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GEOGRAPHICAL ANALYSIS OF GROUNDWATER QUALITY IN SONIPAT DISTRICT, HARYANA

Author's Name: *Sonia*[1]

Affiliation: *[1]Ph.D. Scholar, Department of Geography, MDU, Rohtak, Haryana, India.*

E-Mail: *soniamalik3500@gmail.com*

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Abstract

This study conducts a comprehensive geographical analysis of underground water quality in Sonipat district, Haryana, India, for the period from 2015 to 2020. Sonipat, a rapidly urbanizing region, has witnessed significant growth and environmental changes during this timeframe, warning fears about the state of its underground water resources. Using an extensive dataset of water quality parameters collected from monitoring stations throughout the district, the research examines spatial and temporal trends in water quality. The study identifies significant spatial variations in underground water quality within the Sonipat district. In contrast, rural and agricultural areas tend to have better water quality. The analysis also indicates temporal trends in water quality, with certain contaminants showing fluctuations and gradual increases, potentially linked to urbanization, industrialization, and changes in land use practices. The research contributes to a better understanding of the dynamics of underground water quality in an urbanizing region and offers insights for policymakers, local authorities, and environmental organizations to develop strategies for water quality preservation and management. Given the critical importance of clean water for both public health and the environment, addressing the issues identified in this study is crucial for the sustainable development of the Sonipat district. In Haryana, all districts are affected by salt concentration. A case study of Sonipat district in Haryana, India, found that groundwater levels have changed significantly between 1993 and 2013. In 1209.26 square kilometres of the district, the groundwater table fluctuates between 0 and 1 meter seasonally. This means that rainfall during the monsoon season can't replenish the groundwater levels, and artificial recharge is needed in these areas. The water level in most parts of the district is 5–20 meters below the surface, 2–25 meters deep in the east, and 2–10 meters deep in the northwest. The study also found that 62% of groundwater is suitable for drinking, while 38% is not. The groundwater also needs protection from contamination.

Keywords: *Underground water Quality, Water Quality Parameters, Spatial variations, Temporal Trends, Salinity and Sustainable Development.*

INTRODUCTION

The majority of the liquid fresh water on Earth is stored below in aquifers rather than in lakes, and rivers. In fact, during dry spells, these aquifers feed rivers with a crucial base flow of water. As a result, they are a vital resource that has to be preserved for groundwater to continue supporting humankind and the many ecosystems that depend on it. The contribution of groundwater is essential; two billion people directly rely on aquifers for drinking water, and irrigated agriculture—which produces 40% of the world's food—largely depends on groundwater, according to Morris et al. Future aquifer development will be essential to economic growth, and stable water supplies will be required for home diminishment (Jones, 2017). Depletion of groundwater quality is a complex problem with many underlying causes. Stricter laws, environmentally friendly management techniques, and more public knowledge of the possible repercussions of groundwater pollution are all necessary to address these problems. To protect this priceless resource and guarantee its availability for future generations. Because of the increasing impermeable surfaces and pollutants released from infrastructure, urban area growth might raise the danger of groundwater contamination (Gupta & Sharma, 2018). Groundwater is being over-extracted as a result of fast industrial and urban growth. The normal replenishment of aquifers is disrupted by this excessive pumping, which lowers the water table and increases the salinity of the remaining groundwater. pollution from runoff from agriculture, and industrial effluents. A vital necessity for all living things and physical growth is water. Urban regions are under strain on groundwater quality and quantity due to high population density, industrialization, and shrinking groundwater recharge areas. Fluorosis and methemoglobinemia are among the health risks associated with drinking groundwater of low quality. It makes sense to utilize potable drinking water as a result. Numerous researchers (Abbas et al., 2012; Anwar and Aggarwal, 2014; Gupta and Mishra, 2014; Jadhao, 2013; Pradhan et al., 2011; and Sarita and Jyoti, 2016) have examined groundwater quality in a variety of geological and geomorphological environments, with differing water quality reports.

