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Water Quality mapping using Remote Sensing and GIS- a case study of Pampawa Watershed in Jhabua Dist, Madhya Pradesh, India

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***Abstract* - Groundwater serves as the main sources of water in the urban environment, which is used for drinking, industrial and domestic purposes and often, it is over exploited. Now these days, the groundwater is facing terrorization due to anthropogenic activities. In this study, groundwater sample collects in pre and post monsoon seasons for total 56 villages from 61 predetermined bore wells and open wells representing Pampawa Watershed in Jhabua District, Madhya Pradesh, India. The water samples analyzed for physico-chemical parameters like TDS, Chloride, Fluoride, pH, Hardness and Turbidity using standard techniques in the laboratory. Also, geographic information system-based groundwater quality mapping in the form of visually communicating contour maps was developed using ArcGIS-version 10.1 software to delineate spatial distribution in physicochemical characteristics of groundwater samples.**

***Keywords* - GIS, Groundwater, Spatial Variation, Groundwater quality etc**

I.INTRODUCTION

In India, the greater part of the populace is reliant on groundwater as the main wellspring of drinking water supply [1, 2, and 3]. The groundwater is accepted to be relatively much perfect and free from contamination than surface water. Groundwater can wind up sullied either normally or in view of various sorts of human exercises, private, metropolitan, business, modern, and rural exercises would all be able to influence groundwater quality [4, 5 and 6].

GIS is a viable instrument for groundwater quality mapping and basic for checking the natural change location. GIS has been utilized in the guide grouping of groundwater quality, in view of connecting absolute broke down solids (TDS) values with some aquifer attributes or land utilize and arrive cover [7]. Different investigations have utilized GIS as a database framework with the end goal to get ready maps of water quality as per focus estimations of various synthetic constituents.

In such investigations, GIS is used to find groundwater quality zones appropriate for various uses, for example, water system and local [8]. Babiker et al.[9] proposed a GIS-based groundwater quality record technique which incorporates distinctive accessible water quality information by ordering them numerically with respect to the WHO models. The utilization of GIS innovation has incredibly streamlined the appraisal of characteristic assets and natural concerns, including groundwater. In groundwater ponders, GIS is regularly utilized for site appropriateness investigation, overseeing site stock information, estimation of groundwater powerlessness to defilement, groundwater stream demonstrating, displaying solute transport and filtering, and incorporating groundwater quality appraisal models with spatial information to make spatial choice emotionally supportive networks [10].

A GIS-based examination was done by Barber et al. [11] to decide the effect of urbanization on groundwater quality in connection to arrive utilize changes. Nas and Berktay [12] have mapped urban groundwater quality in Koyna, Turkey, utilizing GIS. For any city, a ground water quality guide is imperative to assess the water safeness for drinking and water system purposes and furthermore as a preparatory sign.

Singh and Lawrence [13] arranged a groundwater quality guide in GIS effectively for Chennai city, Tamilnadu, India however a groundwater quality appraisal in Dhanbad area, Jharkhand, India was significantly more troublesome because of the spatial changeability of various contaminants and extensive variety of pointers that could be estimated. The present investigation endeavors to outline spatial circulation of groundwater quality parameters for Karur District utilizing GIS.

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II.PHYSIOGRAPHY OF THE STUDY AREA

The study area is Pampawa Watershed which is located in Petlawad tehsil of Jhabua district of Madhya Pradesh state, India. Pampawa Watershed located between Longitude 74°42'10.361"E to 74°55'18.536"E and Latitude 22°51'24.406"N to 23°5'17.836"N with covered an area 235 Sq/km. The study area extends from North to South covering 25.5 km and East to West covering 22.5 km with covering of Survey of India toposheets No. 46J/13,46J/9, 46I/16 and 46I/12.

Jhabua district is surrounded by the Vindhyas in the south and the Malwa plateau in the north. The topography of the district is defined by these two main features and by the valleys of Mahi, Anas and Hatni rivers that run through the district. Malwa plateau covers the northeastern part of the district, especially the eastern parts of Thandla and Petlawad Tehsil.

The plateau has an average elevation from 365 m. The plateau gently slopes towards the northeast way to the Mahi valley. The Mahi valley occupies a small area in the northeastern part of the district. Anas joins Mahi in Rajasthan in the north. Mahi, it is major tributary, Anas and other small tributaries, all drain towards the north. Hatni and its tributaries occupy the southeastern part of the district. These rivers drain towards the south in Narmada that runs along the southern boundary of the Alirajpur District.

