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PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER USING GIS AND GPS. A CASE STUDY OF SAHJANWA AND PIPRAULI BLOCK OF GORAKHPUR DISTRICT, U.P.

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Abstract - *Water is the elementary component of social and economic infrastructure and is critical for healthy society and sustainable development. Due to the immense increase in the density of population, fast urbanization, industrialization and agricultural practices, the demand of water is increasing day by day. As a result, surface water and ground water level are decreasing, pollution and increased demand have made good quality water scarce and more expensive. The possibility of ground water toxicants is due to the mixing up of toxic chemicals, fertilizers, waste disposed sites and industrial wastes. Hence, monitoring of ground water quality has become integral. In this project, ground water quality analysis was carried out for Sahjanwa and Piprauli block of Gorakhpur district. The strategically analysed results are represented in the form of map using ArcGIS 10.2.2. Drinking water samples from INDIA MARK II were collected from both the blocks of the district and were analysed for physico-chemical characteristics. The samples were collected and studied in 2019 in 21 locations across villages of both the blocks. The present study intended to calculate the certain specific water quality parameters for drinking water that is pH, Electrical Conductivity (EC), Total hardness (TH), Total dissolved solids (TDS), Nitrates (NO_3). Each parameter was compared with the standard permissible limit prescribed by BIS (IS 10500:2012). This study is carried out with the purpose of calculation of water quality status of both the blocks and demarcation of contaminated areas so that the proper corrective procedures can be taken.*

Key words- **Water Quality, Geographical Information System, Global Positioning System, Physico-chemical parameters, Inverse Distance Weighted, Spatial Distribution**

1. INTRODUCTION

Water is one of the most essential natural resources for all life on Earth, playing a major part in a country's economic development. Groundwater forms the major source of water supply for drinking, domestic, agricultural and industrial uses in India. Due to industrialization and urbanization the usage of ground water has significantly increased in those areas. It leads to over exploitation of groundwater and sea water intrusion in the coastal zones where urbanization is taking place at a faster rate. The water quality deterioration is the main cause of sea water intrusion (Karanth, 1987). Among the many factors affecting the groundwater quality, ground water interaction with earth soil and rocks is one of the important factors. The poor ground water quality affects the plant growth and human health. Urbanization, industrialization and the unregulated growth of the population have altered the landscape of many urban and peri-urban areas. Changes in land use pattern, local topography and drainage systems directly affect both quality and quantity of groundwater. Rapid urbanization has affected the groundwater quantity; over exploitation and improper waste disposal have affected the quality of water. If the quality of groundwater is once contaminated, it is not possible to restore to its original quality. Regular monitoring of groundwater is important to protect their quality from the pollution (Ramakrishnaiah , Sadashivaiah , & Ranganna , 2009).

1.1 Sources of Groundwater Pollution

The major sources of groundwater pollution are principally the same as those of soil pollution and include landfills (waste dumps), accidental spills, agriculture chemicals, septic waste, hazardous waste and atmospheric pollutants (Singh & Shukla, 2010). Dissolved pollutants move with the permeating soil water into groundwater, while organic fluid pollutants may reach the groundwater autonomously. In addition, in areas where surface water penetrates to groundwater, surface water pollution is a probable source of groundwater contamination. The groundwater is believed to be relatively much clean and free from pollution than surface water. Groundwater can become polluted naturally or because of several types of human activities; residential, municipal, commercial, industrial, and agronomic activities can all affect groundwater quality. Contamination of groundwater results in deprived drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and potential health issues. In developing countries like India around 80% of all diseases are directly related to deprived drinking water quality and unhygienic (Chaudhary, Shukla, & kumar, DECEMBER 2015).

