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GEOSPATIAL MAPPING OF URBANIZATION INDUCED PRE AND POST-MONSOON WATER QUALITY FOR KATTANKOLATHUR BLOCK OF TAMIL NADU STATE (INDIA)

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ABSTRACT
The feasibility of quality groundwater determines the health, wealth and growth of the civilization. The exiting human race demands clean water for daily consumption as drinking, different domestic usages and for agricultural activities. The truth is that groundwater is the only source of fresh water to the current civilization. Urbanization on its rapid growth brought a threat to potential safe groundwater resources. Present study aims at examining different factors of water quality both Alkalinity and salinity, around different parts of the Kattankulathur Block. Total 20 sample locations has been chosen in and around the block and samples are collected for both pre and post monsoon period for the year 2014-2015.The block spreads over a geographical area of 378.536 sq. km with variant industries, educational institute, and automobile industries and nearby Thirurpour blocks with more than 60% of textile industries. The study shows though the groundwater suitability for drinking water, agriculture and other domestic uses is presently under safe condition except one sample location. Different physico-chemical parameters like, EC, pH, Ca, Mg, Na, K, HCO_3 , CO_3 , SO_4, Cl, NO_3, F,TDS, TH, TA contours has been plotted along with sample locations for both Pre and Post-monsoon periods.
Keywords: Groundwater, Water Quality, Sampling, Physico-chemical Parameters, Spatial Distribution

INTRODUCTION

Groundwater is the potential source of fresh water source for many countries of the world. The feasibility of quality groundwater determines the health, wealth and growth of the civilization. At current scenario the uncontrolled growth of population along with many fold growth of urbanization alongside industrialization, demands rapid and judicial development of groundwater. Again the untreated dumping of different waste at unsuitable site resulting in leaching or direct contact with groundwater is a major threat to the quality of groundwater. Again untreated industrial effluent and other anthropogenic sources hold a major contribution for the deteorating of groundwater quality. Changes in groundwater quality are due to rock–water interaction and oxidation–reduction reactions during the percolation of water through the aquifers. Groundwater quality based on the physical-chemical and ion exchanges processes of the soil and rock material.[1-3] Chemical contamination of the groundwater is largely reliant on the geochemistry of the soil through which the water flows previous to reaching the aquifers, it is important to understand the hydrogeochemistry of the chemical–soil–groundwater interactions.[4,5] Groundwater quality data give significant evidences to the geologic history of rocks of the area and clues of groundwater recharge, movement, and storage and of water contact with rock material.[6-8] Poor quality of water adversely affects the plant growth and human health. According to World Health Organization (WHO) reports, about 80% of all the diseases in human beings are caused by water [3]. Understanding its importance, numerous studies on groundwater quality with regard to drinking and irrigation purposes have been carried out in different parts of the country.[9-12] The present studies to determine the hydro-geochemical investigations of groundwater were carried out in the Kattankolathur block of Kanchipuram district, Tamil Nadu, India.

Study Area

The study area lies between Latitude 12 °40’ to 12° 48' 54" North, 79 ° 55’ to 80° 1' 57" East is located in North of Tamil Nadu in India, covering about 378.53 Sq. Km area. The major town panchayat and taluk coming under this block are Chengalpattu, Marammalai Nagar, Kattankulathur, Urapakkam, and Vandalur. River Palar is the only major drainage pattern in the study area .Many small-scale industries for auto ancillaries, engineering, wood works, electrical electronic Works along with automobile industries are functioning in the study area and discharging their effluents on the open land and surrounding water bodies. Many manufacturing sector like clay articles are abundant in the study area. There are more than 60 clay units worth turnover of 50 lakh is present in the block. Geologically the study area is covered by crystalline rocks of Archaean age consisting of charnokite and few patches of Gondwana sandstone and conglomerate.

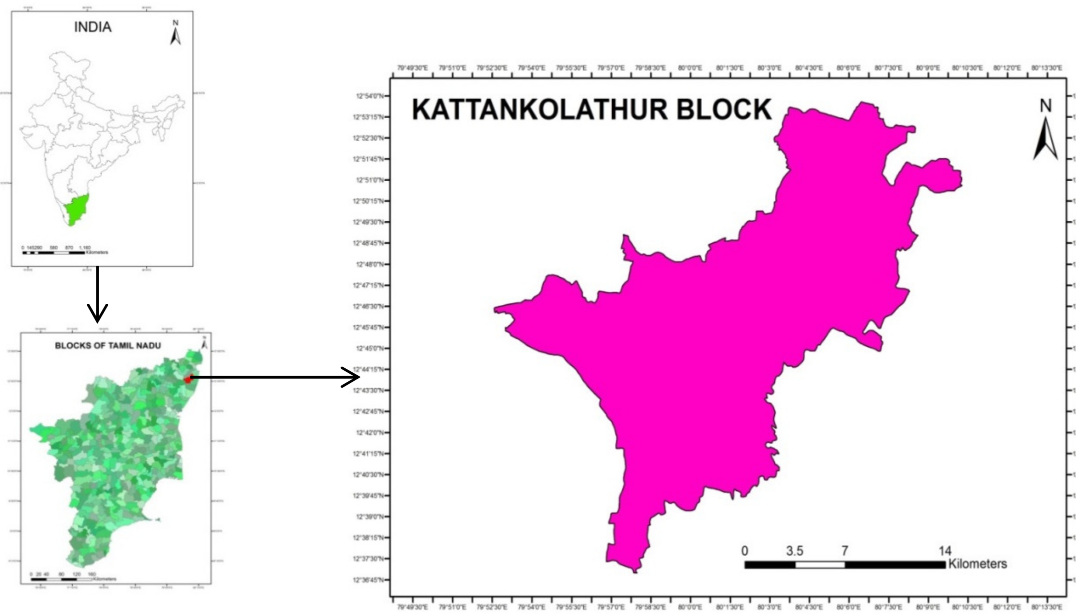

Fig.-1: Location Map of the Kattankolathur Block

EXPERIMENTAL

The tendency of the contaminants is to reach a groundwater source after left out untreated at some locality above the suitable aquifers. Groundwater contamination is an indication of the comparative possibility with which contaminant from these sites will reach the groundwater resources. This considerate basic concept that all groundwater resources are vulnerable when comes in contact with such contaminants.[10] Total 20 sample locations has been chosen in and around the block and samples are collected for both pre and post monsoon period for the year 2014-2015.The block spreads over an geographical area of 378.536 sq. km. Different physico-chemical parameters like, EC, pH, Ca, Mg, Na, K, HCO_3 , CO_3 , SO_4, Cl, NO_3, F,TDS, TH, TA has been tested from these collected sample with required standards and resulted contours has been plotted along with sample locations for both Pre and Post-monsoon periods using Arc GIS software.

Water quality parameters

Electrical conductivity (EC)

Electrical Conductivity can be defined as the ability of a solution to conduct an electric current and measured in micro mhos /cm and reported at 25°C. Electrical Conductivity is a function of concentration of ions, charge and ionic mobility Electrical Conductivity is approximately indicative of ionic strength.

The variation of determines the quality of water for domestic and drinking or other purposes. Depending upon the concentration of EC the quality of water is scaled as<250 µS/cm: Excellent, 250-750 µS/cm: Good, 750-2000 µS/cm: Permissible, 2000-3000 µS/cm: Doubtful, >3000 µS/cm: Unsuitable [12]. The pre monsoon and post monsoon EC has been given in the Figure-2 and Figure-3. The EC value ranges between 260 to 3360 µS/cm for pre monsoon and 220 to 4490 for post monsoon seasons. An electrical conductivity between 150 to 500 µS/cm supports diverse aquatic life.

