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Analysing the Seasonal Variations of Ground Water Quality Index

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Abstract – The point of the present investigation is to evaluate the groundwater quality of Lefunga block, west Tripura locale, Tripura, for irrigation and residential purposes. Nine examples were gathered from bore wells utilized for drinking and irrigation purposes. The water tests were examined for real cations like calcium, magnesium, sodium, potassium, iron and anions like chloride, bi-carbonate and sulfate. Tests were additionally examined for arsenic and fluoride focus. The imperative constituents that impacts water quality for irrigation, for example, Electrical conductivity (EC), Total Dissolved Solids (TDS), Sodium Adsorption Ratio (SAR), Magnesium Adsorption Ratio (MAR), Soluble Sodium Percentage (SSP) and Permeability Index (PI) were resolved and contrasted and standard points of confinement. The estimations of TDS run from 29.33 - 86.00 mg/L, SAR values run from 0.04 – 0.07, MAR esteems extend from 33.56 – 53.68 and SSP go from 3.01 - 5.87. Results demonstrate that they all exist in as far as possible and in this way largely appropriate for irrigation reason. Thus, the groundwater of this region is free from saltiness danger and has no antagonistic impact on soil properties. The got diagnostic information of water tests in Lefunga block propose that the quality of water is inside the standard furthest reaches of WQI order and satisfactory for drinking purposes both in pre and post with the exception of one area having abnormal state of iron substance. Besides, the water tests additionally fall inside suggested restrains and are discovered appropriate for drinking purposes with the exception of one example having large amounts of iron and along these lines rendering it to be extremely poor for drinking purposes according to WQI grouping.

Keywords: Bicarbonate, Electrical, Fluoride, Geology, Irrigation, Sandstone, Temperature, Water, Drinking

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1. INTRODUCTION

The present examination centers on irrigational and drinking water reasonableness of Lefunga block of West Tripura locale in Tripura. Groundwater quality observing is particularly critical in territories where a sizeable piece of the populace relies upon it for standard usage. Groundwater scarcity is an ebb and flow emergency all-inclusive and, in our nation, also. The use of water from ages has prompted its over misuse combined with the developing populace alongside improved way of life because of technological advancements. Accordingly, Sullying of groundwater is not far from the shades of malice of modernization. Other than anthropogenic variables, groundwater quality is influenced due common geological and substance forms. The amount and piece of broke up minerals in common water rely on the kind of shake or soil with which it has been in contact or through which it has passed and the length it has been in contact with these rocks.

At the point when groundwater is polluted, its quality cannot be reestablished back effectively. A few waterborne diseases are spreading gradually in provincial regions. Individuals having a place with underneath neediness line are expending the debased low-quality groundwater absence of mindfulness. In creating countries like India, a noteworthy bit of transmissible diseases are actuated because of the consumption of unfortunate water5,6 . is the most vital need these days and it has been taken at most elevated needs by the different natural assurance agencies.

In creating countries, 80% of diseases are straightforwardly identified with poor drinking water and unsanitary conditions. Groundwater quality investigations give a superior understanding of conceivable changes in quality as improvement advance. Reasonableness of groundwater for local and irrigation objects is controlled by its hydrochemistry. Groundwater quality information gives critical hints to the geologic history of rocks and signs of groundwater energize, development, and capacity Groundwater quality relies upon the quantity of variables, for example, general geology, level of synthetic enduring of winning lithology, quality of revive water and contributions from sources other than water-shake interaction. Outline of groundwater zones based on quality was attempted.

Quality of groundwater may change from spot to put and from stratum to stratum. It additionally differs from season to season. The necessity of quality of water for different purposes, for example, drinking water, mechanical water and irrigation water shift broadly. Hence, a minimal report has been done in the present investigation region to shape a superior understanding with respect to the irrigational and drinking water quality.

- **Study Area**

The present study area, Lefunga block, lies in West Tripura district, Tripura, India. The block lies between 23˚52´22´´N - 23˚56´55´´N and 91˚18´ 10´´ E - 91˚25´ 49´´E**.** The Lefunga block (Study area) is composed of Recent Formation (alluvium), Dupitila Series and Tipam Group.

