ASSESSMENT OF GROUNDWATER QUALITY FOR DOMESTIC PURPOSE IN KONGU UPLANDS, TAMIL NADU; A GEOGRAPHICAL APPRAISAL

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ABSTRACT *The study is an attempt to find the water quality index which indicates the excellence of water in terms of index number that signifies the overall quality of water for any envisioned usage. It is denoted as a rating that reflects the combined effect of different water quality parameters taken into consideration for the calculation of Water Quality Index (WQI). The study has been carried out in Kongu Uplands of Tamil Nadu which is approximately 26,000 sq. km. It administratively lies in eight Districts of the State viz., Coimbatore, Tiruppur, Erode, Karur, Tiruchirappalli, Salem, Namakkal and Dindigulwhich altogether consists of eighty-one blocks.In this present study WQI has been computed for domestic purposeconsidering ten parameters such as pH, total dissolved solids, total hardness, calcium, magnesium, chloride, sulphate, fluoride, nitrate and sodiumas perBureau of Indian Standards (BIS). The data of 186 sample locations for three decades of 1984-2014 is considered for the study. The spatial interpolation namely Inverse Distance Weightage (IDW) and weighted overlay method in GIS is employed to achieve the intended aim. The spatial distribution ofthe resultis categorized and grouped into four classeslow, medium, high and very high for both the periods respectively. It states that the quality of the groundwater is 74 percent and 66 percent highly suitable in pre monsoon and post monsoon respectively. During the post monsoon period there identified thefluctuations in water quality. It is an increase of 11 percent from high to very high suitable class and a considerable level of increase in medium suitability class.*

Keywords: *Kongu uplands, Interpolation, Overlay, BIS Standard, Water Quality Index.*

INTRODUCTION

In India, most of the population depends upon groundwater as the only source of domestic purpose especially for drinking water supply (Sajal Singh and Athar Hussian, 2016). The quality of water varies with its purpose, as the quality requirements of drinking water differs from agricultural and industrial purposes (Kumaraswamy et.al, 2015). The rising demand for water depletes the surface water and hence intrudes into the groundwater which gradually deteriorates and put the nature's ecostatic ability in danger.Groundwater has been considered as one of the purest forms of water available in nature and meets the overall demands of the people (Jonathan, 2012). But the nowadays this natural resource in several places become contaminated from natural sourcesas well as from numerous other human activities (Kumaraswamy et.al, 2010).It is the chief source of water for the drinking, domestic, agricultural, industrialand other purposes (Packialakshmi, 2015). In arid and semi-arid regions due to inconsistency in monsoonal showers, there experienceinadequate surface waters and thus over drafting of groundwater resources.It is important to ensure its high quality at all time so that the consumer's health is not compromised. Groundwater resources areaffected by three major activities firstly by the excessive use of fertilizers andpesticides in agricultural areas, secondly by theuntreated/partially treated wastewater to the environment and finally by the excessive pumping and improper management of aquifers (Sajal Singh and Athar Hussian, 2016). In India the water quality has been popularly determined with the help of BIS standards. This standard was originally published in 1983. A report prepared by the World Health Organization in cooperation with the World Bank showed that in 1975, some 1,230 million people were without safe water supplies. The BIS standard prescribes the requirements and the methods of sampling and test for various domestic purposes of water (BIS Report, 2012).

Water Quality Index is defined as a rating reflecting the composite influence of differentwater quality parameters. Horton (1965) has firstly used the concept of WQI, which was further developedby

Brown, Mc Clelland, Deininger, and Tozer (1970) and improved by Deininger (ScottishDevelopment Department, 1975). WQI is one of the most effective tools to communicate informationon the quality of any water body. It is a mathematical equation used to transform largenumber of water quality data into a single number and an effective tool facilitates easy understanding of the quality of the water to the concerned citizens and policy-makers. The adventof satellite technology and Geographical Information System (GIS) made the sample mapping easy. GIS has wide applications in water quality mapping using which informative anduser-friendly maps can be easily prepared.

STUDY AREA

The present study area, Kongu Uplands have the latitudinal and longitudinal extension of10˚10' to 12º10' North and 76º40' to 78º25' East. It covers an area of 26,000 sq. km approximately, which is nearly one fifth of the total geographical area of the whole Tamil Nadu. It shares its borders with the Kolli Hills in the East, Nilgiris in the West, Stanley reservoir in the North and Palani hills in the South. It is a part of Deccan Plateau which is highly characterized by old crystalline and metamorphic rocks of Archean age. It has an average elevation of 450m in the West gradually decreasing to 200m in the East.