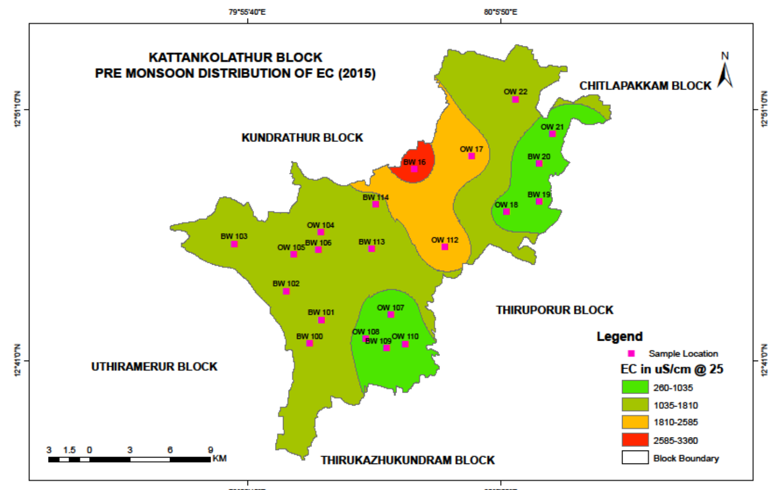

Fig.-2: Spatial Distribution of EC pre monsoon 2015

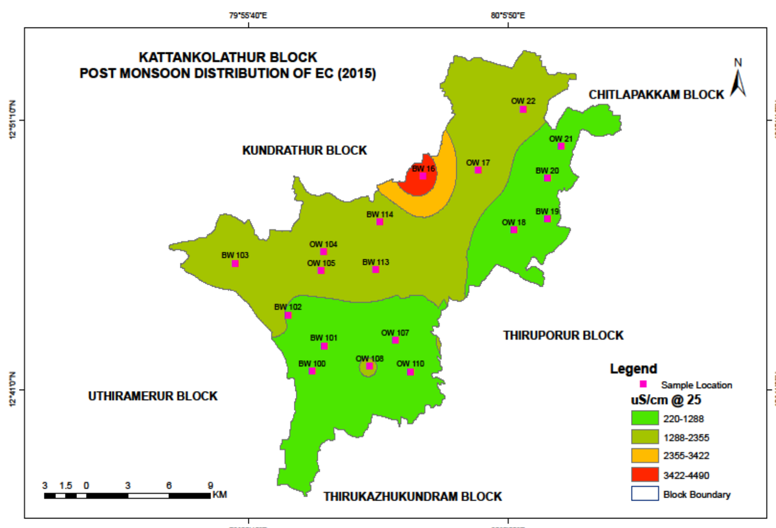

Fig.-3: Spatial Distribution of EC post monsoon 2015

pH

pH is the negative logarithm of the hydrogen ion concentration of a solution and it is thus a measure of whether the liquid is acid or alkaline. The pH scale (derived from the ionisation constant of water) ranges from 0 (very acid) to 14 (very alkaline). The range of natural pH in fresh waters extends from around 4.5, for acid, peaty upland waters, to over 10.0 in waters where there is intense photosynthetic activity by algae. However, the most frequently encountered range is 6.5-8.0. Extremes of pH can affect the palatability of water but the corrosive effect on distribution systems is a more urgent problem.. The range of pH suitable for fisheries is considered to be 5.0-9.0, though 6.5-8.5 is preferable. The pH of the block is well within the limits for both the seasons like 6.9to7.6 and 7.8 to 8 for pre and post monsoon sessions respectively. The Pre and Post monsoon spatial distribution of pH is given in Figure-4 and Figure-5 respectively.

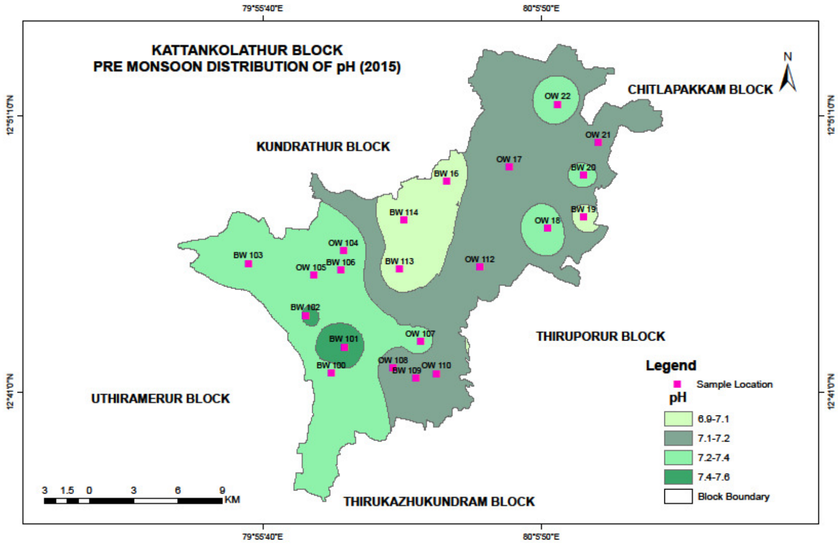

Fig.-4: Spatial Distribution of pH pre monsoon 2015

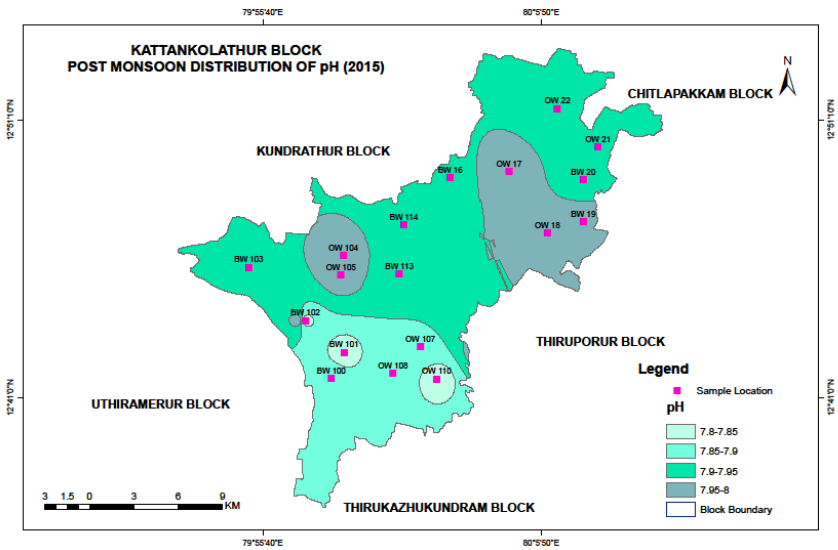

Fig.-5: Spatial Distribution of pH post monsoon 2015

Hardness

Hardness can be measured as Calcium hardness or total hardness. Excess Calcium (Ca_2^+) and Magnesium (Mg_2^+) ions contribute to water hardness. Total hardness takes into account both Ca_2^+ and Mg_2^+ ions with, On average, magnesium hardness representing about 1/3 of total hardness and calcium hardness representing 22 about 2/3 total hardness. Total hardness is the sum of calcium and magnesium hardness. The concentration of Ca_2^+ in freshwater is generally in the range of 0 to 100mg/L. The recommended upper level for drinking water is 50mg/L but higher levels do not cause health risks. If the calcium ion concentration in freshwater drops below 5mg/L, the ability of the water to support life is dramatically decreased, resulting in oligotrophic condition. Figure-6 and Figure-7 respectively show the distribution of calcium for the Pre and Post monsoon period. The calcium concentration of the block is 30-264 and 10-280 for pre and post monsoon seasons. The calcium value of 200 mg/l is permissible. The block is showing a slight growth in the values of calcium growth in a few places.