The undulating landscape is perhaps the most distinctive feature of the topography of Jhabua. The landscape starts displaying such undulations as soon as one enters Jhabua from any direction, either by road or rail. The undulations stop suddenly and almost immediately as one leaves the boundaries of the district. At places, such undulations impart an incredible grandeur to the landscape. This undulating topography determines the water management practices and agriculture of the district.

The people of Jhabua have acquired great skill in cultivating the steep slopes. They lift small quantities of water over great heights in divers' ways. One can often see abundant green crops growing on almost impossible slopes. And, everywhere in the district, there are ploughmen driving their bullocks around slopes that would be elsewhere considered uncultivable by man or animal.Pampawa watershed comes under Malwa plateau, most of the part of study area is plain and little part of the area undulating due to different geological activities.

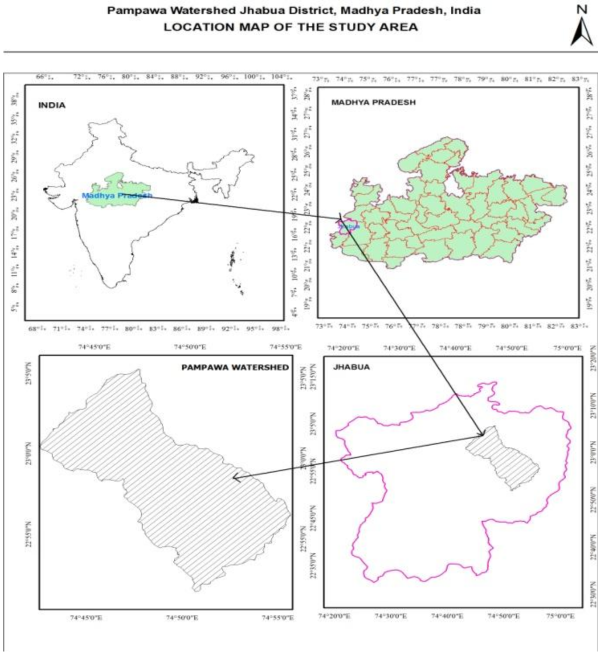

Fig.1 Location map of the study area.

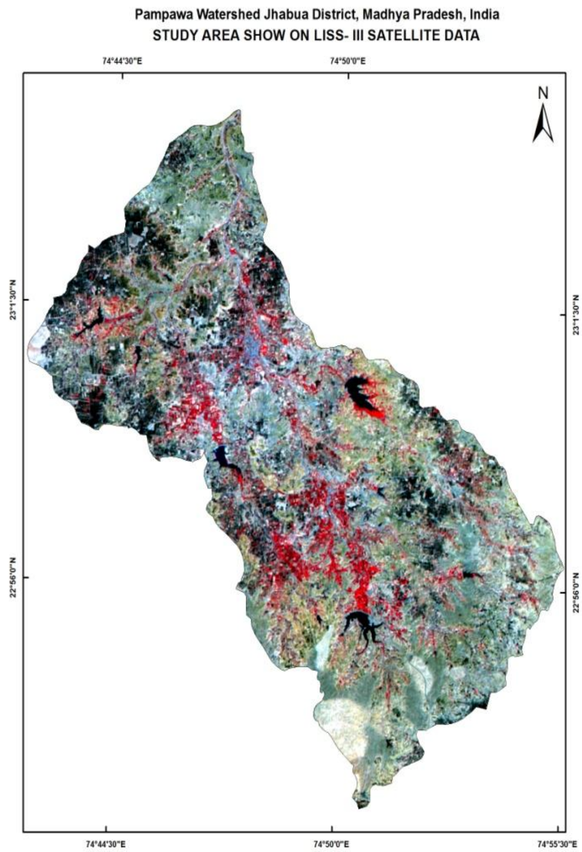

Fig.2 Study area shown on Satellite Data LISS-III.

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Table 1 Water Quality Guideline BIS Standards10500.

S. N.	Parameters	Acceptable (ppm)	Max. Allowable (ppm)
1.	Total Dissolved Solids (TDS)	500	2000
2.	Hardness (as $CaCo_3$)	300	600
3.	Chloride (as Cl)	250	1000
4.	Fluoride (as F)	1	1.5
5.	PH	6.5	8.5
6.	Turbidity	1	5

Table2 Shown below is the villages along with Their water quality parameters.

