International Journal of Geography, Geology and Environment

P-ISSN: 2706-7483
E-ISSN: 2706-7491
NAAS Rating (2025): 4.5
IJGGE 2025; 7(8): 104-107
www.geojournal.net
Received: 10-06-2025
Accepted: 15-07-2025

Lakhveer Singh
Assistant Professor and Head, Department of Geography, Govt. Rajindra College Bathinda, Punjab, India

Corresponding Author:
Lakhveer Singh
Assistant Professor and Head, Department of Geography, Govt. Rajindra College Bathinda, Punjab, India

Underground water crisis in Punjab: A spatio-temporal analysis

Lakhveer Singh

DOI: http://doi.org/10.22271/27067483.2025.v7.i8b.399

Abstract
Punjab, an agrarian state of India, is facing severe underground water crisis associated with high degree depletion of these water resources after the introduction of Green Revolution. Nonetheless, Punjab is getting less amount of river water due to political reasons like Indus water treaty, damming and diversion of river water, water conflict with Haryana, Rajasthan, and central government. However, the water demand for irrigation and domestic as well as industrial purposes is significantly high. In Punjab, out of the total area of 4158 thousand ha under agriculture in state, an area of 4070 thousand ha (97.9 percent) is getting irrigation from canals (27 percent) and tubewells (73 percent). Resultantly, the underground water is being depleted at much faster pace and a large number of blocks in Punjab fall under the category of Over-Exploited. Therefore, the present paper addresses the issue of overexploitation of these underground water resources. The study is based on secondary data collected from various sources. Statistical methods are applied for deriving accurate results. Moreover, the present study provides solutions and alternatives to tackle with the present Punjab underground waters crisis.

Keywords: Green revolution, depletion, underground water resources, over-exploited

Introduction
Water plays central role in the rich diversity of biological processes. The importance of water for life on earth does not require any special introduction, as it is the most precious gift of nature, next only to air. In environment, water exists in three states such as liquid, solid, and gas. It is in dynamic equilibrium between the liquid and gas states at standard temperature and pressure. It is one of the most dynamic components which mold our agricultural, economic and industrial growth. Water has the molecular formula H_2O.

Punjab has endowed with abundance of water in the form of five perennial rivers as well as rich under groundwater aquifers and the hard-working nature of Punjabi farmers harnessed this wealth and created fertile, rich and prosperous farms. However, owing to partition of the country a major portion of these water rich and fertile lands was left in the Pakistan and Punjab was left with only three major rivers (Satluj, Ravi and Beas) and semi-fertile land.

The Indus dispute between India and Pakistan was settled through the good offices of the World Bank with the signing of the Indus Water Treaty on September 19, 1960 which conferred full rights on India on eastern rivers Ravi, Beas and Satluj after the transition period ending March 31, 1970. Thus, the state of Punjab in which these rivers lie became entitled to unrestricted rights of development and use of their waters (Singh, 2002). The central government introduced sections 78 to 80 in the Punjab Reorganisation Act, 1966, under which the central government "assumed the powers of control, maintenance, distribution and development of the waters and the hydel power of the Punjab Rivers" The reallocation of the waters among the states as follows:

Share of Punjab	4.22 MAF
Share of Haryana	3.50 MAF
Share of Rajasthan	8.60 MAF
Quantity earmarked for Delhi water supply	0.20 MAF
Share of J & K	0.65 MAF
Total	**17.17 MAF**

Therefore, Punjab's water needs are not met with the water available to it from its rivers; hence, Punjab has to depend on underground water for its agricultural, industrial and domestic needs.

In the state of Punjab the stage of ground water development is very high, that is, 170 percent. The net annual ground water availability is 2,034,922 ham (hectare metre) whereas annual ground water utilization is 3,466,117 ham (3,395,651 ham for irrigation and 70,466 ham for industry and domestic purpose) in Punjab (Singh, 2013) [5].