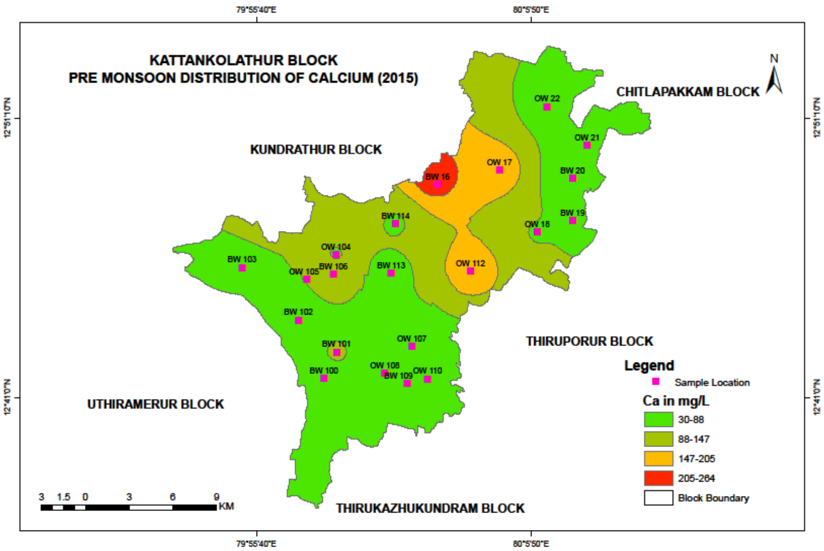

Fig.-6: Spatial Distribution of CA pre monsoon 2015

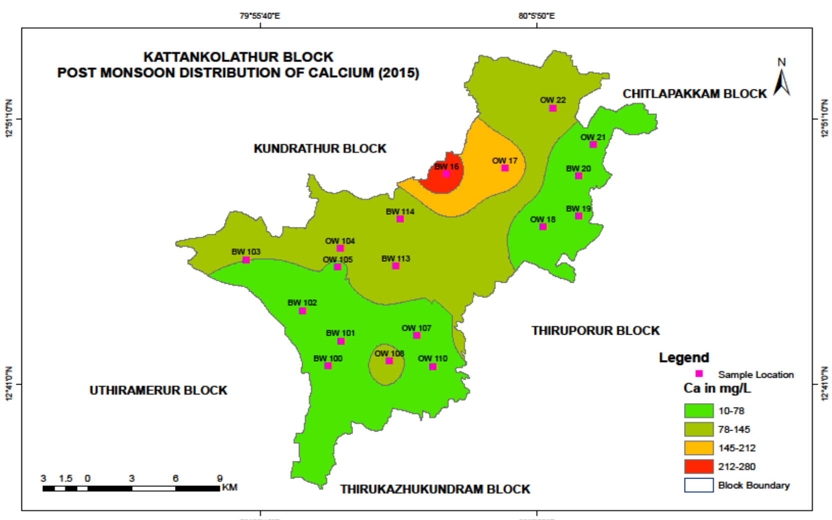

Fig.-7: Spatial Distribution of CA post monsoon 2015

Magnesium (Mg)

The value of magnesium varies between 7-180 for pre monsoon and 10-219 for post monsoon seasons. According to World health organization (WHO), the permissible limit of Mg is 50mg/l. Figure-8 and Figure-9 explain the spatial distributions of magnesium both in pre and post monsoon.

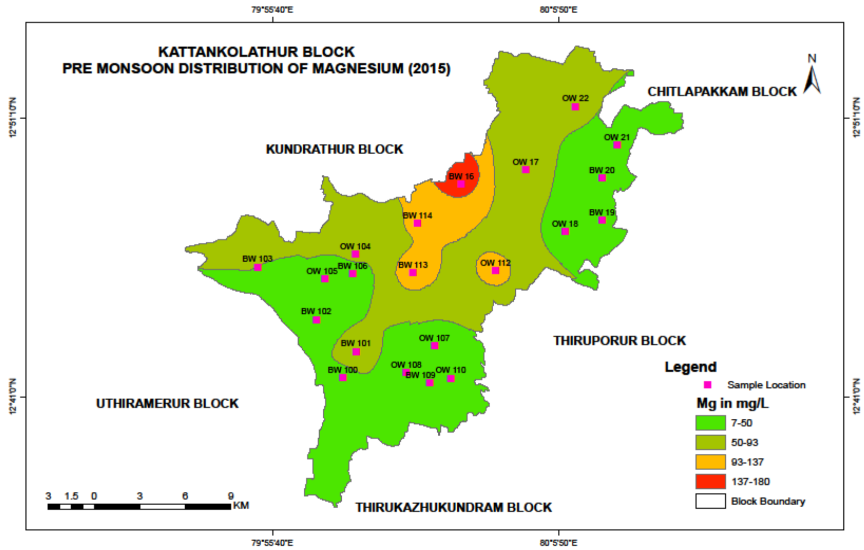

Fig.-8: Spatial Distribution of Mg pre monsoon 2015

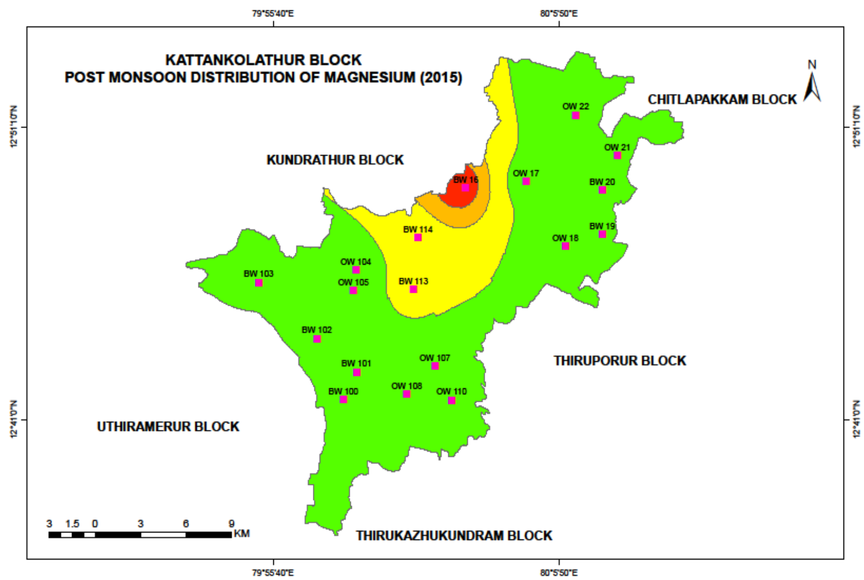

Fig.-9: Spatial Distribution of Mg post monsoon 2015

Sodium (Na)

Sodium salts (e.g., sodium chloride) are found in virtually all food (the main source of daily exposure) and drinking-water. Concentrations of sodium in potable water are typically less than 20 mg/l. The levels of sodium salts in air are normally low in relation to those in food or water. It should be noted that some water softeners can add significantly to the sodium content of drinking-water. However, concentrations in excess of 200 mg/l may give rise to unacceptable taste. The 1958, 1963 and 1971, WHO International Standards for Drinking-water did not refer to sodium.

