ISSN No. 0974-7087

Environmental Information, Awareness, Capacity Building and Livelihood Programme (EIACP)

LiFE Lifestyle for Environment

Programme Centre-Hub

Department of Environment
Chandigarh (U.T.)

Supported by

Ministry of Environment,
Forest & Climate Change
Government of India, New Delhi

paryavaran patra

Current Status and Management Practices of

GROUNDWATER RESOURCES in Chandigarh

Vol. 18.1.1

Current Status and Management Practices of Groundwater Resources in Chandigarh

INTRODUCTION

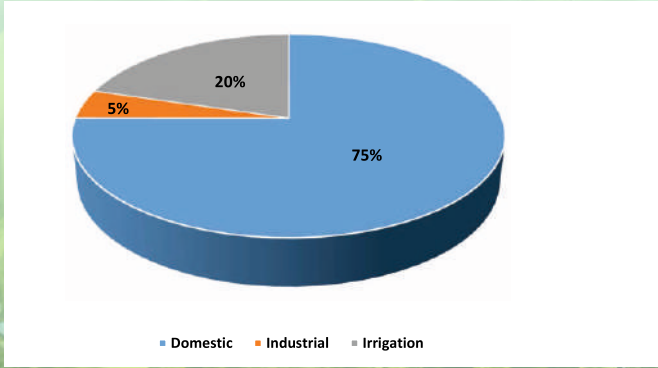
Groundwater, often referred to as the invisible lifeline, is a crucial natural resource that supports ecosystems, agriculture, and provides water for billions of people worldwide. In the context of India, groundwater is the backbone of both agricultural and drinking water security, contributing significantly to these vital sectors. According to the CGWB report (National Compilation on Dynamic Ground Water Resources of India, 2022), the total annual groundwater recharge was assessed at 437.60 billion cubic meters (bcm). After accounting for natural discharge, the annual extractable groundwater resource was approximately 398.08 bcm. The total annual groundwater extraction in 2022 was estimated at 239.16 bcm, resulting in an average groundwater extraction rate of about 60.08% for the entire country (National Compilation on Dynamic Ground Water Resources of India, 2022).

However, experts are increasingly concerned that India is rapidly approaching a crisis of groundwater overuse and contamination. Groundwater overuse, or overexploitation, occurs when the average extraction rate from aquifers exceeds the average recharge rate over time. Out of the total 7089 assessment units in the country, 1006 units in various states (14%) have been categorized as 'Over-exploited,' indicating that groundwater extraction exceeds the annually replenishable groundwater recharge. Additionally, 260 assessment units (4%) fall in the 'Critical' category, with groundwater extraction ranging from 90-100%. Furthermore, there are 885 'Semi-critical' units (12%) where groundwater extraction stands between 70% and 90%, while 4780 units (67%) are considered 'Safe,' with groundwater extraction below 70% (National Compilation on Dynamic Ground Water Resources of India, 2022). Besides, the effects of climate change are expected to exacerbate stress on water resources due to changes in rainfall patterns, leading to reduce per capita water availability.

Many Indian cities, including Chandigarh do not have perennial rivers which makes people to rely on ground water. This reliance on groundwater has become a matter of concern due to over-extraction and the potential risk of aquifer depletion. It underscores the need for sustainable water management practices and the exploration of alternative water sources, such as recycled water etc., to ensure a resilient and secure water supply for these urban centers. Collaborative efforts between governments, communities, and industries are essential in addressing these water challenges and mitigating the impact of increasing water scarcity. A preliminary assessment of the current situation is a vital step in paving the way for Chandigarh to establish a more resilient and environmentally friendly water supply system.

