Assessment of Physico Chemical Parameters of Groundwater Quality Index of Palar Sub Basin using Remote Sensing and GIS

A.Anil, K. Chandra Sekhar Reddy, R.Bhavani

Abstract: ***The present project work is aimed toward assessing the water quality index (WQI) for the floor water of Palar Sub bowl. This technique has been picked by strategy for social affair groundwater tests and presenting the guide to an absolute physico engineered examination. The physico-engineered examination have been stood out from the extraordinary needed characteristics as empowered by technique for method for the field health relationship for ingesting and general prosperity that lets in you to possess unique a summary of this groundwater satisfactory assessment. For finding out Groundwater best in class Index following eleven parameters were thought about: pH, Totalhardness, chlorides, Dissolvedsolids, calcium, Magnesium, sulfate, Nitrate, Flouride, Alkalinity, and sodium. The Water wonderful record for the ones sampl characteristics ranges from fifty 5.85 to 191.26. The most rate of Water first rate record has been explicitly from the better estimations of normal hardness, chlorides, Dissolved solids, Magnesium and alkalinity inside the ground water. using GIS forming strategies with ArcGis 10.1 Spatial movement maps of pH, in vogue hardness, chlorides, Dissolved solids, calcium, Magnesium, sulfate, Nitrate, Flouride, Alkalinity, sodium and WQI were made. Water dumbfounding rundown changed into used to assess the suitability of groundwater from the look at an area for human confirmation. From the WQI appraisal over 90% of the water tests fall in loathsome water bearings. The examinations most likely comprehended that the groundwater of the district dreams some acknowledgment of treatment before confirmation.***

Index Terms:*Physico-chemical analysis, Water Quality Index (WQI), Geographical Information system,Spatial analysis, Palar Sub basin.*

I. INTRODUCTION

Ground water happens virtually everywhere beneath the earth surface now not in single huge spread topographical arrangement anyway in a huge quantity of nearby aquifer frameworks and compartments that have comparative characters. records of the occasion, renewal and restoration of groundwater has superb criticalness in dry and semiarid districts because of disparity in rainstorm precipitation, poor surface waters and overabundance drafting of groundwater property.. bodily modifications within the beginning and constitution of the revived water, hydrological and human variables, may additionally purpose intermittent changes in groundwater excellent. figuring out the excellent is essential earlier than its usage for distinctive cause, as an instance, drinking, agrarian, recreational and present day use.till as of overdue, floor water assessment has been founded on studies center examination, yet the method of satellite tv for pc generation and Geographical records framework (GIS) may be a very helpful tool for creating solutions for water belongings problems surveying water nice[1,2,3].

Water Quality Index (WQI) is a maximum truthful technique for differentiating specific nature of groundwater and its appropriateness for exclusive cause. Water fine Index(WQI) is spoken to as an instrument of studying that gives the composite effect of person water nice parameters on the overall nature of water for human usage. WQI is a numerical condition used to trade massive wide variety of water high-quality records right into a solitary point[5].The gauges for drinking functions as prescribed by using WHO[4,5] has been taken into consideration for the estimation of WQI. Water satisfactory list is the most considerable apparatuses to impart facts on the character of any water body. It is straightforward to comprehension of water best administration and issues via incorporating gadget records and developing a score that portrays through and big water first-class popularity.

The principle quantity of this paintings is to speak approximately the appropriateness of groundwater for human utilization dependent on processed water quality list esteems and age of GIS maps.

II. EXAMINE AREA

Chittoor District is one of the industrious dry season motivated area of rayalaseema place of Andhra Pradesh. officially the region is isolated into 3 earnings divisions that are moreover subdivided in to 66 mandals. The precept seepage bowls are Bahuda, Pincha, swarnamuki, Palar, ponnai and araniyar. Palar Sub bowl lies between north latitude 13052' to 13038' and East Longitude 79054' to 790 45' with an all out waste 703 km2(determine 1). It spread five mandals that is Chandragiri, somala, Puthalapattu.Irala and Pakala. The suggest temperature lies among to 30 ^{0}C to 42 ^{0}C. The place is underlain by rocks of Archaean, proterozoic, jurassiic-caraceous and Tertiary-Quaternary ages. The maximum hooked up shake within the territory has an area with Migmatite complex, speakme to via migmatisedquartzo-feldspar gneiss and are uncovered in the northeastern piece of the locale. greater pro metamorphiccompriseamphibolites, hornblende-powder mica-schist,fuchsit quartzite, calcsillicate shake, marble and united ferruginous quartzite. The extra pro matamorphics