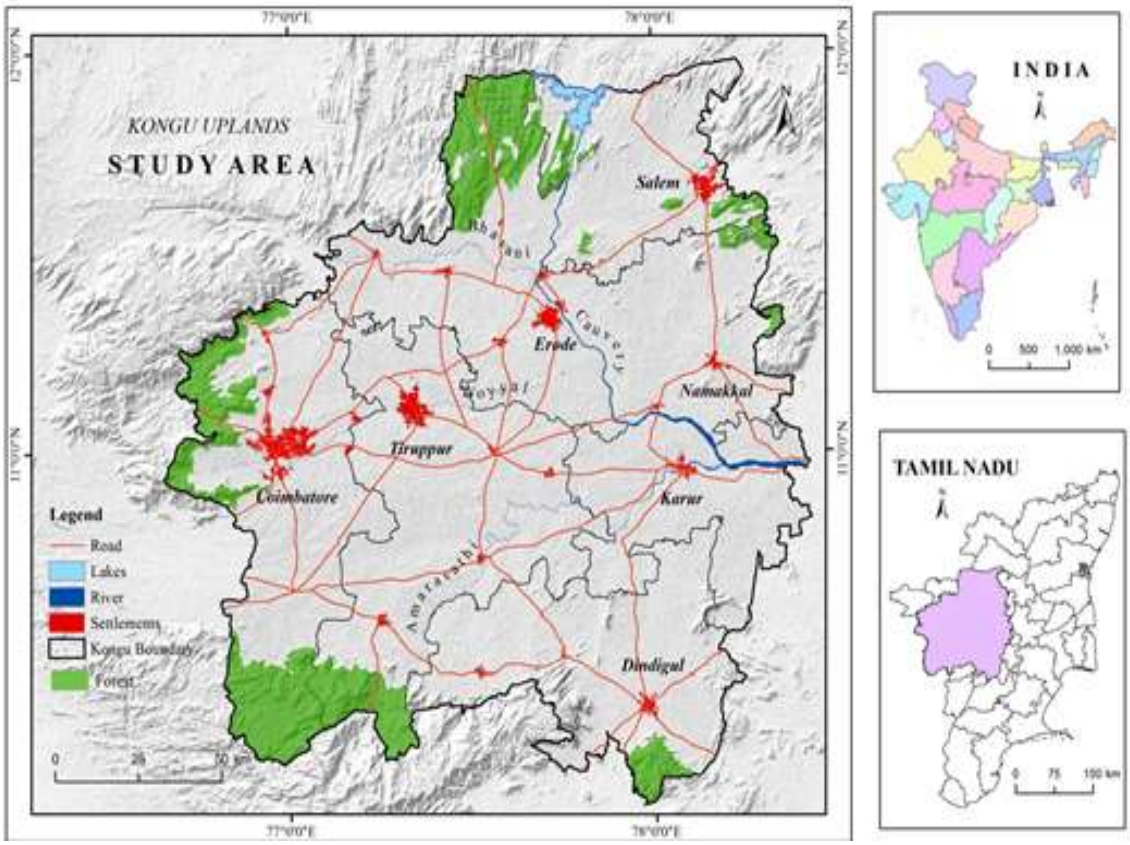

Figure 1: Study Area

The geology of the study area is highly characterized by old crystalline and metamorphic rocks of Archaen age. The region shows a climate of semi- arid nature which makes it subjected to research like this. The total population of Kongu Uplands consists of 98, 335, 71 persons as per the Census of India, 2011. Among this the rural population consist of 69, 870, 82 persons. The total male population is 34, 420, 72 persons and the female population is 33, 644, 54 persons. Kongu Uplands is connected with other parts of the state through well-established transportation systemsviz., road ways, railways and airways. It consists of eighty-one blocks in eight districts of Coimbatore, Tiruppur, Erode, Karur, Tiruchirappalli, Salem, Dindiguland Namakkal in Tamil Nadu.