◆ STATUS OF GROUNDWATER IN CHANDIGARH

According to Report on Dynamic Ground Water Resources of Chandigarh (UT) as on March 2022 ,there are 281 deep tube wells in the city for drinking & domestic use and out of them, 277 are actively in use. Additionally, 23 nos. of tube wells designated for commercial use / industrial use are permitted to withdraw groundwater 217.65 ham/year. Furthermore, 30 tube wells are allocated for irrigation, collectively drawing 5.73 MGD (equivalent to 950.80 hectare-meters per year) of water (as per the "Report on Dynamic Ground Water Resources of Chandigarh, 2022). Figure 1 in the report illustrates the groundwater usage in Chandigarh for the year 2022.



Source: CGWB, Chandigarh

Figure 1: *Percentage of Ground Extraction/ Draft (Ham/Year) 2022*

The Central Ground Water Board has drilled six exploratory wells and eighteen piezometers at various locations within the Union Territory of Chandigarh, as depicted in Fig. 2. These installations serve the purpose of mapping the aquifer's dimensions, assessing the quality of the formation water, and conducting hydrogeological investigations in the region. Both shallow and deep piezometers have been installed to monitor fluctuations in water levels in Chandigarh and to track variations in groundwater quality over time. The details of the these exploratory wells and piezometers are given in Table 1 and 2.

Table 1: Details of Exploratory well constructed by CGWB in Chandigarh UT

S.No.	Location	Total Depth of drilling (m)	Total Depth of T/W(m)	Discharge m^3/min.	Trans-missivity m^2/day	Stora-tivity	Water Quality	Aquifer tapped
1	Sec-10	333.60	145	1.305	312	4.8x10-4	Good	I
2	Sec-28	465.25	279	3	590	3.7x10-4	-do-	II
3	Sec-33	454.15	224	1.88	360	1.5x10-4	Good	II
4	Sec-38	461.21	399	0.83	370	8.6x1-4	Good	II & III
5	Sec-47	449.5	174	1.372	74.8	-	Good	I & II
6	Sec-16	304.8	-	-	-	-	Abandoned	

Source: Hydrogeological Report of Chandigarh U.T.(AAP:2022-23),CGWB,NWR,Chandigarh

Table 2: Details of Piezometer constructed by CGWB in Chandigarh UT

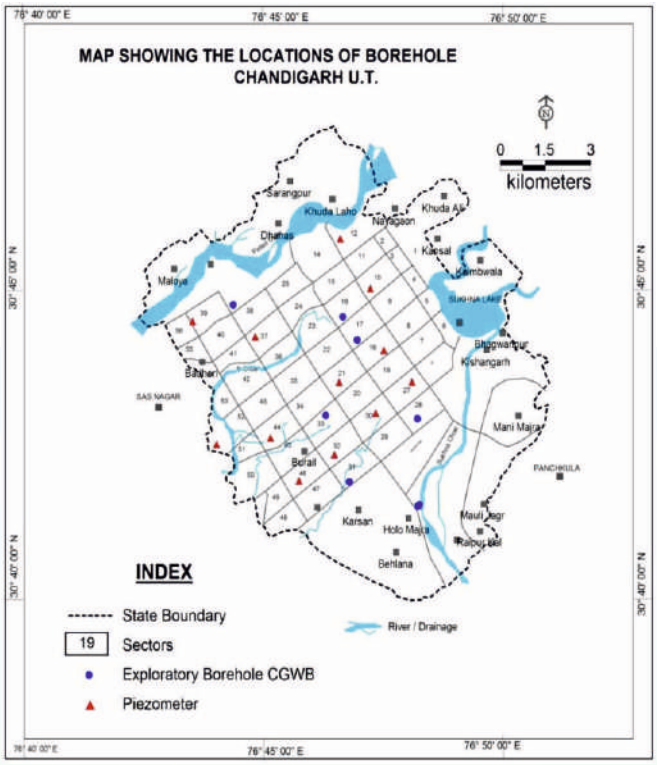
S.No.	Location	Total Depth of drilling(m)	Total Depth of T/W(m)	Water Quality	Aquifer Tapped
1	Sector-18B (Deep Piezometer)	120.98	120	Good	I
2	Karsan Colony	350	119	Good	I
3	Sector-10C (Deep Pz)	120.2	102	Good	I
4	Sector-10C (Shallow Pz)	17	17		VS
5	Sector-44D (Deep Pz)	121	113	Good	I
6	Sector-44D (Shallow Pz)	-	12	Good	VS
7	Sector-39D (Deep Pz)	120	102	Good	I
8	Sector-39D (Shallow Pz)	-	16.5	-	VS
9	Sector-37D (Deep Pz)	120.57	66		I
10	Sector-37D (Shallow Pz)	-	18	Good	VS
11	Sector-31D (Deep Pz)	100.95	67.81	Good	I
12	Sector-31D (Shallow Pz)	-	19	Good	VS
13	Sector-27 (Deep)	236	282	242.70 R.L.	II
14	Sector -21(Shallow)	-	-		VS
15	Sector-21 (Deep)	110	100	Good	I
16	Sector-52	162	95	Good	I
17	Maloya (Deep)	200	146	-	II
18	Maloya (Shallow)	-	60		I