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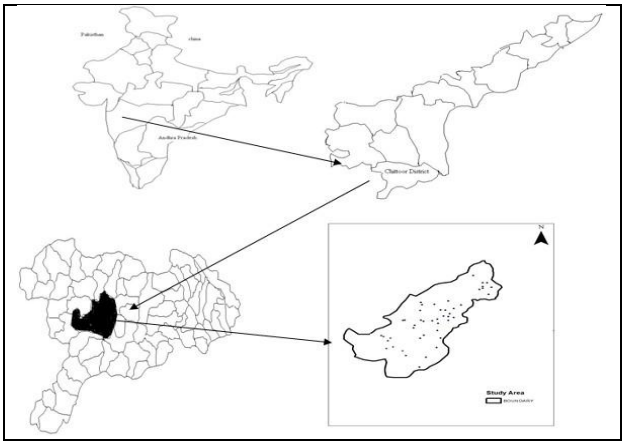
manifest as enclaves with peninsular Gneissic complex (%). The investigation territory significantly covers stone gneiss shake kind and dolerite dykes and quartz veins are to be had. There are basically styles of soils present in the bowl they're red loamy soils and move guides are secured by using darkish dust soils.



III. CHEMICAL ANALYSIS

Water tests had been amassed in July 2016 from 50 boreholes getting the significant aquifer of Palar Sub bowl. The water tests have been amassed in smooth polyethylene bottles. on the period of investigating, the containers were very well cases washed with the groundwater to be tried. inside the occasion of bore wells and hand siphons, the water tests were accumulated in the wake of guiding for 15 min. This become accomplished that lets in you to push off to groundwater set away inside the well. the majority of the groundwater test changed into inspected for 11parameters exhaustive of pH, TDS, general hardness, Magnesium, Sulfate, Nitrate, Fluoride, Alkalinity, Sodium, Chlorides, Calcium. the usage of tremendous method enabled through APHA[6].pH is picked by method for the use of pH meter. typical solids are settled through using dispersal methodology. full scale hardness, calcium, magnesium, alkalinity and chlorides are settled with the guide of titration method. Nitrate is settled with the accommodating resource of BrusinSulphonic destructive strategy and sulfates are constrained by strategies for the usage of Turbedometeric approach. Flouride is picked by techniques for SPANDS strategy. Sodium is picked by methods for Flame photometer approach. most of the water quality parameters changed into imparted in mg/l, other than pH.the cognizance of the compound appraisal have ended up being developed by techniques for figuring molecule parity botches. the mistake have been regularly round 12%. every parameter end up being conversely with the most ideal surely understood keep of that parameter stipulated for exhausting water as suggested with the supportive resource of the part health business undertaking relationship for eating up and general prosperity features. GIS evaluation: The watch is finished with the assistance of topographic sheets, ERDAS and Arcview GIS 10.1. The toposheet of the Palar Sub bowl has a 1:50,000 scale and have advanced toward getting to be digitized to the UTM encourage gadget with the guide of applying the on display screen digitizing approach the utilization of ERDAS recognize as legitimate with programming framework program. GPS is used to plot condition of each inspecting borehole; and at closing, the results of each parameter separated had been familiar with the concerned boreholes. Spatial Analyst, a widely inclusive module of ArcGIS 9.3.,modified into used to find the spatio-common lead of the groundwater first class parameters. The phenomenal topical layers on hardness, pH and ionic centers were dealt with using a spatial addition approach through Inverse Distance Weighted (IDW). This molding framework has been used inside the forefront day see to portray the locational movement of water poisons or segments.. This procedure uses a depicted or a specific course of action of model elements for estimating the yield grid adaptable cost. this can be pick the phone regards using a straightforwardly weighted aggregate of a fixed of model segments and it controls the centrality of showed up elements upon the embedded characteristics set up together totally surely as for their partition from the yield section, conveying thusly a surface lattice similarly as topical isolines [11]. Groundwater great class maps for pH, TH, EC, TDS, Cl, SO4, HCO, NO, Ca, Mg, Na and F from topical layers, set up together completely generally as for the WHO necessities for ingesting water, were made for Palar Sub Basin.