Study area

Indian state of Punjab has been selected for the present study located in northwest part of Indian subcontinent. The total geographical area of the state is 50,362 sq. km. which accounts 1.5 percent of the total area of the country. The average annual rainfall in Punjab is 64 cm. spatially wide regional variation in the average annual rainfall from northeast (140 cm Dhar Kalan) to southwest (25 cm Abohar) is available in the state (Singh, 2012) [4]. Except few hills lying in the north eastern part (highest part 1000 metre) of the state more than 30 percent area of the state is plain and falls below 300 metre contour line. The upper rock strata of the state is soft and most suitable for the utilization of surface as well as ground water through canals, tubewells, etc. (Singh, 2013) [5].

Source of data and methodology

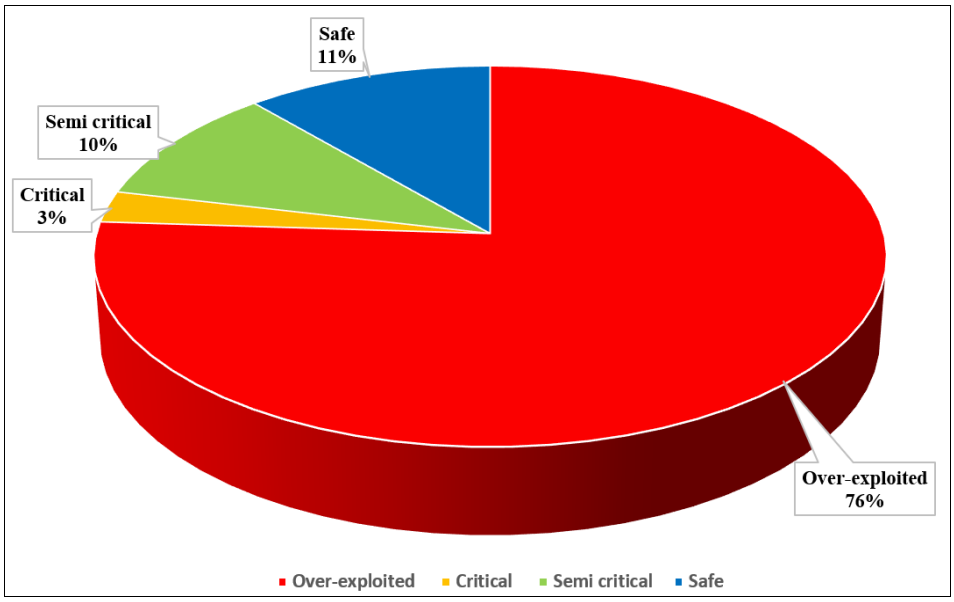
The present study is based on secondary data collected from various sources, departments and agencies such as Department of Central Ground Water, Chandigarh, Department of Punjab Water Resources, Chandigarh, Statistical Abstracts of Punjab for the year of 1980, 2010, 2021, Ground Water Reports, Journals, Books, Newspapers, etc. suitable cartographical, statistical and graphical techniques have been applied for data processing and mapping.

Block has been taken as a study unit to reveal the actual state of underground water in Punjab province. The quality of the underground water is demonstrated based on the geographical regions of Punjab, i.e., Majha Malwa and Doaba, however, Malwa region is divided into Western Malwa and Eastern Malwa to bring accuracy.

Status of underground water in PUNJAB

Basically, the state of Punjab is an agrarian state. Since the introduction of Green Revolution agricultural land scape has changed drastically. There are positive as well negative impacts are made by the productivity-enhancing technology. But the present situation in Punjab closely reflects the agrarian as well as environmental crises are being experienced throughout the state.

Below the pie diagram (Fig 1.1) shows the percentage of the assessment ground water resources under different categories. Large part of the state is under over-exploited category, that is, 76 percent followed by 13 percent critical and semi-critical categories. The safe categories comprises only 11 percent, that shows only small number of blocks are having adequate groundwater resources situated mainly in extreme south-western and north-eastern blocks of the Punjab state.



Source: Ground water resources of Punjab State: 2022

Fig 1.1: Percentage of blocks under different groundwater assessment categories in Punjab

Depletion of underground water table in Punjab

In general, the depth to water level in Punjab State varies from 0.33 m bgl (below ground level) in Hoshiarpur district to 43.58 m bgl in Sangrur district during August 2016. It is observed that shallowest water level conditions prevail in southwestern parts mainly in Muktsar, Ferozepur and Fazilika districts, even water table has been rising in the area comprising blocks of Muktsar, Lambi, Kot Bhai, Khuiyan Sarwar, Abohar and Fazilka creating water logging at many places (Chopra and Krishan, 2014), while deepest water level conditions exist in the central area in Ludhiana, Sangrur and Kandi areas of Hoshiarpur district.