Alluvium stores of later or sub-ongoing waterways including silica Ghilatoli formation sand, silt and clay, and vegetation flotsam and jetsam unconsolidated, light yellow to filthy sand, silt clay with natural Formation and deteriorated vegetable issue; enormous, coarse-grained, abrasive poorly established sandstone with current bedding.

Tipam Group similarly overlies Surma Group and a ribbed sandstone unit with minor slight siltstone bands denotes the gradational contact. The transitional Bokabil-Tipam limit frequently presents issue for its demarcation. It is seen that sandstone unit towards the highest point of Bokabil Formation ordinarily demonstrates a ribbing design. The occurrence of 'ribbed sandstone unit' could characterize changes in depositional parameters and in this manner the base of Tipam Group. Mapping by Nandy and in parts of the state demonstrated that Tipam Group could be broadly separated into two formations. (a) Lower Tipam Formation: (learned at Manzu Bazar) comprising of genuinely thick unit of fine to medium grained sandstone, subarkosic sandstone, including covered layers of thick lenticular bands of sandy shale, siltstone. Moreover, sandy mudstone of brackish to fresh water shallow marine facies. The sandstone unit is medium grained, current bedded having a distinct ribbed pattern, contains boulders of calcareous concretions and coal streaks. The concretions are rounded, spheroidal and oval shaped varying from 10cms to 30cms in diameter. The outer surface of boulders has ferruginous coating but the inner portion is hard and calcareous. Reworked siltstones are closely associated with the lower part of Tipam Group.

Dupitila formation overlies Tipam Group with a rakish unconformity. A slim band of rock combination sets the contact apart. It contains white to yellowish, free, unconsolidated ferruginous sandstone with pink and yellow clay bands. The coarse-grained sandstone contains parts of quartz, quartzite, muscovite, biotite and feldspar with abundant lithic sections. Bedding is undefined because of gigantic and unconsolidated nature of sand rock. There are pockets of well-arranged, medium to coarse-grained quartz and white clay. Sandstone, from which ferruginous material has been filtered away, has framed sand pockets. Hardly any intermittent skylines of iron-covered clay stones and precise class of sandstone happen in ferruginous sand grid inside sandstone. Dainty lateritic soil topping has been recorded on the highest point of a few hills made out of the sandstone.

2. METHODOLOGY

Groundwater samples have been collected from nine locations spanning over the Lefunga block during March – May 2016 (pre monsoon period). [4] Quantitative chemical analyses treatments have been performed on the water samples to determine the concentration of the major cations and anions present in groundwater. All chemical analyses were performed using standard quantitative analysis procedures in accordance with. The parameters measured were pH, electrical conductivity (EC), total dissolved solids (TDS) were measured *in situ* using the potable HI 98130 Combo pH/ EC/ TDS/ Temperature meter by Hanna Instruments. Sodium (Na), potassium were measured using flame photometry, calcium (Ca) and magnesium (Mg) were measured complex-metrically, chloride (Cl^-) was measured following argent-metric analysis, sulphate (SO 2^-) and iron (Fe) was measured sphectophotometrically, bicarbonate ($HCO3^-$) was measured following titrimetric principles, fluoride (F^-) was measured using the Ion selective electrode, and arsenic (As) was detected using atomic absorption spectrophotometer. The quantitative analysis results have been presented in Table 1. All ionic concentrations have been measured in mg/l. For determination of irrigational and drinking water quality, certain water quality indices were calculated for each location, the values and plots of which have been presented in results and discussions.

3. RESULTS AND DISCUSSION

For assurance of irrigational water reasonableness three geochemical records – Sodium adsorption proportion, solvent sodium rate and magnesium adsorption proportion were determined for each water sample and the separate plots were attracted to decipher the quality of water. To decide drinking water reasonableness, Water quality record – where relative loads are allotted to every parameter as per their capability to render water appropriate or inadmissible for drinking has been determined for each water sample.