IV. ESTIMATION OF WATER QUALITY INDEX

Calculating water quality index(WQI), three steps were followed [7]. In the first start, every of the eleven parameters (pH, TDS,TH, Cl, SO4, HCO3, NO 3, Ca, Mg, Na and F) has been assigned a weight supported their impact on primary health (Table 1).

maximum weight of 5 has been assigned to parameters like overall dissolved solids, fluorides and nitrate because of their major significance in water satisfactory evaluation. Bicarbonate is given the minimum weight of two as it plays a trifling role within the water exceptional evaluation [8]. other a few parameters like calcium, magnesium, sodium(Na) and sulphate were assigned a weight among 2 and five relying on their significance inside the general nice of water for drinking functions. inside the second step, the relative weight) of each parameter is computed the use of Eq. (1):

$$Wi = wi / \sum_{i=1}^{n} wi \qquad \text{--------(1)}$$

Where, is the weight of each parameter, is the number of parameters. Weight ( ), calculated relative weight

(^{Wi}) values and the WHO standards for each parameter are given in Table 1. In the third step, quality rating scale (qi) was calculated for each parameter using Eq. (2):

$$qi = \frac{Ci}{Si} x\ 100 \qquad \text{---------(2)}$$

^{qi} is the quality rating, ^{ci} is the concentration of each chemical parameter in each water sample in mg/l and ^{si} is the WHO standard for each chemical parameter in mg/l

In WQI, the SI is first determined for each chemical parameter using Eq. (3)-which is then used to determine the WQI as per the Eq. (4):

$$SI = Wi \; x \; qi \qquad \text{------- (3)}$$

$$WQI = \sum_{i=1}^{n} SIi \qquad \text{- ------- (4)}$$

where, SIi is the sub-index of ith parameter. WQI Values are usually classified into five categories (Table 2): Excellent, good, poor, very poor and unfit for drinking[9,10].

Table 1: Status of Water Quality based on WQI

WQI Range	Status
< 50	Excellent
50-100	Good
100-200	Poor
200-300	Very Poor
>300	Unfit For Drinking

Table 2: Relative weight of chemical parameters

Chemical Parameters	WHO Standards	Weight (wi)	Relative Weight $Wi = wi / \sum wi$
pH	7.0-8.5 (8.5)	4	0.108
TH (mg/l)	100 (mg/l)	2	0.054
Cl (mg/l)	200 (mg/l)	3	0.081
TDS (mg/l)	500 (mg/l)	5	0.135
Ca (mg/l)	100 (mg/l)	2	0.054
Mg (mg/l)	30 (mg/l)	2	0.054
So3 (mg/l)	250 (mg/l)	4	0.108
Nitrate (mg/l)	50 (mg/l)	5	0.135
F (mg/l)	1 (mg/l)	5	0.135
HCo (mg/l)	100 (mg/l)	2	0.054
Na (mg/l)	200 (mg/l)	3	0.081
		$\sum wi$=37	0.999

WQI Contour Maps through GIS: GIS could be a powerful tool for developing solutions for water resources problems for assessing water quality, determining water availability, preventing flooding, understanding the natural environment, and managing water resources on area or regional scale [11]. Visiting each location in an exceedingly study space to live the peak, magnitude, or concentration of a phenomenon is usually difficult or expensive. Instead, measure the phenomenon at strategically dispersed sample locations, and foreseen values is allocated to any or all one of a kind places. The interpolation gear square measure typically divided into settled and geostatistical approaches. IDW, backbone, and fashion are deterministic, even as Ranging is a geostatistical method. The Inverse Distance Weighted (IDW) introduced up as settled interpolation approaches due to they assign values to locations supported the encompassing measured values and on such mathematical formulation that verify the smoothness of the ensuring surface. Determines the mobile values using a linearly weighted `mixture of a group of pattern factors and controls the importance of wonderful factors upon the interpolated values. Groundwater quality classification maps for pH scale, TH, TDS, Cl, SO 4, HCO3, NO3, Ca, Mg, Na and F from thematic layers, supported the World Health Organization Standards for drinking water, have been created for Palar Sub Basin.

V. RESULTS AND DISCUSSION

pH

pH is one of the foremost important operational water quality parameters with the optimum pH required often being in therange of 7.0-8.5. The maximum permissible limit for pH in drinking water as given by the World Health organization is 8.5. The values of pH in the groundwater samples collected varied from 6.28 to 7.48 with an average value of 6.88. Spatial distribution of pH concentrations are shown in Figure.2.

