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Hydrogeological Studies of Degana Block in Nagaur District of Rajasthan, India

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Abstract: ***The study area of Degana block lies in the central part of the Nagaur district of Rajasthan, India. Older alluvium is a principal source of groundwater in Degana block. Tertiary sandstone and Nagaur sandstone are other important aquifers occur in Degana block. Groundwater quality and depth of water varies considerably in Degana block. Excess amount of Fluoride in groundwater (>1.5 mg /lit) causes dental and skeletal fluorosis. Granites, Gneisses and Pegmatites occurs in the surrounding area are major possible source of fluoride in groundwater. Overexploitation of groundwater resources in the block has resulted in water level depletion and Groundwater recharge is limited in the study area. Therefore the study area is recommended for adoption of adequate measures for conservation and judicious management of available groundwater resources.***
Keywords: Banka Patti, Aquifer, Fluorosis, Degana and Nagaur.

I. INTRODUCTION

Nagaur district falls in central part of Rajasthan and covers an area of 1718 sq. km. and lies between 26°23′35″ to 27°42′16″ north latitude and 73°04′32″ to 75°21′39″ east longitude. The district experiences arid to semi-arid type of climate. Physiographically, the district is characterized by moderately high-degraded hills and sand dunes. Well-developed drainage is lacking and mostly the area is having internal drainage system. High concentration of fluoride in a particular belt of this district is so remarkable that people call that area as Banka Patti (Banka-distorted, Patti-belt). Nagaur district has been experiencing acute fluorosis problem for many decades.

The study area of Degana block situated in the central part of Nagaur district, has a geographical area of 1464 sq. kms. Degana block is located between latitudes 26.36’ to 27.06’ North and longitudes 73.53’ to 74.31’ East and has an average elevation of 353 meters (Figure-1).

