Groundwater Modelling Using GIS Techniques: A Case Study Bagh River Watershed Area of Gondia District

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Abstracts: Geographical information systems (GIS) are the most important mapping and modeling tool for groundwater level resources in the present day. There was a challenge to define the groundwater level of A case study Bagh River watershed area pre-monsoon and post-monsoon analysis of Birsola Village, Gondia District, Maharashtra, India, is confronted with the issue of groundwater availability within a few years. To evaluate the suitability of groundwater levels using GIS interpolation model techniques, one must determine the groundwater level's suitability. Geospatial techniques working for Geographical information systems (GIS) are increasingly utilized in water resources management, hydrology, and groundwater level monitoring. This is the greatest benefit of utilizing GIS interpolation techniques. This method of study of groundwater level monitoring to generate data on water level potential position conditions in the area under study is crucial for successful analysis, prediction, and validation. The result is determined by analysis of physicochemical parameters with statistical significance and using the GIS technique for groundwater modeling.

Keywords: Geographical information systems (GIS),Groundwater Modelling, Bagh River watershed area, Physicochemical parameters

1. INTRODUCTION

Approximately 71% of Earth's surface is covered by water, while the seas contain roughly 96.5% of the planet's total water supply. About 97% of the water on Earth is saltwater, found in oceans, seas, and salty aquifers. 1.75 to 2% is found frozen in glaciers, ice, and snow; 0.5 to 0.75% is found as fresh groundwater and soil moisture; and less than 0.01% is found as surface water in lakes, marshes, and rivers, for a total of 2.5 to 2.75%. (Patle D. et.al.,2019). One of the most effective methods for evaluating the suitability of land based on the spatial variability of hydrogeological parameters has been identified as the Geographic Information System (GIS). By combining data on geologic structures, geomorphology, soil, lithology, drainage, land use, vegetation, etc., GIS provides many tools for extracting information about a region's potential groundwater supplements that continue to depend on surface water because traditional groundwater exploration is a time and resource-intensive process. The present work was carried out to investigate the impact of the groundwater quality water samples of watersheds area WGW-1/B, which is defined as Bagh River Watershed Birsola Village of Gondia district, Maharashtra, India using Statistical Study and Geographical Information System (Goitsemang et al. 2020).

2. OBJECTIVES OF THE STUDY

1. To identify qualitatively stressed and problematic study areas. Groundwater quality assessments specific areas of water quality problems.

2. To prepare GIS-based maps from the hydro-chemical study of groundwater Bagh River Watershed (WGW-1/B)

3. To establish the inter-relationship between physicochemical parameters with standard parameters using the statistical approach for groundwater.

4. The main objective of the current study is to make a groundwater quality assessment using GIS, based on the available physico-chemical data during pre-monsoon and post-monsoon seasons of the watershed area.

3. METHODOLOGY AND ANALYSIS

Analysis of the physicochemical parameters of groundwater like Temperature (T), pH, Electrical conductivity (EC), Total dissolved solids (TDS), Nitrate (NO3), Chloride (Cl-), and Fluoride (F-). The analyzed data were compared with standard values recommended by BIS and WHO.

Table 1. Data Analysis for the Parameters and Equipment, Method [6]

Sr. No.	Parameters	Equipment/ Method
1	pH/Temp/EC	pH/Temp/EC Digital meter
2	TDS	TDS meter
3	Chloride	Mohr's Method Using Titration
4	Fluoride	SPADNS Method
5	Nitrate	Spectrophotometer or Colorimeter Method