1.2 Objectives of the Present Study

The objectives of the study are given below-

- To locate the water sample location in map with the help of Global Positioning System
- To assess the Physico-Chemical parameters of drinking water
- To create spatial distribution maps of each parameters
- To identify the stress zones in the study area

2. STUDY AREA

Pipraulí is a Block in Gorakhpur District of Uttar Pradesh State, India. It belongs to Gorakhpur Division. It is located 14 KM towards west from District headquarters Gorakhpur. It is a Block head quarter. The latitude **26°43'36.586"N** and longitude **83°16'0.081"E** are the geocoordinate of the Pipraulí.

Sahjanwa is a Block in Gorakhpur District of Uttar Pradesh State, India. It belongs to Gorakhpur Division. Total area of Sahjanwa is 346 km^2 including 319.53 km^2 rural area and 26.00 km^2 urban area. Sahjanwa has a population of 3,93,807 peoples. It is located 18 KM towards west from District headquarters Gorakhpur. The latitude **26°44'27.017"N** and longitude **83°10'49.384"E** are the geocoordinate of the Sahjanwa.

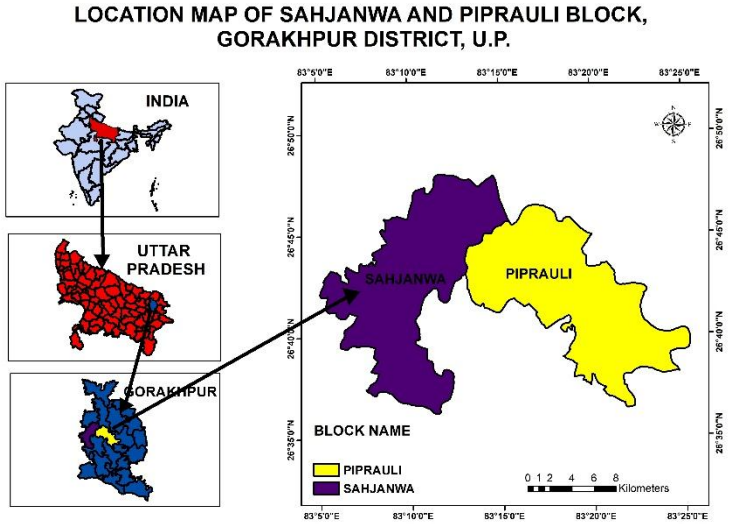

Fig -1: Study area location map

3. DATA AND SOFTWARE USED

3.1 Conventional Data Base

1. Layout Map of Sahjanwa and Piprauli block
2. Groundwater quality parameters

3.2 Instruments Used

1. GPS – Garmin
2. Water Quality Field Kit
3. UV- Visible Spectrophotometer

3.3 Software Used

1. ARC GIS 10.2.2
2. Microsoft package
3. UV Analyst Software

4. METHODOLOGY

4.1 Collection of water sample

A total of 21 ground water samples were collected from India Mark II handpump which is well distributed within both the block of Gorakhpur district. Global Positioning System (GPS) was used to locate the water sample locations and mapping of water quality was done using Inverse Distance Weighted (IDW) Interpolation technique in ArcGIS 10.2.2. Each sample was collected by 1 litre acid washed polyethylene HDPE bottle. The bottle was totally filled with water taking care that no air bubble was stuck within the water sample. Then to avoid evaporation, the double plastic caps of the bottles were sealed. Precaution was also taken to avoid sample disturbance during transfer to the laboratory. Electrical conductivity (EC) and potential of hydrogen (pH) were determined on the field itself using digital meters. Physical and Chemical parameters are analysed as per the standard method of Ground water quality prescribed in standard method for the examination of water and waste water American public health association (APHA 1995). The samples were kept at a temperature below 4°C prior to analysis in the laboratory. The location of sampling sites is shown in figure 2.