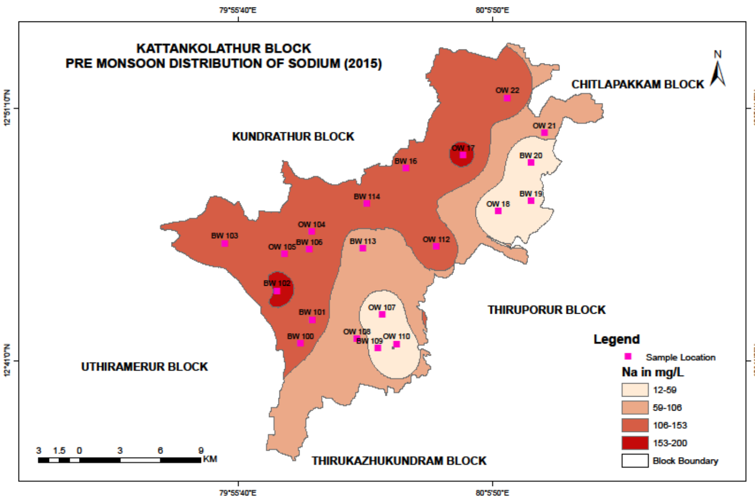

Fig.-10: Spatial Distribution of Na pre monsoons 2015

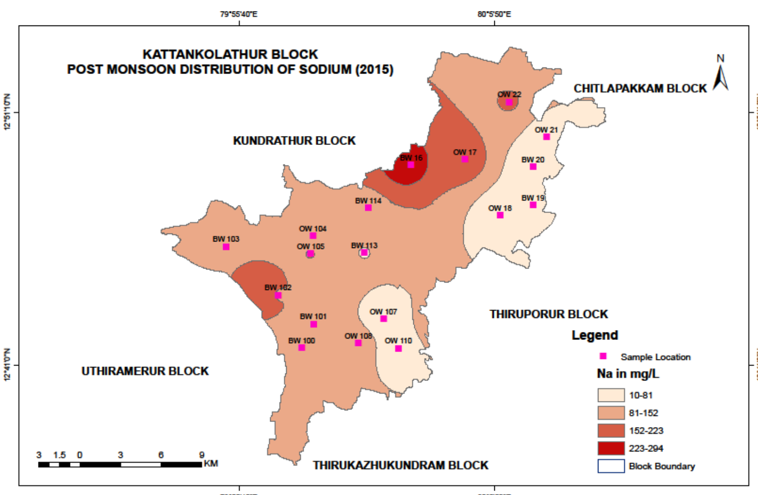

Fig.-11: Spatial Distribution of Na post monsoon 2015

In the first edition of the Guidelines for Drinking-water Quality, published in 1984, it was concluded that there was insufficient evidence to justify a guideline value for sodium in water based on health risk considerations, but it was noted that intake of sodium from drinking-water may be of greater significance in persons who require a sodium-restricted diet and bottle-fed infants. The pre and post monsoon distribution of Sodium (Na) varies between 12-200 mg/l and 10-294 mg/l in both pre and post monsoon seasons and are plotted in the Figure-10 and Figure-11 above.

Potassium (K)

Potassium is an essential element in humans and is seldom, if ever, found in drinking water at levels that could be a concern for healthy humans. It occurs widely in the environment, including all natural waters. It can also occur in drinking-water as a consequence of the use of potassium permanganate as an oxidant in water treatment. Figure-12 and Figure-13 show the spatial distribution of Potassium over the study area for Pre and Post Monsoon period. The concentration of potassium varies between 0-117 mg/l and 3-137 mg/l for pre and post monsoon periods.

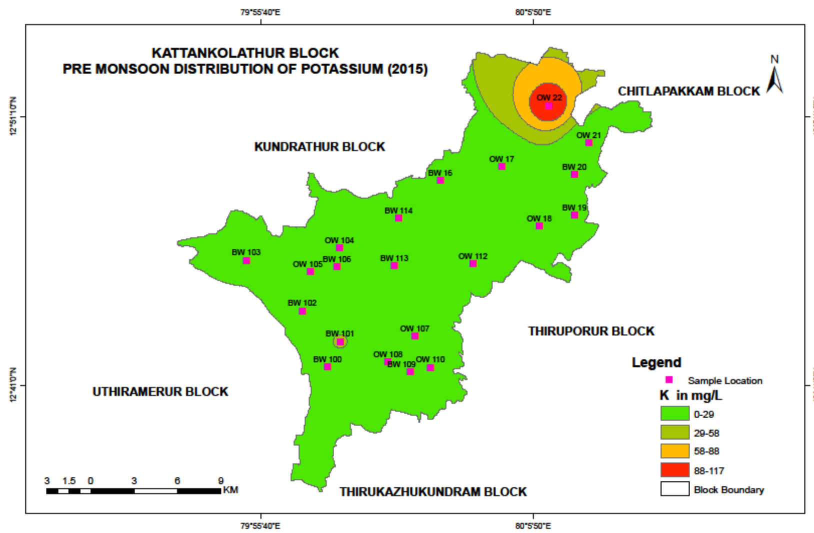

Fig.-12: Spatial Distribution of Potassium Pre monsoon 2016

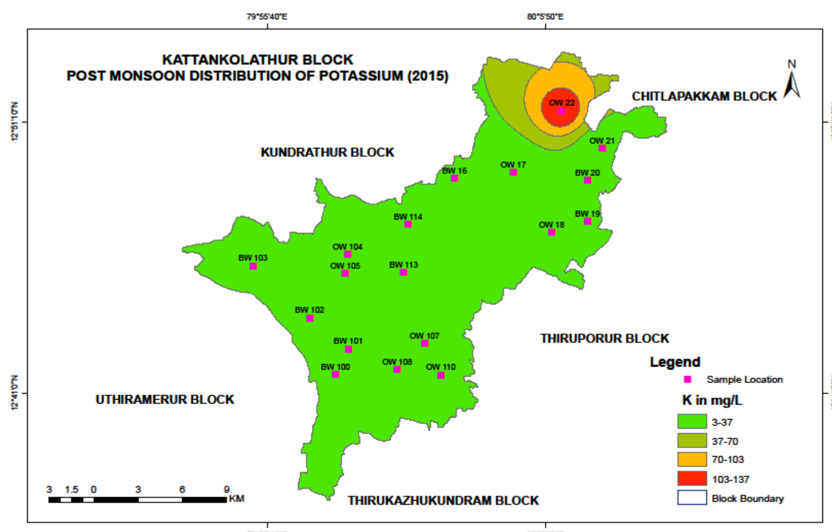

Fig.-13: Spatial Distribution of Potassium post monsoon 2015

Similarly the spatial distribution of Bicarbonate (HCO3) and SO4 is given in the Figures-14, 15, 16 and 17. The variation of HCO_3 ranges between 92-525 mg/l in pre monsoon season and 85-586 in post monsoon seasons. The SO_4 concentration varies between 1-99 mg /l and 1-120 mg /l for both the seasons respectively.