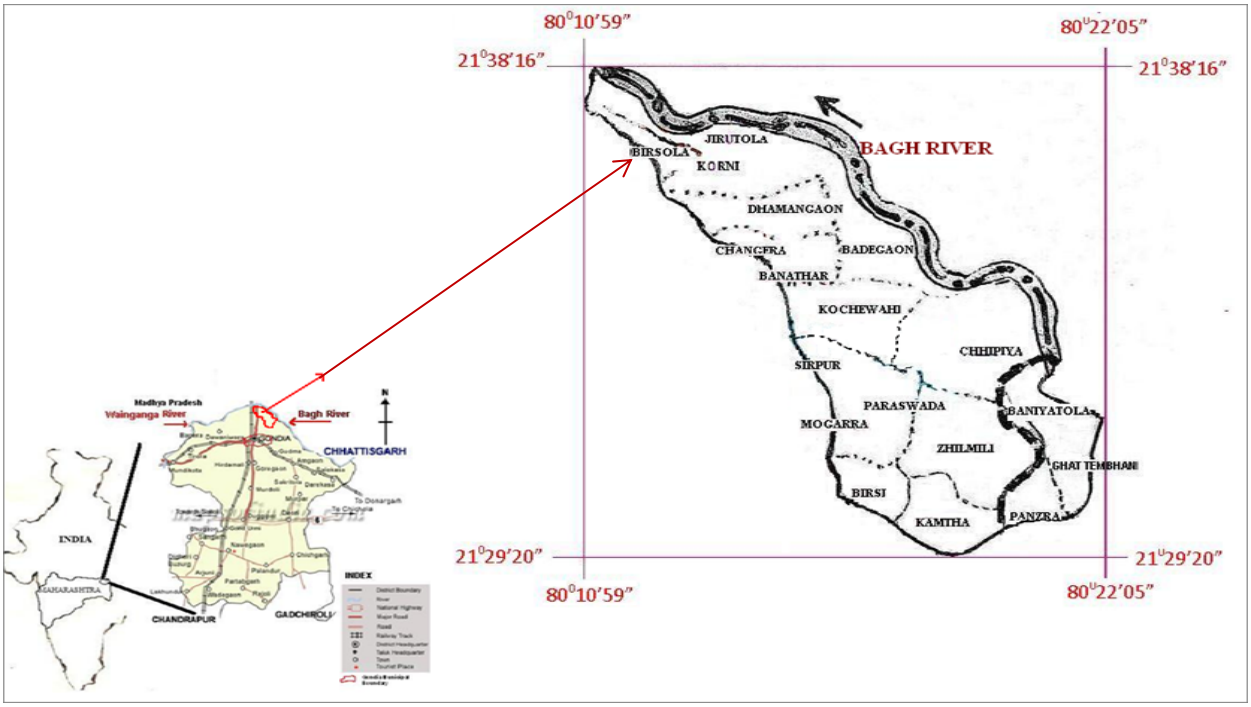

Figure 1. Birsola Village, Bagh River Watershed Gondia District

3.1. A Case Study Area

The Groundwater samples from Birsola Village of Bagh River Watershed (WGW-1/B), Gondia District have been collected systematically for both seasons (pre-monsoon & post-monsoon) in figure 1. For the drinking water samples, the samples were collected from different utilization perspective areas like the main market, residential areas & schools of the villages. Samples were collected from the study area by grab sampling method. Some of the parameters like Temperature, pH, TDS, and Conductivity, of the samples were done onsite with the help of multi-parameter analyzer by Eutech Cyberscan 660. For further examination, samples were gathered in 1-liter polyethylene bottles and kept in the lab at 40°C. Utilising APHA guidelines, a laboratory chemical analysis was performed. Double distilled water was utilised to make the solutions, and AR grade reagents were used for the analysis. To determine the correlation between any two examined parameters, analysis has been done.

4. RESULTS

4.1. Result of Physicochemical Analysis

The results of analysis data of physicochemical parameters and GIS modeling. A statistical study has been done for the average values of parameter and GIS mapping have been studied for Birsola Village. All the parameters are compared with water quality standards suggested by ICMR, BIS10500:2012, and WHO. The samples from Birsola Village, Bagh River Watershed has been analyzed for physicochemical parameter during premonsoon and post-monsoon seasons.

Table 2: Premonsoon and Postmonsoon Analysis of Birsola Village, Bagh River Watershed Gondia District