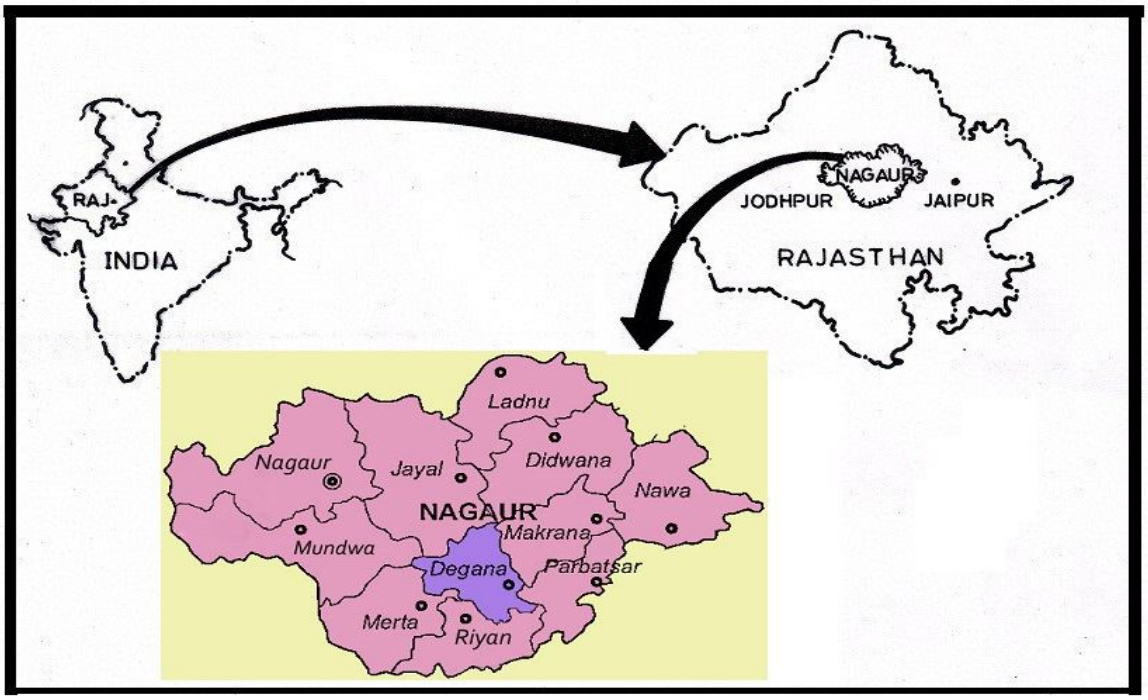

Figure-1. Location map of Degana block, Nagaur District

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A. General Geology

Geologically, Nagaur district has a wide spectrum of rock formations i.e. the Archaean basement rocks to the recent alluvial and desert sands of great Thar Desert. The Geological succession in Nagaur District is represented by the Archaean basement, Aravalli Supergroup, Middle Proterozoic Delhi Supergroup as the older sequences followed by Erinpura Granites, Malani volcanics, Marwar Supergroup and Tertiary rocks. The Aeolian sand, kankars, clays etc of Quaternary age are the youngest formations of the district (Table-1). Rocks of Marwar Supergroup, which overlies rocks of Delhi Supergroup, occupy more than 50% area of the district (Gaur and Vyas, 2007; Vyas, 2014). General geological succession of Degana block is given in Table-2.

TABLE-1. GEOLOGICAL SUCCESSION OF NAGAUR DISTRICT.

Pleistocene and Holocene Sediments		Older and younger alluvium and desert sand.
Tertiary rocks		Merta, Indawar, Mokala, Matasukh and Igyar-Kasnau Lignite
		Boulder spread
..... Unconformity.....		
Marwar Super group	Nagaur Group	Sandstones, shales and evaporites.
	Bilara/Hanseran Group	Limestones and dolomites.
	Jodhpur Group	Conglomerate, sandstones and shales.
Malani Igneous Suite		Rhyolites, tuffs, pyroclastics, and granites.
Erinpura Granite		Granitic gneisses.
Delhi Super group	Ajabgarh Group	Phyllites, biotite schists.
	Alwar Group	Conglomerate, arkose, quartzites & amphibolite
	Raialo Group	Quartzites, limestones, marbles and conglomerates
Aravalli Super group		Phyllite, schists, greywackes, carbonaceous-phyllites and mylonites.
Archaean Basement		Granitic gneisses, schists and amphibolites.

Table- 2. Geological Succession of Degana block, Nagaur district.

Recent	Recent Alluvium
Quaternary	Silts, Clays, Gravels, Pebbles, Lime kankars & Wind blown Sands.
Tertiary	Grits and Sandstone.
Post- Delhi	Granites, Pegmatites & Quartz veins.
Pre Cambrian	Quartzites, Phyllites, Schists, Carbonaceous Phyllites & Mylonites
Archaean Basement	Granitic gneisses, Schists and Amphibolites

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B. Hydrogeology

Hydrogeologically; Nagaur district can be classified into three formations viz. consolidated formation, semi-consolidated formation and unconsolidated formation. Groundwater occurs under unconfined to semi-confined conditions in rocks of Delhi Super Group, Nagaur Sandstone, Bilara Limestone and unconsolidated sediments (valley fills and alluvium). These form the chief source of groundwater in the district. Principal aquifers of Nagaur district are shown in Figure-2.

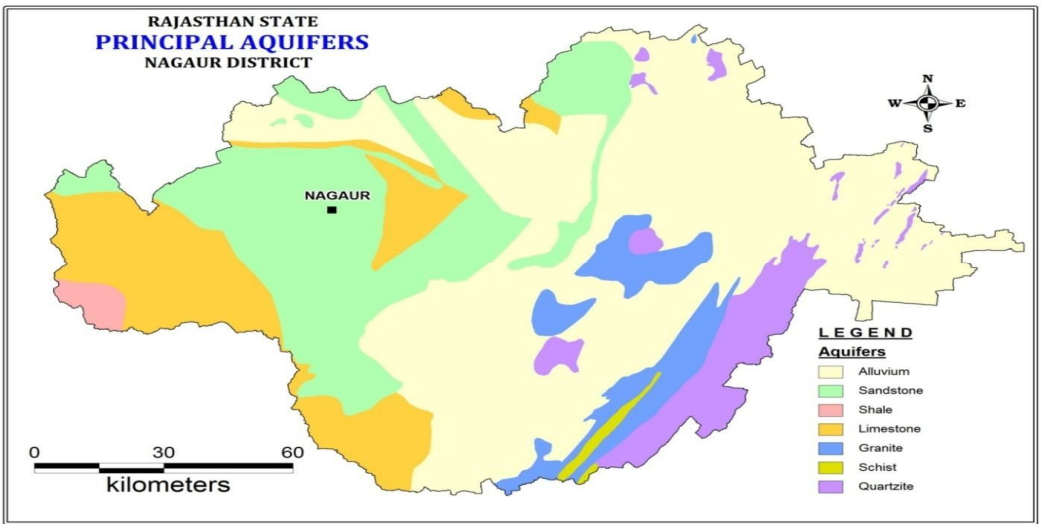

Figure-2. Principal Aquifers in Nagaur District (After CGWB, 2017)