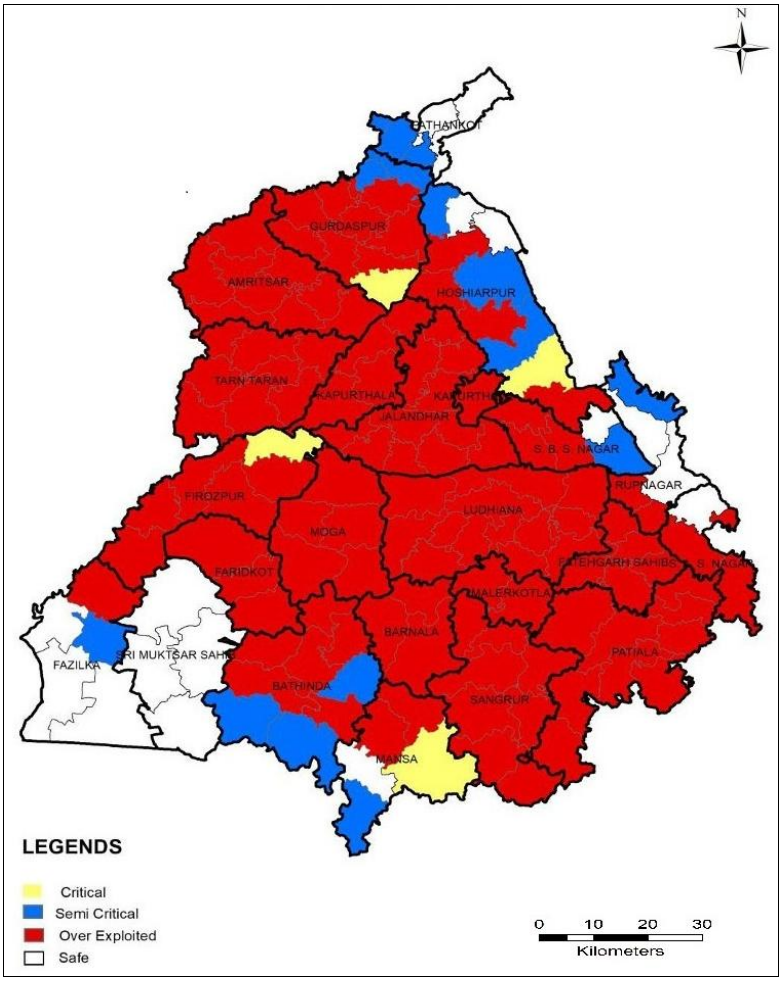
Table 1.1: District wise categorization groundwater assessment blocks of Punjab State as on 31.03.2022

Sr. No.	Districts	No. of Blocks	Over-exploited	Critical	Semi critical	Safe
1	Amritsar	9	9	0	0	0
2	Barnala	3	3	0	0	0

3	Bathinda	9	6	0	3	0
4	Faridkot	3	3	0	0	0
5	Fatehgarh Sahib	5	5	0	0	0
6	Fazilka	5	1	0	1	3
7	Ferozepur	6	5	1	0	0
8	Gurdaspur	11	8	1	2	0
9	Hoshiarpur	10	4	1	3	2
10	Jalandhar	11	11	0	0	0
11	Kapurthala	5	5	0	0	0
12	Ludhiana	13	13	0	0	0
13	Malerkotla	2	2	0	0	0
14	Mansa	5	2	1	1	1
15	Moga	5	5	0	0	0
16	Muktsar	4	0	0	0	4
17	Pathankot	6	0	0	3	3
18	Patiala	9	9	0	0	0
19	Rupnagar	5	2	0	1	2
20	Sangrur	8	8	0	0	0
21	SAS Nagar	3	2	0	0	1
22	SBS Nagar	5	3	0	1	1
23	Tarn Taran	8	8	0	0	0
Total	**Punjab**	**150**	**114**	**4**	**15**	**17**

Source: Ground water resources of Punjab State: 2022

In most of rural and semi-urban areas of Punjab State, ground water is a major resource for drinking and irrigation uses especially in areas where surface water is inadequate or unavailable. Underground water resources of State Punjab have been estimated as on 31.03.2013 in the above table 1. Due to inadequate supply of water from other sources like surface water and atmospheric rainfall, Punjab utilizes more ground water than its net annual availability and thus underground water level is decreasing (Singh, 2013) [5]. Because of over-exploitation of ground water in Punjab, the extraction of ground water has increased by 200 times during last three decades.