POST-MONSOON ANALYSIS								
Sr. No.	**Source Type**	**Location**	**Physicochemical Parameters**					
			pH	**Temp**	**NO3**	**TDS**	**EC**	**Cl**	**F**
1	Hand Pump	Opp. H/o Gobraya Devdhari	7.1	25	107	906	1416	216	0.223
2	Hand Pump	Opp. H/o Mauji Ganfase	7	26	109	916	1431	212	0.22
3	Open Well	Opp. H/o Rupelal Devadhari	7.4	27	108	892	1394	211	0.214
4	Open Well	Opp. H/o Dashru Bahe	7.4	27	110	871	1361	209	0.216
5	Open Well	Opp. H/o Lakhan Matre	7.3	27	89	893	1395	218	0.195
6	Open Well	Opp. H/o Haridas Bangade	7.1	26	99	891	1392	211	0.205
7	Open Well	Near H/o Kanaya Pache	7.2	26	111	915	1430	222	0.22
Total			**50.5**		**733**	**6284**	**9819**	**1499**	**1.493**
Average			**7.214**		**104.71**	**897.71**	**1402.71**	**214.14**	**0.213**
PRE-MONSOON ANALYSIS								
Sr. No.	**Source Type**	**Location**	**Physicochemical Parameters**					
			pH	**Temp**	**NO3**	**TDS**	**EC**	**Cl**	**F**
1	Hand Pump	Opp. H/o Gobraya Devdhari	7.23	26	8.29	230	759	226	0.534
2	Hand Pump	Opp. H/o Mauji Ganfase	7.17	26	5.93	203	755	74	0.479
3	Open Well	Opp. H/o Rupelal Devadhari	7.03	28	38.04	382	763	51	0.304
4	Open Well	Opp. H/o Dashru Bahe	7.32	27	35.42	401	756	87	0.428
5	Open Well	Opp. H/o Lakhan Matre	6.71	29	42.85	44	766	186	0.299
6	Open Well	Opp. H/o Haridas Bangade	6.96	25	40.19	327	763	194	0.345
7	Open Well	Near H/o Kanaya Pache	7.25	28	35.2	281	897	95	0.294
Total			**49.67**		**205.92**	**1868**	**5459**	**913**	**2.683**
Average			**7.096**		**29.42**	**266.8571**	**779.85**	**130.43**	**0.384**

