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Evaluation of water resources: A case study of Rohtak district, Haryana

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Abstract
Water is one of the most important natural resources for life. Because of the rapid increase in population, urbanization, and industrialization, the demand for water to meet various needs is constantly increasing. Water that is present below the Earth's surface and fills any gaps in the soil or geologic strata is known as groundwater. It is additionally known as subsurface water.
Data related to underground water table were obtained from Central Ground Water Board of the Ministry of Water Resources. Maps of underground water table depth, quality and surface water resources were prepared in Arc GIS software. After the analysis of maps, the depth of the underground water table in the study area ranges from 0 to 20 meters. The maximum area of the study area is 3-10 meters, which covers 48.35% of the study area. The minimum area is 10-20 meters deep and covers 1.43% of the study area. In Rohtak block, the maximum depth is observed in the villages of Brahmanvas, Chamaria, Aryanagar, and Bohar. The quality of groundwater varies from fresh to saline. Fresh underground water quality occupies the largest area, accounting for 59.8% of the study area. Saline underground water quality accounts for 0.5% of the study area. In terms of surface water resources, this district lacks a perennial river. The main irrigation channels in this area are artificial drain no. 8 and sub drains, major canals, distributaries, and minor canals. This research paper will make a better understanding of water resources in Rohtak district. It will help to analyse and understand the current status of underground water depth, quality and surface water to build up any water resource management plan. A water resource management plan will ensure the sustainable use of water resources which is very important for our ecosystem.

Keywords: Underground water quality, GIS

Introduction
One of nature's most important resources for supporting life is water. Its development and management are critical in agricultural production. Integrated water management is critical for poverty reduction, environmental sustainability, and long-term economic development. (Kumar, C. P. 2018) [1]. Water resources have been and continue to be an important factor in the development of all societies, especially in terms of their ability to grow economically (Ashfaq A., Ahmad F. (2014) [2]. Groundwater is all the water that fills the voids, pores, and fissures within geological formations due to atmospheric precipitation, either directly through rainfall infiltration or indirectly through rivers, lakes, or canals. Groundwater is typically supplied by sands, gravel, sandstones, and limestone formations, though some may be drawn from impervious rocks such as granite when they have an overburden of sand or gravel (Ojo et. al 2012) [3]. Although groundwater is an essential component of the hydrological cycle and a significant source of drinking water, its pollution has been brought on by various anthropogenic activities and is now of global concern. Groundwater quality degradation is a common occurrence due to anthropogenic activities' rapid expansion as a major source of pollutant dispersion in the subsurface environment (Song K. *et al*. 2020) [4]. Groundwater has contributed significantly to India's economic growth and has been a strong factor in the country's long-term socioeconomic development. Groundwater resources provide more than 75 percent of India's rural domestic water requirements, 50 percent of its urban water requirements, and more than 50 percent of its irrigation requirements. (Aneja R. 2017) [5]. The water level is the depth of the groundwater table from the ground level. Groundwater is regarded as a valuable resource by human societies. This natural resource is under tremendous stress as a result of rapid population growth and the injudicious expansion of groundwater irrigation. In areas where surface water is insignificant, groundwater irrigation via tube wells provides the majority of irrigation (Neeraj, Manju, Mamta 2019) [6].

Groundwater is present in Haryana in quantities of 0.7248 million hectares (ha), of which 0.65236 million hectares (ha) are netly usable for irrigation. Mahendergarh had the greatest drop in water table between 1974 and 2001 (11.74 meters), followed by Kurukshetra (11.15 meters), Panipat (5.94 meters), Gurgaon (5.89 meters), Rewari (4.13 meters), Panchkula (3.30 meters), Karnal (3.09 meters), Kaithal (3.00 meters), Faridabad (2.05 meters), and Ambala (1.10 meter). Continuous rice, wheat, and heavy-duty crops like sugarcane are the primary causes of groundwater drawing. (Kumar V., Kumar P., Kumar D. 2006) [7] In the districts of Rohtak and Jhajjar in the state of Haryana, the heavy surface irrigation employed and the construction of canal systems that brought a large area under irrigation and assisted in the adoption of heavy irrigation crops like rice have caused the water table to rise in the central part of Haryana, although agricultural production has increased significantly. (Neeraj, Suman, 2014) [8]. For sustainable development to be achieved, water resources must be managed effectively and sustainably. In times of limited water availability, the management of water resources should focus on increasing water supply and controlling water demand. (Khadse G.K., Labhasetwar P.K., Wate S.R. 2012) [9].