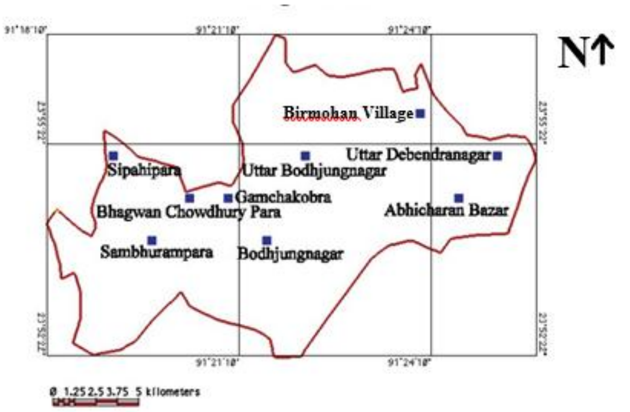

Figure 1: Study area map

Table 1: Quantitative Results

L. No.	Location Name	pH	EC	TDS	Ca	Mg	Cl-	SO4 2-	HCO3 -	F-	Na+	K+	Fe	As
L1	Uttar Bodhjungnagar	4.79	59.43	70.0	11.78	3.57	18.86	3.02	19.14	0.11	0.84	0.11	0.19	BDL
L2	Abhicharan Bazar	5.23	121.2	86.0	9.82	5.95	16.5	15.4	45.5	0.43	0.85	0.28	3.06	0.01
L3	Birmohan Village	5.10	147.29	44.67	7.85	3.97	18.87	2.18	23.92	-	0.52	0.07	0.12	BDL
L4	Uttar Debendranagar	4.36	157.01	78.0	10.47	3.97	18.87	2.97	36.67	0.31	1.02	0.35	0.57	BDL
L5	Bodhjungnagar	4.60	66.86	54.0	9.16	6.37	23.57	2.37	22.32	0.18	0.67	0.16	0.52	0.013
L6	Gamchakobra	5.01	36.52	29.33	10.47	5.55	18.86	2.66	52.62	0.17	0.78	0.19	0.11	BDL
L7	Bhagawan Chowdhury Para	4.59	35.9	34.67	7.85	3.97	18.86	2.75	20.73	0.11	0.49	0.12	0.16	BDL
L8	Sambhurampara	4.84	124.4	30.67	9.16	3.97	18.86	3.02	20.73	0.11	0.99	0.24	0.69	BDL
L9	Sipahipara	4.79	51.3	42.0	10.47	6.34	22	2.86	35.08	0.14	0.684	0.115	0.08	BDL

- **Sodium adsorption ratio (SAR)**

All out, salt concentration and likely sodium risk of the irrigation water are the two noteworthy constituents for deciding SAR. In the event that water utilized for irrigation is high in Na+ and low in Ca2+ the particle trade complex may wind up saturated with Na+ which annihilates the soil structure, because of the scattering of clay particles and lessens the plant growth. Abundance saltiness diminishes the osmotic movement of plants. Sodium rate surpassing half was taken as a notice of sodium danger. Notwithstanding, in 1954, it was suggested that the sodium rate is to be supplanted by a critical ratio named the Sodium Adsorption Ratio or SAR in light of the fact that it has an immediate connection with the adsorption of sodium by soils . This ratio is determined from the accompanying equation:

$$SAR = [Na^{+}] / \{([Ca^{2+}] + [Mg^{2+}]) / 2\}^{1/2} \ldots \quad (1)$$

Where, concentrations of the ions are expressed in meq/L.

Accordingly, the concentration of sodium, magnesium and calcium particles determination is of incredible importance for surveying the appropriateness of water for irrigation purposes. This strategy is broadly utilized now days for determining the appropriateness of irrigation waters. In this strategy, the electrical conductivity and SAR esteem for the water are first assessed and from that point, its position is situated on the standard U.S. Saltiness outline. The graph gives direct indication of the saltiness and alkalinity dangers. As indicated by this chart, the irrigation waters have been arranged into 16 distinct groups, each having explicit properties.

When plotted on the U.S. Salinity diagram each point gives the classification of the water sample based on two classifications:

- The salinity hazard is represented by C1, C2, C3, C4 classes along the X axis along which electrical conductivity is plotted.
- The exchangeable sodium accumulation in soil is represented by S1, S2, S3, S4 classes along the Y axis along which the SAR values are plotted.