Water is present in all parts of the earth's surface, atmosphere, and subsurface. The growing population has increased the need for water in practically every aspect of life. Over time, there has been a rise in demand for groundwater. Our ecosystems and potentially the lives of future generations are in danger due to overexploitation and unrestrained pollution of this essential resource. Therefore, there is an urgent need for precise and effective management of this resource due to the great shortage of water resources, as well as the ever-increasing demand and unequal distribution. Numerous academics from India and other countries have studied groundwater (Jasrotia et al., 2012; Saxena, 2012; Sinha et al., 2012; Gontria and Patil, 2011; Rekha et al., 2011; Nag, 2005; Colten, 1998; Al-Saleh, 1992)—a multitude of groundwater studies. Sustainable agriculture relies heavily on the prudent use and observation of soil and water resources. In dry and semiarid environments, the main challenges to agricultural production are the over-drafting of groundwater and the degradation of its quality (Pradhan et al., 2011). Water has been crucial to the advancement and expansion of human civilization. According to Yadagiri et al. (2015), water is now vital to the economic development of all modern countries. Groundwater resources are under strain due to groundwater resource depletion and pollution from a variety of chemical and biological causes. Determining irrigation water quality characteristics is essential to developing effective farming. An important source of water supply is the groundwater aquifer. Of the 3.62 mha total cultivated area, 1.24 mha is irrigated by canals. 1.65 mha is irrigated using tube wells, many of which provide water of questionable quality. 37% of the water in the state is high quality, 8% is normal, and 55% is bad quality. Thus, ongoing groundwater resource monitoring is essential to the sustainable management of water resources. The kind and concentration of dissolved salt in the water indicate the irrigation quality of the water (Etteieb et al., 2017). The Sonipat district has isolated groundwater troughs and mounds in several locations as a result of extensive pumping in the city. Over the past ten years, the water table has generally dropped throughout the district, in light of the current research on groundwater mapping. Water is a natural resource, fundamental to life, agriculture and sustainable development. The Sub-region is a water scarce, dependent to a large extent on surface water and sources located outside. A Functional Plan on Groundwater Recharge for NCR was prepared in 2009 by the NCR Planning Board to assess groundwater resources in NCR and to guide the participating states on various aspects of groundwater management in NCR. Groundwater forms a major source of water in NCR. Monsoon and non-monsoon rainfall, irrigation return flow, recharge from canals, lakes, ponds and floods contribute to groundwater resources. This annual recharge of the aquifer contributes towards dynamic groundwater resources, a significant quantity of which is stored in the aquifer and part of it contributes to the rivers as base flow. In addition to this annual recharge, a large quantity of groundwater remains stored in the aquifer below the zone of annual fluctuation known as a static resource.

Study Area

The district of Sonipat is bounded by 280 48'15" to 290 17'10" North latitude and 760 28'40" to 770 12'45" East longitude. It falls in the survey of India topo sheets no.53C,53D, 53G & 53H covering an area of 2260.53 sq. km. Sonipat is one of the smallest districts in Haryana State and covers 5.11 % area of the state. The district is surrounded by Panipat district in the north, Jind district in the west, Rohtak district in the S.W direction and Delhi in the South. The district headquarter, Sonipat is connected by metalled roads with important cities of the state and to Delhi. It is also connected by a broad gouge railway line with Delhi and Chandigarh. Gohana, Ganaur, Rai & Kundli are the other important towns in the district. Sonipat district is one of the densely populated districts of the state. The total population of the district as per 2001 census is 12,79,175. The population density is 471 persons per sq. km against the state average of 372 persons per sq. km.

Physiography The area forms a part of the Indo-Gangetic plains and exhibits flat terrain with a general slope from North to South. The area is devoid of any prominent topographic features. However, a natural depression exists in the North & Northwest of Gohana (290 08'22" N & 760 42'55" E). The maximum elevation of the plain is 230m above msl. Topographically the district can be divided into the following units.