Source: Hydrogeological Report of Chandigarh U.T.(AAP:2022-23),CGWB,NWR,Chandigarh

AQUIFER DISPOSITION

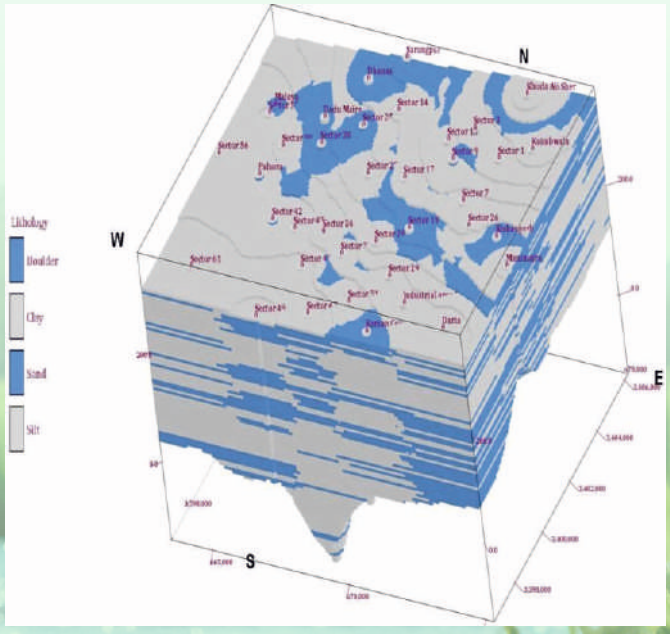
As per the Central Ground Water Report 2022-23, the aquifer system in Chandigarh belongs to alluvial fan deposits, which include both older and younger alluvial materials. The primary aquifer system in Chandigarh is formed from these alluvial fan deposits, comprising boulders, sand, silt, and clay. The dominant lithological formations are a combination of sand and clay, often with silt mixed in with them. The coarser sediments and boulders are predominantly located in the northern and northeastern areas of the region. This geological diversity contributes to the complexity of the underground aquifer system.

The aquifer system is categorized into four distinct groups, extending to a depth of 400 meters. The depth and thickness of these aquifers vary significantly, which are discussed in detail in Table 3.



Source: CGWB, Chandigarh

***Figure 2**: Map showing Locations of Exploratory Wells and Piezometers in Chandigarh*



Source: CGWB, Chandigarh

***Figure 3 :** 3-Dimension Lithological Model of Chandigarh*

Table 3 : Aquifer Grouping in Chandigarh (U.T.)