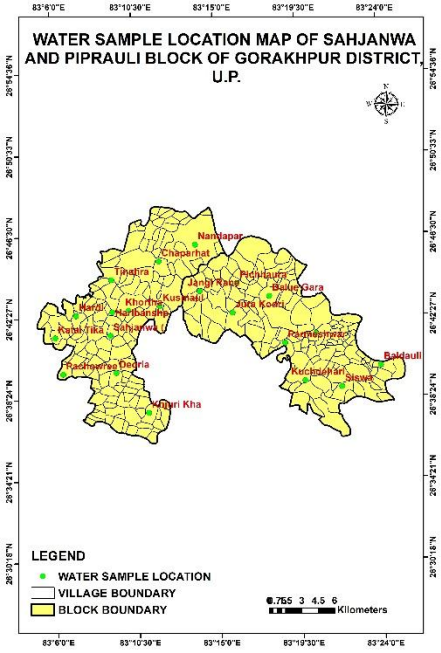

Fig -2: Water sample location map

Table 1: BIS water quality Standards (IS 10500:2012)

S.NO	Parameters	Acceptable (mg/L)	Max Allowable (mg/L)
i.	pH	6.5-8.5	No relaxation
ii.	Electrical Conductivity (µS/cm)	Not Specified	----------
iii.	Total Dissolved Solids	500	2000
iv.	Total Hardness (as $CaCO_3$)	300	600
v.	Nitrate	45	No relaxation

Table 2: Instruments used for determination of parameters

S.No.	Parameters	Instruments
i.	pH	Digital pH-meter
ii.	Electrical Conductivity (µS/cm)	Digital Conductivity-meter
iii.	Total Dissolved Solids	Digital Conductivity- meter
iv.	Total Hardness (as CaCO3)	Titrimetric method (with EDTA)
v.	Nitrate	UV-Visible Spectrophotometer

4.2 Software Used

ArcGIS is a software based on geographic information system (GIS) for working on maps and geographic data kept up by the Environmental Systems Research Institute (ESRI). It is used for creating and utilizing maps, assembling geographic data,

analysing mapped data also for sharing and finding geographic information, using maps and geographic data in a scope of uses and overseeing geographic data in a database.

4.3 Spatial Interpolation

Spatial interpolation is a process of using points with known values to estimate values at other points. Spatial Interpolation is a means of converting point data to surface data.

4.4 Inverse Distance Weighted

Inverse Distance Weighted (IDW) is a procedure for interjection that measures cell esteems by averaging the estimations of test information focuses in the territory of each planning cell. The closer a point is to the point of convergence of the cell being assessed, the more effect, or weight, it has in the averaging system.

5. RESULTS AND DISCUSSION

Ground Water Quality Parameters

The major ground water quality parameters such as,
1. pH
2. Electrical Conductivity
3. Total dissolved solids
4. Total hardness
5. Nitrate

have been estimated in 21 location throughout the Sahjanwa and Piprauli block. the statistical Parameters of ground water samples of study area are summarized in Table-3.

Table 3: Water quality analysis of the collected ground water samples

S. No.	Location	pH	EC (µs/cm)	TDS (mg/l)	TH (mg/l)	NO_3 (mg/l)	Block Name
1.	Nandapar	7.4	394	236	181	0	Piprauli
2.	Tinahra	7.4	395	237	221	0.04	Piprauli
3.	Chaparhat	7.5	353	212	154	0.11	Piprauli
4.	Pichhaura	7.4	380	228	201	0	Piprauli
5.	Balue Gara	7.4	340	204	168	0.05	Piprauli
6.	Jangl Ranee Sohas Kunwar	7.4	374	224	188	0	Piprauli
7.	Khortha	7.4	392	235	194	0.02	Piprauli
8.	Kusmaul	7.4	388	233	198	0.28	Piprauli
9.	Jura Kodri	7.6	348	209	164	0.05	Sahjanwa
10.	Hardi	7.4	375	225	191	0.1	Sahjanwa
11.	Haribanshpur	7.5	347	208	184	0.09	Sahjanwa
12.	Sahjanwa (NP)	7.7	365	219	154	0	Sahjanwa
13.	Pharsa Dan	7.6	306	184	147	0	Sahjanwa
14.	Katai Tikar Khas	7.6	502	301	208	0.65	Sahjanwa
15.	Parmeshwarpur	7.7	386	232	161	0.09	Sahjanwa
16.	Baidauli	7.7	391	235	174	0	Sahjanwa
17.	Kuchdehari	7.7	376	226	181	0	Sahjanwa
18.	Pachowree	7.5	301	181	147	0.3	Sahjanwa