Drainage The River Yamuna, which borders the district in the East, is the main river in the district. The district is drained by drain no.8, which was constructed to take out excess monsoon runoff from uplands to River Yamuna. The areas east of upland plains are more prone to flooding because of their low-lying nature.

Soils Type • (Psammaquents and Haplaquepts)- These soils are found in Yamuna Plains • Haplaquept- These soils are non-saline, alkalinity hazards are classified as typic ustochrepts but water-logged soils with loam to clay loam texture showing the effect of glazing, are classified as aeric/ typic Haplaquepts. Areas with periodic soil moisture have soils classified as cambrics and torropsamments.

Rainfall: The normal annual rainfall of the district, based on the record for the period 1901-1980 is 567 mm recorded in 30 rainy days in a year. There is no meteorological observatory in the district, so the climatological data of the nearby observatory at Delhi has been taken as representative of the climatological conditions of the district. About 76% of the annual rainfall is recorded during the southwest monsoon from June to September. July is the wettest month of the year with 7.5 rainy days and 169 mm rainfall. During the period 1901-80, deficient to scanty rainfall was recorded in 18 years. The probability of occurrence of rainfall in the range of 400-700 mm is 0.65.

Source: Survey of India

Irrigation: Irrigation in the district is done by surface and groundwater as well. Around 42% of the area is irrigated by tubewells and the rest of the area is irrigated by canals. About 96% area has been irrigated concerning net sown area in the district. The district has a high irrigation intensity of 159%. About 91% area of the district is gross area irrigated concerning total cropped area. The area, which is irrigated by surface water lies towards the west where groundwater is mostly saline while groundwater irrigation is maximum in the eastern parts adjoining the Yamuna River. In this part of the district, groundwater is fresh. The canal irrigation is mainly done by the West Yamuna Canal system.

Rainfall: The normal annual rainfall of the district, based on the record for the period 1901-1980 is 567 mm recorded in 30 rainy days in a year. There is no meteorological observatory in the district, so the climatological data of the nearby observatory at Delhi has been taken as representative of the climatological conditions of the district. About 76% of the annual rainfall is recorded during the southwest monsoon from June to September. July is the wettest month of the year with 7.5 rainy days and 169 mm rainfall. During the period 1901-80, deficient to scanty rainfall was recorded in 18 years. The probability of occurrence of rainfall in the range of 400-700 mm is 0.65. January is the coldest month with a mean daily maximum temperature of 21.3 C and a mean daily minimum temp 7.3oC. May is the hottest month with a mean daily maximum temp 26.6oC. In May and June, the maximum temperature sometimes reaches about 47oC.