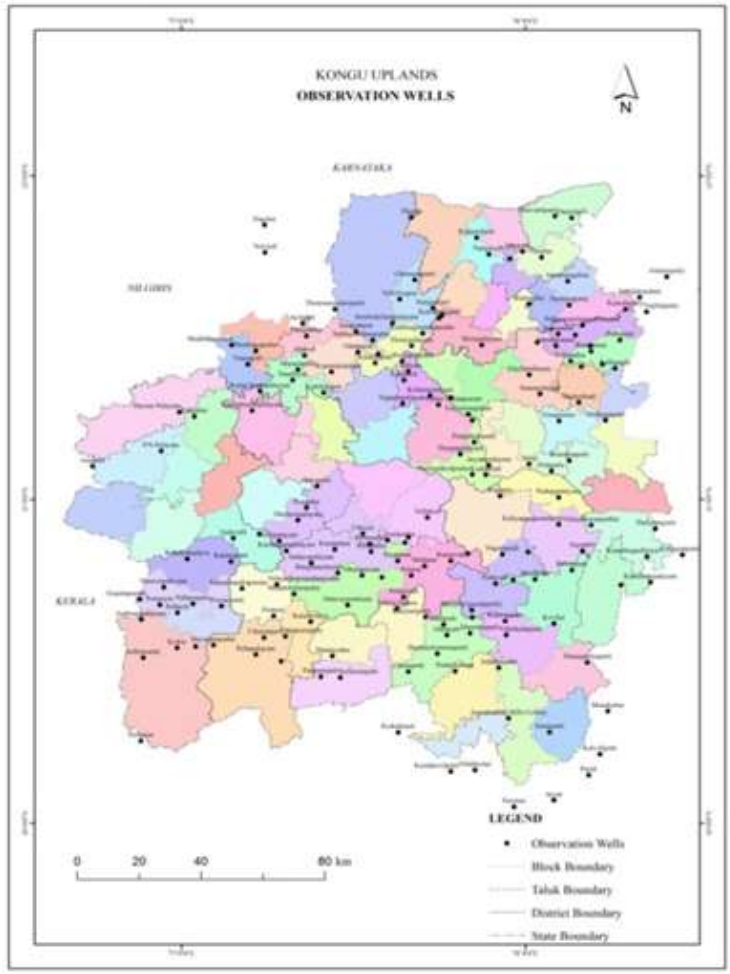

Figure 2: Observation Wells

MATERIALS AND METHODS

The study focuses on findingof the water quality index for the two periods of pre monsoon and post monsoon considering the water quality data for three decades from 1984 to 2014. The data has been collected from State Ground and Surface Water Resources Data Centre, Taramani, Chennai for 186 sample locations in the study area.The weighted overlay method in GIS is employed to find the WQI. The water qualityparameters chosen for analysis are pH, total dissolved solids, total hardness, chloride, sulphate, calcium, magnesium, fluoride, nitrate and sodium. The location specific values of the parameters are interpolated for its spatial distribution using inverse distance weightage method in GIS and further reclassified based on BIS: 10500-2012 standard for water quality. Secondly the spatial layers are overlaid using overlay analysis in GIS assigning rank to each parameters and weight for its classes respectively.

The method adopted to identify the water quality index is as follows:

$$\mathbf{DWQI=\sum^{10} (R_i * W_i)}$$

Where, DWQI=Domestic WQI;

R_i = Rating factor for parameter and W_i = Weight for parameter.

Logically the ratings and weightings are summarized.

RESULTS AND DISCUSSION

The water qualityparameters considered for the analysis are classified based on the BIS Standards as follows:

Table 1: Classification of Groundwater based on BIS Standards

	BIS Standard		Pre Monsoon				Post Monsoon			
	Desirable	Undesirable	Desirable samples		Undesirable samples		Desirable samples		Undesirable samples	
Parameters	Limit		No.	%	No.	%	No.	%	No.	%
pH	6.5 - 8.5	< 6.5/>8.5	91	48.92	95	51.07	33	17.74	16	8.60
TDS as CaCO3(mg/l)	< 500	> 2000	26	13.97	17	9.13	24	12.90	16	8.60
TH as CaCO3(mg/l)	< 200	> 600	7	3.76	61	32.79	8	4.30	60	32.25
Ca (mg/ l)	< 75	> 200	111	59.67	4	2.15	107	57.52	4	2.15
Mg (mg/ l)	< 30	> 100	4	2.15	56	30.10	12	6.45	47	25.26
Na (mg/ l)	<200	> 200	34	18.27	52	27.95	131	70.43	55	29.56
Cl (mg/ l)	< 250	> 1000	96	51.61	5	2.68	86	46.23	2	1.07
SO4 (mg/ l)	< 200	> 400	151	81.18	3	1.61	166	89.24	3	1.61
NO3 (mg/ l)	< 45	> 100	161	86.55	25	13.44	8	4.30	1	0.53
F (mg/ l)	< 1.0	> 1.5	104	55.91	22	11.82	125	67.20	13	6.98

pH

Hydrogen ion concentration (pH) is an important factor in determining water quality as our bodyrequires a natural pH of 7.4 to run efficiently without being over acidic or alkaline. The pH value of natural water indicates the net alkalinity or acidity.In the study area pH was found to be 7.2-8.6 in premonsoon and 7.5- 8.5 in post monsoon periods. The desirable class is less than 8 and undesirable is greater than 8.5 as per BIS standard. The number of samples having permissible limit of water quality in pre monsoon and post monsoon is 91 and 33 respectively.The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon is 48.92 % and 17.74 %.The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 95 and 16 respectively. The percentage of samples fall in impermissible limit is51.07 % and 8.60% in premonsoon and post monsoon respectively and is concentrated mostly in Eastern parts of the study area.

Total Hardness

Total hardness is defined as the sum of calcium and magnesium in mg/l.TH in Kongu Uplands ranges from 103-1776 mg/land 91-1586 mg/l in pre monsoon and post monsoon respectively. The classless than 200mg/l is desirableand greater than 600mg/l is undesirable as per BIS standard. The number of samples having permissible limit of water quality in premonsoon and postmonsoon is 7 and 8 respectively. The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon is 3.76 % and 4.3 % respectively. The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 61 and 60 respectively. The percentage of samples falls in impermissible limit is32.7 % and 32.2 % in premonsoon and post monsoon respectively which is concentrated in North-Eastern portions of the study area.