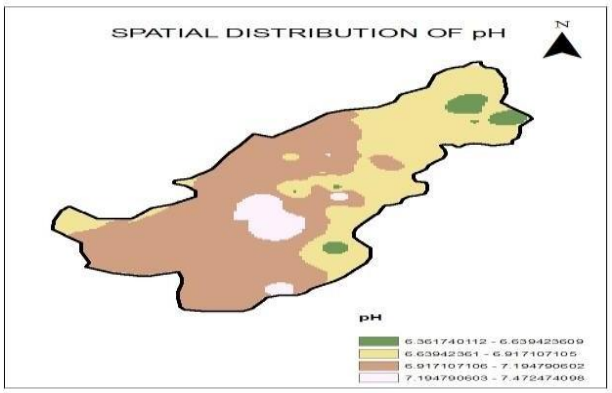


Figure 2: Spatial distribution of pH

Total Dissolved Solids (TDS)

Concentration of dissolved solids in groundwater decides its pertinence for drinking, irrigation or industrial purposes. The concentration of dissolved matter in water is given by the weight of the material on evaporation of water to dryness up to a temperature of 1800C. The values are expressed in mg/l. The major constituents of TDS include Bicarbonates (HCO) Sulphates (SO 2+) and Chlorides (Cl-) of Calcium, Magnesium, Sodium and Silica. Groundwater containing over one thousand mg/l of total dissolved solids is usually referred as briny water. In the study area, the TDS amount ranges from 350 mg/l to 1300 mg/l with an average of 781 mg/l. The spatial distribution of TDS concentrations are shown in Figure.3.

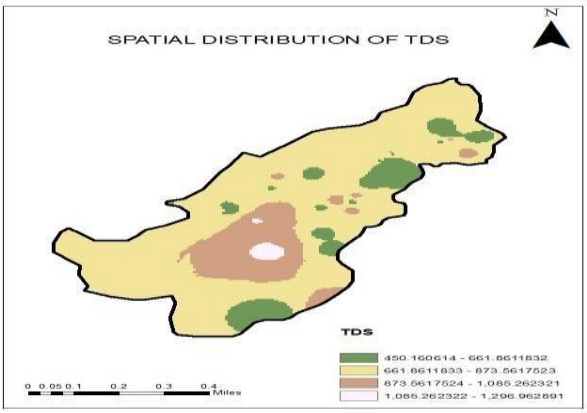


Figure3: Spatial distribution of TDS

Table 3: Water Quality parameters Valuesfor collected Groundwater samples at various locations