GROUNDWATER SCENARIO

(Hydrogeology) Groundwater occurs in alluvial sand, silt, kankar and gravel, which form potential aquifer zones. Depth to water level during pre-monsoon varies from 1.57 - 24.84 while during post-monsoon it varies from 0.64- 22.46 m. The depth to water level lies within 5 – 20 m below the land surface in most parts of the district. It rests between 2 to 25m deep on the eastern side and 2 to 10m in the northwestern parts of the district. Only in small patches in the Rai block, the water table is deeper having a range of 20m to 40m. Water table elevations range from 230 to 220m amsl and the general ground water flow is from northwest to southeast. In general, the water table has declined all over the district over the past decade. During the past decade, the district has recorded a fall of less than 1m to 7m. The decline was 2 to 4m in most parts of the district. Long-term water level fluctuations indicate the rise of water level over the last decade in Mundlana, Kathura, K Harkhoda and Rari blocks. The trend of rise of water level is in the range of 0.05 to 0.32m/year. The trend of decline of water level is 0.05 to 0.95m/year. Central Ground Water Board has drilled 15 wells under the groundwater exploration programme; 8 are exploratory wells, 5 are piezometers and 2 are slim holes. Out of 8 boreholes drilled for groundwater exploration, 7 were abandoned due to poor quality of groundwater or due to inadequate thickness of permeable granular zones. Granular zones exist down to 460m depth i.e. to depth explored. However, the chemical quality of groundwater is not fresh in deeper horizons in most parts of the district and shallow horizons; in some parts. In general, the quality of groundwater in shallow dug well zones is fresh in the eastern northern, and northwest parts and gradually deteriorated in the western and southwestern parts. Also, the deep zones below 150m depth contain brackish/saline groundwater. Several shallow tubewells exist in all the blocks - more in number in Sonipat, Rai and Ganaur blocks and these tap water-bearing zones in the shallow unconfined aquifer group. These tubewells yielded 300 to 600 lpm for moderate drawdowns. Detailed test drilling has established the occurrence of three distinct aquifer groups, down to 450m depth in the Upper Yamuna Basin which includes the Sonipat district. Aquifer group I which was unconfined extends from the water table down to 70m depth. A tubewell located at Khera in the eastern part of the district and tapping this aquifer group-I yielded 4540 pm for about 7.5m of drawdown. Aquifer characteristics at the Khera site were - Transmissivity: 2340m2 /day; Lateral Hydraulic conductivity - 36m/day and specific yield - 2.15 x 10-1 (21.4 -I contain fresh water in eastern parts of the district. Aquifer group II which is under semiconfined/confined state occurs in the depth range of 90 to 200m and has not been tested for its yield and aquifer characteristics since the formation water is saline. Aquifer group-III which too is under confined state occurs in the depth range of 250 to 400m and contains brackish saline ground water.

Data Sources and Methodology

Database and research methodology for a study on groundwater quality in the Sonipat district from 2015 to 2020 was prepared. Gather groundwater quality data for Sonipat district (Government of India). The primary objective of the study was to evaluate groundwater quality by examining various parameters. Data collection was executed through which provided data from 2015 to 2020. The data included parameters such as pH, Electrical Conductivity (EC), Total Hardness, Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate, Sulphate, Chloride, Fluoride, and Nitrate, resulting in the creation of a comprehensive dataset. Multiple data sources, including the Atal Bhujal portal, remote sensing, and GIS, were consolidated into a single dataset to facilitate comprehensive analysis. Spatial analysis was employed to detect trends and patterns, supported by spatial statistics. Microsoft Excel was utilized to generate graphs, charts, and tables to visually represent these trends. Interpreting the results involved comparing statistical findings with GIS and remote sensing data to identify the key factors influencing changes in groundwater quality. Visual representations, such as maps, graphs, and tables, were crafted to effectively communicate the findings. The study culminated in the compilation of a comprehensive scientific report, which included sections covering the introduction, data sources, methods, results, discussion, and conclusions. Peer review was considered to validate the scientific rigour of the study. The study is carried out in Sonepat district of Haryana, India. The study is done through secondary data. A survey of India's (SOI) topographical sheet on the 1:50,000 scale was used to prepare the base map and preparation of point map of the well location. The study area falls in the Survey of India (SOI) topo-sheets no. 53C, 53D, 53G and 53H.

Objective of the Study

- To examine the spatial analysis of Ground Water Quality in Sonipat District.

Results and Discussion

The block-wise groundwater resource potential in the district has been assessed as per GEC-97 as of March 2009. The stage of groundwater development ranges between 78% (block-Kathura) to 196% (block-Rai). The total replenished groundwater resource in the district is 774.26 mcm, of which the total existing groundwater draft, by all means, is 945.35 mcm. The net utilizable groundwater resources for future irrigation development are -173.64 MCM.

