	189	237
Mules	98	6	-
Donkey	-	-	-
Camels	5	-	-
Pigs	271	135	138

Source: Directorate of Economics and Statistics UT Chandigarh, 2020; DoAHD, 2019

Table 49: Total Area under Fish Culture, Fish seed production and Fish production

Item	Unit	2015-2016	2016-2017	2017-2018	2018-19	2019-20
Total area under fish culture	Hectare	275	275	275	275	275
Fish Seed production	Lakh	8.00	8.00	8.00	8.00	8.00
Fish Production (Accural)	Tonnes	128.00	124.00	136.00	139.00	132.00

Source: Animal Husbandry & Fisheries Department, U.T. Chandigarh, 2020

3.3 Input Level – Consumption of Agrochemicals

Nutrients are absorbed from the soil by plants for their growth. Mineral fertilizers are widely used in agriculture to optimize production. An increase in the consumption of mineral fertilizers increases the risk of an impact on the environment. The use of pesticides on crops and for other purposes poses a threat to human health and the environment. The risks vary considerably from one pesticide to another, depending on the intrinsic characteristics of their active ingredients and use patterns.

The application of fertilizers and pesticides is remarkably lower due to the small agricultural area. Data on the application of fertilizers and pesticides during 2015-2020 shows a decreasing trend, with a total application of 25-35 tons of fertilizers and 0.15 tons of pesticides during 2017-18 (see Table 50&51).

Table 50: Consumption of chemical fertilizers

Year	Fertilizers* (Tons)
2015-2016	40 to 45 M.T.
2016-2017	30 to 35 M.T.
2017-2018	30 to 35 M.T.
2018-2019	30 to 35 M.T.
2019-2020	25 to 35 M.T.
2020-2021	25 to 35 M.T.

**in terms of Material being brought by the farmers from neighboring villages of Punjab & Haryana States.*

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

Table 51: Consumption of pesticides

Year	Quantity (M.T. in Technical Grade)	Area Covered in Hectares
2015-2016	0.18	240
2016-2017	0.17	230
2017-2018	0.17	230
2018-2019	0.17	330
2019-2020	0.15	225
2020-2021	0.15	225

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

3.4 Agricultural workforce

The census report (2011) highlights an overall number of workers engaged in the agriculture sector. This includes cultivators & agricultural laborers, which increased from 2704 laborers in 2001 to 4265 laborers in 2011. This was a marginal increase from 2141 cultivators to 2578 cultivators. There is an increase in the number of agricultural laborers by 200% (from 563 to 1687) (see Table 52).

Table 52: Workers involved in agriculture in Chandigarh U.T. over the census year 2001 & 2011

Agricultural Workforce	2001	2011
Cultivator		
Male	1687	2114
Female	454	464
Total	2141	2578
Agricultural Labourers		
Male	461	1375
Female	102	312
Total	563	1687
Total Agricultural Workers		
Male	2148	3489
Female	556	776
Total	2704	4265
Total Workers		
Male	284419	328159
Female	56003	75977
Total	340422	404136

Source: Census 2001, 2011

4. Impact

4.1 Land use change away from agriculture and its implications

Land-use change reflected in land-cover change and land-cover change is the main component of environmental change, affecting climate, biodiversity, and ecosystem services, affecting the land-use decision. The UT Chandigarh has a limited area of agriculture. The Cultivated area has shrunk from 5441 hectares in 1966 to 1797 hectares in 2020 (see Table 53). Rapid urbanization and expansion of Chandigarh City have led to the gradual acquisition of agricultural land.

Table 53: Land use pattern – agriculture (in hectares)

Year	Total area according g to Village papers	Forests	Not available for cultivation	Other Uncultivated land excluding fallow land	Current fallow land	Fallow land other than current fallow	Net Area Sown	Total Cropped Area	Area sown more than once
2018 -19	7026	212	5374	172	53	50	1164	1820	656
2019 -20	7026	212	5382	173	54	49	1155	1797	642
2020 -21	7025.65	212.46	5475.73	146.49	28.33	49.78	1112.87	1727.17	614.3

Source: Directorate of Economics and Statistics, Chandigarh Administration (2020)

4.2 Environmental Impacts of Agriculture

The groundwater level of Chandigarh UT, improved to 15.02 meters from 18.66 meters from ground level. There has been a substantial increase in groundwater (GW) draft from 58 ham/year in 2017 to 951 ham/year in 2020 (see, Figure 56).

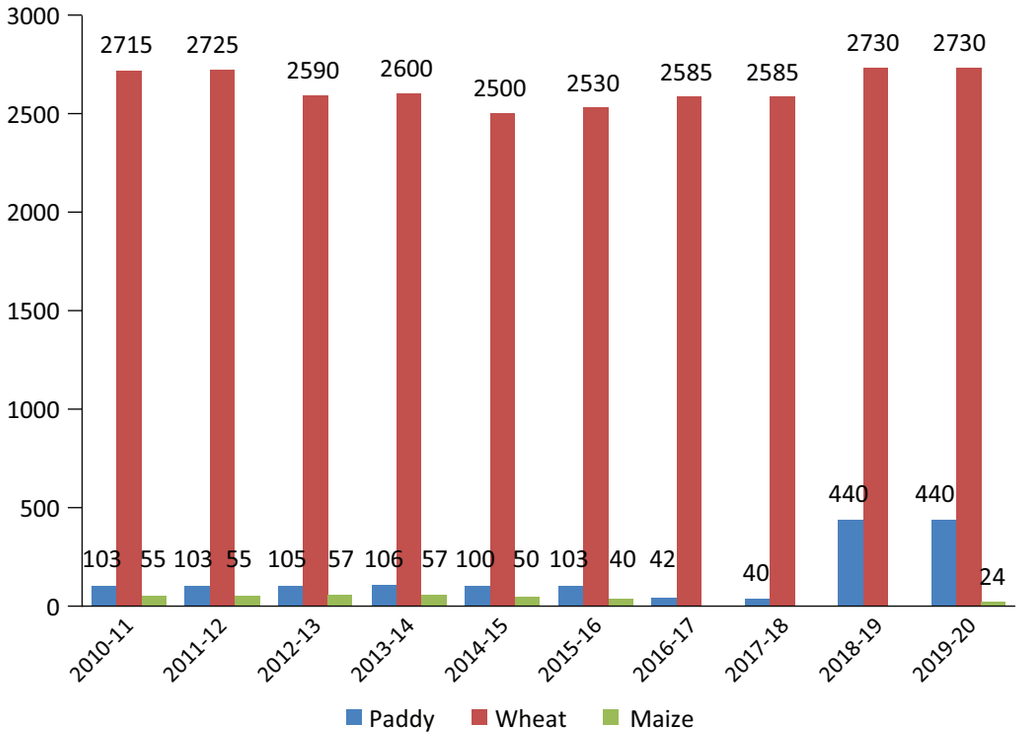

Figure 56: Increase in groundwater extraction for irrigation and other purposes in Chandigarh, U.T., 2017 & 2020

Source: Chandigarh Administration & Municipal Corporation and CGWB, 2021