Aquifer Group	Depth Range (mbgl)		Thickness (m)	
	From	To	Min	Max
Aquifer I	0	33-139	33	139
Aquifer II	48-261	66-271	10	72
Aquifer III	100-292	121-323	10	78
Aquifer IV (Based on only6 data points)	132-378	153-399	12	21

Source: CGWB, Chandigarh

WATER TABLE ELEVATION

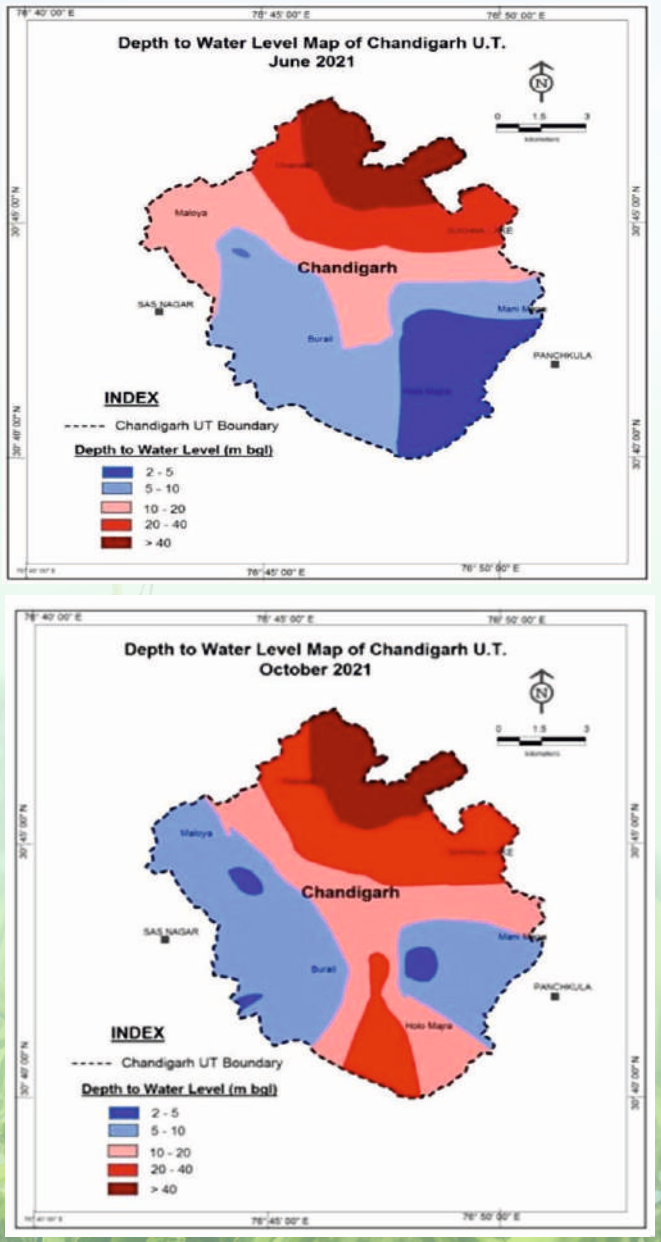
The ground water in Chandigarh U.T. flows from north to south west and southern directions. There is a 20-meter difference in water table elevation between the northern and southwestern parts, ranging from 330m amsl to 310m amsl due to hydraulic differences. The ground water moves from north to south western directions. In the western part, the groundwater flow aligns parallel to Patiala-Ki-Rao, while in the eastern area, it takes an oblique path to Sukhna Choe. The groundwater flow from the extreme north to the southwestern part suggests that groundwater recharge occurs in an area parallel to the Siwaliks.

WATER TABLE DEPTH

In the period before the monsoon season, the water table depth in the shallow aquifer system exhibits a range from 3.84 meters below ground level (mbgl) in the southern sectors (Sector 44) to 17.11 mbgl in the northern sectors (Sector 10). In the western and southwestern areas encompassing sectors 37 to 46, the water level remains shallow, measuring less than five meters in depth. This phenomenon is a result of the fine sediment characteristics and lithological boundaries. Conversely, in the northern sectors, water levels are found to be over 7.0 mbgl. During the post monsoon season, the water table depth varies from 3.06 mbgl in the southern part (Sector 44) to 12.68 mbgl in the northern part (Sector 10) of the city. Figure 3 Illustrates a three-dimensional lithological model of Chandigarh.