GROUND WATER RESOURCES OF SONIPAT DISTRICT, HARYANA STATE

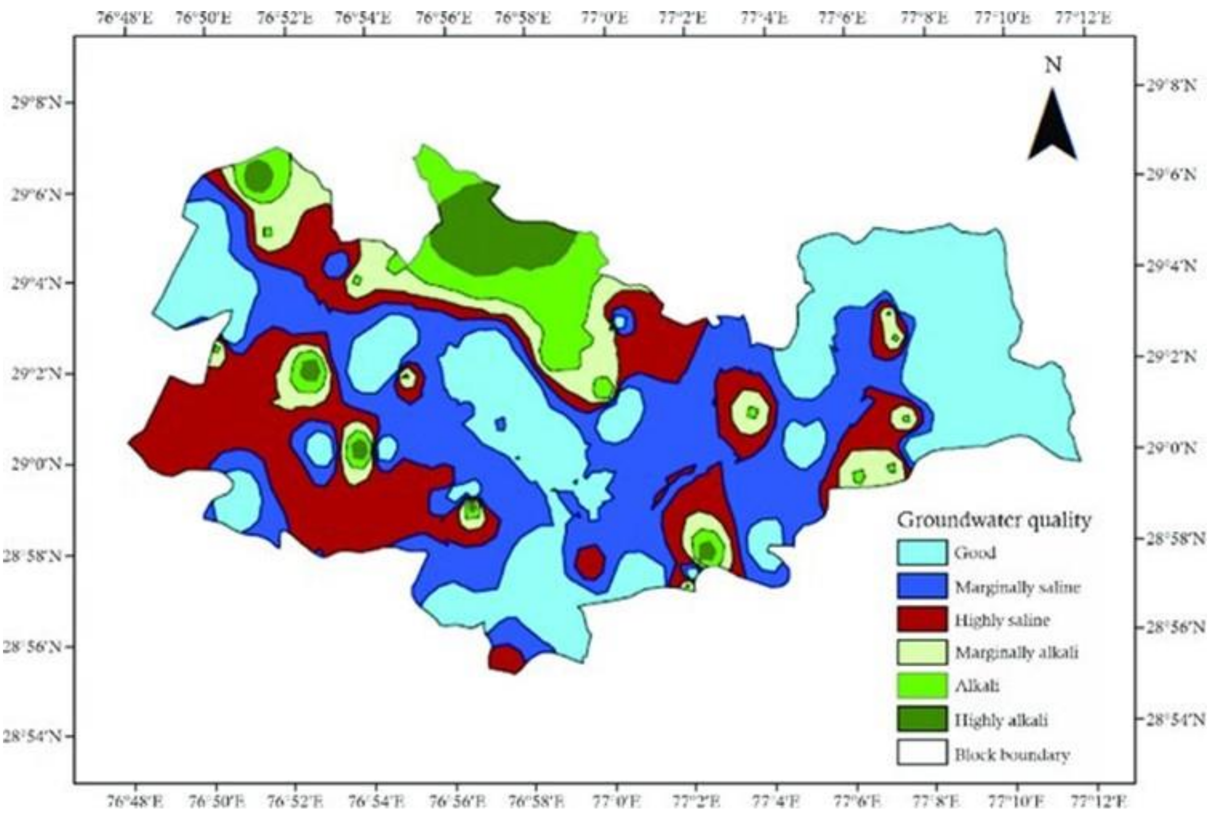
Block	Net annual ground water availability (ham)	Existing gross ground water draft for irrigation (ham)	Existing gross ground water draft for all uses (ham)	Provision for domestic & industrial requirement supply to 2025 (ham)	Net annual ground water availability for future irrigation development (ham)	Stage of ground water development (%)	catagory
Ganaur	19778	22384	23711	1327	-3933	120	OVER EXPLOITED
Gohana	7609	10183	10282	99	-2673	135	CRITICAL
Kathura	5344	4187	4193	261	896	78	SAFE
Kharkhoda	8067	11420	11541	121	-3474	143	CRITICAL
Mundlana	15751	12566	12575	9	3176	80	SAFE
Rai	7902	14472	15526	1054	-7624	196	OVER EXPLOITED
Sonepat	12975	15410	16707	1297	-3732	129	OVER EXPLOITED
Total	**77426**	**90622**	**94535**	**4168**	**-17364**	**122**	

