ENVIS CENTRE, CHANDIGARH
Newsletter
Paryavaran - Patra
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Chandigarh State of Environment

GROUNDWATER QUALITY OF CHANDIGARH

1. INTRODUCTION

Groundwater serves as a prominent source of fresh water. Among all the sources of water, only 2.5% is fresh water, out of which 0.75% is groundwater. In Chandigarh, groundwater is used for various domestic, agricultural and industrial purposes. However, with the timely changes in the surface activities owing to increased population, rapid industrialization and advancements in agricultural practices, Chandigarh's groundwater is susceptible to contamination. Therefore, it is crucial to regularly monitor the groundwater quality of Chandigarh.

2. MONITORING OF GROUNDWATER QUALITY IN CHANDIGARH

The Chandigarh Pollution Control Committee and Central Ground Water Board (CGWB), collaboratively, collect and analyze the various parameters of groundwater quality of Chandigarh. These organizations have been monitoring the quality of Chandigarh's groundwater since many years and in this newsletter the emphasis will be given on data collected and analyzed within the time period of 2016 to 2020. The details of the geographical location of the sampling sites are given in Figure 1.

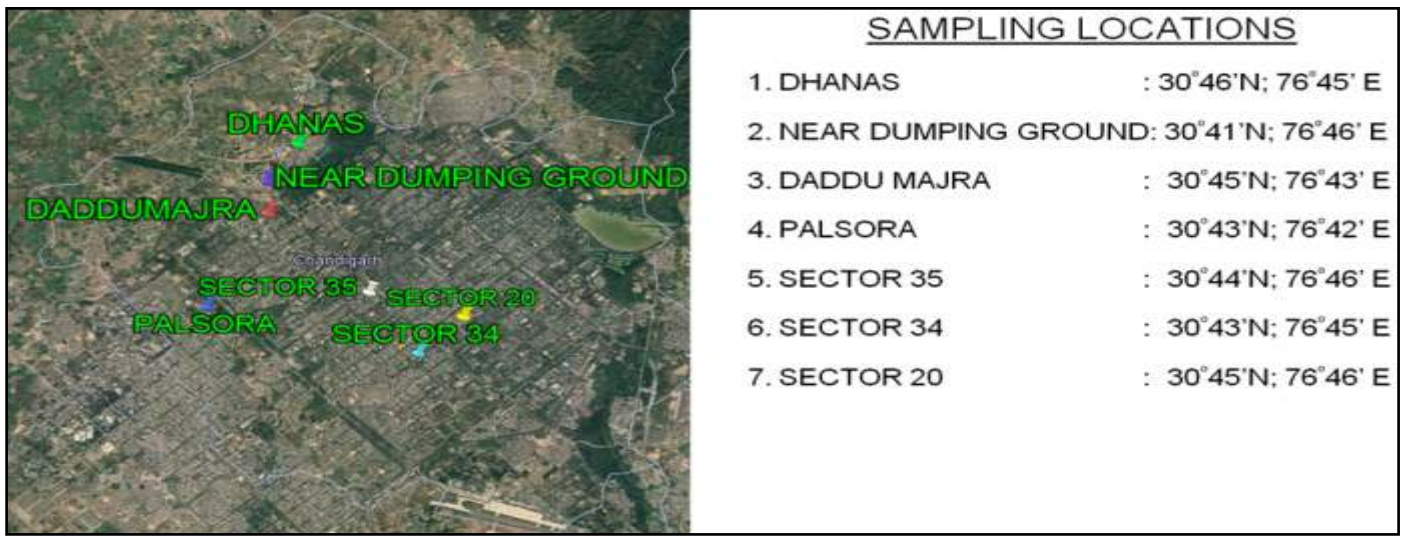

Figure 1. Groundwater sampling locations in Chandigarh

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3. MONSOONS IN CHANDIGARH

Climate in Chandigarh is of humid sub-tropical climate type with five types of major seasons viz., spring, autumn, summer, monsoons and winter. Among these seasons, the monsoon season impacts the groundwater quality of Chandigarh, the most. The monsoons in Chandigarh falls from early July to mid-September and average maximum rainfall received during this period is 7.70 inches in a day. Therefore, in order to estimate the impact of monsoons on the groundwater quality, it is sampled twice a year i.e., once before monsoons (pre-monsoon), during the month of April, and once after monsoons (post monsoon), during the month of October. Therefore, this newsletter also presents the comparison of groundwater quality of Chandigarh during pre-monsoon and post-monsoon seasons. The average depth of Chandigarh's groundwater during pre and post monsoon seasons for the year 2018 is shown in Figure 2.