Older alluvium, Tertiary Sandstone and Schist, Phyllites, Granite /Gneiss are hydrogeological formations demarcated in the Degana block. Groundwater generally occurs under water table conditions in alluvium and schist but semi confined to confined in sandstone due to presence of overlying argillaceous beds. Depth to water generally increases towards western part of the district. Groundwater movement is in southeast to northwest direction. During Pre-monsoon, the water levels in major part of the district varied in depth from 20 to 40 meters. Deeper water levels (>40 meters) were observed in northwestern, northeastern, western, southwestern and central parts of the district (Figure-3; CGWB, 2017).

Depth of groundwater varies considerably in the open wells of Degana block (Figure-4). In Degana block in older alluvium average depth to water is 40 meters below ground level. Yield of wells and tube wells from these aquifers varies from 36 to 540 m3/day and groundwater having electrical conductivity between 4000-8000 micro-siemens /cm. at 25° c. Average depth to water in Tertiary Sandstone is 50 meters below ground level and the yield from these resources varies from 18 to 540 m3/day. Other water bearing formation schist located in the northeast part of the Degana block, in these aquifers groundwater is available only in weathered zone and yield from these is low to moderate (Gouran and Vyas, 1998; Vyas, 2010).

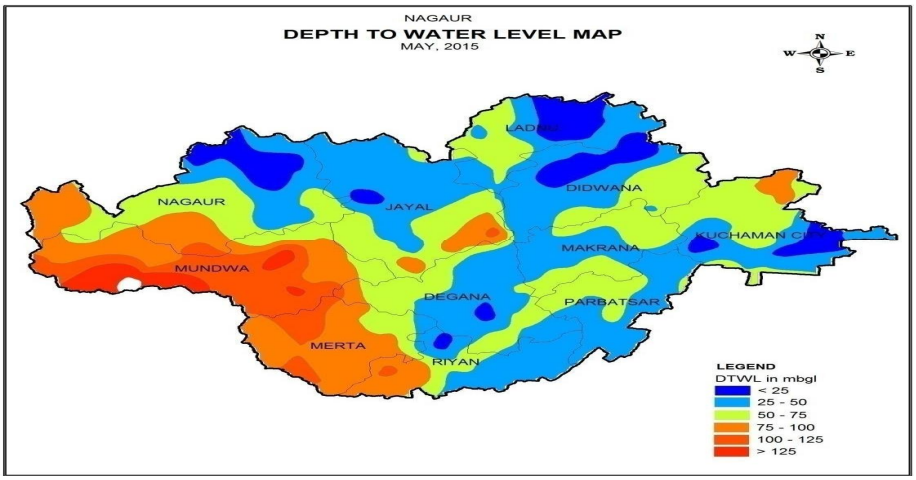

Figure-3. Water level map of Nagaur district during Pre Monsoon- 2015(after CGWB, 2017)

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Figure 4. Measuring groundwater level of open well in degana block

Groundwater level recorded in Pre and Post Monsoon seasons during 2016 and 2019 were analyzed and given in Table-3. Abnormal values recorded in Antroli Kalan and Nimbari Chandawatan villages for Pre to Post Monsoon season-2019. Water level depletion recorded in almost all key well stations except Bachhwari, Bhadwasi, Kitalsar, Nimbari Chandawatan and Thata for Pre Monsoon-2016 to Pre Monsoon-2019 seasons.

Table-3. Groundwater fluctuations in Degana block of Nagaur district for period 2016 and 2019. groundwater level values are in meters below ground level.