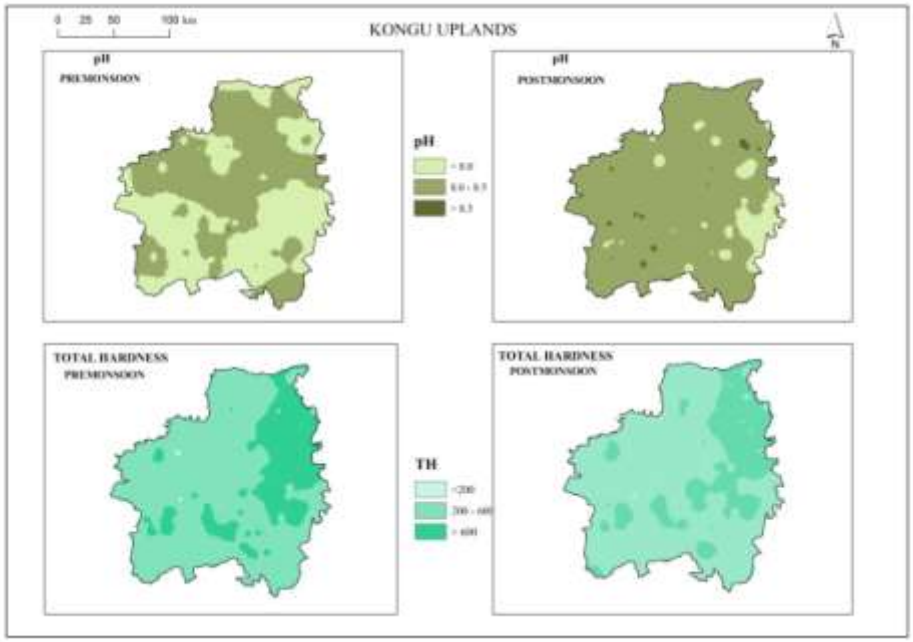

Figure 3: pH and TH – Pre monsoon and Post monsoon

Total Dissolved Salts

Total dissolved salts in Kongu Uplandsfalls in between160 to 4034mg/l and 147 to 3071mg/l in premonsoon and postmonsoon respectively. The 500mg/l is the desirable classand greater than 2000mg/l is the undesirable classes according to BIS standard. 7 and 24 are the number of samples having permissible limit of water quality in premonsoon and postmonsoon respectively. The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon accounts for 13.97 % and 12.9 % respectively and is distributed as patches in North-Western and central south of Kongu Uplands. The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 17 and 16 respectively. The total of 9.13%and 8.60%of samples fall in impermissible limit in premonsoon and post monsoon respectively which has a concentration in Eastern parts of the study.

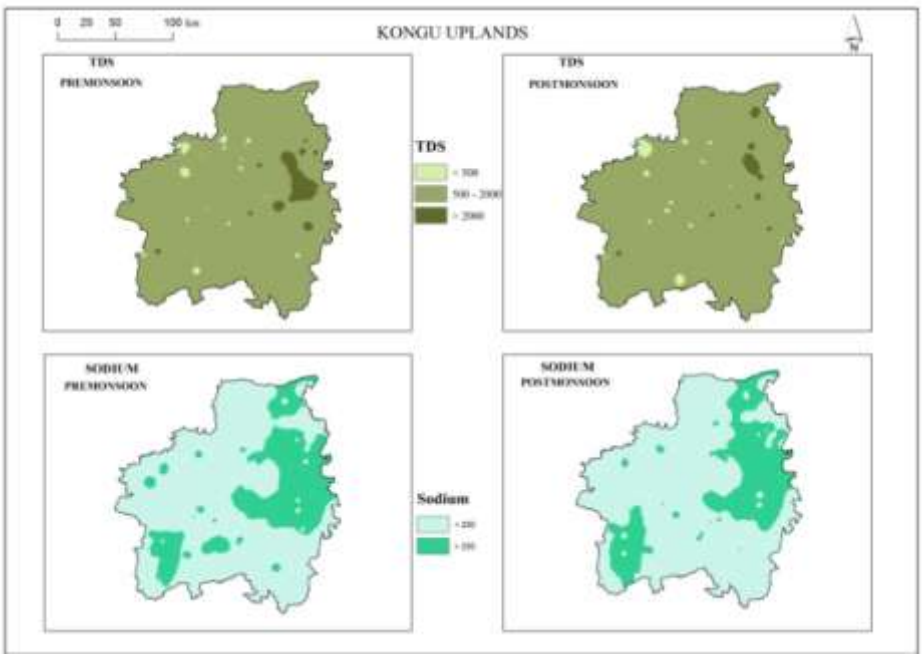

Figure 4: TDS and Sodium – Pre monsoon and Post monsoon

Sodium

Sodium is one of the important chemical constituents of the cation group.Its concentration in Kongu Uplands ranges from 12-922 mg/lin pre monsoon and15-6853 mg/l in post monsoon respectively. The desirable class is less than 200mg/land undesirable is greater than 200mg/l based on BIS standard. The number of samples having permissible limit of water quality in premonsoon and postmonsoon is 34 and 131 respectively. The percentage of 18.27 % and 70.4% of the total samplesshowspermissible limit of water quality in premonsoon and postmonsoon respectively. Thetotal number of 52 and 55 samples are having impermissible limit of water quality in premonsoon and postmonsoon periodsrespectively. The percentage of 27.9 % samples in pre monsoon and 29.5% in post monsoon falls in impermissible limit of water quality.