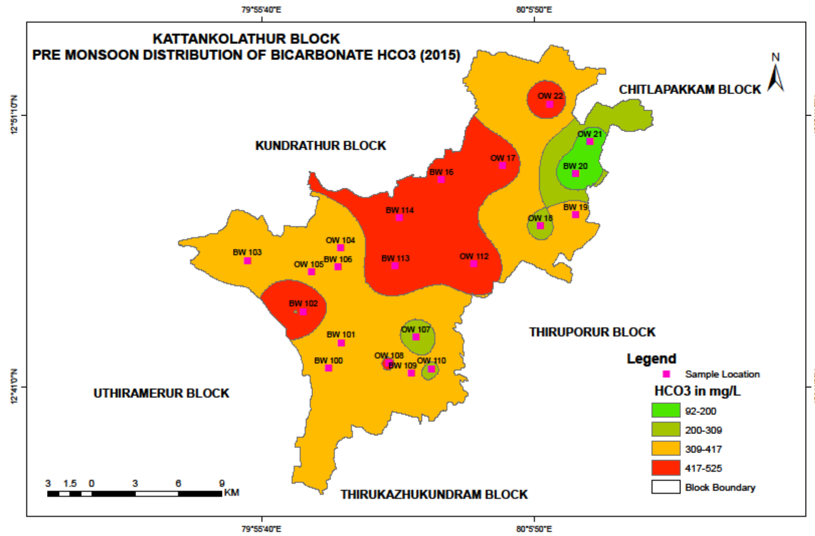

Fig.-14: Spatial Distribution of HCO_3 pre monsoon 2015

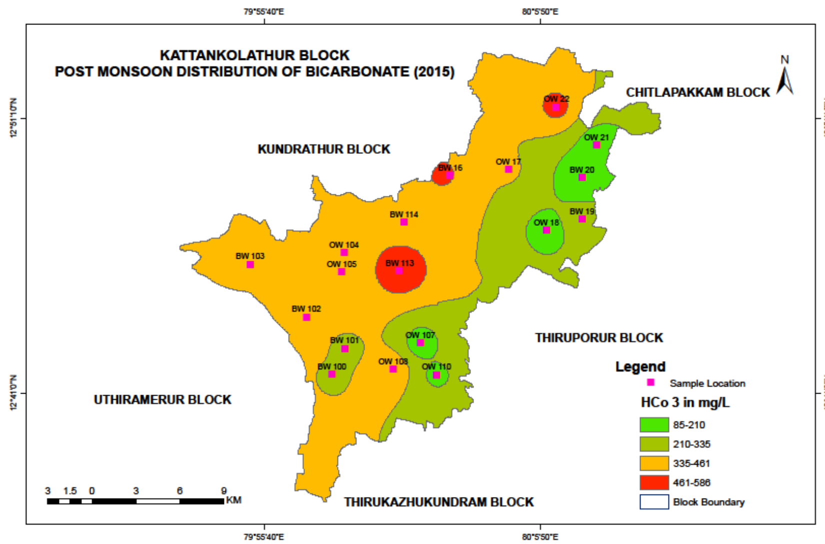

Fig.-15: Spatial Distribution of HCO_3 post monsoon 2015

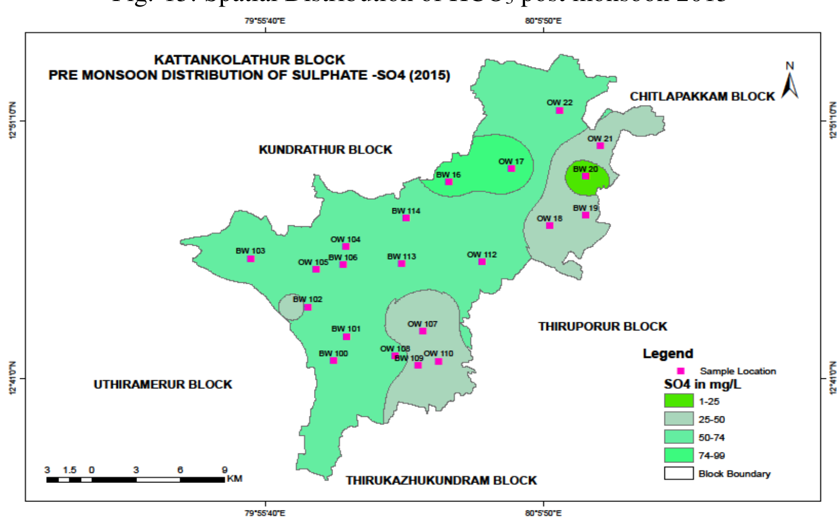

Fig.-16: Spatial Distribution of SO_4 pre monsoon 2015

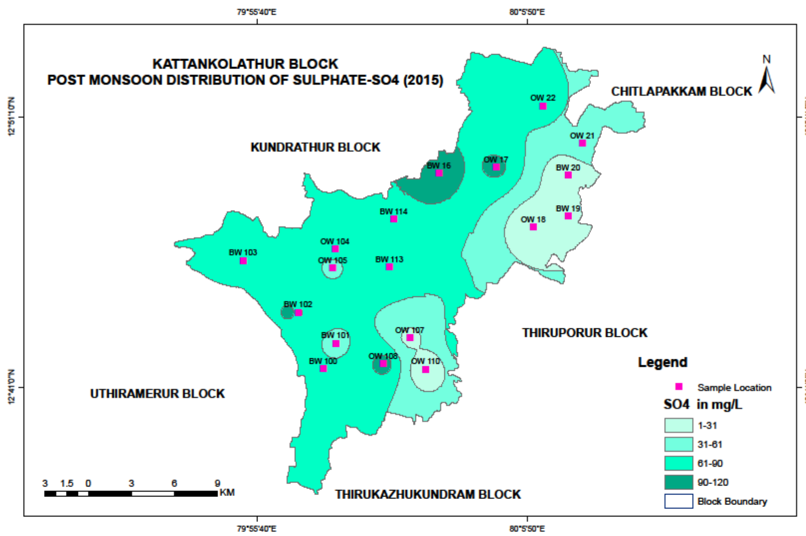

Fig.-17: Spatial Distribution of SO_4 post monsoon 2015

Chloride (Cl^-)

Commonly higher Chloride is due to weathering from silicate rich rocks. Since, due to the lack of Cl bearing minerals in silicate terrain, it might have derived from anthropogenic (human) sources including usages of fertilizer, human and animal waste, and industrial applications. These sources can result in significant concentrations of chloride in groundwater because chloride is readily transported through the soil.[13]

The maximum allowable limit of Cl for drinking water specified as per the WHO is 600 mg/l. Chloride itself in drinking water is generally not harmful to human beings. But it may contribute to the total dissolved solids (TDS) in drinking water. The value of chlorine varies between 18-752 and 9-1120 for both the seasons. The spatial distribution of chloride in the study area during both the seasons is shown in the Figure-18 and Figure-19.