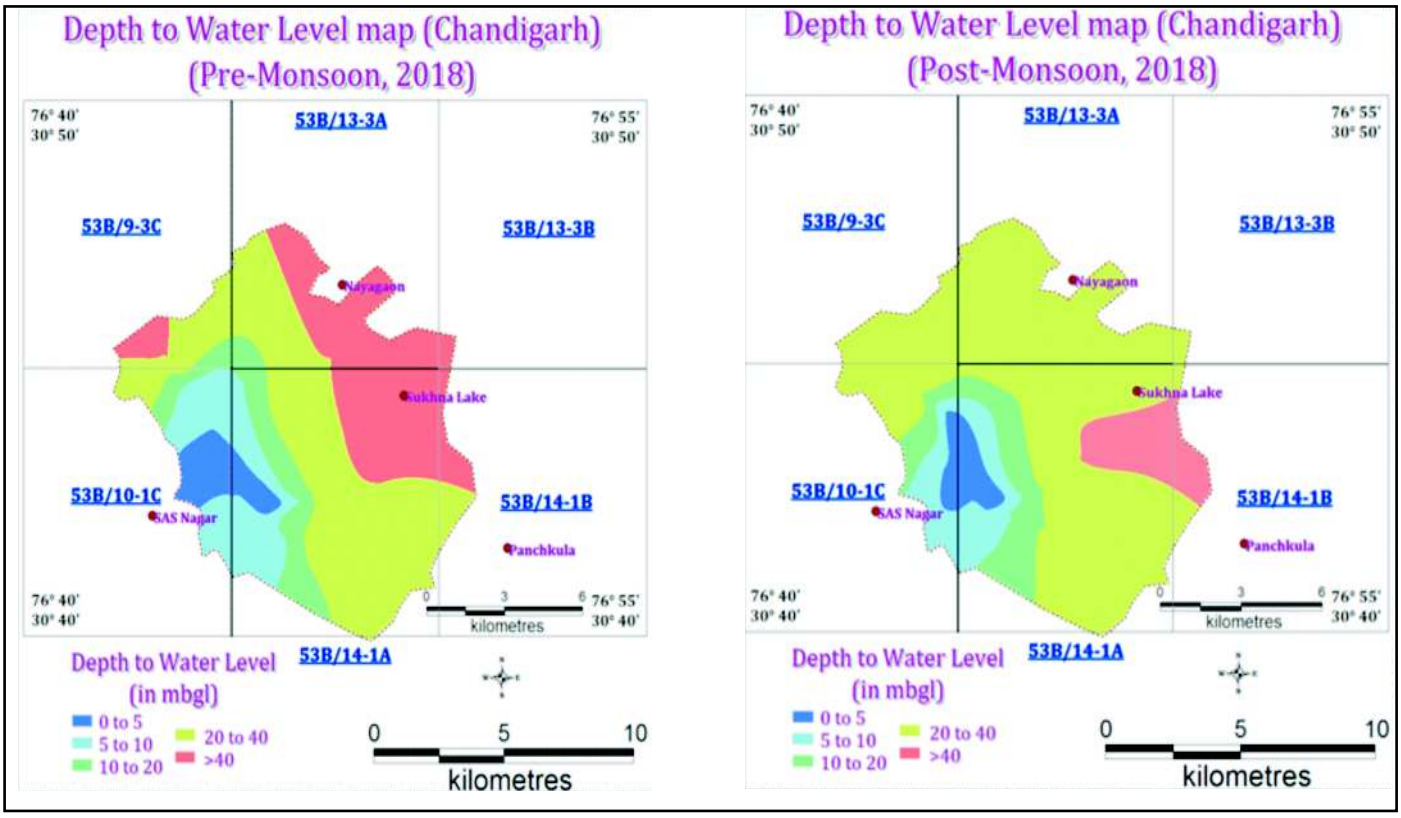

Figure 2. Depth to water level map of Chandigarh for pre and post monsoon (Source CGWB)

From Figure 2, it is evident that during post-monsoon season the level of groundwater in Chandigarh is increased and hence, the area depicting the depth of groundwater >40 mbgl (meters below ground level) can also be seen to decrease. Owing to the lesser depth of groundwater in the areas of Chandigarh, falling under 53B/10-1C, the major increase was observed in the area with depth of groundwater between 20 to 40 mbgl.