Study area

The current study area is Haryana's Rohtak district. Due to its location in the center of the Haryana state, Rohtak has no shared borders with any other states in India. Jind is adjacent to Sonipat to the south, Jhajjar to the east, Hisar to the west, and Bhiwani to the north. The district's latitude ranges from 28°40'30" N to 29°05'35" N and its longitude ranges from 76°13'22" E to 76°51'20"E. The Rohtak district covers a land area of 1669 km2. Rohtak district is located in a low-lying region of the Gangetic plain. In the study area, the winters are too cold and the summers are too hot due to the continental climate. Location map of the study area is displayed in figure-1.

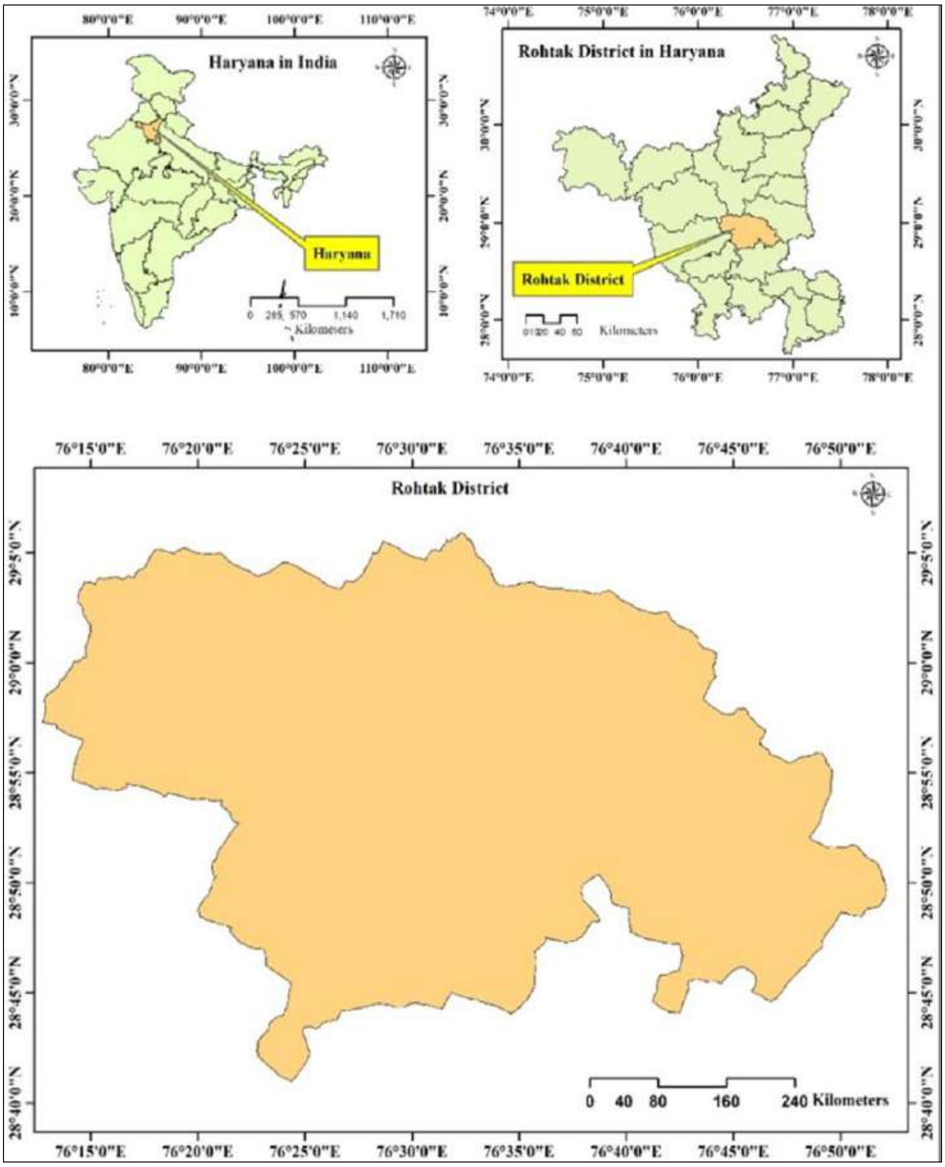

Fig 1: Location map of study area

Data source and Methodology

Data Source

Data were obtained from the Central Ground Water Board of the Ministry of Water Resources regarding the depth and quality of underground water. Sentinel 2B Satellite Image (29-1-2021) and Toposheet of Rohtak district were used to make the surface water resource map.

Software Used

- ArcGIS Desktop
- Microsoft Office

Methodology

After obtaining data on the depth and quality of the underground water table in the form of depth points and P.H and E.C values, these were entered into the Arc GIS software. The maps of underground water table depth and quality were created using the interpolation process. Sentinel satellite image (2021) and Toposheet were used to make the surface water resource map. With the help of image interpretation techniques, the linear polygons related to drains, canals and distributaries were cut and verified with Google Earth. Finally, map composition was completed, and all required maps were prepared. Detailed methodology is discussed in figure-2.