Village Name	Fluoride	Tds	Ph	Chloride	Turbidity	Hardness
Tadvi	0.78	300	7.22	104	3	108
Semliya M.V.	0.2	300	8.02	94	2	302
Semalpada	0.5	100	7.1	102	5	140
Ramgad	0.4	200	7	100	4	180
Ramgad	0.4	200	7	100	4	180
Ramgad	0.4	200	7	100	4	180
Pipalipada	0.5	300	7	156	4	208
Petlawad	1.2	300	7.92	108	4	200
Petlawad	0.2	300	8.02	94	2	302
Petlawad	0.2	100	7.62	86	1	170
Meda	0.5	200	7.52	56	1	140
Meda	0.5	200	7.52	56	1	140
Mathuriya M.V.	1	400	7.32	204	1	146
Mandir	1	100	7.42	202	4	256
Manasiya M.V.	0.5	100	7	100	2	256
Maida	1.3	100	8.02	104	2	200
Lalarundi M.V.	0.4	500	7.1	98	4	208
Kudwas	1	100	7.42	94	2	270

Jathipada	Jathipada	Jathipada	Jhuma Todi	Junwaniya M.V.	Kacharakha dan M.V.	Kachbi M.V.	Kachnariya	Kachnariya	Kalsadiya M.V.	Khedi
0.92	0.92	0.92	0.78	0.4	0.48	0.4	0.4	0.4	0.78	0.4
200	200	200	200	500	100	500	100	100	300	200
7.52	7.52	7.52	7	7	8.02	7.44	7.52	7.52	7	7.48
240	240	240	98	104	68	90	156	156	100	130
1	1	1	2	2	2	1	4	4	2	1
208	208	208	204	304	106	206	300	300	102	132

Dholikhali M.V.	Ghodathal M.V.	Govindpura	Govindpura	Gulbakhor i	Gulbakhori	Gulripada	Harijan	Hatela	Heer Ninamapad a M.V.
1.2	0.4	0.3	0.3	1.2	1.2	0.4	1	0.5	1.2
400	100	100	100	200	200	100	300	100	500
7.38	7	7.52	7.52	7.18	7.18	7.4	7.38	7	7.42
202	68	84	84	106	106	90	94	182	140
2	1	4	4	2	2	2	5	3	1
308	256	102	102	204	204	106	310	142	240

Bariya	Bariya	Bheru Pada	Bherupada	Bichli Todi	Bilwal	Bilwal	Chawariya M.V.	Chopati	Dawariya	Dhaniya Rundi
1.2	1.2	1	0.38	0.38	0.82	0.82	0.2	1	1	0.5
300	300	400	300	100	100	100	100	300	300	200
7.52	7.52	7.44	8	8	7.52	7.52	7.62	7.52	7	7
94	94	72	140	102	98	98	86	104	98	138
2	2	5	1	3	2	2	1	2	5	3
300	300	156	156	156	108	108	170	240	146	202

Alsiyakhe di M.V.	Alsiyakhe di M.V.	Amarholi M.V.	Ambapada M.V.	Amli	Amliyar	Badi Unnai	Badi Unnai	Bani M.V.	Bani M.V.	Banjakhali
0.48	1.2	1.2	0.5	1.2	1	0.5	0.5	0.82	0.82	1.3
200	100	200	400	100	100	200	200	100	100	100
7.46	7	7.1	7.98	7	7.62	7	7	7.42	7.42	7.4
100	156	98	104	70	90	96	96	140	140	102
4	2	1	4	1	2	1	1	2	2	1
204	300	186	300	300	268	208	208	126	126	216

III.RESULT AND DISCUSSION

1.Chloride - Chloride is one of the most important parameter in assessing the water quality and higher concentration of chloride indicates higher degree of organic pollution**[2]**. According BIS/ICMR the permissible limit of chloride in drinking water is 250 mg/l. spatial distribution of Chloride in the study area, was obtained due to the chloride concentration fluctuating between 56 and 240 mg/l. Pampawa watershed is comprised of 56 villages. The spatial distribution of chloride is indicated in the map below. The maximum concentration of chloride is found in Dula Khedi, Ruparel Jamli, Semalpada, Mathuria and Soila. The maximum concentration of Chloride in the study area is 240 mg/l which is less than the acceptable limit of BIS i.e. 250mg/l. Details are show about chloride distribution on figure no 3.

2.Fluoride-Ground water usually contains fluoride dissolved by geological formation. The desirable limit of Fluorides is 0.5-1.5 mg/l, beyond this limit the water is considered as poor quality. Based on these findings the spatial variation map for fluoride is presented in map no…… The maximum concentration of fluoride in the study area is 1.29 mg/l and the minimum concentration is 0.2 mg/l.

Following villages have the maximum concentration of Fluoride Rampuria, Dula khedi, Khoriya, Kodli, Jhonsar, Rupgarh,Anant Khedi, Ruparel Jamli, Amarpura, Sagadia, Kudwas, Dhanpura, Alasya Khedi,Ratamba, Mathuria, and Jamli. As the concentration of Fluoride is within the allowable limits of BIS, so the use of water is not an issue for the people, flora and fauna of the area. Details are showing about Fluoride distribution on figure no 4.

