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Urbanization persuaded geochemical impact assessment of groundwater quality for Kattankulathur block, Tamil Nadu, Southern India

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Abstract : Quality of groundwater assurances the wellbeing, success, and improvement of the society. The existing humanoid demands clean water for daily consumption as drinking, different domestic usages and agricultural activities. It is a known fact that groundwater is the only source of freshwater in the highly urbanized regime. The over inhabitants and non-judicial development of groundwater along with the dumping of untreated urban solid waste is a potential source of threat for groundwater contamination. For the current study, the Kattankulathur Block of Kanchipuram district of Tamil Nadu has been undertaken to understand the urbanization trend and its impact on groundwater. The block is having a geographical area of 378.536 sq. km with variant educational and industrial sectors and besides with Thirurpour blocks, which is having more than 60% of textile industries. The present urbanized area is of an extent of 55.44sq.km.(2014), which is more than two-fold compared to the year 1995 which was 22.509.km for this block. Present study targets at examining various factors of water quality around different parts of the Kattankulathur Block. The spatial distribution of water quality contours has been plotted using ArcView. The study shows though the groundwater potential is decreasing in alarming rate, the potentiality of groundwater concerning drinking water quality.
Key Words : Groundwater, Water Quality Parameters, Spatial Distribution, Urbanization.

Introduction:

Groundwater is largest source of fresh water for major part of the world.The uncontrolled growth of population, many fold growth of urbanization and industrialization, demands quick and non-judicial development of the available source of groundwater.[1]The other threat to groundwater is the dumping of untreated solid wastes, which because of leaching and other processes affects groundwater.[2]Again unprocessed industrial effluent and other anthropogenic sources embracesignificantinfluence for the deterioration of groundwater.[3] Changes in groundwater quality are due to rock–water interaction and oxidation–reduction reactions during the percolation of water through the aquifers.[4]Groundwater quality based on the physical-chemical and ion exchanges processes of the soil and rock materials. Chemical contamination of the

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reactions during the percolation of water through the aquifers.[4]Groundwater quality based on the physical-chemical and ion exchanges processes of the soil and rock materials. Chemical contamination of the groundwater is largely reliant on the geochemistry of the soil through which the water flows previously to reach the aquifers.[5]As per World Health Organization (WHO),nearly 80% of all the diseases in human beings are caused by water.

Determination of groundwater quality requires a proper method to calculate accurate quality at local and regional scales using readily available information. In this work, an integrated Geographical Information System (GIS) and Water Quality Analysis based methodology has been utilized for the assessment of groundwater quality in the study area. All the data were prepared as GIS layers and were integrated through GIS tools to identify the distribution patterns of frequency for different elements and to demarcate the high concentration zones.This study is attempted to understand the hydro geochemical investigations of groundwater for an interval of 10 years viz. 1995 and 2015 for pre and post monsoon seasons.

Study Area

The study area, Kattankulathur Block which extended from 12°40’ to 12°48'North, and 79°55’ to 80°1'East and is situatedat North of TamilNadu state of southern India. The Geographical area of the block is about378.53 Sq.Km. Chengalpattu, Marammalai Nagar, Kattankolathur, Urapakkam, and Vandalur are the major town panchayat and taluk of this block (Figure 1).Palar is the primary drainage of the block and is flowing along the southern part of the blockneighboring Chengalpattu. Different small-scale industries for automobile, engineering, wood works, electrical and electronic works, manufacturing sector arefunctioning in the block, which are discharging untreated effluents to the open lands, nearby water bodies and wetlands, which in turn affecting the groundwater regime by different ways.[5]The major industrial output of this area is from Ford and other small scale industries.

Urbanization Trend:

The block shows a tremendous growth of urbanization pattern for the last few decades,by means of new development of towns, educational institutes,(Schools and engineering colleges) industries(Small or Large scale),automobile sectors, Shopping malls, factories and hospital sectors. The growth of urbanization has come up to a geographical area of 55.44 sq. Kmin the year 2014 (Figure 2) from 22.509 sq. Km in 1995 (Figure 3) which is a twofold rise in the areal extent. This upsurge in uncontrolled urbanization is bringing a threat to quantity as well as the quality of ground water. Groundwater potential is decreasing because of the unplanned construction and unattended uses of groundwater along with an improper planning of conservation of available water. Also, the quality is deterioratingthrough untreated dumping which are possible sources of contamination.