In the deeper aquifer system, the water table depth ranges from 15.69 mbgl (Sector 39) to 61.08 mbgl (Sector 46) in the pre-monsoon season and from 15.65 mbgl (Sector 39) to 62.66 mbgl (Sector 46) in the post-monsoon season. The depths of the water table in Chandigarh, both pre- and post-monsoon, are illustrated in Figure 4 using a map.

Long-term analysis of water level fluctuations over the course of decades in the deep aquifer system reveals a significant declining trend in water levels across all parts of the city, with a range of 0.32 to 1.55 meters per year. This decline can be attributed to heavy extraction from the deeper aquifer for domestic and agricultural purposes. The Union Territory of Chandigarh falls within the ***SEMI-CRITICAL*** category in terms of its groundwater status.



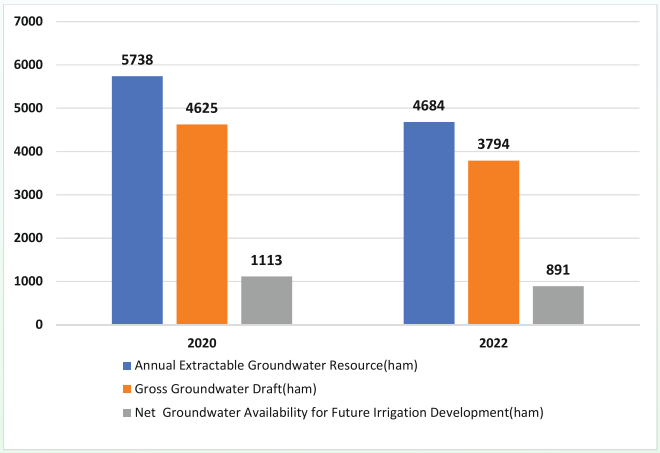
Source :Hydro-geological report of Chandigarh U.T. (AAP:2022-23)

Fig. 4: *Map showing Depth of Water level Pre- Post-Monsoon: 2021 of Chandigarh UT*

GROUNDWATER LEVEL

Rising Trends: In the extended analysis, it's evident that long-term water levels in Burail and Sector 52 (Shallow) are displaying an upward trajectory. This phenomenon may be attributed to localized hydrogeological conditions specific to that area.

Declining Trends: Upon examining the extended data for water levels over time, it is apparent that Sector-31D, Sector-37, and Sector-37 D in shallow aquifers, as well as Sectors 3, 12-D, Sector-27 (Bhujal Bhawan), Sector 21-D, Sector 39-D, Sector 44, and the village of Maloya, are experiencing a declining trend. This decline is likely a result of excessive groundwater extraction, signifying the need for prudent management of surface water resources and the conservation of groundwater.



Source: CGWB, Chandigarh

Figure 5: *Ground water status of Chandigarh U.T.*

♦ STATUS OF MANAGEMENT PRACTICES OF GROUNDWATER RESOURCES

Understanding the current practices for managing groundwater in Chandigarh is essential for ensuring the sustainable and efficient utilization of this vital groundwater resource. It plays a pivotal role in safeguarding the environment, supporting urban development, and adapting to evolving climate conditions. This knowledge serves as the cornerstone for making well-informed decisions and crafting effective policies and strategies for the management of groundwater resources.

In accordance with the existing hydrogeological conditions, the most appropriate methods for artificially replenishing groundwater in the Union Territory of Chandigarh includes the use of trench cum recharge wells and the construction of check dams, particularly in forested or hilly areas (amounting to over 150 check dams). The dimensions of these trenches are tailored to specific site conditions and depend on water availability. Additionally, groundwater recharge occurs through various means, including rooftop rainwater harvesting structures (totalling 202), natural rainfall in green and open areas, addressing water supply leakages, supplying tertiary-treated water from sewage treatment plants, groundwater irrigation, and the presence of tanks and ponds (a total of 9 such structures).