19.	**Deoria**	7.4	531	319	268	0.01	Sahjanwa
20.	**Siswa**	7.6	358	215	161	0	Sahjanwa
21.	**Khjuri Khas**	7.5	379	227	181	0.09	Sahjanwa

pH: The pH values of the analysed samples ranges from 7.4 to 7.7 (Table 3) which is within the permissible limits prescribed by BIS. The ranges are classified in the spatial variation map shown in figure in 3.

EC (Electrical Conductivity): Electrical Conductivity represent the salt content of water. By analysing electrical conductivity pollution status can be ascertained. Electrical conductivity varies from 301 µS/cm at location **Pachowree** to 531 µS/cm at location **Deoria**.

Total Dissolved Solids (TDS): To determine the suitability of ground water for any purposes, it is important to classify the ground water depending upon their hydro chemical properties based on their TDS Values. The TDS values ranges from 181 to 319 mg/l (Table 3). The maximum TDS recorded in **Deoria** and minimum in **Pachowree**. Spatial distribution of Total Dissolved Solids is shown in Figure 4.

Total Hardness (TH): Hardness is the property of water which avoids lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the divalent cations (primarily calcium or magnesium salt or both). Hardness although have no health effects it can make water unsuitable for domestic and industrial use. The value of total hardness varies from 147 mg/l to 268 mg/l (Table 3). The maximum value was found in **Deoria**. Spatial distribution of Total Hardness is shown in Figure 5.

Nitrate: Groundwater comprises nitrate due to leaching of nitrate with the percolating water. It results from the added nitrogenous fertilizers, decay of dead plants and animals etc. The nitrate content in the study area varied in the range of 0.0 mg/l to 0.65 mg/l (Table 3) and found within the prescribed limit. Spatial distribution of Nitrate is shown in Figure 6.