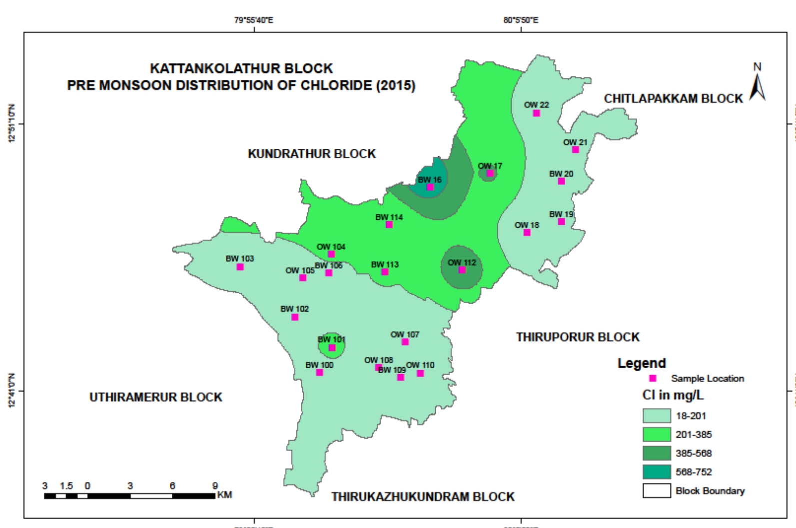

Fig.-18: Spatial Distribution of Chloride Pre monsoon 2015

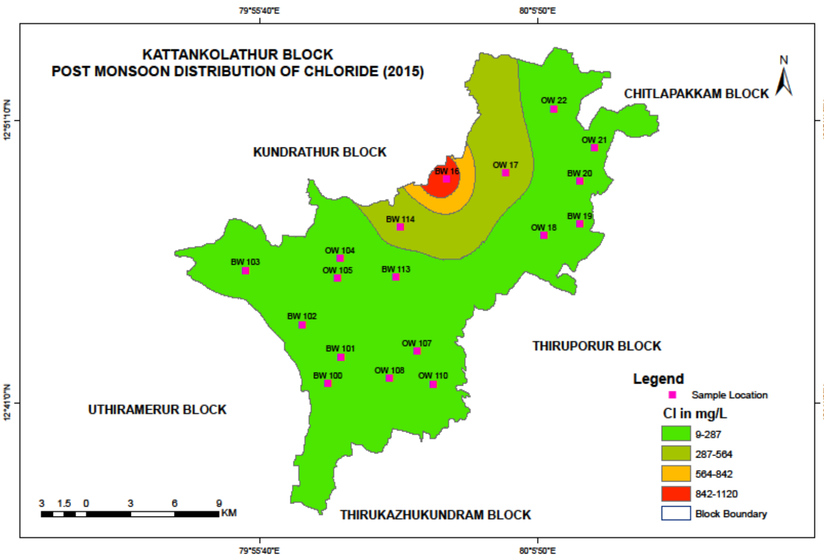

Fig.-19: Spatial Distribution of Chloride Post monsoon 2015

Nitrate (NO_3) is found naturally in the environment and is an important plant nutrient. It is present at varying concentrations in all plants and is a part of the nitrogen cycle. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater disposal and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks. The 1958 WHO International Standards for Drinking-water referred to nitrates, stating that the ingestion of water containing nitrates in excess of 50–100 mg/l (as nitrate). Nitrate concentration varies from 5 to 81 and 3to118 mg/l for both pre and post monsoon respectively and the spatial distribution of Nitrate is given in the Figures- 20 and 21.

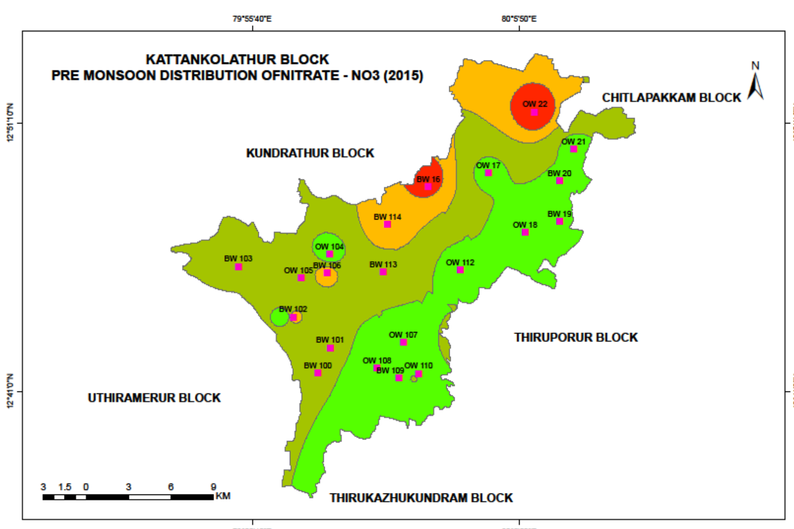

Fig.-20: Spatial Distribution of NO_3 pre monsoon 2015

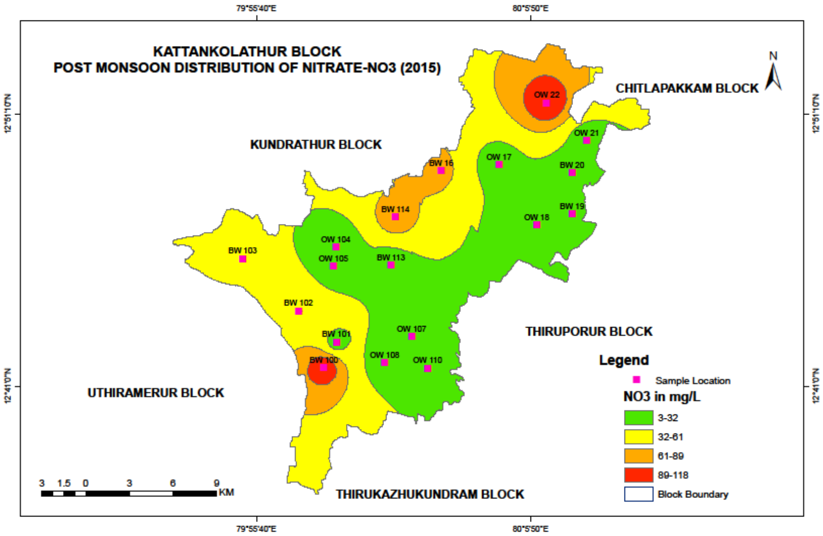

Fig.-21: Spatial Distribution of NO_3 post monsoon 2015

Fluoride

Fluorine is a common element that is widely distributed in the earth's crust and exists in the form of fluorides in a number of minerals, such as fluorspar, cryolite and Fluor apatite. Traces of fluorides are present in many waters, with higher concentrations often associated with underground sources. In areas rich in fluoride-containing minerals, well water may contain up to about 10 mg of fluoride per litre, although much higher concentrations can be found. In addition, fluoride exposure in some areas is considerably higher as a consequence of a range of practices, including the consumption of brick tea and the cooking and drying of food with high-fluoride coal. According to WHO guidelines the permissible limits of Fluorine in drinking water is 1.5mg/l. The value of fluoride for both pre and post monsoon varies between 0.12-1.13mg/l and 0.23-1.13 mg/l respectively. The Figure-22 and 23 shown below gives the spatial distribution of Fluoride of the Kattankulathur block.

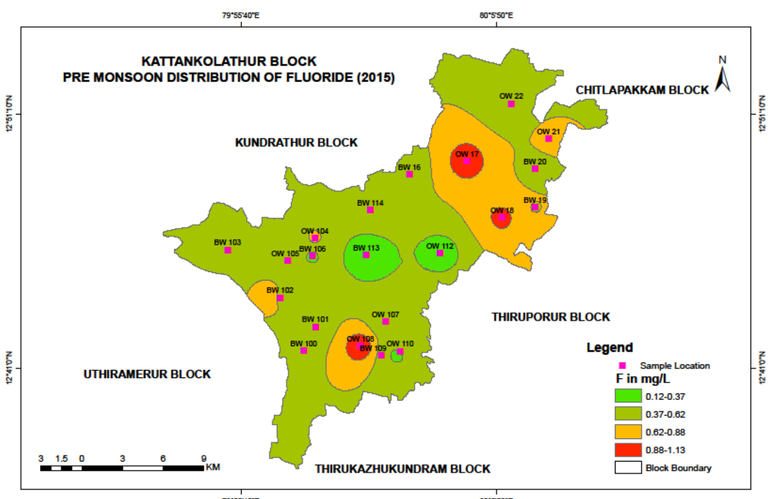

Fig.-22: Spatial Distribution of F pre monsoon 2015

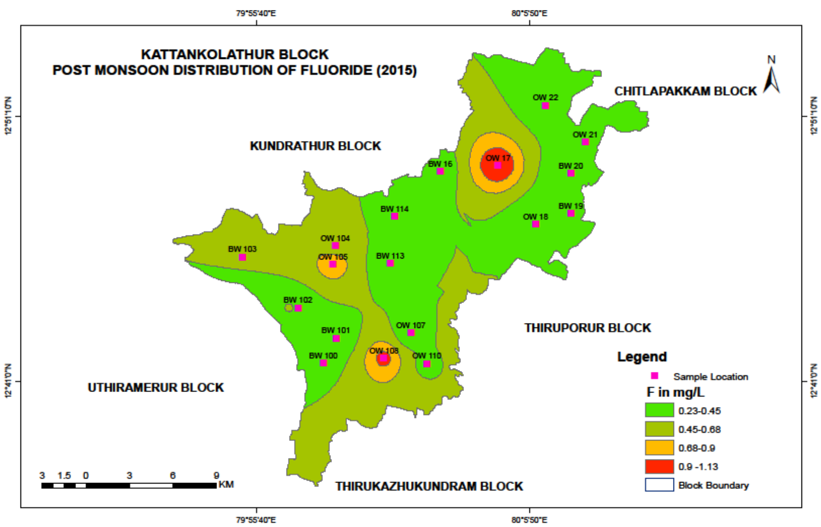

Fig.-23: Spatial Distribution of F post monsoon 2015

Total Dissolved Solids (TDS)

Total Dissolved Solids means the total concentration of dissolved solids or minerals in water. TDS is determined from the weight of the dry residue after a sample of water is evaporated. It may also be calculated from the summation of the total concentration of all ions in the water.