As per the counts and plot, all water samples of the present examination are appropriate for irrigation w.r.t SAR qualities and fall inside the C1-S1 class. All SAR esteems have been introduced in Table 2.

- **Soluble sodium percentage (SSP)**

EC and sodium concentration are imperative in characterizing irrigation water. The salts, other than influencing the growth of the plants straightforwardly, additionally influence soil structure, penetrability and aeration, which in a roundabout way influence plant growth. Solvent Sodium Percentage (SSP) Todd was determined by the accompanying condition:

$$SSP = [(Na + K) / (Ca + Mg + Na + K)] \times 100 \ldots\ldots \quad (2)$$

Where, all the ionic concentrations are expressed in meq/L.

The SSP values have been presented in Table 2. According to the Wilcox diagram plot, all samples fall in the Very good – Good range.

- **Magnesium adsorption ratio (MAR)**

By and large Ca2+ and Mg2+ keep up a condition of equilibrium in generally groundwater. Amid equilibrium more Mg2+ in groundwater will unfavorably influence the soil quality rendering it antacid bringing about the reduction of crop yield Kumar and Paliwal had built up the accompanying condition for figuring the magnesium risk (MAR):

$$MAR = (Mg^{2+} * 100) / (Ca^{2+} + Mg^{2+}) \ldots\ldots \quad (3)$$

Where, all the ionic concentrations are expressed in meq/L.

Table 2: Analyzing the water quality indices

Location No.	Location Name	SAR	SSP	MAR	P.I.
L1	Uttar Bodhjungnagar	0.05	4.25	33.56	60.72
L2	Abhicharan Bazar	0.05	4.28	50.24	84.40
L3	Birmohan Village	0.04	3.26	45.74	83.97
L4	Uttar Debendranagar	0.07	5.87	38.72	86.32
L5	Bodhjungnagar	0.04	3.25	53.68	59.45
L6	Gamchakobra	0.05	3.78	46.91	91.10
L7	Bhagawan Chowdhury Para	0.04	3.26	45.74	78.31
L8	Sambhurampara	0.07	5.87	41.94	70.12
L9	Sipahipara	0.04	3.01	50.23	70.14

MAR categorizes groundwater into two broad classes; water having MAR < 50 is considered suitable for irrigation whereas those having MAR > 50 are considered unsuitable. According to calculations MAR values are marginally above 50 at three locations - Abhicharan bazaar, Bodhjungnagar and Sipahipara. Rest of the locations have suitable values. All MAR values have been presented in Table 2.

- **Permeability index (P.I.)**

The permeability of soil is influenced by long haul utilization of irrigation water and is affected by sodium, calcium, and magnesium and bicarbonate substance in soil. Another adjusted standard has developed dependent on the solvency of salts and the response happening in the soil arrangement from cation trade for evaluating the quality of rural waters. Soil permeability is influenced by long haul utilization of irrigation water and is affected by - (I) Total disintegrated solids, (ii) sodium substance and (iii) bicarbonate content. To join the initial three things. Has observationally built up a term called, 'Permeability Index' in the wake of leading a progression of investigations for which he has utilized an extensive number of irrigation waters fluctuating in ionic connections and concentration. The accompanying recipe gives the permeability list:

$$PI = Na^{+} + [\{(HCO^{-})^{1/2} / (Ca^{2+} + Mg^{2+} + Na^{+})\} * 100] .... (4)$$

Where, the ions are expressed in meq/L.

On plotting the P.I. values on Doneen's chartff, it very well may be seen four areas fall in Class II and four areas fall in Class III. One area falls in the marginal range. The permeability record esteems have been exhibited in Table 2.

Water quality index (WQI)

This study has been carried out in three major steps:

In the initial step the deliberate physico-concoction parameters have been doled out loads as per their relative importance in controlling drinking water quality.

In the second step, a relative weight is calculated using the following equation:

$$W_i = w_i / \sum w_i .... \quad (5)$$

Where wi is the weight assigned to each parameter and ∑wi is summation of all the weights assigned to each parameter.