4. GROUNDWATER QUALITY OF CHANDIGARH

The sampling location-wise description of groundwater quality w.r.t. its BOD, COD, hardness, TDS, NO_x-N, sulphates and phosphates, is described in Figure 2 and the description of these parameters is mentioned in Table 1.

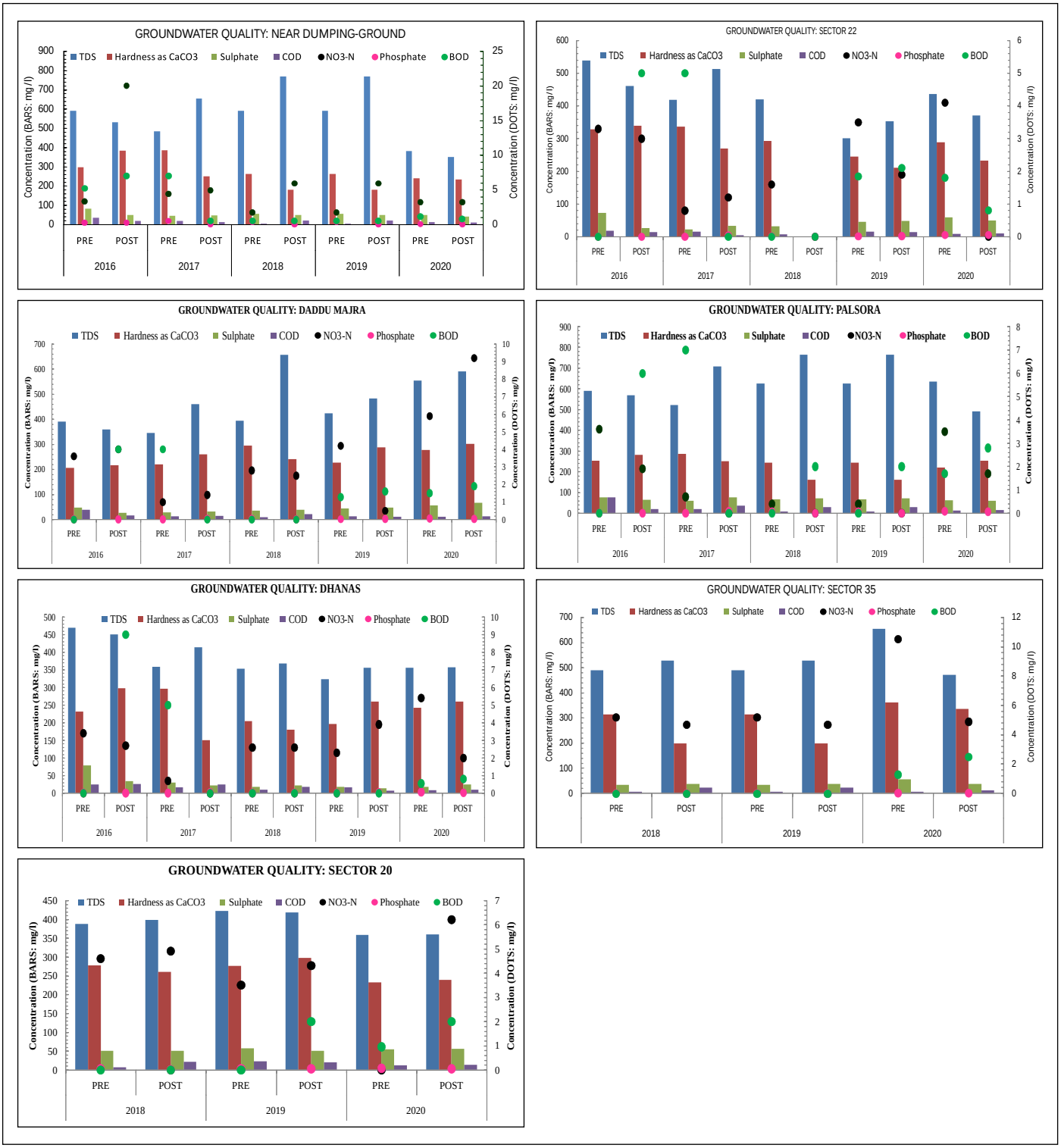

Figure 2. Pre and post monsoon trend of Chandigarh's groundwater quality

Table 1. Description of the various groundwater quality parameters (source: IS 10500:2012)