Calcium

Calcium naturally presents in water and may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. It is a determinant of water hardness, as it can be found in water as Ca^{2+} ions. Calcium content in the ground water of the study area ranges from 18-347 mg/land 23-216 mg/l in pre monsoon and post monsoon respectively. The desirable class is less than 75mg/landundesirable is greater than 200 mg/l as per BIS standard. The number of samples of 111 and 107 are having permissible limit of water quality in premonsoon and postmonsoon respectively. The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon is 59.6% and57.5 % respectively. The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 4 and the total percentage of samples that falls in impermissible limit is2.15% and in pre monsoon and post monsoon respectively.

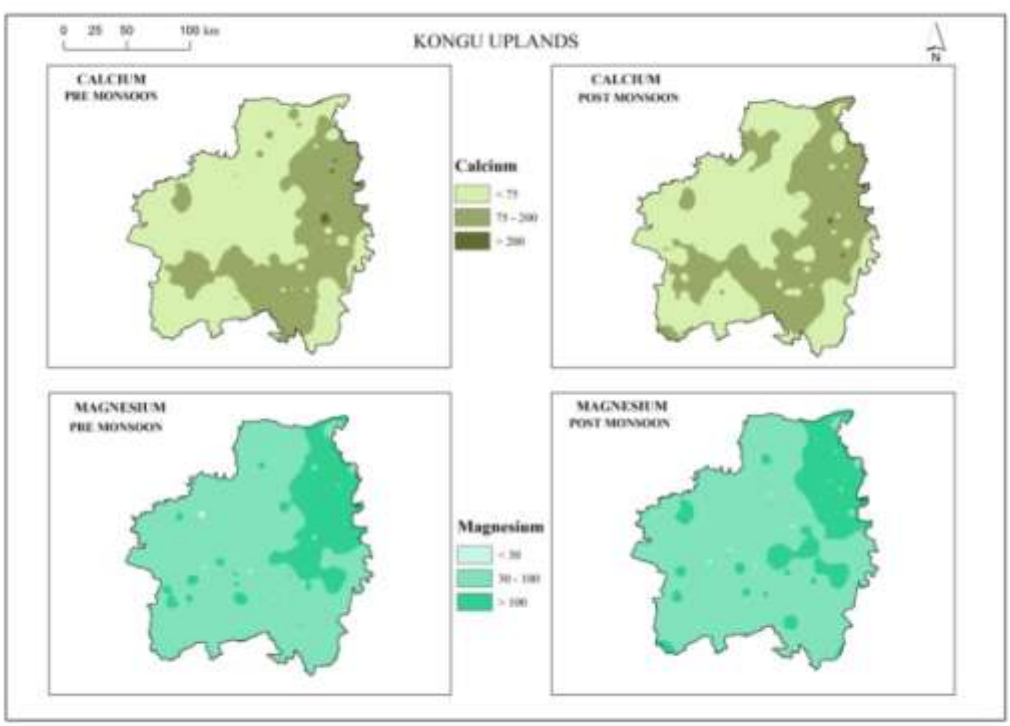

Figure 5: Calcium and Magnesium – Pre monsoon and Post monsoon

Magnesium

Magnesium mainly present in groundwater as Mg^{2+}. Its content in the water of Kongu Uplands ranges from 10-252 mg/land 11-263 mg/l in pre monsoon and post monsoon respectively. The desirable class is less than 30mg/landundesirable is greater than 100 mg/l as per BIS standard. The number of samples having permissible limit of water quality in premonsoon is 4 and postmonsoon is 12 respectively. The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon is 2.15 % and6.4% respectively. The number of samples having impermissible limit of water quality in premonsoon

and postmonsoon is 56and47 respectively. The percentage of samples falls in impermissible limit is30.10 % and 25.3% in premonsoon and post monsoon respectively.

Sulphate

Sulphate ranges from 6-672 mg/lpre monsoon and 9-604 mg/l in post monsoonin the Kongu Uplands. As per BIS standard the desirable class is less than 200mg/land undesirable is greater than 400 mg/l. The number of samples having permissible limit of water quality in premonsoon and postmonsoon is 151and166 respectively. In pre monsoon 81.18% and in post monsoon 89.24% is the percentage of permissible limit of water quality here. The number of three samples are having impermissible limit of water quality in pre monsoon and post monsoon and the percentage of samples falls in impermissible limit is 1.61.