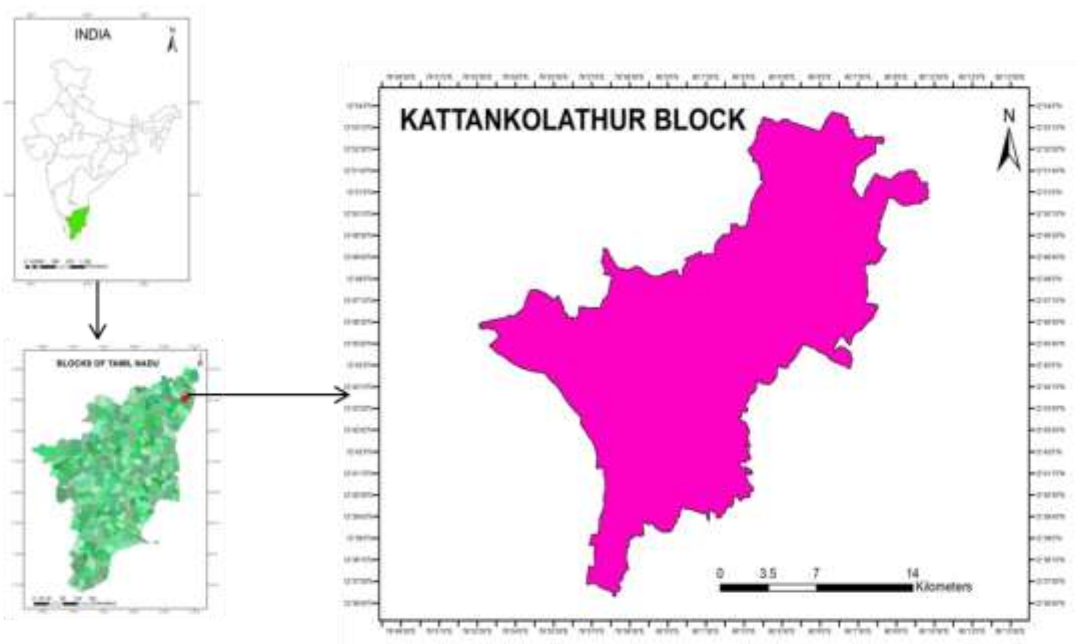

Figure 01:Location map of the Kattankolathur Block

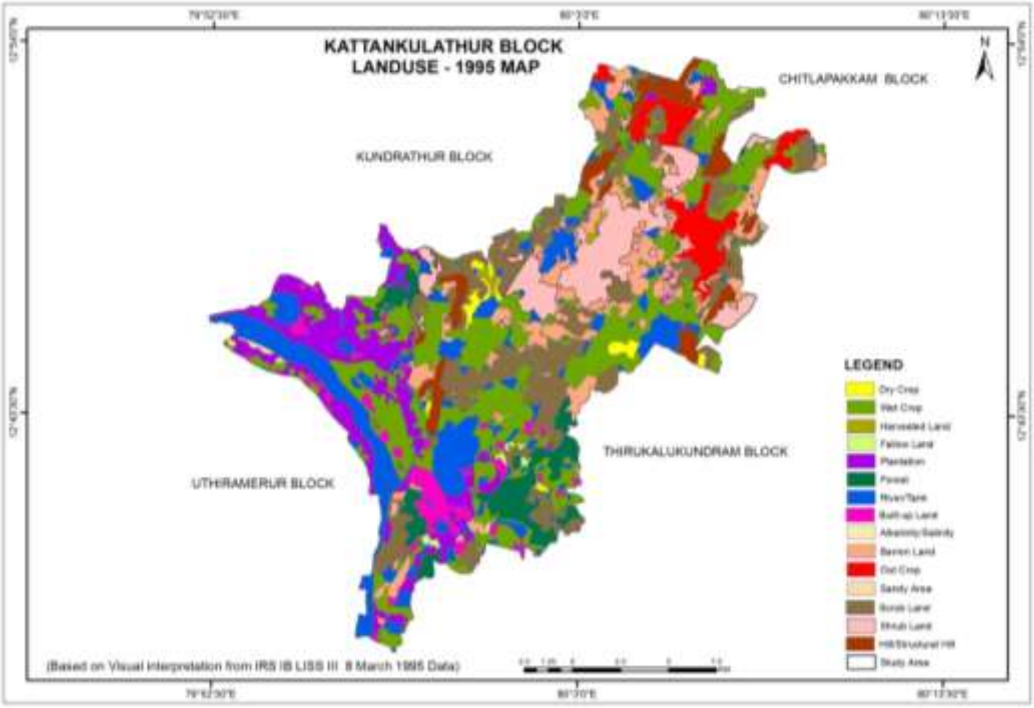

Figure 02:Landuse and land cover map of Kattankulathur block for the year 1995

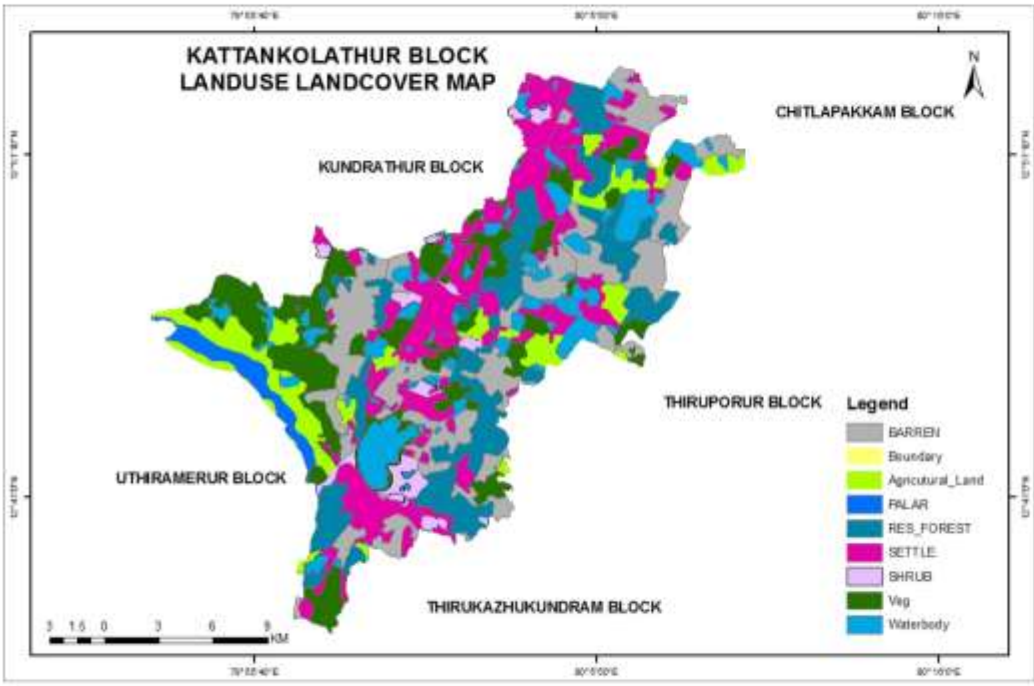

Figure 03:Landuse and land cover map of Kattankulathur block for the year 2014

Chloride (Cl^-)

Higher Chloride is because of weathering from silicate-rich rocks. Major silicate terrain shows a lack of Cl; hence it might have derived from different anthropogenic (human) sources which include usages of fertilizer, human and animal waste, and industrial effluents. These sources can result in significant concentrations of chloride in groundwater because chloride is conveyed through the soil to the aquifers.[5]

The maximum allowable limit of Cl for drinking water specified as per the WHO is 600 mg/L. Chloride itself in drinking water is usually not harmful to human beings. But it may contribute to the total dissolved solids (TDS) in drinking water. The spatial distribution of chloride for the year 1995 in the study area during both the seasons isgiven in Figure 04andFigure 05.The pre-monsoon cl value range from 32-547 mg/l and post monsoon is 25-749 mg/l. Similarly, the cl value for the pre and post monsoon ranges from 18-752 and 9-1120 mg/l respectively.[5]