S. No.	Parameters	Desirable limit (ppm)	Description
1	Biochemical oxygen demand (COD)	Not available	The BOD depicts the amount of oxygen present in water that can assist microorganisms to decompose the organic matter present in it. Therefore, high BOD depicts the high microbial activity and hence, poor quality of water.
2	Chemical oxygen demand (COD)	Not available	The COD of water depicts the availability of oxygen for breaking down its organic and inorganic matter. The basic difference between BOD and COD is that in the estimation of COD, the chemical degradation of matter is reported. High COD generally depicts the industrial disposal.
3	NO_3-N	50	Nitrate can occur naturally in surface and groundwater at a level that does not generally cause health problems. High levels of nitrate in well water often result from improper well construction, well location, overuse of chemical fertilizers, or improper disposal of human and animal waste.
4	Total hardness	300	Hardness of water is induced due to the presence of salts. Generally, the water is made hard due to the presence of calcium and magnesium salts. Therefore, water can be hard due to geogenic and industrial contaminations.
5	Total dissolved solids (TDS)	500	TDS defines the presence of dissolvable solids in water. In preliminary analysis, the TDS of water can represent the level of its contamination.
6	Sulphates	200	The major sources of sulphates in groundwater are geogenic, municipal and industrial discharges. When naturally occurring, they are often the result of water passing through rock or soil containing gypsum. Point sources include sewage treatment plants and industrial discharges such as tanneries, pulp mills, and textile mills. Runoff from fertilized agricultural lands also contributes sulfates to water bodies.
7	Phosphates	Not available	Phosphate content of water is made high due to the contamination caused by excreta of living beings, contact with phosphorus rich rocks, discharge from laundry, industries and fertilizer-rich agricultural run-off. High phosphorus content in water may lead to eutrophication.

From Figure 2 and Table 1, it is evident that among all the parameters, the TDS of sampling locations: Near Dumping Ground, Daddu Majra and Palsora, was depicted to be greater than the desirable limits. Similarly, during the years 2016 and 2017, total hardness in groundwater samples of Near Dumping Ground and Sector 22 was observed to be greater than the desirable limits, however, in the later years it was reported to be within the permissible limits. In this way, the impacts of seepage of contaminants from surface of dumping ground can be inferred. It can also be correlated with the increase in TDS level of groundwater, near dumping ground, in the post monsoon season.

5. IDENTIFYING THE SOURCES OF GROUNDWATER CONTAMINATION

The major sources of groundwater contamination can be geogenic, industrial waste disposal, seepage of agricultural products, leakage of domestic waste etc. Therefore, in order to identify the sources of possible groundwater contamination in Chandigarh, it is imperative to discuss its elevation, land use-land cover (LULC), subsurface lithology and location of industrial and agricultural areas.

5.1 ELEVATION OF CHANDIGARH

The contour map of Chandigarh's elevation is shown in Figure 3, which explains that the flow of water, owing to decrease in elevation of Chandigarh, can be expected to be from North-East direction to South-West direction of Chandigarh. Similarly, it can also be deduced that any kind of contamination, in Chandigarh's groundwater, can transfer from higher elevation points to lower elevation points of Chandigarh.

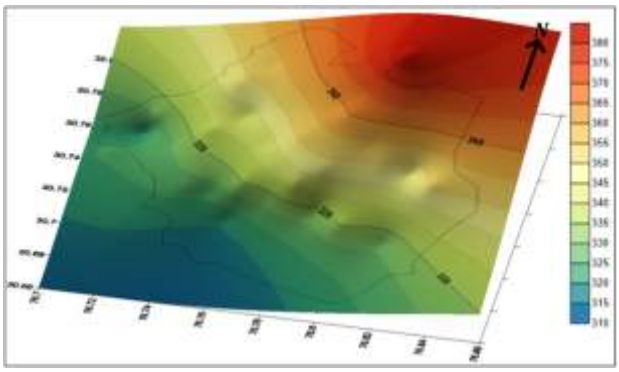

Figure 3. Elevation map of Chandigarh

5.2 SUB-SURFACE LITHOLOGY OF CHANDIGARH

The sub-surface lithology of Chandigarh is shown in Figure 4. It can be seen that the sub-surface of Chandigarh mainly consists of three types of lithospheres i.e., sandstone, older alluvium and younger alluvium. Alluvium soil is a fertile one and contains substantial amount of organic matter that can seep with rain water and impact the quality of groundwater. Among the old and young alluvium, the particles are lesser bound in latter one and hence, can easily mix with the seeping rain water.