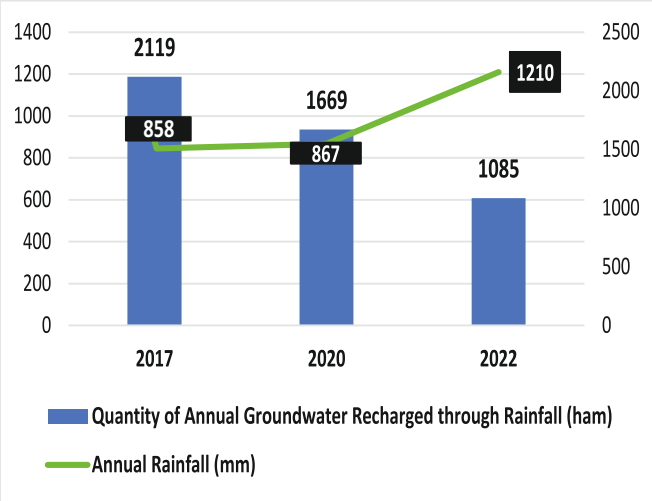
♦ GROUND WATER RECHARGE THROUGH RAINFALL AND OTHER SOURCES

Table 4 shows the quantity annual groundwater recharged through rainfall and other sources (recharge through leakages, ponds & tanks and artificial recharge structures) during monsoon and non monsoon season. Other sources are significant contributors to the annual groundwater recharge in Chandigarh, playing a crucial role during both monsoon and non-monsoon seasons by supplying a substantial amount of water to replenish the underground aquifers. Figure 6 is the chart illustration depicting the trend of groundwater recharge over the years.

Table 4: Annual Groundwater Recharge in Chandigarh UT

Quantity of Annual Groundwater Recharged (ham)					
Year	Monsoon		Non-monsoon		Total
	Rainfal	Other	Rainfall	Other	
2017	1631	687	488	1410	4216
2020	1187.7	1610.54	481.54	3095.43	6375.6
2022	772.06	1424.78	313	2694.85	5204.69

SOURCE: Central Ground Water Board, Chandigarh



SOURCE : CGWB, Chandigarh

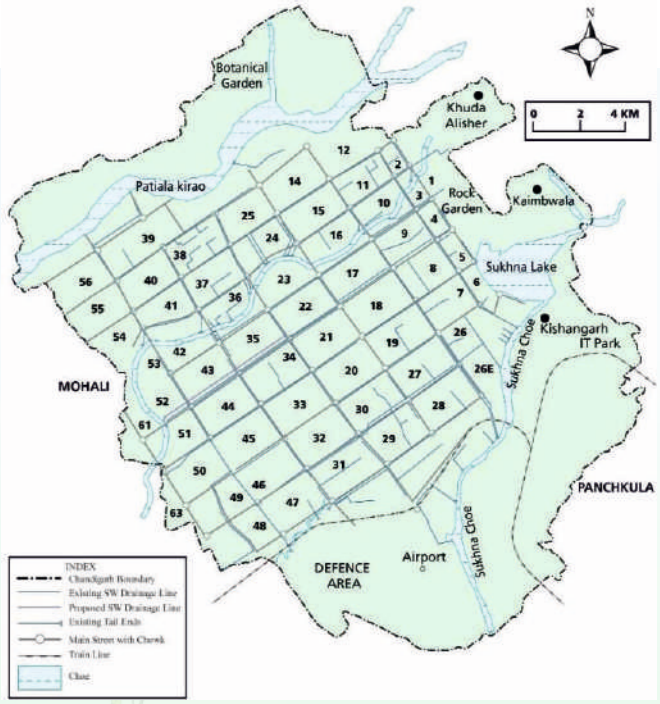
Figure 6 : *Graph showing variation of groundwater recharge due to rainfall with annual rainfall*

On observing the trend of annual rainfall and the groundwater recharged through rainfall for the year 2017, 2020 & 2022 using Figure 6, it can be said that there is no direct relationship between the quantity of rainfall and the quantity of groundwater recharged due to rainfall.