According to WHO's standard, water with TDS of more than 1500 mg/L is not suitable for drinking purpose? No recent data on health effects associated with the ingestion of TDS in drinking water appear to exist; however, a high concentration of total solids will make drinking water unpleasant.
TDS comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and small amounts of organic matter that are dissolved in water. TDS in drinking-water originate from natural sources, sewage, urban runoff and industrial wastewater. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste. The study area shows a variation of 145 to 1794 mg/l and 121 to 2394 mg/l in TDS concentration for both seasons. Figures-24 and 25 show the spatial distribution of TDS for the given block.

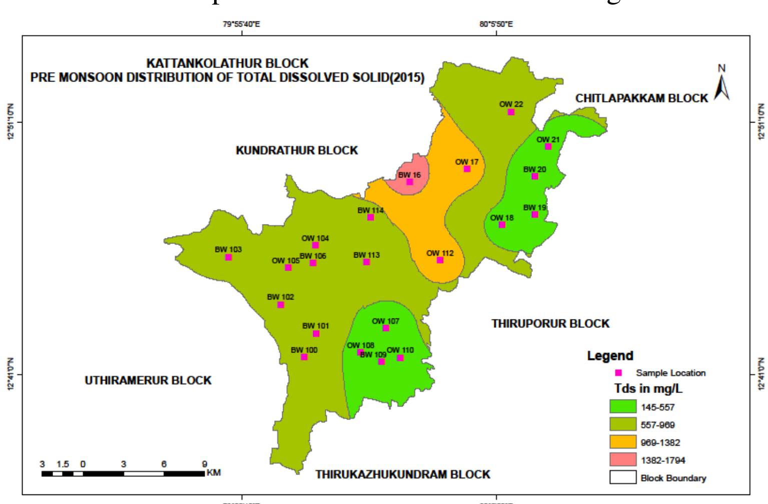

Fig.-24: Spatial Distribution of TDS - Pre monsoon 2015

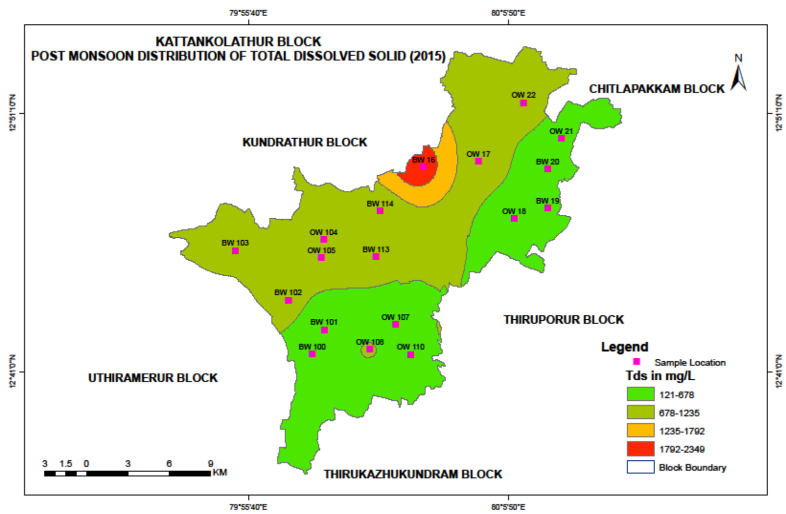

Fig.-25: Spatial Distribution of TDS - Post monsoon 2015

As the host rocks belongs to Charnockite and granitic suites, there can be some oxidation and reduction processes in groundwater and surface water, thereby causing enrichment in the total dissolved solids.

Total Hardness (TH)

The presence or absence of the hardness minerals in drinking water is not known to pose a health risk to users, but hardness of water causes scaling of irrigation pipes. The Total Hardness is calculated by the formula,

$$TH\ mg/L = 2.497\ Ca^{2+} + 4.115\ Mg^{2+}$$

The total hardness is commonly classified in terms of degree of hardness as soft (0 to 60 mg/L), moderately hard (60 to 120 mg/L), hard (120 to 180 mg/L) and very hard (>180 mg/L)categories .
The total hardness shows 80% of the samples are suitable for irrigation during both the seasons (Table-1).The spatial distribution of total hardness values in the study area during both the seasons are shown in the Figures-26 and 27 show the spatial distribution of TH over the block.**.** The samples fall in very hard category during pre-monsoon season show ranging between 57.5% to 77.5% during this period. The value of TH is 105-1400 mg/l for pre monsoon and 65-1600 mg /l for post monsoon seasons.

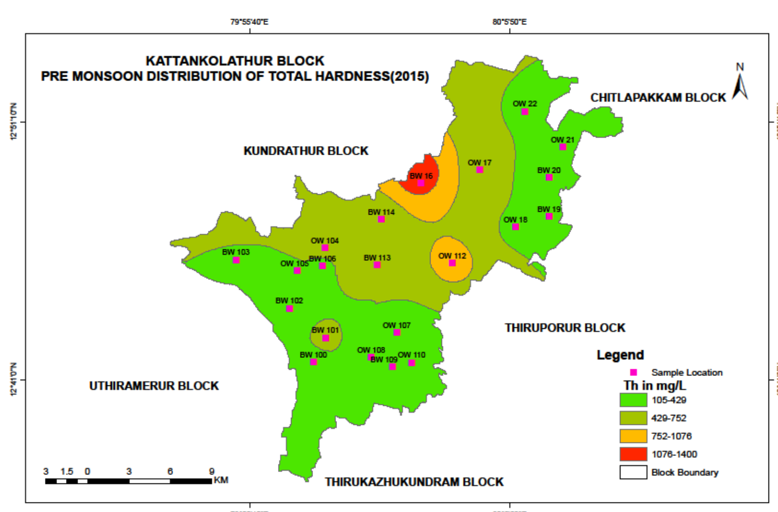

Fig.-26: Spatial Distribution of Total Hardness - Pre monsoon 2015

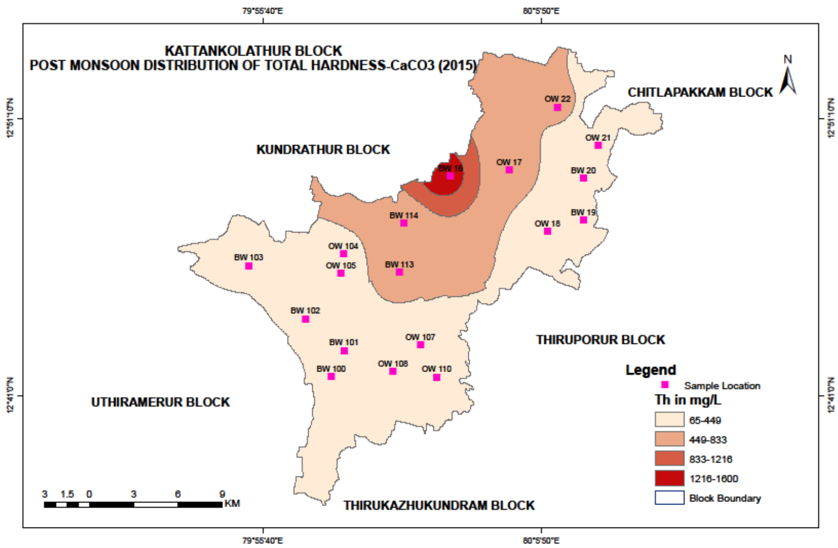

Fig.-27: Spatial Distribution of Total Hardness - Post monsoon 2015

The samples fall in very hard category during post monsoon season show increasing from 52.5% to 75% during the period 1998 and 2008 and decreased to 70% in the year 2015.