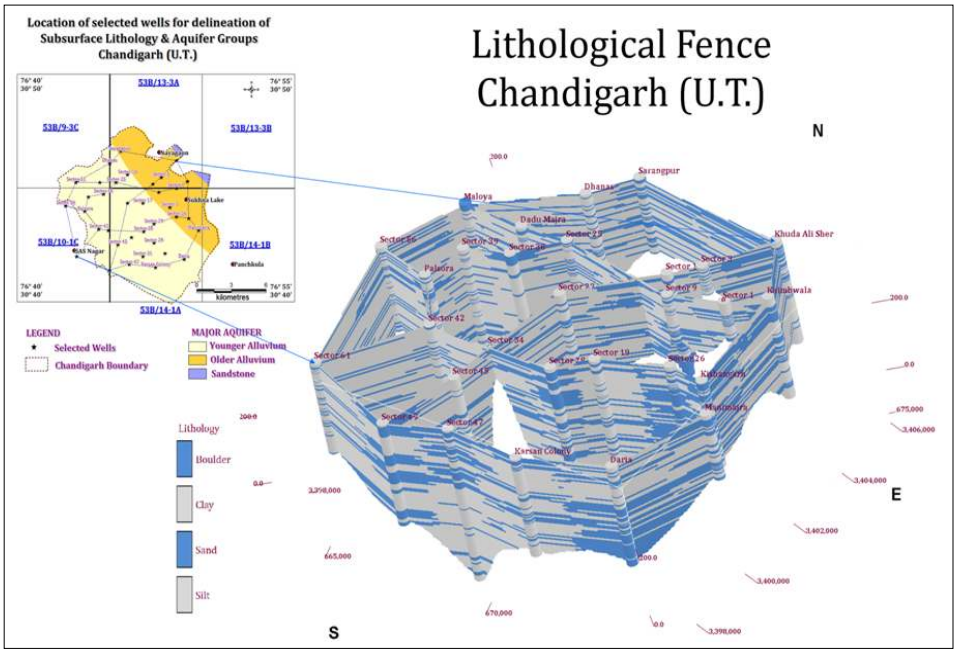

Figure 4. Sub-surface lithology of Chandigarh

Further, from the soil-profile of Chandigarh it can be seen that it comprises mainly of boulders, clay, sand and silt. The area of Chandigarh, falling towards the North-West direction, can be observed to have higher proportion of clay and silt. However, its areas falling in the South-East direction shows higher proportion of boulders and sand. As clay and silt contains large amount of organic matter, they can also impact the quality of groundwater underneath.

5.3 LAND-USE LAND-COVER OF CHANDIGARH

The LULC of Chandigarh is shown in Figure 5 which clearly shows the location of agricultural and industrial areas which, are the most expected source of surface activities leading to groundwater contamination. It can be seen that the agricultural and industrial areas are mostly located at the periphery of Chandigarh. The hazard vulnerability analysis also depicted that the areas of and around the industrial areas are highly vulnerable to chemical spills. In this way, the rain water can also carry the chemicals from surface to the groundwater underneath.