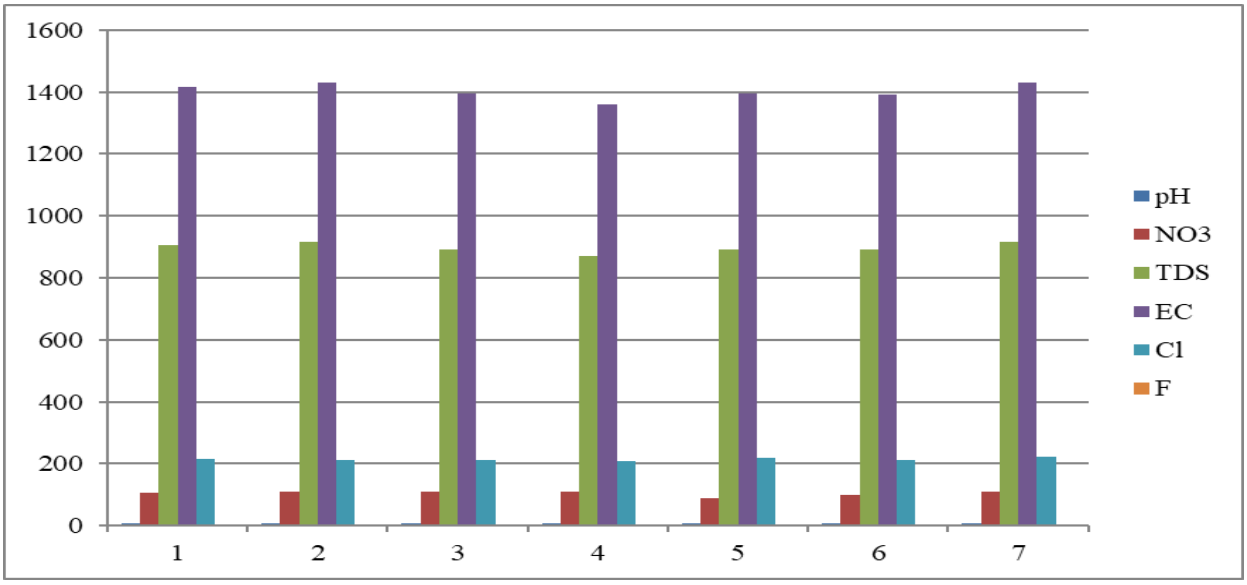

Figure 2. Analysis of Postmonsoon Graphical Representation of Birsola Village

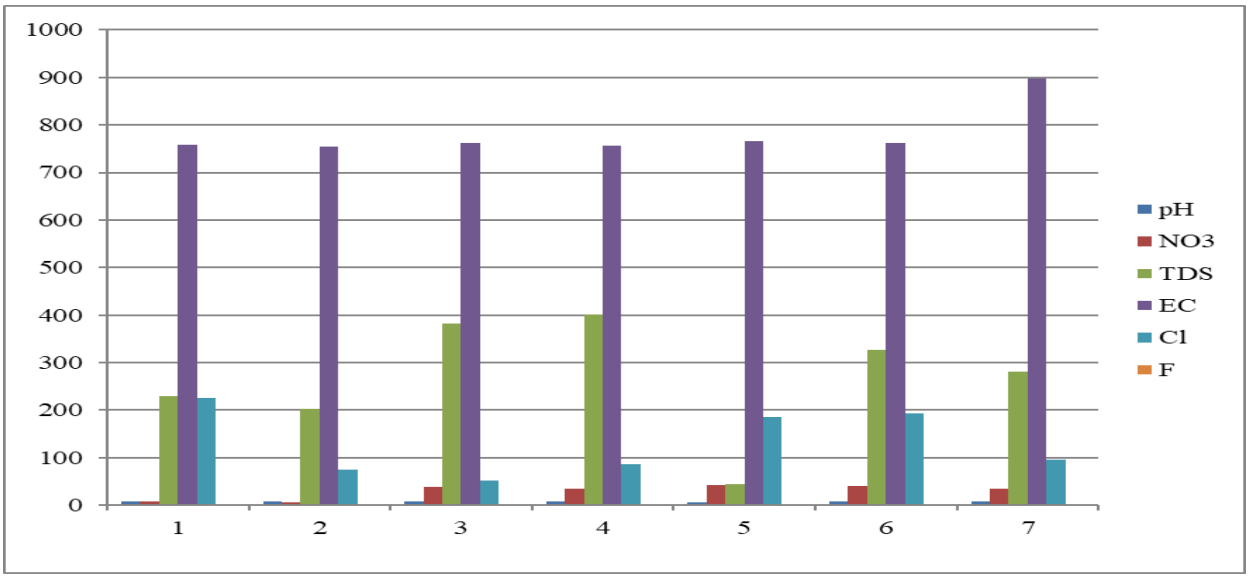

Figure 3. Analysis of Premonsoon Graphical Representation of Birsola Village

Nitrate concentration of Birsola village of all 7 samples during post-monsoon and of samples 3 to 6 during premonsoon are found above the ICMR, BIS, and WHO desirable limits. TDS concentrations of all samples are above the ICMR desirable limit and BIS permissible limit during post-monsoon whereas it is within the limits during premonsoon. Other parameters of Birsola village are within the limits during premonsoon and post-monsoon as shown in Figure 2, Figure 3, and Table 2.

4.2. Result of Statistical Analysis of GIS Mapping

1. pH- In the present study, it was observed that the average concentration of pH samples during premonsoon season was observed as potable water with desirable limits except 5% (5.03 km^2), and during postmonsoon average pH was observed within the desirable limit except for 0.74% (0.75km^2) area of Birsola Village with potable water with permissible limit shown in Figure 4.