			TH	SO_4^{2-}	Fluoride	CL^-	TDS	Ca^{2+}	Mg^{2+}	Na^{2+}	NO_3^-	Alkalinity
Sample	**T(°C)**	pH	---------- mg/l ----------									
1	33.5	6.54	380	17.7	0.2	166	550	231	125	100	1.2	221
2	30	7.32	160	15.2	0.1	157	890	65	72	258.5	0.1	65
3	33	6.76	220	9.65	0.3	59	950	105	92	90	0.1	95
4	33	6.60	450	20.75	0.2	279	970	265	232	91.8	0.25	256
5	31	6.84	270	14.45	0.3	124	450	158	89	104.9	1.1	148
6	30	6.65	240	12.5	0.2	54	650	91	125	85.6	0	98
7	32	6.75	280	16.75	0.3	89	550	138	119	68	0	128
8	30	6.36	280	10.3	0.2	32	550	165	92	50.6	0.1	155
9	31	6.76	390	20.3	0.2	121	850	145	222	108.2	0.1	138
10	31	6.71	250	13.65	0.3	69	450	78	149	97.2	0.45	68
11	31	6.52	340	18.55	0.3	179	850	265	52	96.7	0.4	255
12	34	7.02	440	13.8	0.2	149	850	198	219	110.1	0	188
13	30	7.48	420	24	0.2	114	850	231	165	106.9	0	227
14	30	6.61	460	25.5	0.2	214	950	231	205	111.3	0.75	221
15	32	6.89	460	25.05	0.2	224	1050	298	139	106.1	0.8	258
16	29	6.87	470	25.2	0.1	214	950	231	215	137.8	1	221
17	31	6.85	460	19.65	0.2	164	950	248	189	53.4	0.25	238
18	33	6.55	260	12.25	0.2	49	550	165	72	39	0.6	155
19	31	6.77	260	11.95	0.2	54	550	148	89	45	0.6	138
20	31	6.28	280	10.95	0.2	124	550	165	92	42	0.45	155
21	32	6.43	210	12.05	0.3	29	350	98	89	41.4	1.2	88
22	32	6.84	450	22.95	0.2	109	950	198	229	105.7	0	188
23	31	6.44	460	29.35	0.2	114	950	215	222	83.5	0	205
24	32	6.95	440	23.85	0.2	119	1050	331	85	108.7	0.45	335
25	31	6.60	320	19.45	0.3	119	650	165	132	71.3	0	155
26	31	7.25	500	16.9	0.1	214	950	198	279	86.6	1.4	188
27	32	7.16	260	24.3	0.4	314	1050	315	72	191.1	1.6	305
28	30	6.39	450	33.2	0.1	184	950	181	245	105.3	0.9	171
29	30	7.23	260	12.7	0.2	41	450	148	89	39.4	1.1	138
30	30	7.02	380	15.85	0.2	132	850	198	159	97	0.25	188
31	32	6.75	280	7.2	0.2	49	750	131	125	47.6	0.6	121
32	30	6.78	440	19.7	0.2	114	950	181	235	83.6	0	171
33	32	6.83	460	20.15	0.1	116	950	198	239	110.9	1	188
34	31	7.18	250	10.85	0.1	47	550	148	79	42.6	0.5	138
35	31	6.85	380	13.7	0.2	121	750	181	175	69.6	1.2	171
36	31	6.68	440	25.35	0.2	134	850	198	219	94	1.1	188
37	32	6.85	280	10.45	0.1	119	550	131	125	125.9	0.7	121
38	30	7.20	280	6.75	0.1	39	550	131	125	50.9	1.6	121
39	30	6.79	260	6.3	0.1	39	550	265	12	58.1	1.7	255
40	30	6.78	280	2.7	0.1	44	550	98	159	48.2	0	88
41	30	7.10	420	11.1	0.1	131	750	165	232	69.2	0	155
42	30	7.20	340	36.75	0.1	199	850	231	85	113.3	0.7	221
43	32	7.26	490	36	0.2	204	1020	265	252	98.4	0	255
44	31	7.18	280	7	0.2	41	450	98	159	49.9	1.4	88
45	31	7.08	380	17.35	0.2	87	650	131	225	73.8	0.45	121
46	31	7.11	360	17.8	0.2	89	750	181	155	82.7	0.1	171
47	31	7.26	470	16.35	0.3	161	950	231	215	58.1	1.6	221
48	30	7.44	610	26.5	0.3	399	1300	165	422	166.9	1.4	155
49	30	7.42	560	26.45	0.1	399	1150	265	272	176.5	1.6	255
50	30	6.84	500	16.7	0.1	224	1050	231	245	120.5	1.6	221

Total Hardness (TH)

Hardness in water is caused primarily by the presence of carbonates and bicarbonates of Ca, Mg, Sulphates, Chlorides and Nitrates. Total hardness is a measure of Ca2+ and Mg2+content in water and is expressed as equivalent of

CaCo3. Water with hardness not greater than 75 mg/l is considered as soft. Hardness of 75-150 mg/l is not offensive for most purposes. Hardness minimum value of 160 mg/l and maximum value of 610 mg/l. The spatial distributions of Total Hardness concentrations represented in Figure.4.

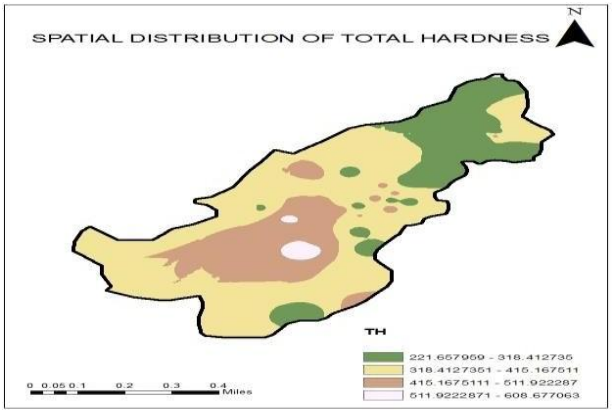


Figure 4: Spatial distribution of TH

Sulphate (So4)

Sulphates available in natural waters at concentration up to 50 mg/l. concentration of 1000 mg/l can be found in water having contact with certain geological formations such as pyrite, lignite and coal. Sulphate concentration ranges from 3 mg/l to 40 mg/l. The spatial distribution of chloride concentrations are shown in Figure.5