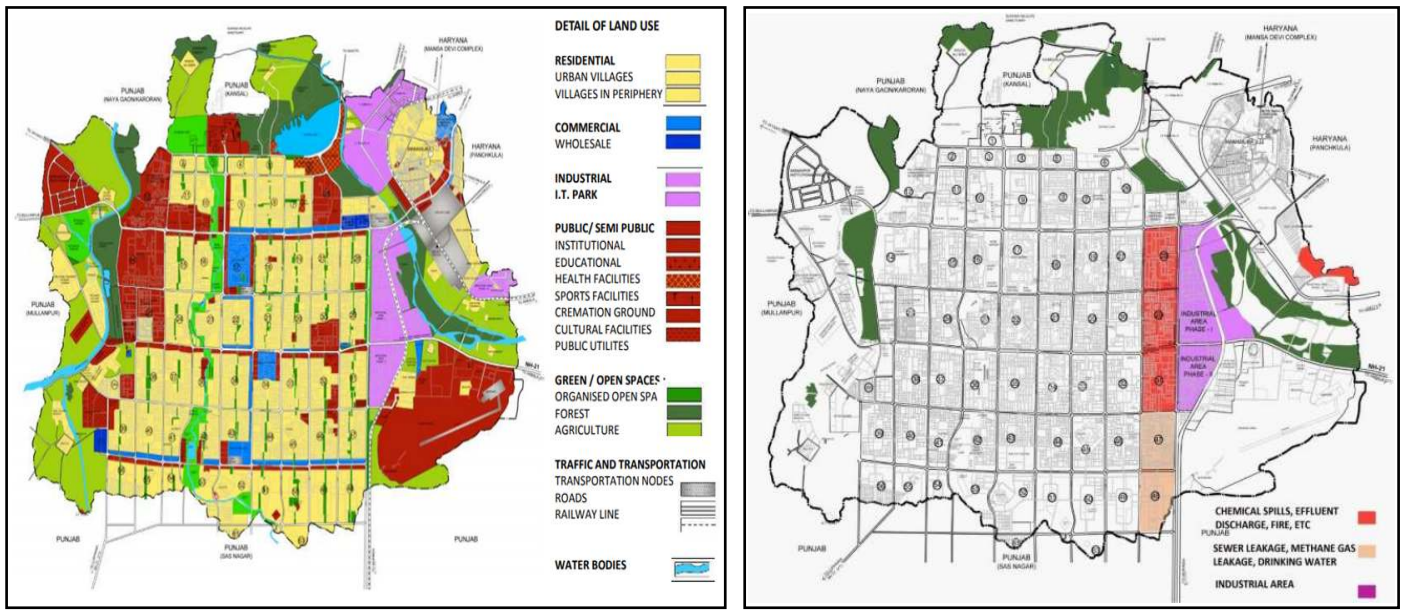

Figure 5. LULC and hazard analysis of Chandigarh

5.4. LOWERING OF GROUNDWATER LEVEL

Along with the above-mentioned anthropogenic sources of groundwater contamination, another cause that could significantly contribute in groundwater contamination is increase in the depth of groundwater. With the increase in the depth of groundwater the concentration of contaminants can be depicted to increase. Therefore, Administration of Chandigarh also regularly monitors the depth of its groundwater and is shown in Figure 6.

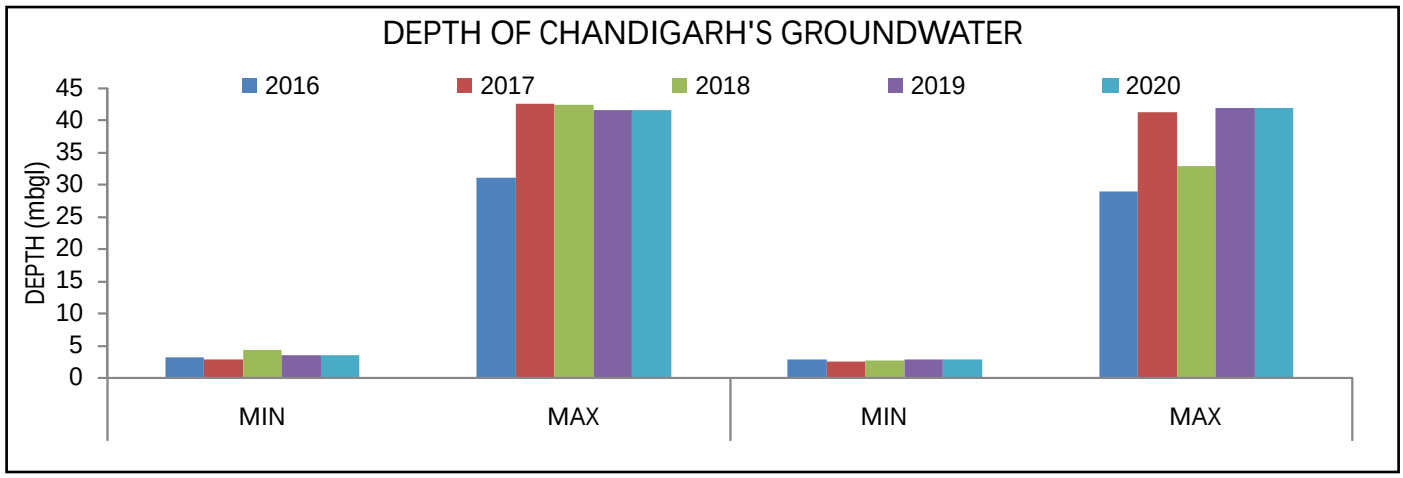

Figure 6. Depth of Chandigarh's groundwater from 2016 to 2020

As could be seen from Figure 6, the average depth of Chandigarh's groundwater varies from 3.39 – 39.82 mbgl and 2.72 – 37.32 mbgl in pre-monsoon and post-monsoon season, respectively. Therefore, during post-monsoon season the depth of Chandigarh's groundwater generally decreases which dilutes the contamination level. Also, from 2016 to 2020, it can be seen that there is a slight decrease in the level of groundwater. Therefore, administration of Chandigarh is inclined towards its replenishment, as well.