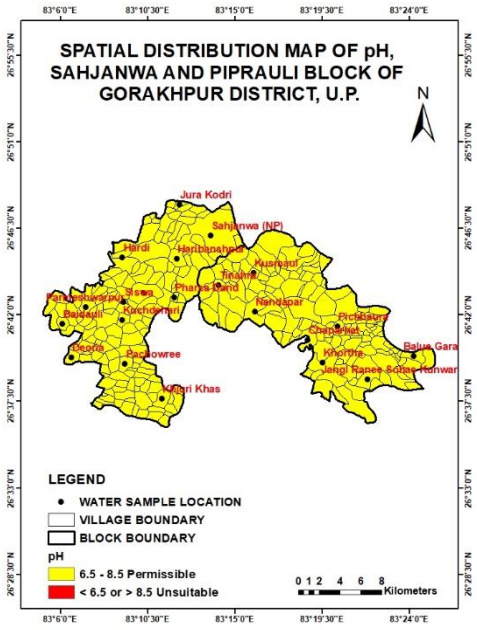

Fig- 3: Spatial distribution map of pH

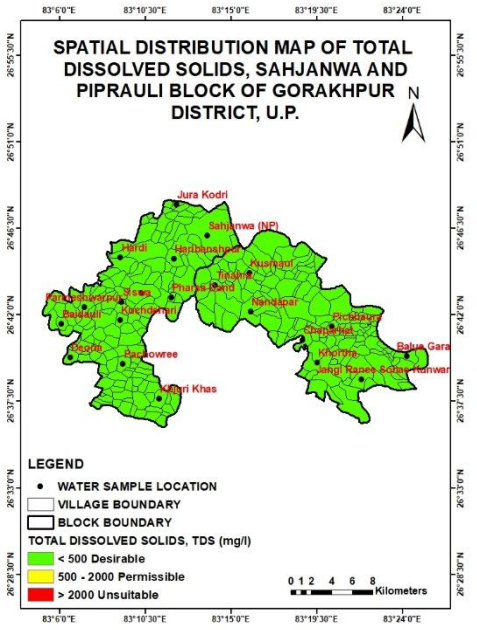

Fig- 4: Spatial distribution map of TDS

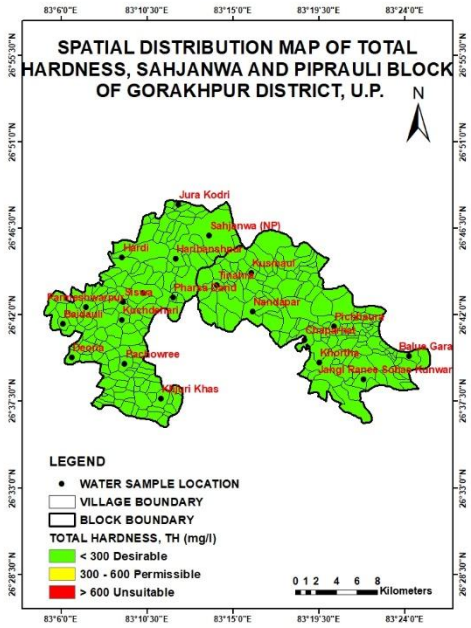

Fig- 5: Spatial distribution map of TH

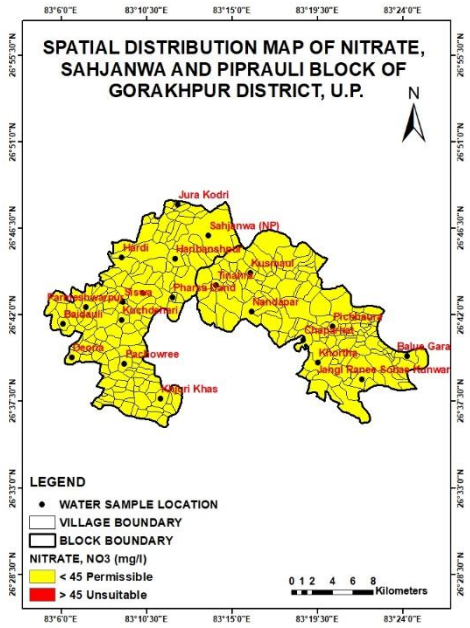

Fig- 6: Spatial distribution map of NO_3

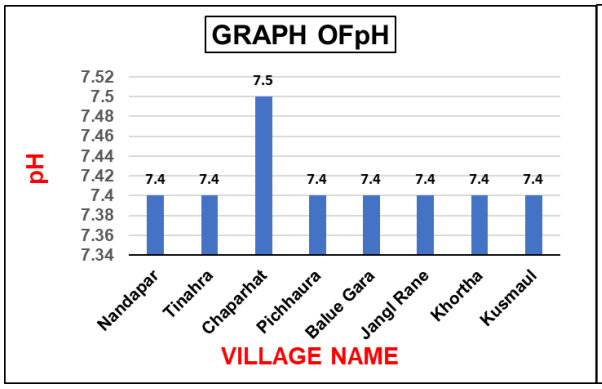

Chart -1: Variation of pH in Piprauli block

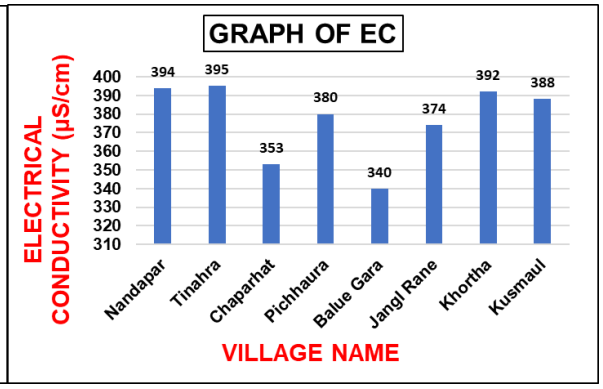

Chart -2: Variation of EC in Piprauli block

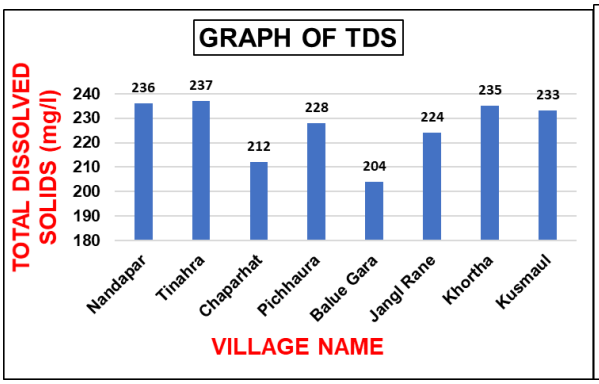

Chart -3: Variation of TDS in Piprauli block