In the third step a quality rating (qi) is assigned for each parameter using the following equation:

$$q_i = (C_i \times S_i) / 100......... \quad (6)$$

Where, Ci is the concentration of each chemical parameter in each water sample in mg/L, and Si is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of WHO.

Using the relative weight and quality rating scale values SI for each parameter is calculated.

Water quality Index or WQI is then calculated using the equation below:

$$SI_i = W_i \cdot q_i .... \quad (7)$$

$$WQI = \sum SI_i .... \quad (8)$$

The loads allocated to every parameter and every single important computation have been exhibited in Table 3, Water Quality Index esteems have been displayed in Table 4 and Water Quality Index order has been introduced in Table 5. The outcomes acquired have been plotted in type of a pie outline in. Arsenic is observed to be beneath perceivable breaking points at most areas and no specific WHO standard is accessible for potassium. Thus, these two parameters have been forgotten from WQI figuring's. As indicated by the outcomes, just the water sample gathered from Abhicharan bazaar has been observed to be unsuitable for drinking; most presumably because of its high iron substance.

Table 3: Relative weight of measured parameters

Parameter	WHO Standard	Weight (w_i)	Relative Weight (W_i)
pH	6.5	5	0.128205128
EC	2250	2	0.051282051
TDS	1000	4	0.102564103
Ca	200	2	0.051282051
Mg	100	2	0.051282051
Cl^-	1000	3	0.076923077
SO_4^{-2}	400	5	0.128205128
HCO^{-}_{3}	732	3	0.076923077
F^-	1.5	5	0.128205128
Na^+	200	3	0.076923077
Fe	0.3	5	0.128205128

Table 4: Water quality index values

Location Name	WQI
Uttar Bodhjungnagar	13.09953
Abhicharan Bazar	209.2634
Birmohan Village	8.311796
Uttar Debendranagar	39.07922
Bodhjungnagar	35.65273
Gamchakobra	7.641207
Bhagawan Chowdhury Para	11.04098
Sambhurampara	47.26482
Sipahipara	5.587693

Table 5: WQI classification and outcomes

WQI Value	Water Quality	Percentage of Samples
<50	Excellent	88.88
50-100	Good	0
100-200	Poor	0
200-300	Very Poor	11.11
>300	Unsuitable	0

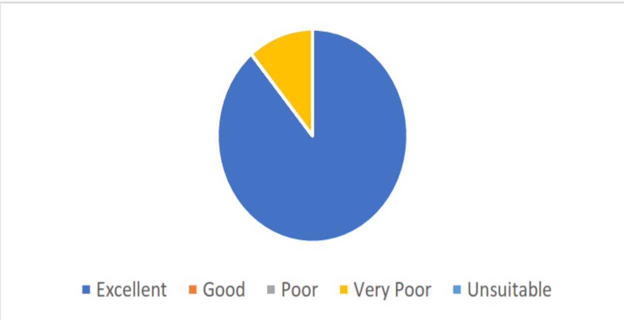

Figure 2: WQI results

4. CONCLUSION

The quality of groundwater in Lefunga Block of West Tripura District, Tripura has been contemplated for drinking and irrigational purposes utilizing some vital water quality parameters. The expository information recommends that the electrical conductivity estimations of water of Lefunga Block are well inside the WHO gauges while pH esteems are beneath the WHO principles demonstrating its acidic nature. The iron substance in water sample is inside the extreme suitable breaking point aside from in one site in pre-storm and esteem diminishes in post-rainstorm, which might be expected to revive of water assets amid storm. Largely, the quality of water of Lefunga Block is reasonable for local consumption with the exception of a couple of areas. The geochemical water quality lists uncover that the groundwater samples from ten unique areas from Lefunga block have incredible water quality Index esteems with the exception of Abhicharan Bazar area. The critical impacting water quality parameters for irrigation, for example, EC, Na%, SAR, MH, PI and KR were resolved and contrasted and standard cutoff points. The diagnostic information recommend that the groundwater quality of Lefunga Block is reasonable for irrigational utilizes, as they present neither saltiness risks nor loss of soil properties.

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