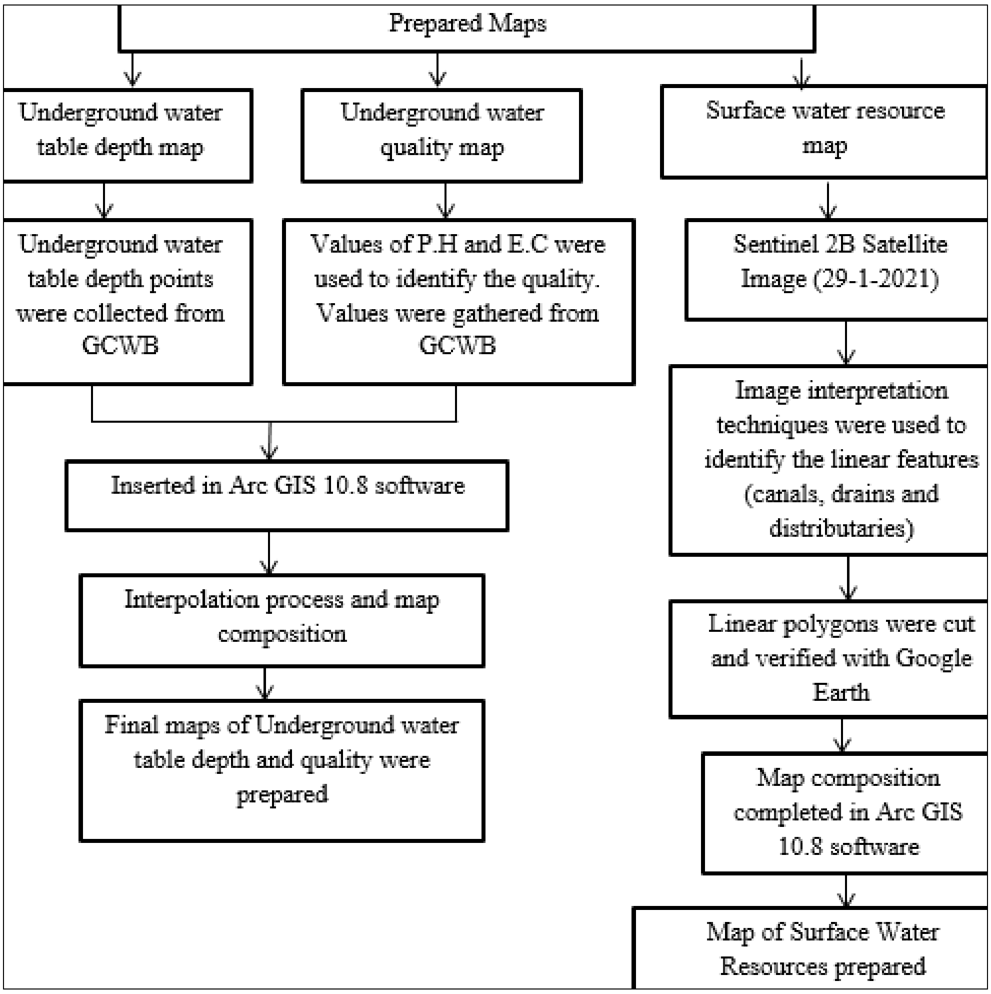

Fig 2: Methodology Flow Chart

Results and Discussions

Underground water table Status

Underground water table depth information is critical for determining the total information about water resources in any area. The depth of the underground water table in the study area ranges from 0 to 20 meters. 7.18% of the study area is under 0-1.5 meters and 43.01% is under 1.5 to 3 meters. The maximum area of the study area is 3-10 meters, which covers 48.35% of the study area. The minimum area is 10-20 meters deep and covers 1.43% of the study area. In Rohtak block, the maximum depth is observed in the villages of Brahmanvas, Chamaria, Aryanagar, and Bohar. It can easily see that most Rohtak district water tables fall under 1.5 to 10 meters. The aerial extent of underground water table depth in meters is shown in Table- 1 and related map is displayed in Figure -3.

Table 1: Water table depth in relation to aerial extent

Depth range in Meter	Area in Km^2	Percentage
0-1.5	120	7.18
1.5-3	718	43.01
3-10	807	48.35
10-20	24	1.43
Total	1669	100