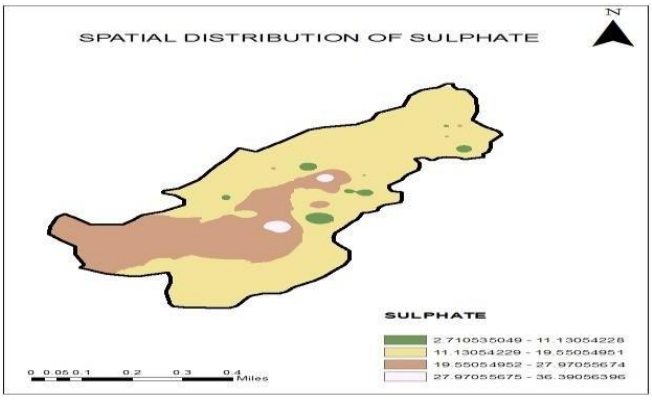


Figure 5: Spatial distribution of Sulphate

Chloride (Cl)

Chloride is held in all natural waters at greatly numerous cognizance depending at the geochemical conditions. essential property of chloride in groundwater are the materials of igneous and metamorphic rocks like gneiss and granite and so on. due to sewerage disposal and leaching of saline residues inside the soil, ordinary chloride concentrations also can rise up. Chlorides can handiest be eliminated with the aid of reverse osmosis system and electrolysis.chloride concentration of collected samples ranges from 29 mg/l to 400 mg/l. The spatial distribution of chloride concentrations represented in Figure.6

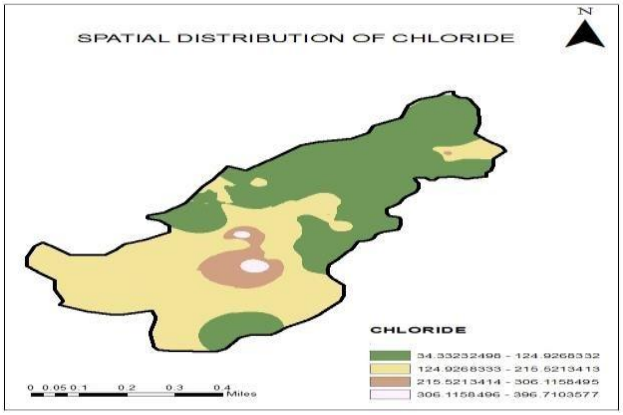


Figure 6: Spatial distribution of Chlorides

Bicarbonates (HCO3)

Alkalinity is provoked because of carbonates, bicarbonates and hydroxides of calcium, magnesium, potassium and sodium. CaCo3 is the most in vogue constituent that causes alkalinity. Bicarbonate is communicated in mg/l as caco3 and for drinking water limited to a hundred mg/l as caco3. in vogue Bicarbonate inside the Palar Sub bowl groundwater levels among sixty five mg/l to 335 mg/l. Water having bicarbonate not more prominent than 100 mg/l as caco3 is suitable for home admission. greater alkalinity in home grown waters will support of makers (green growth and phytoplankton companies) The spatial circulation of bicarbonate focuses are shown in discern.7.

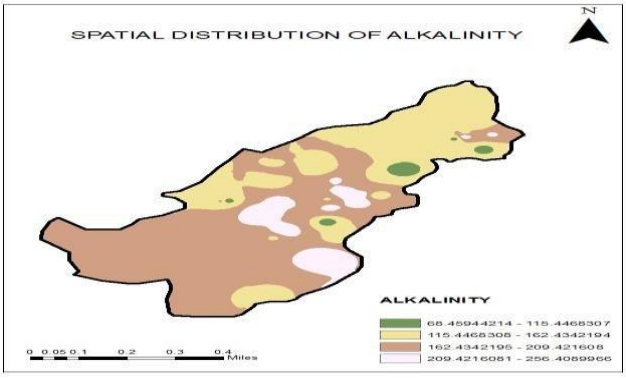


Figure 7: Spatial distribution of Alkalinity

Sodium (Na+)

High supply of sodium content in the ground water is due to because of salts. Desirable limit of sodium content in the ground water is 200 mg/l. Sodium in the ground water basin ranges between 39 mg/l to 258 mg/l. Spatial distribution of Sodium concentrations are shown in Figure 8.