Source: Ground water resources of Punjab State: 2022

Fig 2: Categorization of ground water assessment blocks in Punjab: 2022

As on 31/03/2022, out of total 150 block, 114 block are under over-exploited category while 4 are under critical category and 15 are under semi-critical category (Table 1.1). However, only 17 blocks are under safe category in the all three geographical regions of Punjab. Spatial distribution of the block with their category can be depicted in Map. The district-wise categorization of blocks is also listed in Table 1.1. The reason for this stage of ground water development are excessive withdrawal of underground water primarily to meet the growing demands of agriculture in addition to industrial and domestic purposes. Surface water resources in the state are limited and are decreasing due to overexploitation. Therefore, stress is more and more on underground water utilization.

Table 2: Number of tube wells in Punjab (1970-71 to 2020-21)

Year	Number of tube wells (in Lakhs)		
	Diesel operated	Electric operated	Total
1970-71	1.01	0.91	1.92
1980-81	3.20	2.80	6.00
1990-91	2.00	6.00	8.00
2000-01	2.85	7.88	10.73
2010-11	2.40	11.42	13.82
2020-21	1.65	12.54	14.19

Source: Statistical Abstract of Punjab 1980, 1991, 2001, 2011, and 2021 vide Director, Agriculture, Punjab

Table 3: Proportion of gross cropped area under irrigation in punjab from different sources 1970-71 to 2020-21

Period	1970-71 (in percent)	2020-21 (in percent)
i) Canals	42.28	26.74
ii) Tubewells	57.33	73.26

Source: Agriculture at a Glance, 2020-21, Directorate of Agriculture, Punjab and Directorate of Land Records 1991, 2009

At present, there are 14.19 lakhs tubewells as compared to 1.92 lakhs in 1970-71 and about 89% of total tubewells are electric-operated while the rest are operated with diesel engines. Out of the total irrigated area, the area under irrigation by groundwater through tubewells has increased from 57.33 percent to about 73.26 percent during this period.

Summary and Conclusions

The state of Punjab is endowed with abundant water resources but the diversion of its surface water resources to the neighboring states put more stress on underground water resources to meet the daily domestic, industrial and agricultural needs. On the basis of the study and related discussion conducted about the conditions of underground water in Punjab, it can be concluded that:

- Groundwater draft in the state has been resulted into over-exploitation of the aquifers of the region. More than 80 percent of the state are under the category of over-exploited and only 20 percent area is under critical and safe zone.
- The number of tubewells has been increased tremendously from 1.92 lakh in 1970-71 to 14.19 lakh in 2020-21.
- More than 70 percent under irrigation in Punjab is being irrigated with the help of underground water.
- Exiting cropping pattern in the state has led over extraction of underground water for irrigation purposes.

References

1. Central Ground Water Board. Groundwater Year Book Punjab and Chandigarh (UT). Chandigarh: Central Ground Water Board; 2017.
2. Ground Water Management Circle, Central Ground Water Board. Ground Water Resources of Punjab State (as on 31st March, 2022). Punjab: Water Resources Department; Dec 2022.
3. McDonald AT, Kay D. Water Resources: Issues and Strategies. Harlow (UK): Longman Scientific and Technical; 1988.
4. Singh J. Trends in Crop Combination Regions in Punjab. Patiala: Twenty First Century Publications; 2012. p.214.
5. Singh J. Irrigation Development and Over Exploitation of Ground Water Resources in Punjab. Geogr Rev India. 2013;75(2):139–52.
6. Singh Y. Canal Irrigation and Its Ecological Implication in Punjab, India. Malays J Trop Geogr. 2009;40(1–2):53–64.
7. Government of Punjab. Statistical Abstract of Punjab. Chandigarh: Economic and Statistical Organisation; 2013.