3.Hardness-Hardness in water is caused primarily by the presence of carbonates and bicarbonates of calcium and magnesium, as well as due to sulphates, chlorides and nitrates**[2]**. The acceptable allowable limit by BIS for Hardness is 300 mg/l. The maximum concentration of Hardness in the study area is 310 mg/l and the minimum concentration is 102 mg/l.

Following villages have the maximum concentration of Hardness Kachnariya, Dholikhali, Bariya, Petlawad, Kudwas, Amliyar, Barijan, Semliya, Ghodathal and Amli. High concentration of Hardness is not good for drinking and other valuable uses of water. Details are showing about Hardness distribution on figure no 4.

4.Total Dissolved Solids (TDS)-The mineral constituents dissolved in water constitute dissolved solids. The total concentration of dissolved mineral in water is a general indication of the overall suitability of water for many types of uses. The Total Dissolved Solids (TDS) is classified into four ranges (100-200 mg/l, 201-300 mg/l, 301-400 mg/l and 401- 500 mg/l). The spatial distribution map of TDS is prepared based on these ranges. More than 6 villages are having high concentration of TDS; these villages are Dula Khedi, Rupgarh, Mathuri, Kachbi, Lalrundi, Junwaniya and Hirani Namapada. Groundwater with less than 500 mg/l of dissolved solids is generally satisfactory for domestic use and for many industrial purposes. If the water with more than 1000 mg/l of dissolved solids usually gives disagreeable taste or makes the water unsuitable in other respects **[2]**. Details are showing about TDS distribution on figure no 5.

5.Turbidity- Turbidity is an optical determination of water clarity. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Suspended solids and dissolved colored material reduce water clarity by creating an opaque, hazy or muddy appearance. Turbidity measurements are often used as an indicator of water quality based on clarity and estimated total suspended solids in water. The turbidity of water is based on the amount of light scattered by particles in the water column [2].

The more particles that are present, the more light that will be scattered. As such, turbidity and total suspended solids are related. However, turbidity is not a direct measurement of the total suspended materials in water. Instead, as a measure of relative clarity, turbidity is often used to indicate changes in the total suspended solids concentration in water without providing an exact measurement of solids [3].

Turbidity unit is NTU, turbidity range from 1 to 5 NTU. Minimum of turbidity range is 1 NTU and Maximum range of 5 NTU. Concentration of turbidity in water is following villages are having more; Kardawat, Anant Khedi, Rupgarh, Petlawad, Jhonsar and Dadia**[4].**

6.PH- Ph is a measure of the hydorgen ion concentration of a solution. Solutions with a high concentration of hydrogen ions have a low Ph and solutions with a low concentrations of H+ ions have a high Ph. The Ph value distributed in study area as from 7 to 8.1, 7 value is minimum and 8.1 value is maximum. Concentration of Ph in water is following villages are having more; Bhensgubada, Petlawad, Anant Khedi, Khoria, Panash, Semli and Khachra Khadan. Pure water should have a Ph of 7.0 solutions with a Ph below 7.0 are termed acidic and solutions with a Ph above 7.0 are termed basic. These are villages having their Ph value more than 7.

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V.CONCLUSION

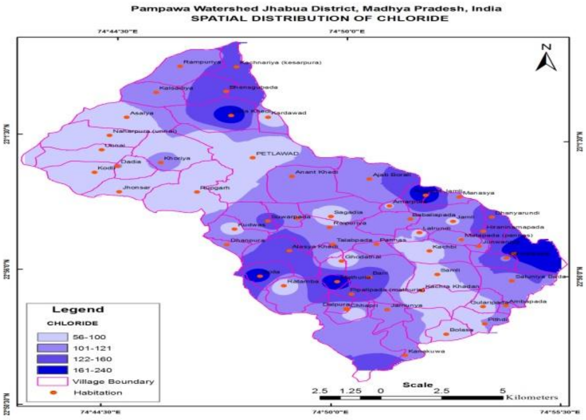

Fig.3 Spatial Distribution of Chloride.