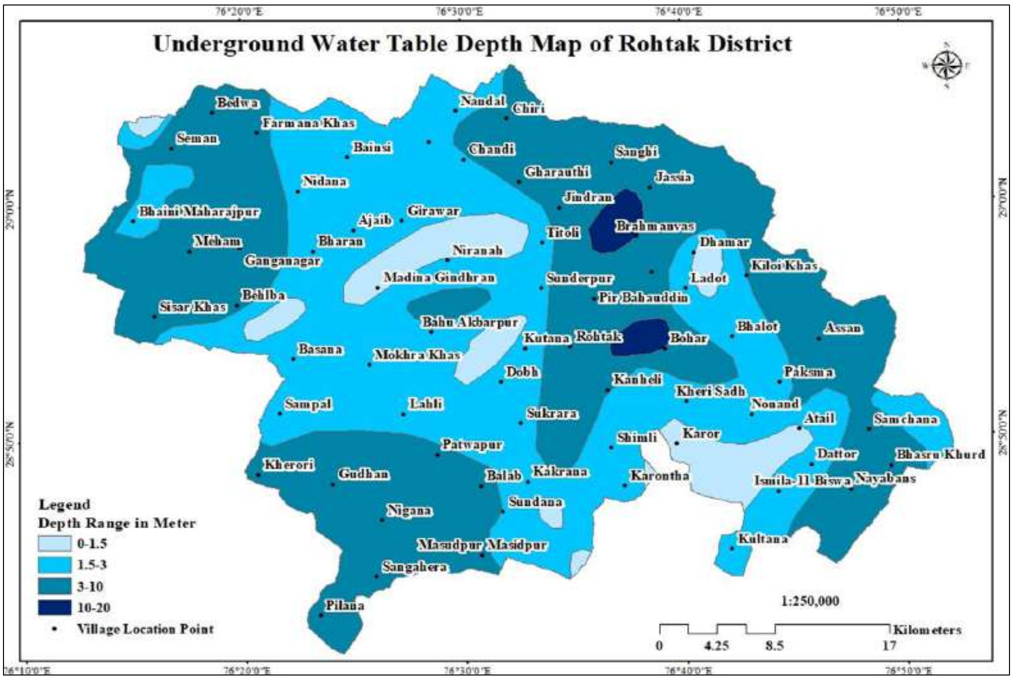

Fig 3: Underground water table depth map of Rohtak district

Water quality status

Electrical conductivity

Soil electrical conductivity (EC) is a measure of the salt content of soil (salinity). Soil EC is a trustworthy general indicator of soil fertility. It has the potential to display the soil's texture, its capacity to hold nutrients, and an excess of soil nutrients (for example, excessive sodium levels leading to salinity). Low EC values imply few nutrients are available, while high EC levels represent an abundance of nutrients. Low EC levels are commonly found in sandy soils with minimal organic matter, whereas high EC levels are typically found in soils with a high clay concentration.

In the Rohtak district, groundwater quality ranges from fresh to saline. Fresh underground water quality accounts for 59.8% of the study area. The water table quality is marginal in 37.2% of the area. Sub-marginal underground water table quality accounts for 37.2% of the study area, while saline underground water quality records for 0.5% of the study area. In the Kalanaur block, the surrounding areas of the villages of Pilana and Kahanaur have marginal underground water quality. In the nearby Girawar village in the Meham block of the study area, saline underground water quality has been noted. The aerial extent of electric conductivity is shown in table-2 and the related map is displayed in figure- 4.

Table 2: Electric conductivity in relation to aerial extent

Status	Electrical Conductivity (µS/cm)	Area in square kilometers	Percentage to total area of the district
Low (Fresh)	0-2000	999	59.8
Medium (Sub-Marginal)	2000-4000	620	37.2
High (Marginal)	4000-6000	42	2.5
Very High (Saline)	>6000	8	0.5
	Total	1669	100