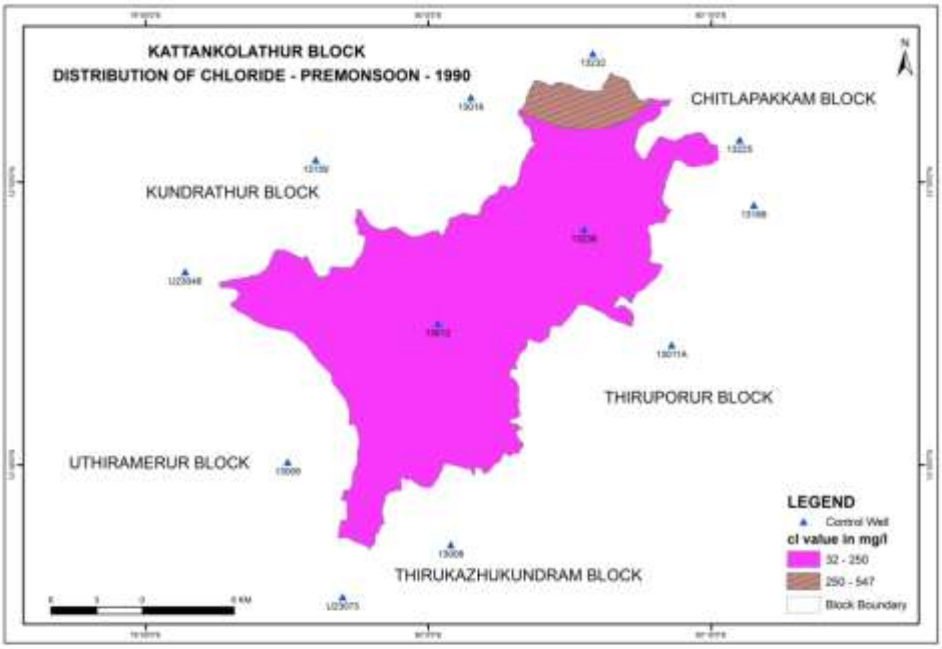

Figure 04: Spatial Distribution ofchloride – Pre-monsoon 1990

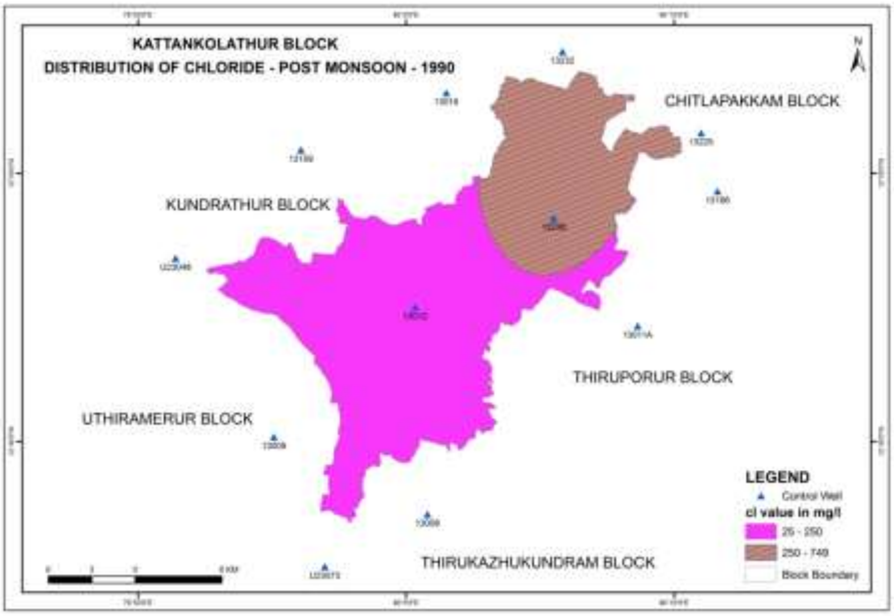

Figure 05: Spatial Distribution ofchloride - Post monsoon 1990

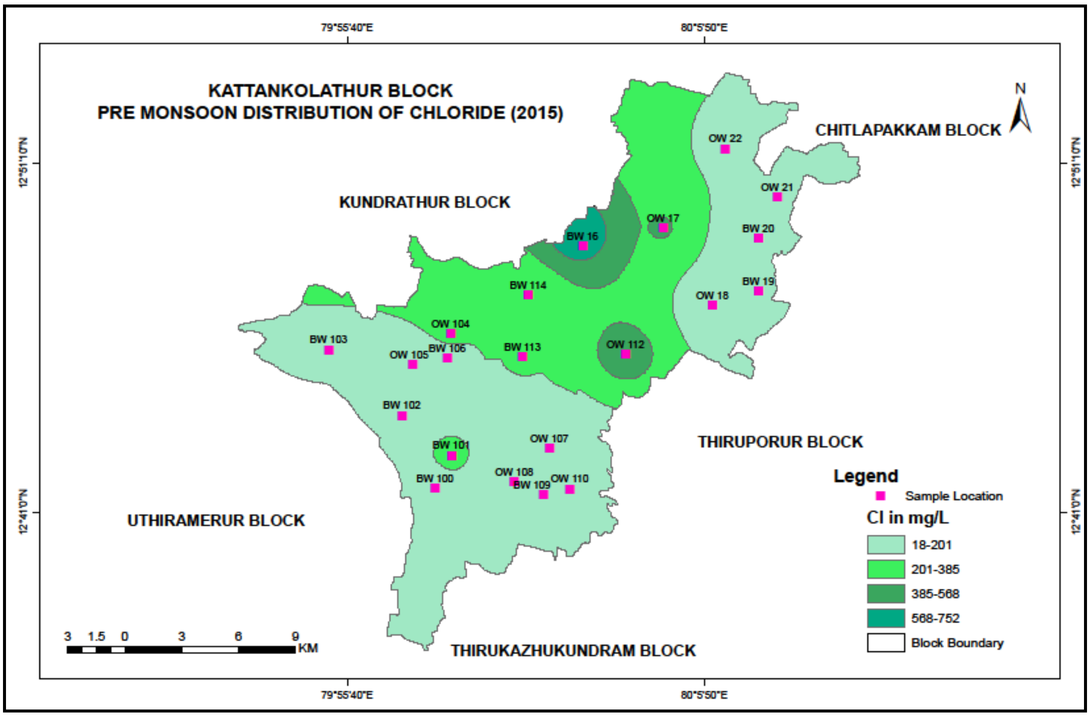

Figure 06: Spatial Distribution ofchloride -Post monsoon 2015

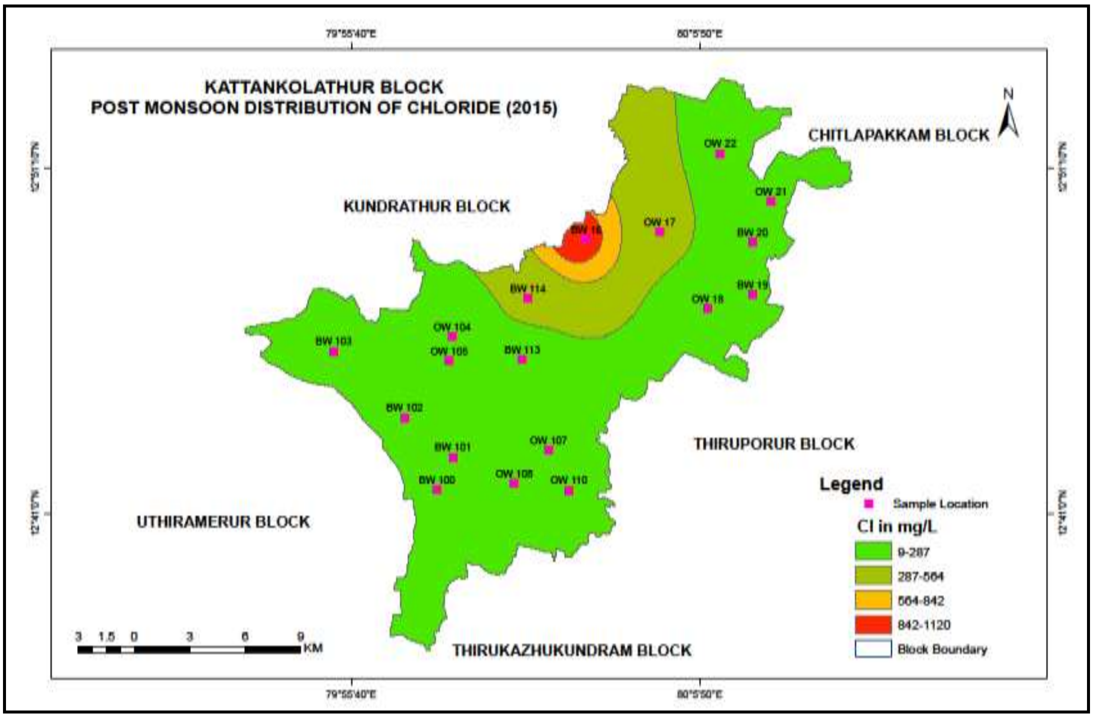

Figure 07:Spatial Distribution ofChloride- Post monsoon 2015

Total Dissolved Solids (TDS)

TDS signifies the total mass of the dissolved minerals or other solids in water. TDS is calculated from the weight of the dry residue after a sample of water is evaporated. It can also calculate from the summation of the total concentration of all ions in the water.

According to WHO guidelines the waterhaving a TDS concentration > 1500 mg/l is not acceptable for drinking purpose.

For the current study in the block, value of TDS ranges from 118-1428 mg/l for pre-monsoon, 120-1422 mg/l for post moon soon for the year 1995 and 145-1794 mg/l, 121-2349 mg/l for pre and post monsoon respectively in 2015.(Figure 8, 9, 10 & 11).[5]