Buffering Capacity (Alkalinity)

Buffering capacity (also called alkalinity) refers to the capability of water to neutralize acid. The presence of calcium carbonate or other compounds such as magnesium carbonate contribute carbonate ions to the buffering system. Alkalinity is often related to hardness because the main source of alkalinity is usually from carbonate rocks (limestone) which are mostly $CaCO_3$.For protection of aquatic life the buffering capacity should be at least 20 mg/L.

If alkalinity is naturally low, (less than 20 mg/L) there can be no greater than a 25% reduction in alkalinity. Alkalinity is a measure of how much acid can be added to a liquid without causing a large change in pH. Higher alkalinity levels in surface waters will buffer acid rain and other acid wastes and prevent pH changes that are harmful to aquatic life. Figures-28 and 29 show the spatial distribution of Alkalinity ($CaCO_3$) over the block for the two seasons.

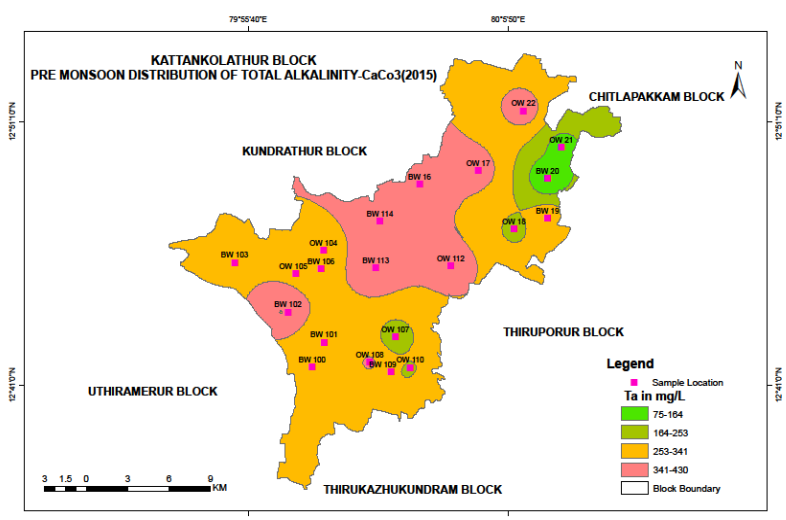

Fig.-28: Spatial Distribution of Total Alkalinity pre-monsoon 2015

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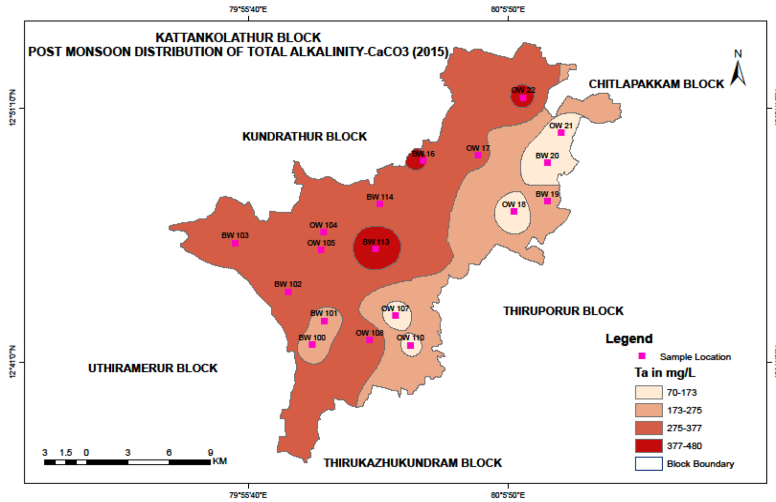

Fig.-29: Spatial Distribution of Total Alkalinity post monsoon 2015

The value of TA varies between 75 to 430 mg/l and 70 to 480 mg/l in pre and post monsoon seasons. In the present study, higher hardness is present in 80 to 85% of the sub-basin area in both the seasons.

Table-1: Pre and Post Monsoon Variation of Different geochemical parameters

S.No.	Geochemical Parameter	Pre-Monsoon		Remark	Post-Monsoon		Remark
		Min	Max		Min	Max	
1	EC	260	3360	Potheri	220	4490	Potheri
2	pH	6.9	7.6	Pullipakkam	7.8	8	Kumuli
3	Ca	30	264	Potheri	10	280	Potheri
4	Mg	7	180	Potheri	10	219	Potheri
5	Na	12	200	Attur RS backside	10	294	Potheri
6	K	0	117	Oonamcherri	3	137	Oonamcherri
7	HCO_3	92	525	Singaperumal Koil	85	586	Singaperumal Koil
8	CO_3	0	0	-----	0	0	-------
9	SO_4	1	99	Kayarambedu	1	120	Potheri
10	Cl	18	752	Potheri	9	1120	Potheri
11	NO_3	5	81	Oonamcherri	3	118	Oonamcherri
12	F	0.12	1.13	Tennur	0.23	1.13	Kyrambedua
13	TDS	145	1794	Potheri	121	2349	Potheri
14	TH	105	1400	Potheri	65	1600	Potheri
15	TA	75	430	Singaperumal Koil	70	480	Singaperumal Koil

CONCLUSION

The above study shows the variation of different geochemical parameters of ground water which are essential for the domestic and drinking water purposes. The parameters like pH, Ca, Mg , CO_3, HCO_3, NO_3,, F are well within or slightly above the limits , which are of not much concern or little care can be taken through awareness and treatment, so as not to cross the permissible limit. Whereas the parameters like TDS, TH and TA are beyond the permissible limit which requires immediate attention for treatment and necessary measures to reduce these geochemical parameters. This is mainly due to the untreated solid wastage and host rock compositions. The both season data has been collected keeping in view of the well locations, distribution over the block and proximity to the settlement.

REFERENCES

1. S. Manjunatha and J. Davithuraj, *International Journal of Recent Trends in Science And Technology*, **11,1,** 95(2014)
2. L.A. Richards, US Department of Agricultural Handbook,. **60**(1954)
3. X. Rosario Arun Kumar et al., *World Applied Sciences Journal*, **17(8)**, 1033(2012)
4. Chander Kumar Singh et al., *International journal of Geomatics and Geosciences,* **62(7)**, 1387 (2011)
5. H.A. Tirpude et al*., Asian Journal of Environmental Science* **8(2)**, 111(2013)
6. Pulle, J. S et al *Pollution Research,* **24(3)**, 657(2005)
7. Saumitra Mukherjee et al. *Journal of Environmental Earth Sciences* , **72(1),** 111(2014)
8. S.L. Arunkumar et al., *International Journal of Earth Sciences and Engineering*, **4(6)**, 986(2011)
9. M. Arunprakash et al, *Journal of Environmental Earth Sciences* ,**71(2)** , 947(2014)
10. S Venkateswarana et al. *International Journal of Earth sciences and engineering,* **8(2),** 292 (2015)
11. S. Durgadevagi and R. Annadurai, *Rasayan J. Chem*, **9(3)**,465 (2016)
12. K. Prasanna and R. Annadurai, *Rasayan J. Chem*., **9(2),** 319(2016).
13. R. F. Stallard, and J. M. Edmond , *Journal of Geophysical Research: Oceans* **92(C8),** 8293(1987) .

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