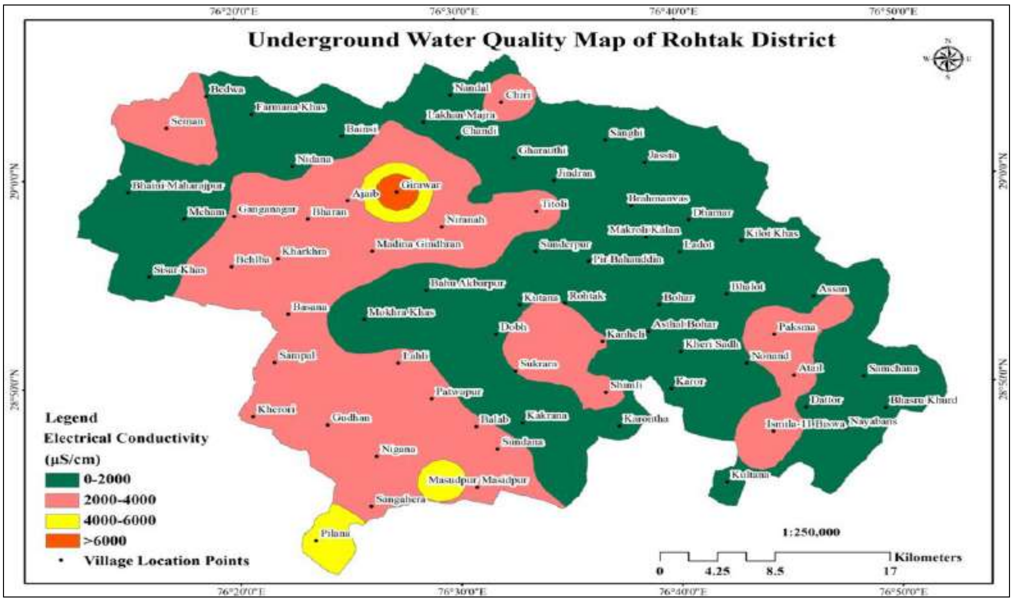

Fig 4: Underground water quality map of rohtak district

Surface water resources

In Rohtak district, there is no perennial river. The main source of irrigation in this area is artificial drain no. 8 and sub drains, major canals, distributaries, and minor canals. The drains that run through this area are as follows: artificial drain no. 8, Pakasma drain, Gadhra drain, and Kalanaur drain. Western Yamuna canal and Bhiwani sub branch are two major canals. Rohtak Distributary, Bhalaut Distributary, Dulehra Distributary, Ismaila Distributary, and Kalanaur Distributary are the distributors. Minor canals include Asan, Jasrana, Rohana, Chiri, Meham, and others. Table-3 depicts the lengths of canals, drains, and distributaries. Map of surface water resources displayed in figure-5.

Table 3: Length of canals, drains and distributaries

Drainage	length in Kilometers	Percentage to total