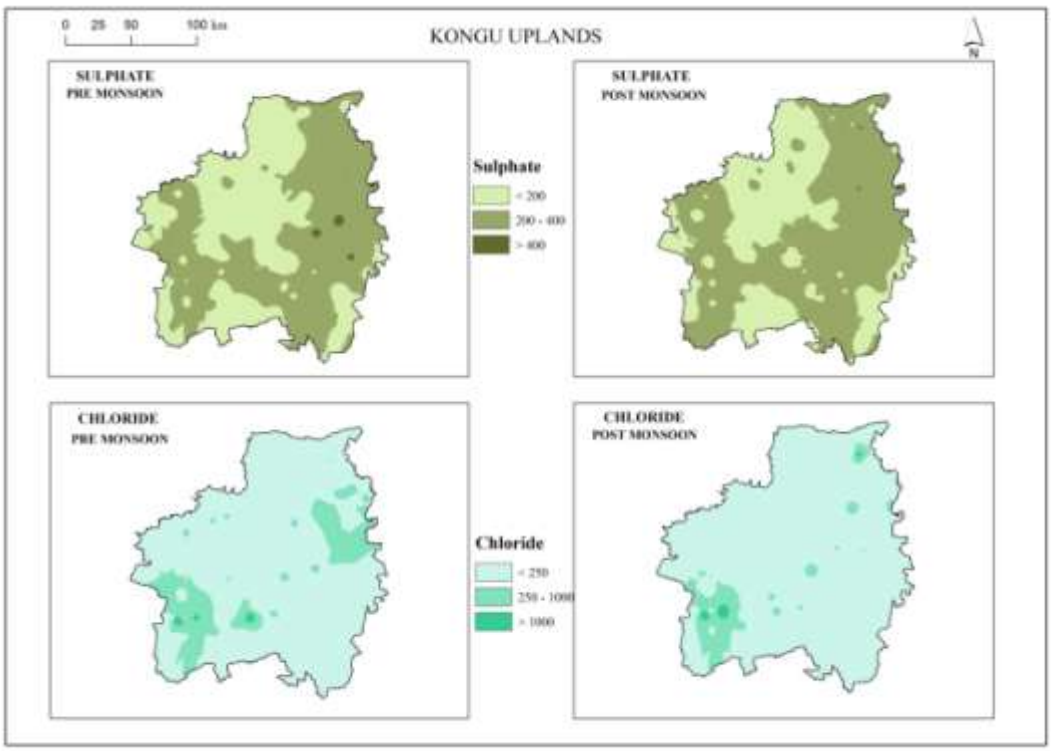

Figure 6: Sulphate and Chloride – Pre monsoon and Post monsoon

Chloride

Chloride contents in the groundwater of Kongu Uplands ranges from 28-1513 mg/lin pre monsoon and 22-1086 mg/l in post monsoon. As per the BIS standard the desirableclass is the class that falls inless than 250 mg/land undesirable class is the class that is greater than 1000 mg/l. The numbers of 96 and 86 samples are having permissible limit of water quality in premonsoon and postmonsoon respectively. The percentage ofsamples having permissible limit of water quality in premonsoon 51.6% and postmonsoon is 46.2 % respectively. The number 5 and 2 samples are having impermissible limit of water quality in premonsoon and postmonsoon. The percentage of samples falls in impermissible limit is2.69% in pre monsoon and 1.07 % in post monsoon respectively.

Nitrate

Nitrate in Kongu Uplands ranges from 1 to 115mg/lin pre monsoon and 2 to 113mg/l in postmonsoon respectively. The desirable class is less than 45mg/land undesirable is greater than 45mg/l as per BIS standard. The number of samples having permissible limit of water quality in premonsoon and postmonsoon is 161 and8 respectively. The percentage ofsamples having permissible limit of water quality

in premonsoon and postmonsoon is 86.55 % and4.30 % respectively. The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 25 and1 respectively. And the percentage of samples falls in impermissible limit is13.4% and 0.53% in premonsoon and post monsoon respectively.