S.N.	Name of village	Pre-2016	Post -2016	Pre – 2019	Post – 2019	Difference between		
						Pre- 2016 to Post- 2016	Pre-2019 to Post- 2019	Pre-2016 to Pre- 2019
1	Achhojai	22.30	21.10	23.90	22.10	01.20	01.80	(-)01.60
2	Antroli Kalan	74.40	73.90	81.30	81.45	00.50	(-)00.15	(-)06.90
3	Bachhwari	47.00	46.40	44.50	42.60	00.60	01.90	02.50
4	Bhadwasi	46.90	46.40	46.80	45.90	00.50	00.90	00.10
5	Butati	73.45	72.90	76.40	76.25	00.55	00.15	(-)02.95
6	Chandaroon	26.70	26.05	29.70	26.50	00.65	03.20	(-)03.00
7	Degana	25.40	25.15	28.80	28.65	00.25	00.15	(-)03.40
8	Gunsali	46.20	45.82	50.60	49.70	00.38	00.90	(-)04.40
9	Jakhera	45.37	44.76	52.40	51.75	00.61	00.65	(-)07.03
10	Jalsu Nanak	33.80	32.55	36.25	34.70	01.25	01.55	(-)01.25
11	Kitalsar	51.50	50.30	48.20	46.80	01.20	01.40	03.30
12	Kutiyasani	38.80	38.60	42.50	40.60	00.20	01.90	(-)03.70
13	Manjhi	47.90	47.25	51.40	48.40	00.65	03.00	(-)03.50
14	Mogas	68.75	68.65	75.40	74.76	00.10	00.64	(-)06.65
15	Nimbari Chandawatan	90.92	90.10	90.60	90.85	00.82	(-)00.25	00.32
16	Nimbari Kothariyan	53.50	53.10	58.30	54.90	00.40	03.40	(-)04.80
17	Palri Kalan	36.70	36.35	38.10	34.80	00.35	03.30	(-)01.40
18	Pundlota	35.70	35.05	37.35	36.70	00.65	00.65	(-)01.65
19	Rajapura	46.60	46.10	51.70	47.70	00.50	04.00	(-)05.10
20	Rewat	35.76	35.40	40.70	36.90	00.36	03.80	(-)04.94
21	Thata	33.00	32.20	29.20	26.40	00.80	02.80	03.80

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C. Groundwater Quality Of Degana Block

To study the groundwater quality of Degana Block groundwater samples were collected from different 22 villages during Pre-monsoon - 2018 (in the month of May/June) period. Most of the Groundwater samples show concentration of fluoride, nitrate, chlorides and total dissolved solids much higher than the limit prescribed by the Bureau of Indian Standards (1992). Groundwater in block is alkaline. pH value of groundwater samples ranges from 7.5 (thata) to 8.5 (kitalsar & sanjoo). 72.72% (total 16) villages were found to have groundwater with fluoride content exceeding the prescribed permissible limit. Groundwater in 31.81% (07) villages has fluoride content ranging between 1.6 to 3.00 mg/l. About 36.36% (8) villages have fluoride in the groundwater ranging between more than 3 to more than 5.00 mg/l. Fluoride concentration ranges from 0.54 ppm (Rajod) to 6.81 ppm (Kitalsar). All types of aquifer in Nagaur district have shown a high concentration of fluoride in the groundwater (Vyas, 2015).

Nitrate concentration in groundwater within desirable limit lies only in seven villages. All other samples show nitrate in the groundwater exceeding 45 mg /litre. Over all 31.81% (07 villages) samples in the block have nitrates exceeding the emergency limit i.e.100 mg /litre. Nitrate concentration ranges from 04 ppm (AKELI-B) to 375 ppm (JAKHERA). The Bureau of Indian Standards (1992) suggested chlorides in drinking water to the extent of 250 mg/l in general and up to 1000 mg/l in emergency to be good for the human health. Chemical analysis of samples has shown that about 90.90% villages in the block have chlorides in the groundwater more than 250 mg/l. Chlorides concentration ranges from 150 ppm (Luniyas) to 4050 ppm (Chudiyas). Over all 77.27% (17 villages) samples in the block have T.D.S. in the groundwater exceeding the emergency limit i.e. 2000 mg /litre. Values of T.D.S. ranges between 485 ppm (Luniyas) to 9500 ppm (Chudiyas).

II. CONCLUSION

Six major aquifers demarcated in Nagaur district. Depth to water in these aquifers varies from 3 meters to 90 meters below ground level. Groundwater movement is in southeast to northwest direction. Arid to semi-arid climate, low, and erratic rainfall, absence of surface water resources, recurrent famines and lowering of the water table aggravates the miseries of inhabitants. In Degana block of Nagaur district the groundwater quality have quality issues. The available groundwater has impurities like fluoride, nitrate, chloride; sulphate and total dissolved solid etc. Overexploitation of groundwater in Degana block resulting in depletion of water table at alarming rate along with desaturation of aquifers and deterioration in chemical quality of groundwater. Application of remote sensing and geographic information system (GIS) should be used for better management schemes. Groundwater storage of existing depleted aquifers can be improved by adopting various suitable artificial recharge methods. Rainwater harvesting during monsoon season for drinking purposes should be promoted; which offers a good source of drinking water (Quereshi and Vyas, 2017). Canal will be the next alternative for long term solution for availability of water for irrigation, domestic and industrial purposes in the study area.