Branch Canal	213	44.6
Main Canal	76	15.9
Drain	77	16.3
Distributaries	111	23.2
Total	477	100

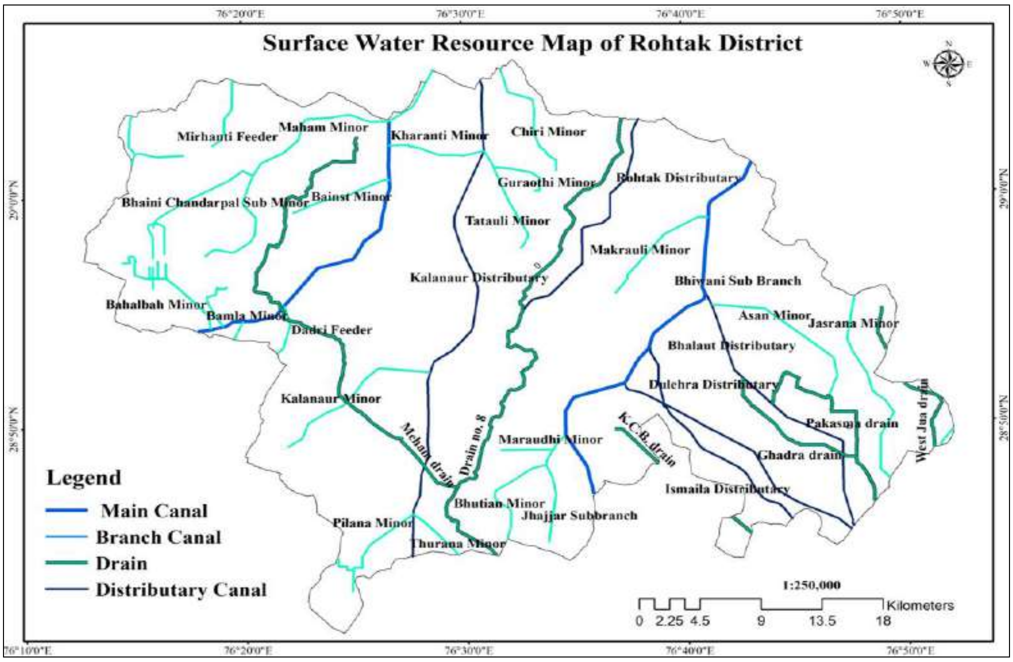

Fig 5: Surface water resource map of Rohtak district

Conclusion

The most important resource for all life on earth is water. Since there is a big demand and a small supply, good resource management is crucial. Underground water table depth ranges from 0-20 meters and the maximum area comes under 3-10 meters which are 48.35% of the total area. Underground water quality ranges from fresh to saline, with freshwater quality covering the most area (59.8% of the total study area). The study area lacks perennial rivers in terms of surface water resources. Drains, canals, and distributaries meet all surface water resource needs in the study area. We currently need to conserve and sustainably use underground water resources based on their current conditions.

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