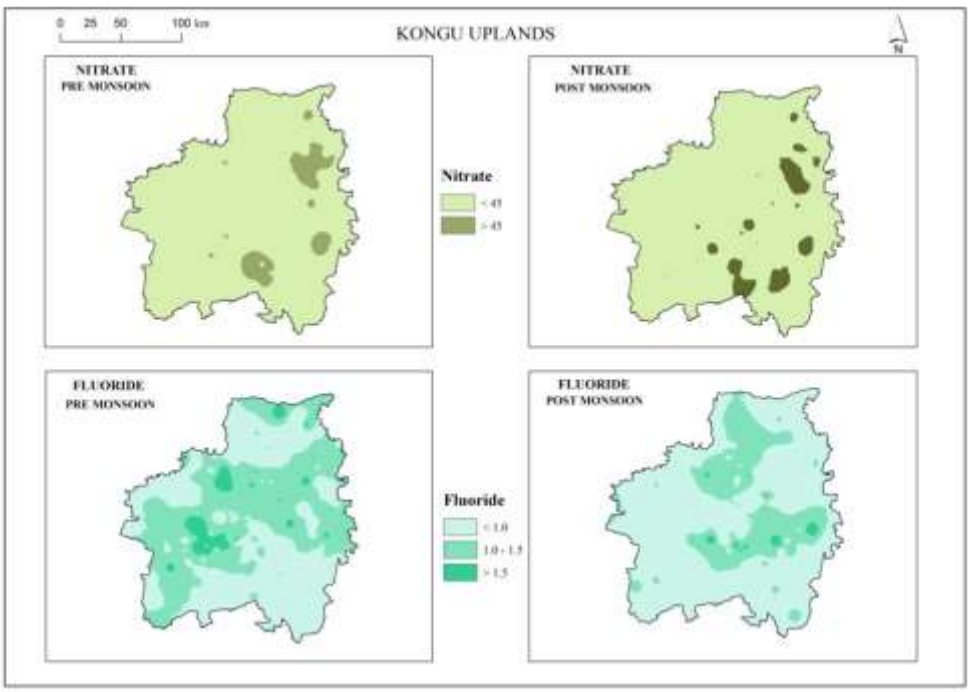

Figure 7: Nitrate and Fluoride – Pre monsoon and Post monsoon

Fluoride

Fluoride in Kongu Uplands ranges from 0.6 to 2.1 mg/l in pre monsoon and 0.6 to 2.2 mg/l in postmonsoon respectively. The desirable class is less than 1.0 mg/land undesirable is greater than 1.5 mg/l as per BIS standard. The number of samples having permissible limit of water quality in premonsoon and postmonsoon is 104 and 125 respectively. The percentage ofsamples having permissible limit of water quality in premonsoon and postmonsoon is 56 % and 67.2 % respectively. The number of samples having impermissible limit of water quality in premonsoon and postmonsoon is 22 and 13 respectively. And the percentage of samples falls in impermissible limit is11.82 % and 6.98% in premonsoon and post monsoon respectively.

Table 2: Range of concentrations (mg/l), ratings and weightings of various parameters for domestic ground water quality analysis

Minerals	Range of Concentrations& Rank			Weight
	6	4	2	
pH	<8.0	8.0-8.5	>8.5	**4**
TDS	<500	500-2000	>2000	**5**
Total Hardness	<200	200-600	>600	**3**
Calcium	<75	75-200	>200	**2**
Magnesium	<30	30-100	>100	**3**
Sodium	<200		>200	**2**
Chloride	<250	250-1000	>1000	**4**
Sulphate	<200	200-400	>400	**6**
Nitrate	<45		>45	**8**
Fluoride	<1.0	1.0-1.5	>1.5	**3**

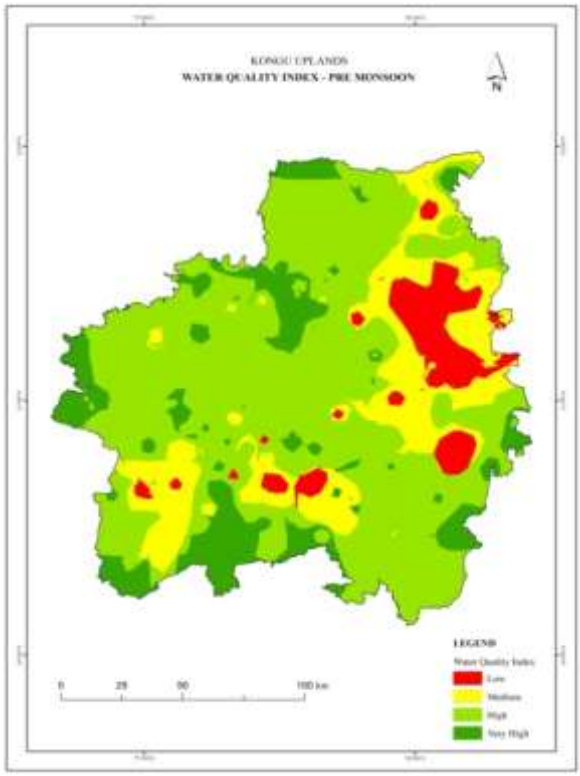

Figure 8: WQI premonsoon

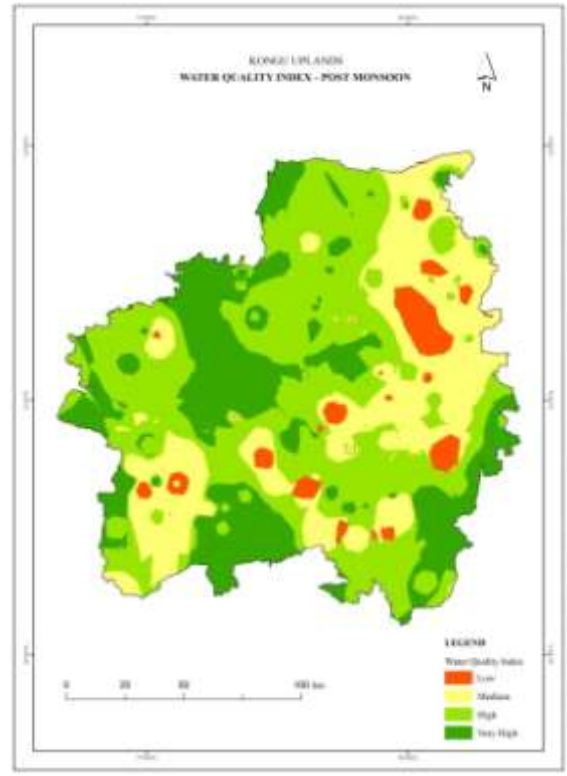

Figure 9: WQI postmonsoon

Table 3: Status of ground water Quality for domestic purposes (as per BIS Standards)

Class	Pre monsoon		Post monsoon	
Area	**sq.km.**	**percentage**	**sq.km.**	**percentage**
Low	1888	7.2	1200	4.6
Medium	4685	18.0	6866	26.4
High	15729	60.5	11207	41.1
VeryHigh	3664	14.1	6693	25.7