Source: CGWB

Discharge of the tubewells increases from west to east towards river Yamuna. Good aquifers exist in the floodplain of the Yamuna River. The discharge of tubewells constructed in Mundlana, Gohana, Kathura, and Kharkoda blocks is generally up to 10 lps(86.4_m3 /day). However, in the eastern parts of the Ganaur, Sonipat and Rai blocks high discharge wells of up to 20 lbs have been reported.

Groundwater quality

The shallow groundwater of the district is generally alkaline and is moderate to highly mineralized with EC ranging from 597 to 6710μS/cm. at 250C . Groundwater occurring in the southern and N-W parts of the district is more saline as compared to groundwater occurring in the rest of the district. Among anions, either bicarbonate predominates or none of the anions dominates. Similarly, among cations, sodium predominates in 50% of the samples and the remaining calcium + magnesium combined dominates. On comparing the ionic concentration of major ions with the recommended limits prescribed by the Bureau of Indian standards for drinking water, it is found that more than half (68%) of the groundwater is not suitable for drinking purposes mainly due to salinity and fluoride contents that exceed the maximum permissible limits of these chemical parameters, which are 3000μS/cm. and 1.5mg/l respectively.



Source:

Groundwater yearbook

Possibility Of Artificial Recharge

There are a few isolated pockets located in the eastern part of the district where water levels are declining very fast. Fresh groundwater at a deeper level is being exploited by deep tubewells. Limited possibilities of artificial recharge exist in these areas during monsoon season, where excess runoff from upland areas can be utilised. Some of the drains which were constructed to drain out excess water can be utilized for artificial recharge by constructing suitable recharge structures, such as injection wells, recharge shafts etc.

Declining water levels There are certain areas in the district, which have recorded water level decline in the recent past. Since groundwater is the only source of irrigation in around 42% area of the district, groundwater aquifers are under great stress due to increased demand in irrigation and the industrial sector. Necessary remedial measures need to be taken to arrest the further decline of water levels in the areas and a suitable methodology to be adopted to recharge the aquifers. Water logging & Ground Water Salinity Parts of Kathura, Gohana, Mundlana and Kharkhoda blocks have problems with shallow water levels or water-logged areas and soil and water salinity at shallow levels. CSSRI, Karnal had taken up pilot projects in the district. One project comprised of areas in Gohana block covering 5000 ha in 5 villages viz. Bali, Revlasa, Moj, Kot wali and Lath. Another project was in Mundlana covering 50 ha area. Horizontal subsurface drainage was installed in Mundlana in years 1985, 87. Soil in the area was sandy loam having hydraulic conductivity of 0.8m/day. Horizontal drains were laid at a depth of 1.75m having variable drain spacing of 50, 67 and 84m. It was found that salinity levels at the initial stages of the project were in the range of 25,000 - 30,000 micromhos and had reduced to below 5000 micromhos after a gap of about 5 years. Similar experiments were conducted in Ishapur Kheri (58 ha) and Mehlana (41 ha) where horizontal subsurface drainage was laid.

Conclusion

Construction of shallow tubewells in areas along active flood plains of river Yamuna, which have shallow water levels can help in augmenting water supplies in the area. Areas witnessing the decline of water levels have to be demarcated and rainwater harvesting to artificial recharge measures be taken up in a big way to reduce the impact. Areas having shallow water levels and soil water salinity be improvised using subsurface drainage. Improved agricultural practices like establishing good crop stands, sowing/planting practices, material management, Irrigation water management e.g. land levelling should be implemented in the shallow water levels areas.

Local farmers and NGOs be educated in water management, conjunctive use of saline and fresh water, rainwater harvesting and artificial recharge methods.

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