GROUND WATER RECHARGE THROUGH STORM WATER DRAINAGE IN CHANDIGARH

Chandigarh's drainage system is structured around a network of both natural and artificial channels and water bodies, all of which ultimately channel surface runoff into the 'N' Choe. These 'N' Choes collectively constitute the primary stormwater drainage system for the city. They serve as the principal conduits for stormwater. The responsibility for constructing and maintaining the stormwater drains lies with the Municipal Corporation. These stormwater lines have been laid across more than 90% of the Union Territory's area, encompassing a range of sizes from 12 inches to 96 inches, which includes brick drains and RCC box channels. The total length of the stormwater drains extend to 713 kilometres. Chandigarh benefits from a

natural topography as there is a natural slop of 10 from east north towards south which helps in naturally drainage and cleansing. It's important to note that Chandigarh employs a closed drainage system, which has a minimal impact on the environment. Map showing storm water drainage in Ch ndigarh is given in Figure 7.



SOURCE: Centre for Science and Environment

Figure 7: *Map showing Storm Water Drainage in Chandigarh*

As the rainfall increases the annual stormwater increases positively impacting the availability of stormwater for ground water recharge. A technical report by the Centre for Science and Environment on rainwater harvesting in Sector 26, Chandigarh, outlines the assessment of rainwater harvesting potential within the stormwater drain network. This methodology has been uniformly applied throughout Chandigarh to calculate the overall potential for rainwater harvesting in this report. For these calculations, a runoff factor of 0.4 is used, reflecting mixed land usage. (Reference report: Chandigarh technical report PDF (cdn.cseindia.org)

Rainwater harvesting potential=Area (sq m) x average annual rainfall (m) x runoff-coefficient (for mixed landuse)

Table 5 illustrates the annual rainfall, rainwater harvesting potential for groundwater recharge from the year 2017-2022.

Table 5: Rainwater harvesting potential for ground water recharge

Year	Annual rainfall in (m)	Area of Chandigarh in sq m	Run-off coefficient for mixed landuse	Rainwater harvesting potential in cu m	Rainwater harvesting potential in Hectare meters
2017	0.858	114000000	0.4	39124800	3912.48
2018	1.086	114000000	0.4	49521600	4952.16
2019	0.94	114000000	0.4	42864000	4286.4
2020	0.867	114000000	0.4	39535200	3953.52
2021	0.819	114000000	0.4	37346400	3734.64
2022	1.21	114000000	0.4	55176000	5517.6

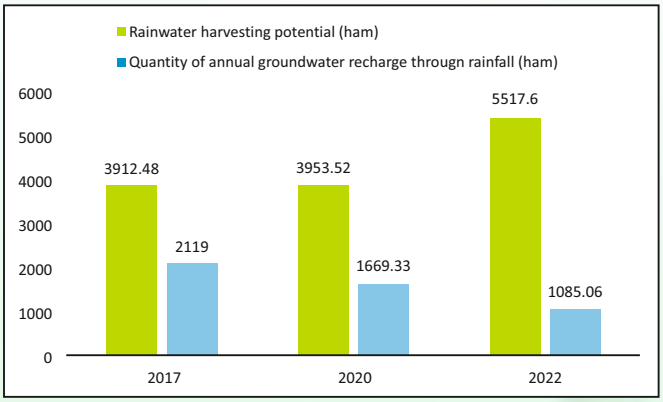


Figure 8: *Graph illustrating comparison between quantity of annual groundwater recharged through rainfall and the rainwater harvesting potential*

It has been found that the quantity of annual groundwater recharged through rainfall is much lower than the rainwater harvesting potential as shown in Figure 8 and there is huge scope for recharging groundwater by tapping and using the unutilized stormwater.

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