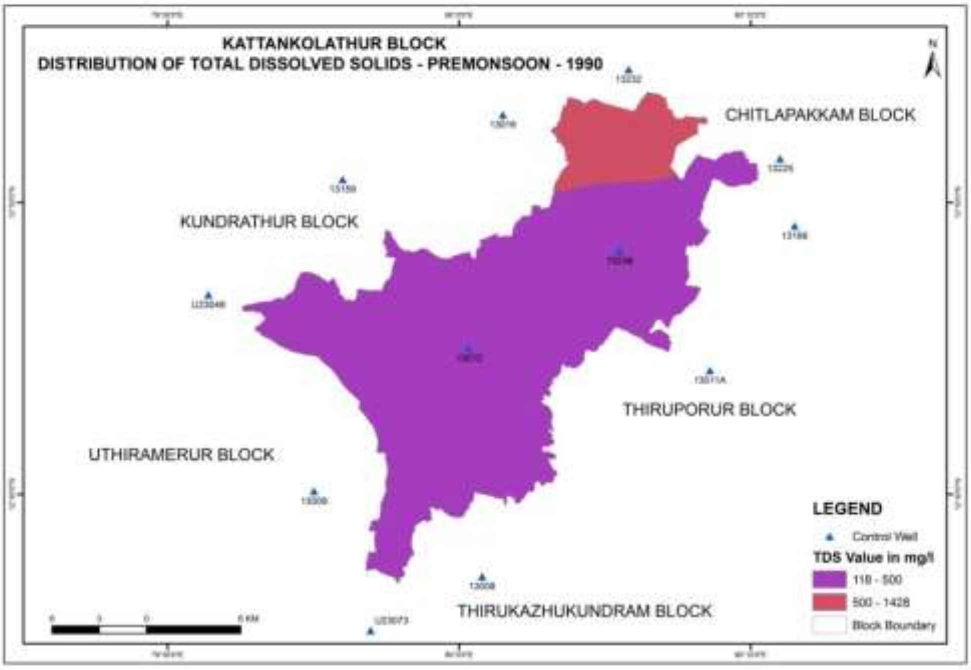

Figure 08: Spatial Distribution ofTDS Pre-monsoon 1990

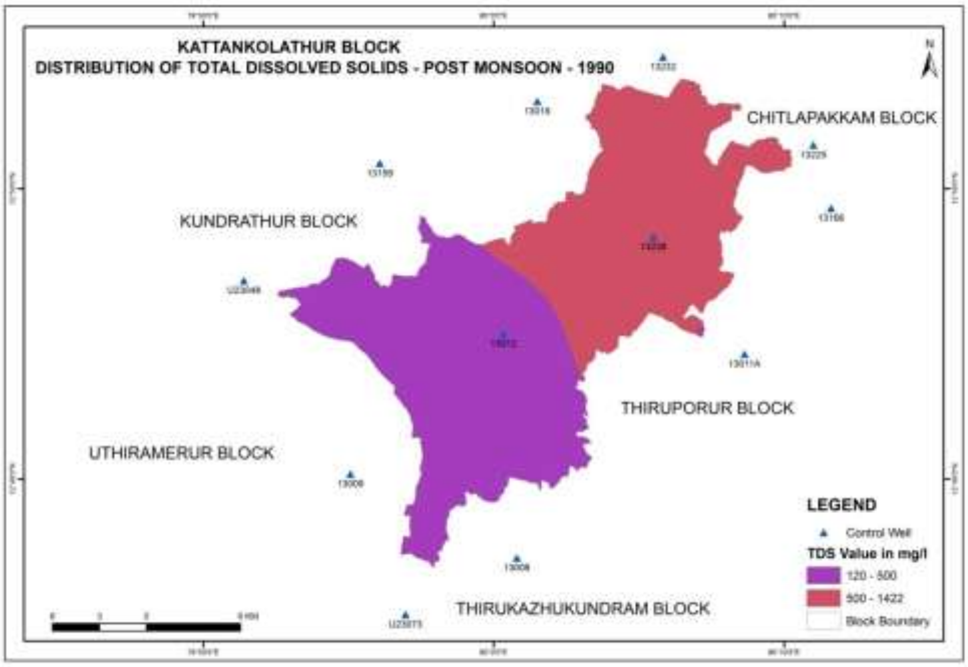

Figure 09: Spatial Distribution ofTDS Post monsoon 1990

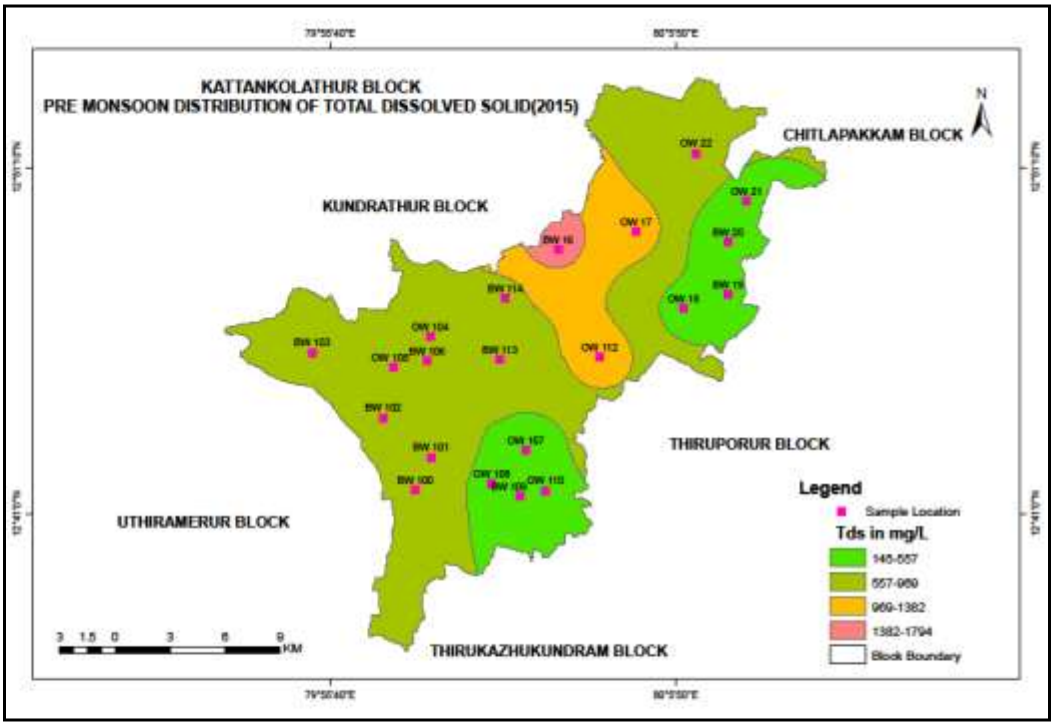

Figure 10: Spatial Distribution ofTDS Pre-monsoon 2015

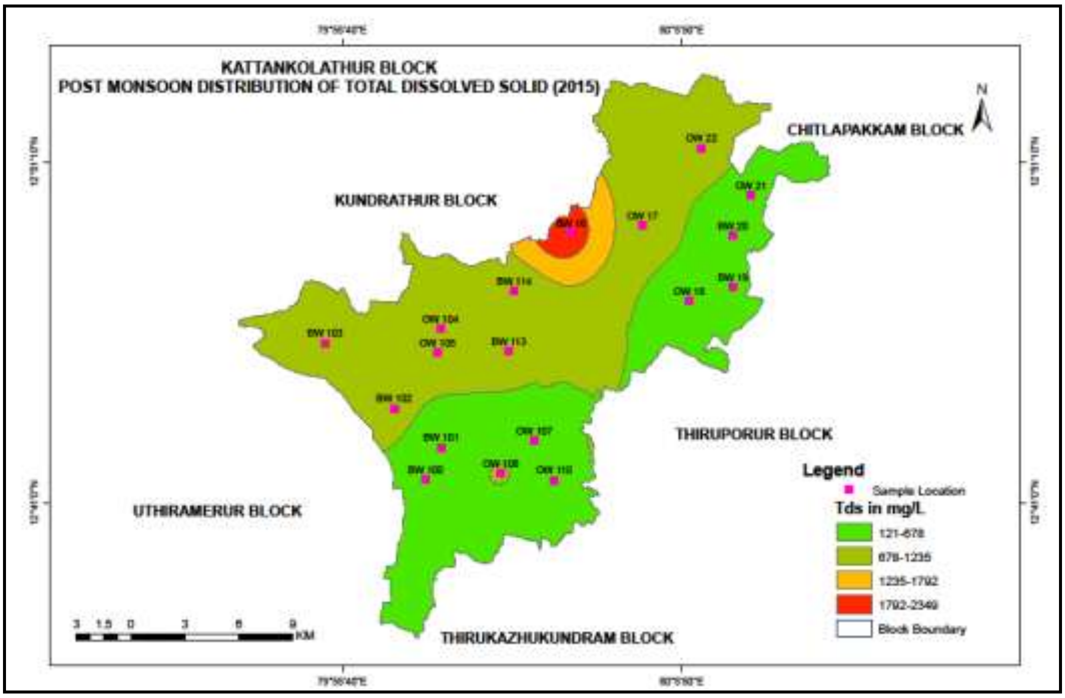

Figure 11: Spatial Distribution ofTDS Post monsoon 2015

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 the hardness of water causes scaling of irrigation pipes. The Total Hardness is calculated by the formula,

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

According to Durfer and Backer (1964), the common classification of total hardnessis, 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 in rapport of their degree of hardness. The TH is plotted for the both pre and post monsoon seasons for the year 1990 and 2015.[5]