6. EFFORTS TAKEN TO RECHARGE CHANDIGARH'S GROUNDWATER

Chandigarh administration has implemented several Artificial Recharge Schemes under Central Sector Scheme, with a motive of sustaining the quality and depth of Chandigarh's groundwater. Also, vide notification dated 26.10.2008, authorities have made legal frameworks to make rain water harvesting mandatory. In this way, reduction in burden on groundwater can be speculated. Some of the Artificial Recharge Schemes are listed in Table 2.

Table 2. Various Artificial Recharge Schemes implemented in Chandigarh

S. No.	Year	Scheme
1	1998-1999	Scheme of roof-top rain water harvesting at CSIO Complex, Chandigarh
2	2000-2001	Injection wells and Piezometers Artificial recharge to groundwater under Central Sector Scheme in Punjab University, Chandigarh
3	2000-2001	Artificial recharge to groundwater in Leisure valley, Chandigarh
4	2001-2002	Scheme for roof-top rainwater harvesting at Bhujal Bhawan Chandigarh
5	2001-2002	Artificial recharge to groundwater at office of Chandigarh Housing Board in Sector – 9, Chandigarh
6	2001-2002	Scheme for rain water harvesting at DAV School in Sector -8, Chandigarh
7	2001-2002	Artificial recharge to groundwater at TTTI, Sector -26, Chandigarh
8	2001-2002	Scheme for utilizing surplus water monsoon run-off for sectors: 27, 19, 30 and 20 of Chandigarh
9	2003-2004	Artificial recharge to groundwater for Government College for Girls, Sector 11 of Chandigarh
10	2013-2015	Artificial recharge to groundwater through roof top and surface run off covering whole of Punjab University, Chandigarh. In this regard, a total of 54 recharge structures have been constructed.

Also, the Chandigarh Administration has constructed several structures to harvest the rain water by collecting it and mixing it with groundwater. List, of these structures built since 2016, is mentioned in Table 3.

Table 3. Rain water structures built in Chandigarh

S.No.	Year	Rain Water Harvesting Structure	Location	Specifications
1	2016-17	Dr. Ambedkar Institute of Hotel Management & Tutrition Technology	Sector-42 U.T.Chandigarh	(i) 3 nos Trench of size 8.48 mtr X 3.24 mtr. (ii) Drilling of Tubewell 3 nos upto depth 100 mtr below from Ground Level. (iii) Layin of RCC pipe for cater the rain water to trench.
2	2019-20	Providing Rain Water Harvesting System in Govt. ITI, Sec. 28, Chandigarh	Govt. ITI Sector-28, Chandigarh	5 No. Bore Well
3	2019-20	Construction of Govt. Heigh School in Maloya Site-I, Chandigarh (Composite work) (PHS)	Maloya, UT, Chandigarh	1 No. Bore Well
4	2019-20	Construction of Mini Sports Complex at Sector-27, Chandigarh (Composite work)	Govt. Sr. Sec. School Sector-27, Chandigarh	2 No. Bore Well
5	2019-20	Construction of Mini Sports Complex at Sector-8, Chandigarh (Composite work)	Govt. Sr. Sec. School Sector-8, Chandigarh	2 No. Bore Well

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Status of Groundwater in Chandigarh

Parameters	Units	2016	2017	2018	2019	2020
Annual replenishable groundwater resources	haM/y	2159	2159	4216	4216	6375
Provision of industrial, domestic and other uses	haM/y	216	216	422	3320	3674
Available groundwater resources	haM/y	1943	1943	3794	3794	5738
Net groundwater draft	haM/y	NA	NA	3378	3378	4624
Balance groundwater	haM/y	1943	1943	416	416	1114
Level of groundwater	%	NA	NA	89	89	80.60

Various UN's Sustainable Development Goals concerned with the management of groundwater

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To,