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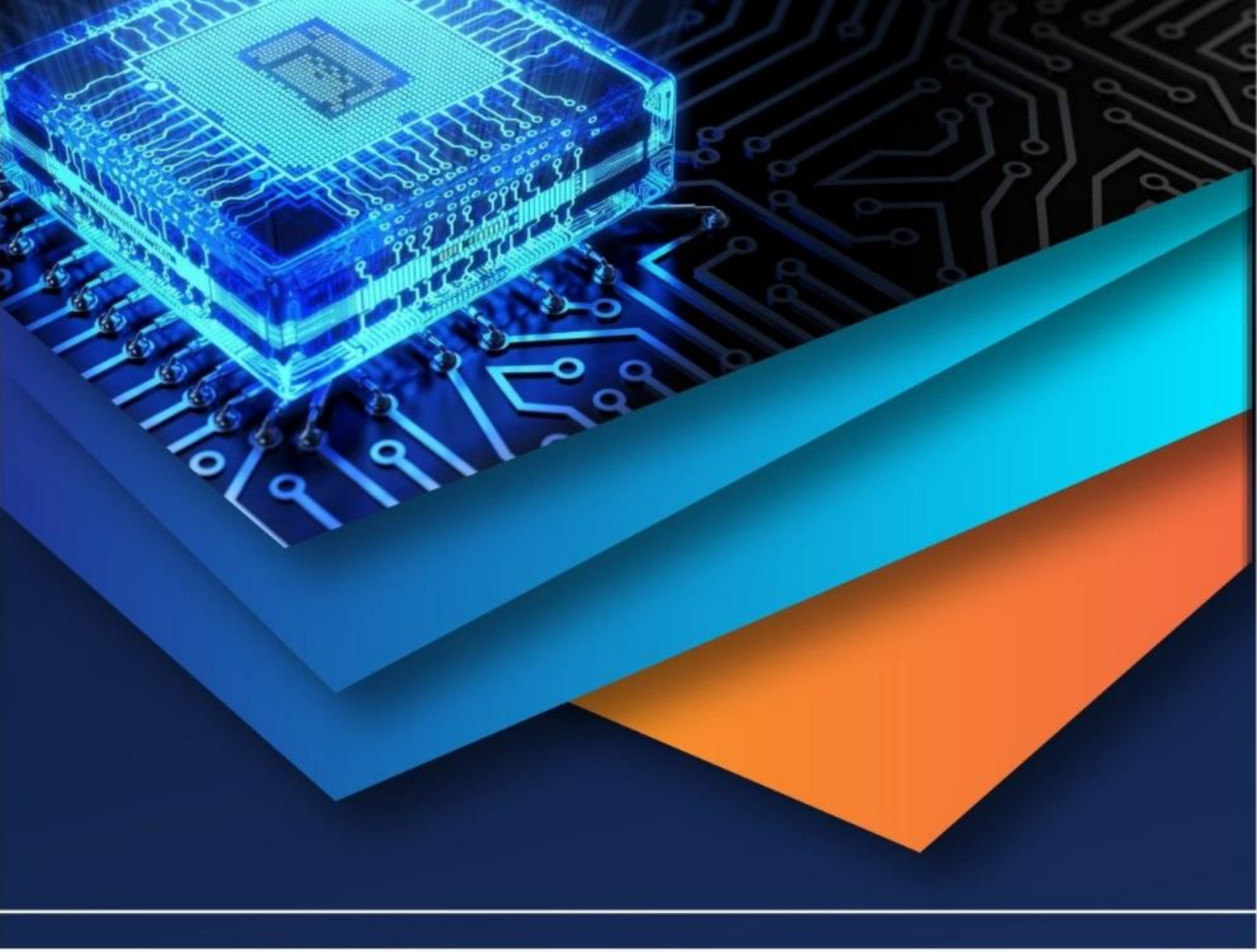

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