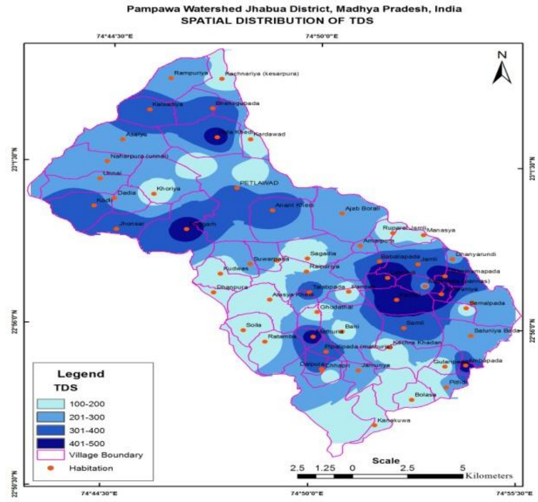

Fig.6 Spatial Distribution of TDS.

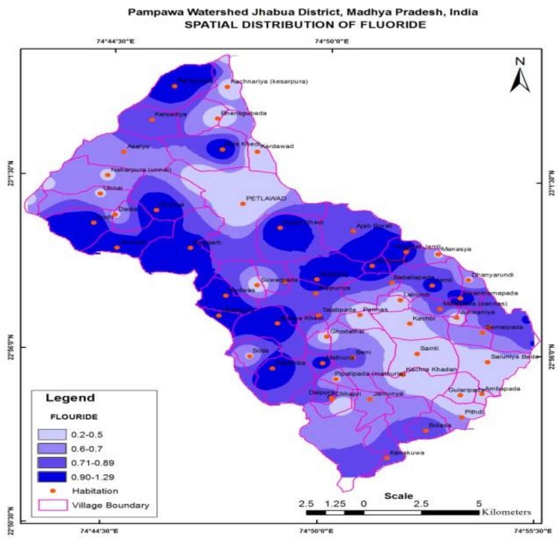

Fig.4 Spatial Distribution of Fluoride.

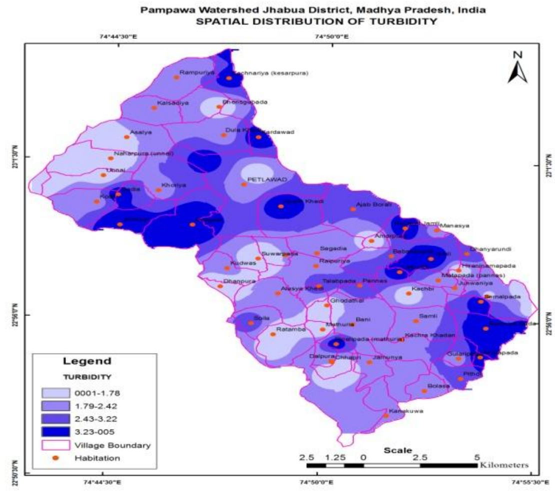

Fig.7Spatial Distribution of Turbidity

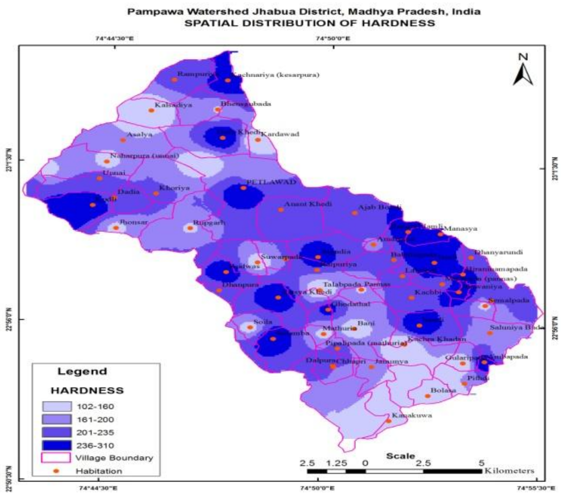

Fig.5 Spatial Distribution of Hardness.

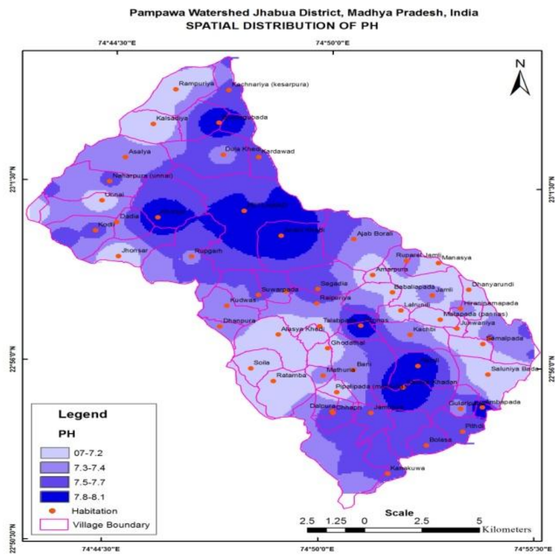

Fig.8 Spatial Distribution of pH.

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