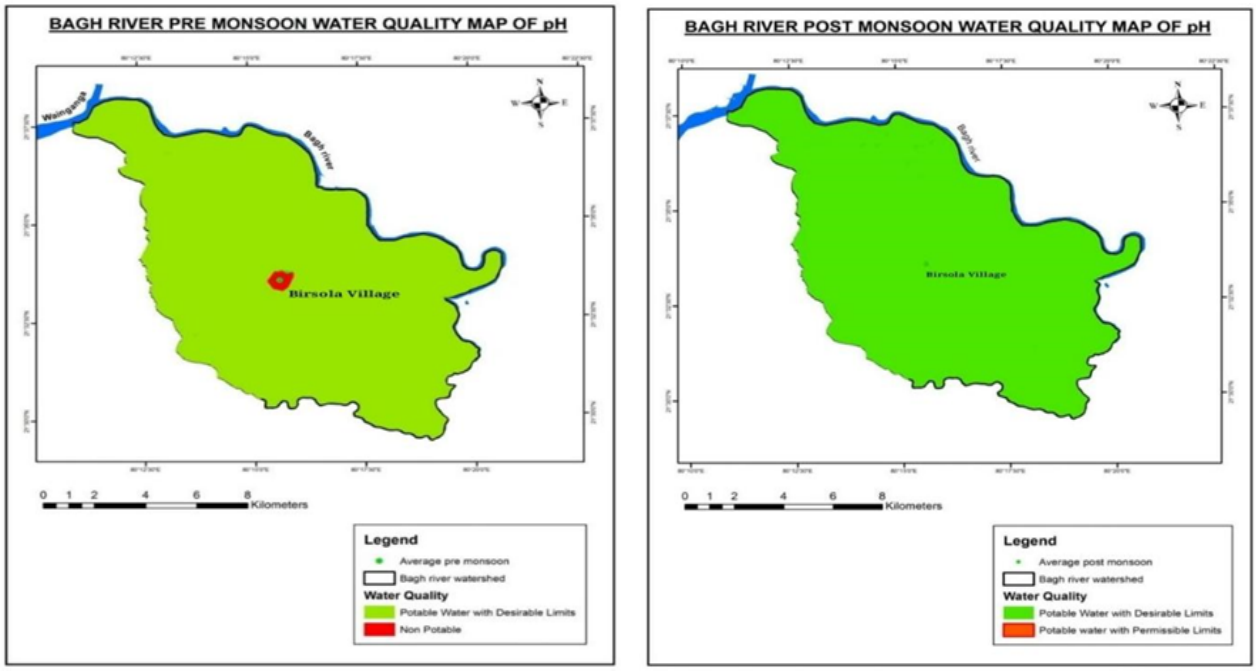

Figure 4: Premonsoon and Postmonsoon Spatial Distribution of Average pH of BRW area, Birsola Village

2. Electrical Conductivity (EC)- Electrical Conductivity in BRW Birsola Village was obtained of the average concentration of EC was found in BRW area during premonsoon in 32% (32.24km^2) with non-potable water and remaining 68% (68.52 km^2) with desirable limit and whereas during postmonsoon it was found with desirable and permissible limits in 26.5% (26.7km^2) area and 73.5% (74.06km^2) area as shown in Figure 5.

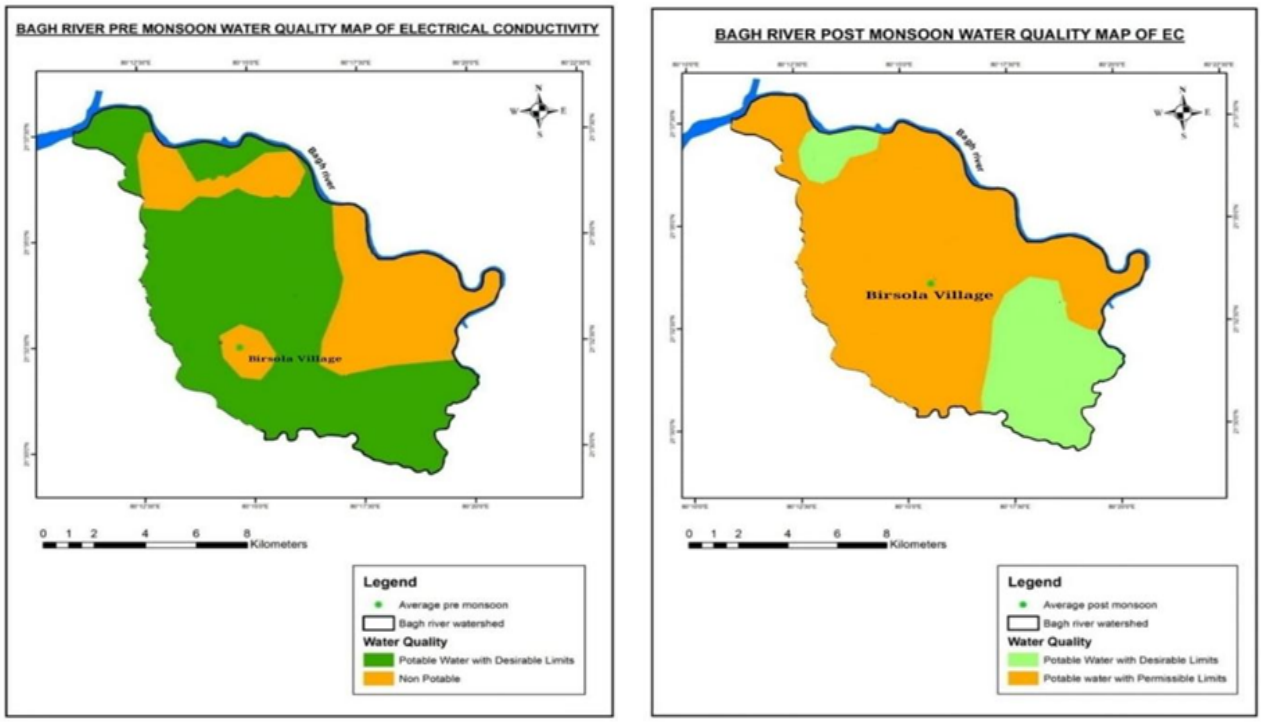

Figure 5. Premonsoon and Postmonsoon Spatial Distribution of Average EC of BRW area, Birsola Village

3. Total Dissolved Solids (TDS)- The average concentration of TDS in the BRW area during premonsoon was found in 61% (61.46km^2) area with desirable limit 39% (39.3km^2) area with permissible limit and during postmonsoon it was observed that entire area was having potable water with permissible limit except for Birsola Village which was having potable water with desirable limit as shown in Figure 6.