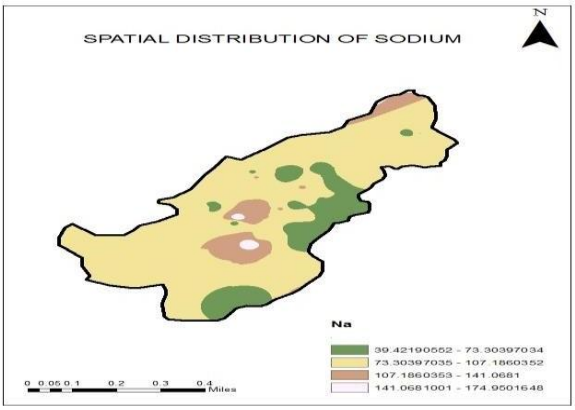


Figure 8: Spatial distribution of Sodium

Calcium (Ca 2+)

Calcium held in water due to limestone, gypsum, dolomite and gypsiferrous minerals. Permissible limit of calcium is 75 mg/l. Calcium concentration ranges from 65 mg/l to 331 mg/l. The spatial distribution of calcium concentrations are shown in Figure.9.

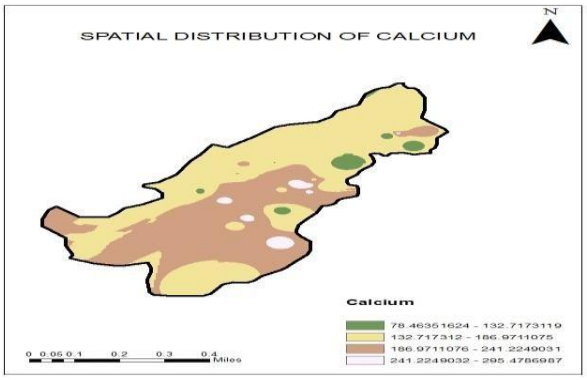


Figure 9: Spatial distribution of Calcium

Magnesium (Mg 2+)

Magnesium in water is mainly due to the presence of olivine, biotite, augite and talc minerals. Allowable limit of magnesium is 30 mg/l. Quality analysis of water samples collected indicates the magnesium concentration ranges from 12 mg/l to 422 mg/l. The spatial distribution of magnesium concentrations are shown in Figure.10.

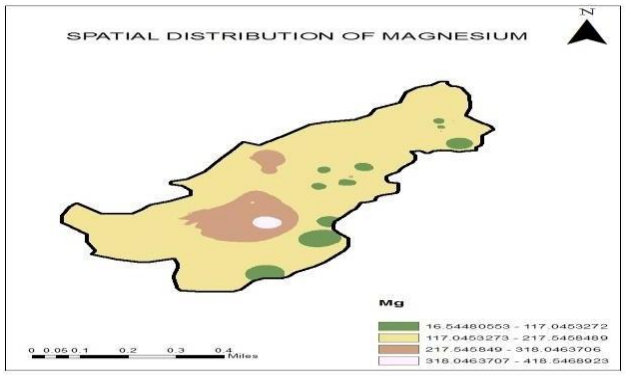


Figure 10: Spatial distribution of Magnesium

Flouride

Fluoride is found in all natural type of waters at different concentrations. The fluoride concentration in water is restricted by fluorite solubility, so that in the presence of 40 mg/L calcium it should be limited to 3.1 mg/L. surplus fluoride intake causes various types of fluorosis, primarily dental and skeletal fluorosis. Bureau of Indian Standards has prescribed 1 mg/l as the acceptable limit and 1.5 mg/l as the allowable limit for fluoride. The fluoride concentration of all groundwater samples in present study is in the range 0.1–0.4 mg/l (Figure.11)

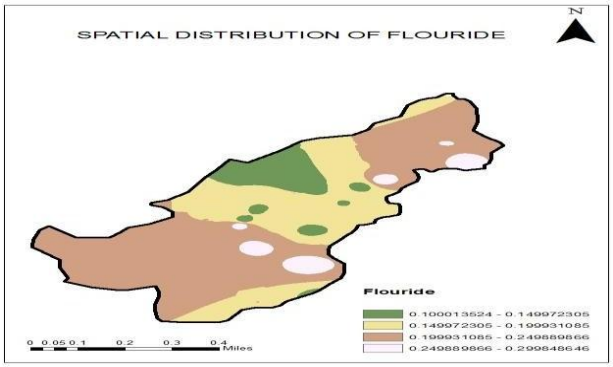


Figure 11: Spatial distribution of Flouride

Nitrates

Nitrate is the important nutrients in an ecosystem. In the present study water samples from the stations (s1 to s50) showed low concentrations of nitrate (0 to 1.7 mg/l) well below permissible levels as per the standards.