CONCLUSION

WQI has been computed based on ten different quality parameters inorder to assess the suitability of groundwater for domestic purposes in eighty-one blocks of Kongu Uplands in Tamil Nadu. The results depict thatground water distributed in 3664 sq.km that is around 14.11% of the total geographical area of the study area in pre monsoon and 6693 sq.km that is 25.77% of area in post monsoon is very highly suitable for domestic purposes. These are spatially distributed in parts of North-Western and Southern portions of Kongu Uplands in pre monsoon and Northern, Southern, central and Eastern parts of the study area in post monsoon period. The groundwater distributed in 15729sq.km that is 60.5% in pre monsoon and 11207 sq.km i.e.41.1 % is highly suitable and is distributed throughout the Kongu Uplands in pre monsoon except in the Eastern portions. The groundwater distributed in 4685 sq. km that is 18.0% in pre monsoon and 6866 sq.km i.e. 26.4% in post monsoon comes under medium class. The groundwater distributed in 1888 sq.km in pre monsoon i.e. 7.2% and 1200 sq.km in post monsoon that is 4.6% shows low quality. It states that the quality of the groundwater in 74 percent and 66 percent of the study area are highly suitable for the domestic usage both in pre monsoon and post monsoon respectively. During the post

monsoon the fluctuations in water quality has also been identified i.e. an increase of 11 percent from high to very high suitable classes and a considerable level of increase in medium suitability class.

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REFERENCES

1. **Abdul Hameed M., Jawad Alobaidy., Haider, S., Abid., Bahram, K.** and **Maulood.,** (2010). Application of Water Quality Index for Assessment of Dokan Lake Ecosystem, Kurdistan Region, Iraq. ***Journal of Water Resource and Protection***, 2(9), pp. 339-343.
2. **Balachandar, D., Sundararaj, P., Rutharvel Murthy K.,** and **Kumaraswamy K.,** (2010).An Investigation of Groundwater Quality and Its Suitability to IrrigatedAgriculture in Coimbatore District, Tamil Nadu, India – A GIS Approach. *International Journal of Environmental Sciences, 1(2),* pp. 176-190.
3. **Balaselvakumar, S., Kumararaswamy, K., and Jawahar Raj, N.,** (2015). Evaluation of Groundwater Quality for Irrigated Agriculture in Marudaiyar Sub-Basin, Tamil Nadu. *International Journal of Current Research,* 7(10), pp.21444-2145.
4. **Chopra, R.,** and**Krishan, G.,**(2014). Analysis of Aquifer Characteristics and Groundwater Quality in Southwest Punjab, India. *Journal of Earth Science and Engineering*, 4, pp.597-604.
5. **Gopal Krishnan, Surjeet Singh., Kumar, C.P., Garg, P.K., Suman Gurjar, Gosh, N.C.,** and **Anju Choudary.,** (2016). Assessment of Groundwater Quality for Drinking Purpose by Using Water Quality Index (WQI) in Muzaffarnagar and Shamli Districts, Uttar Pradesh, India. *Hydrological Current research*, 7(1), pp. 1-4.
6. **Gopal Krishan., Surjeet Singh., Kumar, C.P., Suman Gurjar.,**and **Ghosh, N.C.,** (2016). Assessment of Water Quality Index (WQI) of Groundwater in Rajkot District, Gujarat, India. *Journal of Earth Science & Climatic Change,* 7(3), pp.2-4.
7. **Jonathan YISA., Tijani Oladejo JIMOH.,** and **Ohiemi Michael OYIBO.,**(2012), Underground Water Assessment using Water Quality Index, *Leonardo Journal of Sciences,* 21, pp. 33-42.
8. **Mufid al-hadithi.,** (2012).Application of Water Quality Index to Assess Suitability of Groundwater Quality for Drinking Purposes in Ratmao –Pathri Rao Watershed, Haridwar District, India. *American Journal of Scientific and Industrial Research,* 3(6), pp. 395-402.
9. **Packialakshmi, S., Meheli Deb.,** and **Hrituparna Chakraborty.,** (2015), Assessment of Groundwater Quality Index in and Around Sholinganallur Area, Tamil Nadu. *Indian Journal of Science and Technology*, 8(36), pp. 1-7.
10. **Sajal Singh.,** and **Athar Hussian.,** (2016), Water Quality Index Development for Groundwater Quality Assessment of Greater Noida Sub-Basin, Uttar Pradesh, India. *Cogent Engineering*, 3, pp. 1 – 17.
11. **Srinivas, J., Purushotham, A.V.,** and **Murali Krishna K.V.S.G.,** (2013). Determination of Water Quality Index in Industrial areas of Kakinada, Andhra Pradesh, India. *International Research Journal of Environment Sciences,* 2(5), pp. 37-45.
12. **Srinivas Rao, G.,** and **Nageswararao, G.,** (2013). Assessment of Groundwater Quality using Water Quality Index. *Archives of Environmental Science,* 7, pp. 1-5.
13. **Sunita Kumari .,** and **Jyoti Rani.,** (2014).Assessment Of water Quality Index of Ground Water In Smalkhan, Haryana. *International Journal of Latest Research in Science and Technology,* 3(6), pp. 169-172.

If you cannot do great things, do small things in a great way.

~ Napoleon Hill