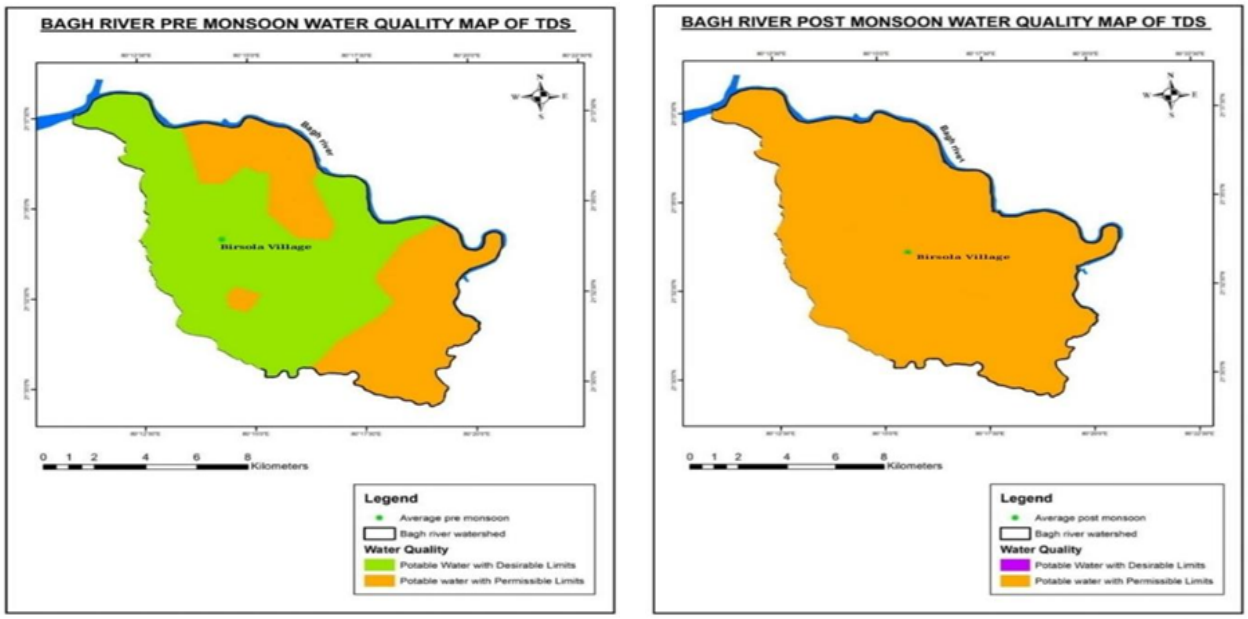

Figure 6. Premonsoon and Postmonsoon Spatial Distribution of Average TDS of BRW area, Birsola Village

4. Nitrate- The average concentration of TDS in the BRW area, Birsola Village during premonsoon was found as potable water with desirable limits in 100% (100.76km^2) area whereas during postmonsoon same area was having non-potable water as shown in Figure 7.