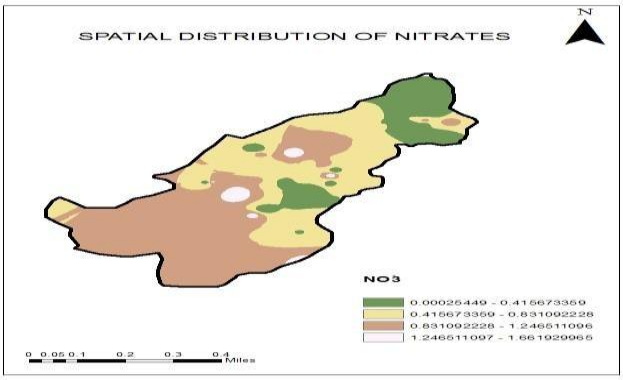


Figure 12: Spatial distribution of Nitrates

VI. CONCLUSIONS

in the present examination, an undertaking become made to survey and to plot groundwater best of Palar Sub Basin. Spatial dissemination maps are addressed that an enormous segment of the all inclusive community of the models offered a pH cost inside the most extraordinary sensible limit; water high bore concerning a pH cost is in the restriction. The TDS cost of Palar Sub Basin is outstandingly over the top which terminations it's miles saline water. In our examination, spatial assignment guide of TH demonstrates that an a huge part of the groundwater tests falls inside the inconvenient class causes confirmation of cleaning chemical used for cleansing goal. Washed does not happen through all of the particles demanding hardness are actuated. The essential cation design in Palar Sub Basin is Ca 2+ >Mg 2+ >Na +. for all intents and purposes all groundwater tests outperform the best appropriate

impediment of magnesium; Sodium(Na) centers are inside the most sensible control. The abundance of the essential anions in Palar Sub Basin is inside the going with solicitation: HCO3->Cl->SO4 -. HCO3 thought is over the most outrageous sensible point of confinement. excess bicarbonate in water is hurting for water framework which results in soil mischief and decrease gather yield.

The Water satisfactory Index is a totally significant and a compelling gadget to survey and to report at the accompanying data to the decision makers if you should be fit for fathom the reputation of the groundwater best. the general point of view on the WQI (table of the present see quarter exhibits a by and large WQI. regardless, best eleven territories had a stunning last item with a WQI underneath one hundred. This examination allows that the use of GIS and WQI methods should give profitable information to water quality assessment for Palar Sub bowl.

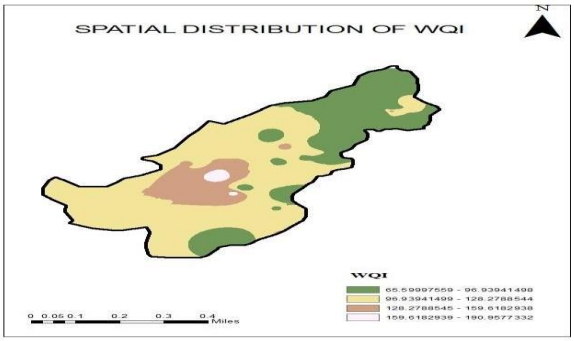


Figure 13: Spatial distribution of Water Quality Index

Table 4. Water Quality Index Values for different samples

Sample	WQI	Status
1	98.27	Good
2	72.993	Good
3	76.764	Good
4	140.395	Poor
5	74.854	Good
6	73.546	Good
7	78.205	Good
8	71.588	Good
9	113.502	Poor
10	73.157	Good
11	96.17	Good
12	122.14	Poor
13	114.357	Poor
14	130.422	Poor
15	126.950	Poor
16	132.595	Poor
17	124.515	Poor
18	67.386	Good
19	69.065	Good
20	75.072	Good
21	55.851	Good
22	125.739	Poor
23	126.374	Poor
24	117.94	Poor
25	89.77	Good
26	139.77	Poor
27	117.59	Poor
28	129.20	Poor
29	65.87	Good
30	107.03	Poor
31	80.038	Good
32	123.75	Poor
33	127.37	Poor
34	65.007	Good
35	104.109	Poor
36	121.605	Poor
37	79.483	Good
38	73.363	Good
39	66.495	Good
40	113.325	Poor
41	98.362	Good
42	145.394	Poor
43	74.406	Good
44	103.806	Poor
45	98.59	Good
46	138.35	Poor
47	191.26	Poor
48	168.04	Poor
49	166.048	Poor
50	141.808	Poor

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