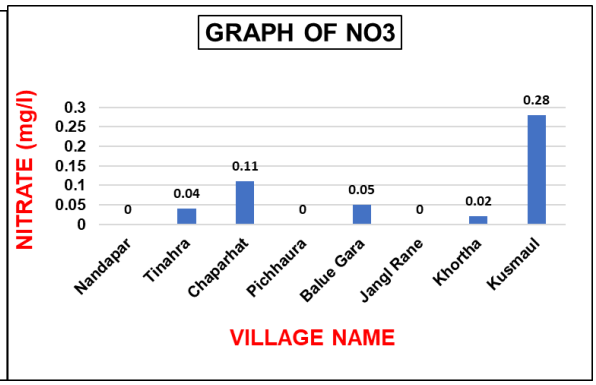

Chart -4: Variation of NO_3 in Piprauli block

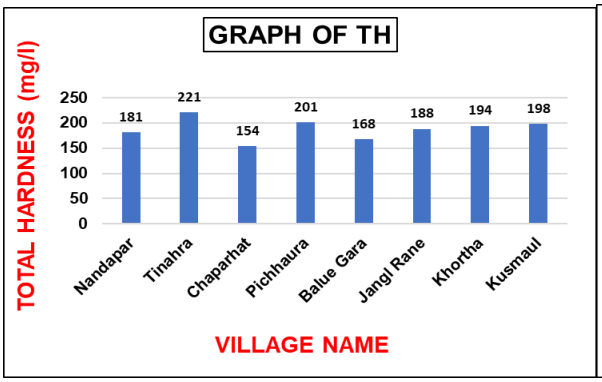

Chart -5: Variation of TH in Piprauli block

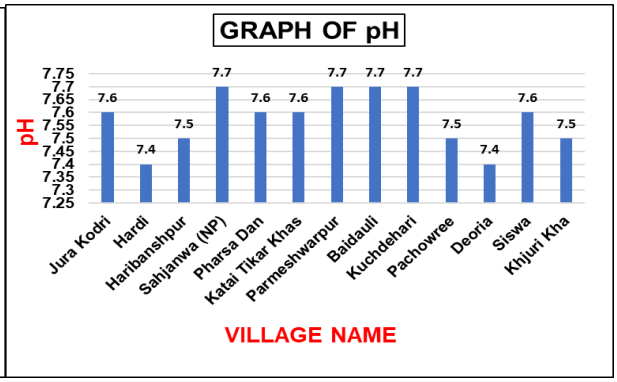

Chart -6: Variation of pH in Sahjanwa block

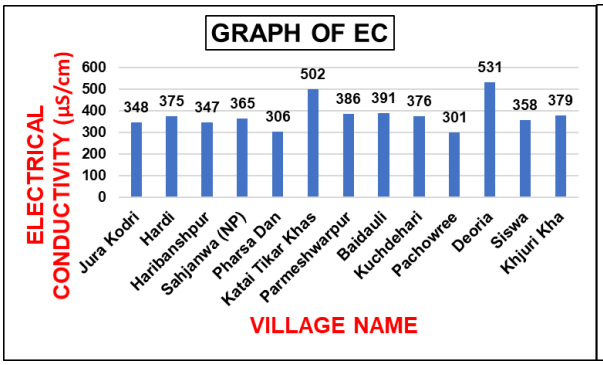

Chart -7: Variation of EC in Sahjanwa block

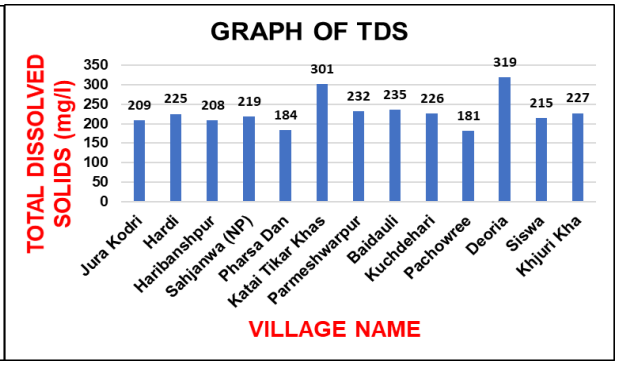

Chart -8: Variation of TDS in Sahjanwa block

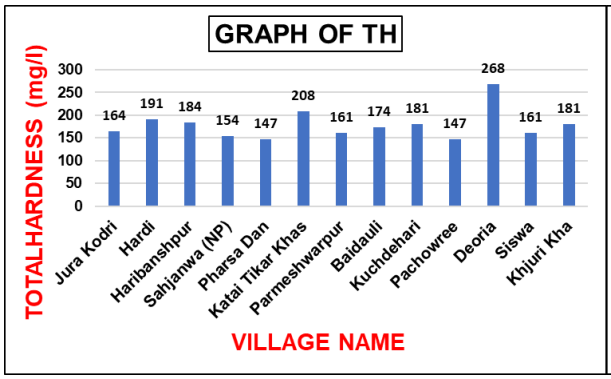

Chart -9: Variation of TH in Sahjanwa block

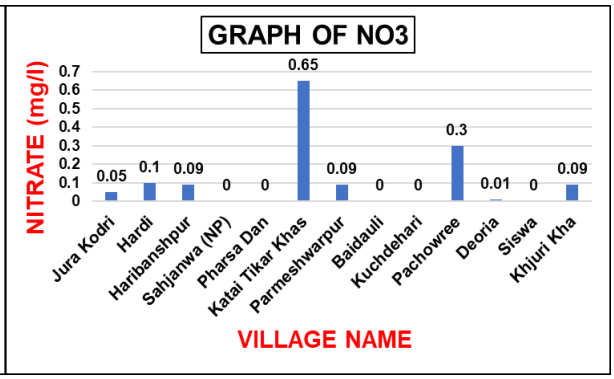

Chart -10: Variation of NO_3 in Sahjanwa block

6. CONCLUSIONS

1. The assessment of physicochemical characteristics of groundwater is done by collecting representative groundwater samples.

2. The status of ground water quality is identified in all the sample locations of the study area with respect to physical and chemical parameters using ArcGIS software.

3. In the study area, all water quality parameters (pH, electrical conductivity, total hardness, nitrate, and TDS) are within the permissible limit as per BIS (IS 10500: 2012). It is safe for human being.

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