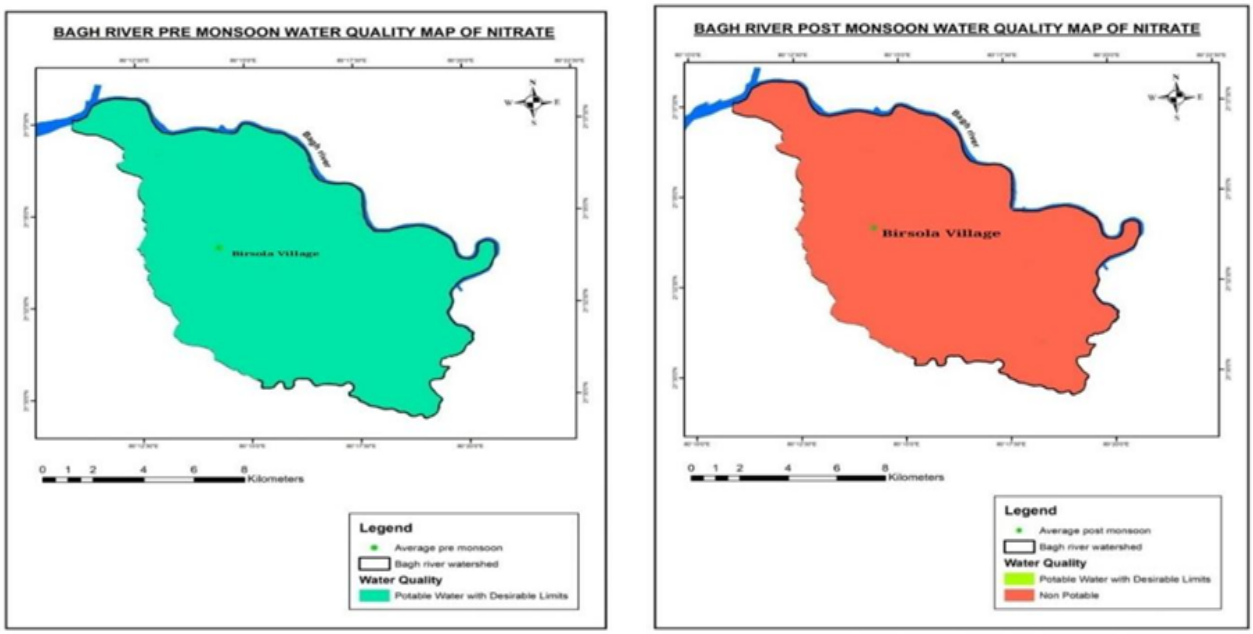

Figure 7. Premonsoon and Postmonsoon Spatial Distribution of Average NO_3 of BRW area, Birsola Village

5. Chloride- The average chloride concentration in the area was observed in desirable limits during the premonsoon season and post-monsoon was observed in desirable limits except in the 4.09% (4.13km^2) area of Birsola village as shown in Figure 8.

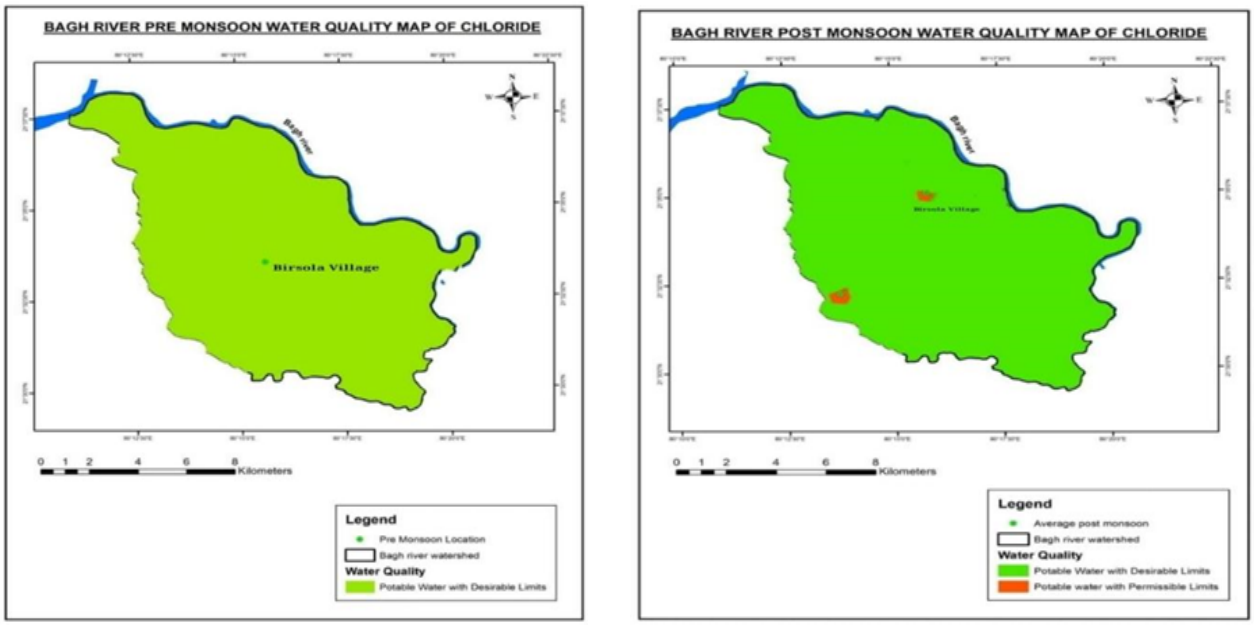

Figure 8. Premonsoon and Postmonsoon Spatial Distribution of Average Chloride of BRW area, Birsola Village

6. Fluoride- The average fluoride concentration in the area was observed within desirable limits during the premonsoon area and postmonsoon it was found within desirable limits except for 1.58 % (1.6km^2) area of Birsola Village with permissible limit as well as with non-potable zone as shown in Figure 9.

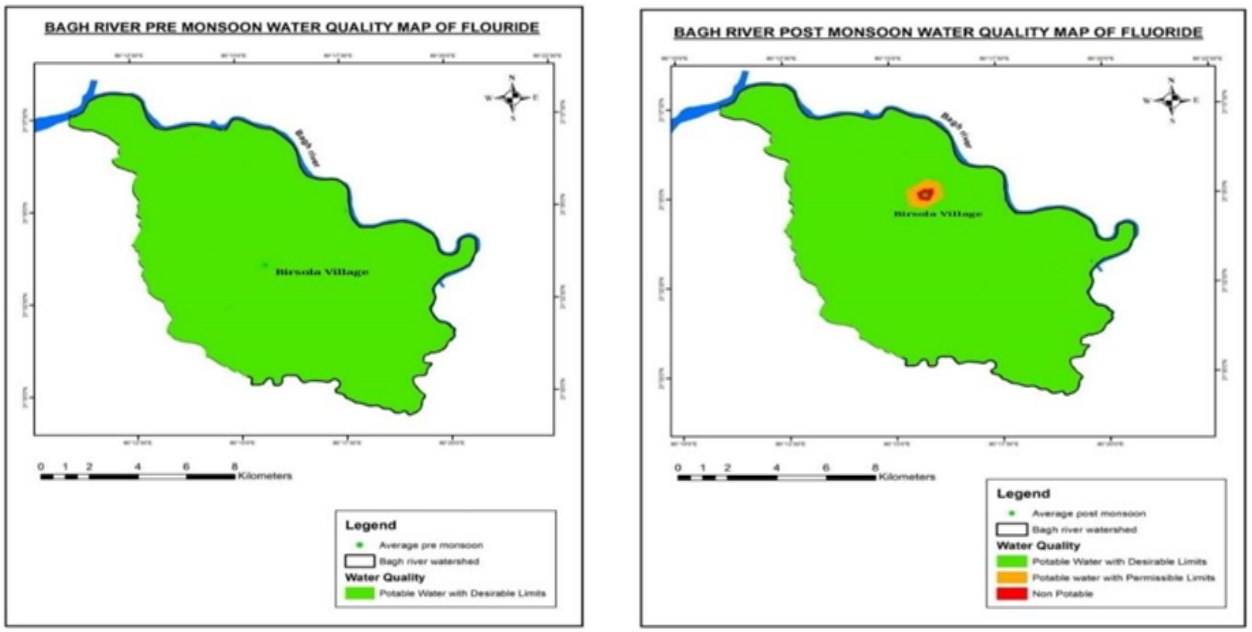

Figure 9. Premonsoon and Postmonsoon Spatial Distribution of Average Fluoride of BRW area, Birsola Village

5. CONCLUSIONS

1. The physicochemical parameters such as pH, TDS EC Cl, and F are well within the permissible limits for the BRW area Birsola Village.

2. Due to the buffering effect of carbon dioxide in water, the pH of the water typically varies only slightly. both seasons in the BRW area whereas the average pH values of 1.32% exceed the desirable limits.

3. The average concentration of EC is found 5.84% during premonsoon and 5.75% during postmonsoon exceeds the limits prescribed by BIS.

4. In the BRW region, the percentage of drinking rural water wells and pumps that exceed WHO criteria for total dissolved solids (TDS) is around 24.49% during the pre-monsoon season and approximately 1.95% during the post-monsoon period.

5. The average concentration of nitrate in the BRW area is found 74%, 14.27%, and 10.87% during premonsoon and 135.15%, 51.61%, and 39.3% during postmonsoon above desirable limits of ICMR, BIS, and WHO.

6. In the post-monsoon period, the concentration of Cl in 2.6% of rural water wells and pumps was more than the threshold set by the World Health Organisation. It was discovered that the concentrations of Cl in 29.1% of rural water wells and pumps were greater than the WHO limit during the pre-monsoon period, whilst BRW regions had a concentration of 10.62%.

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