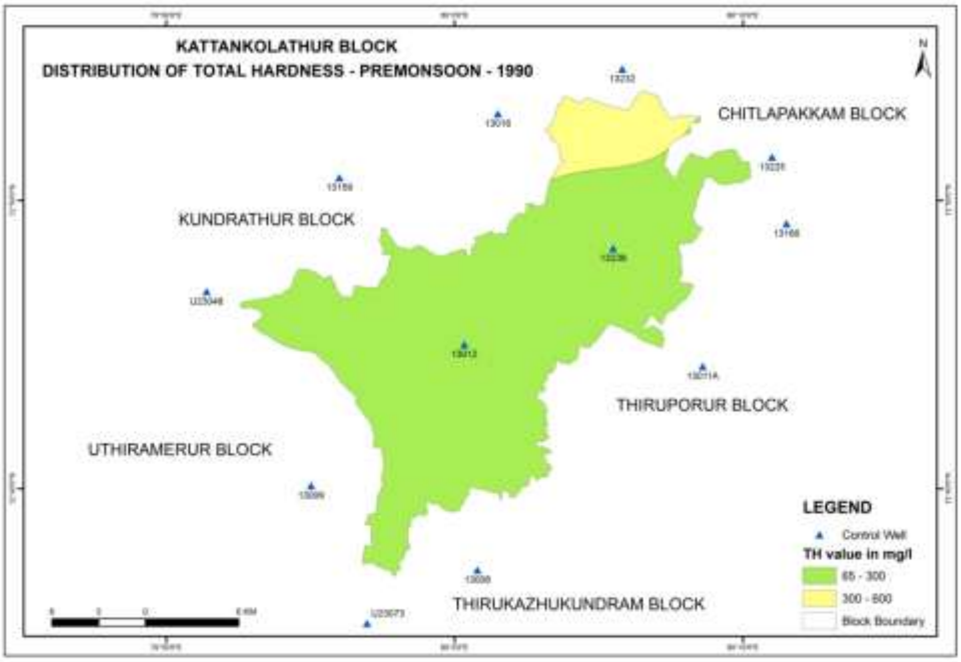

Figure 12: Spatial Distribution ofTH Pre monsoon 1990

The value of TH ranges from 65-300 mg/l and 55-490 mg/l for pre and post monsoon seasons in the year 1995, whereas the value becomes 105-1400 mg/l in pre monsoon and 65-1600 mg/l in post monsoon for the year 2015. (Figure 12, 13, 14 & 15)

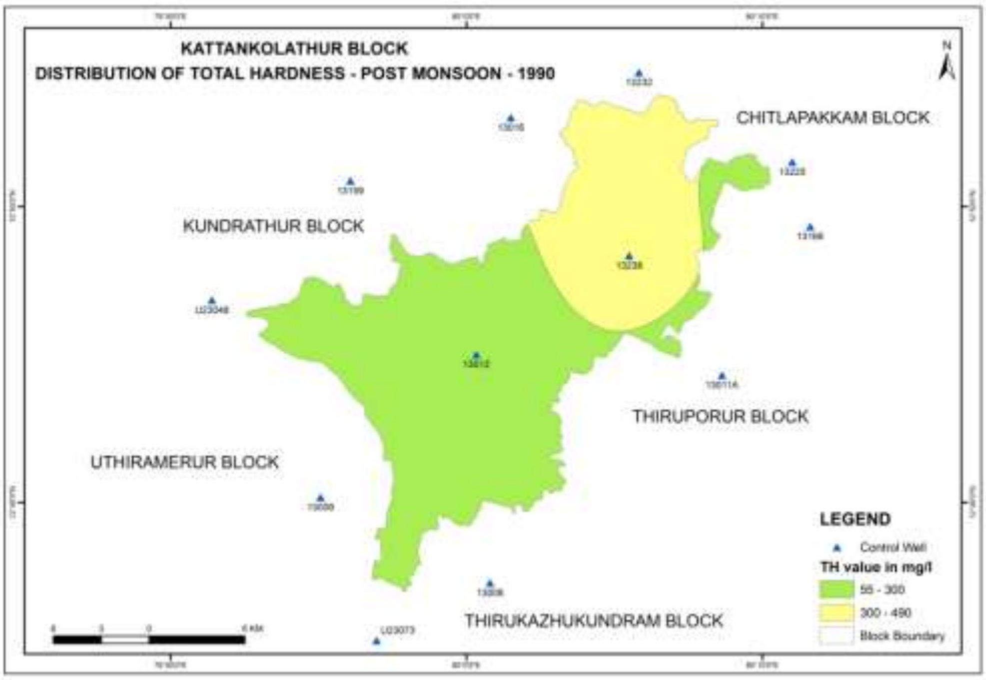

Figure 13: Spatial Distribution ofTH Post monsoon 1990

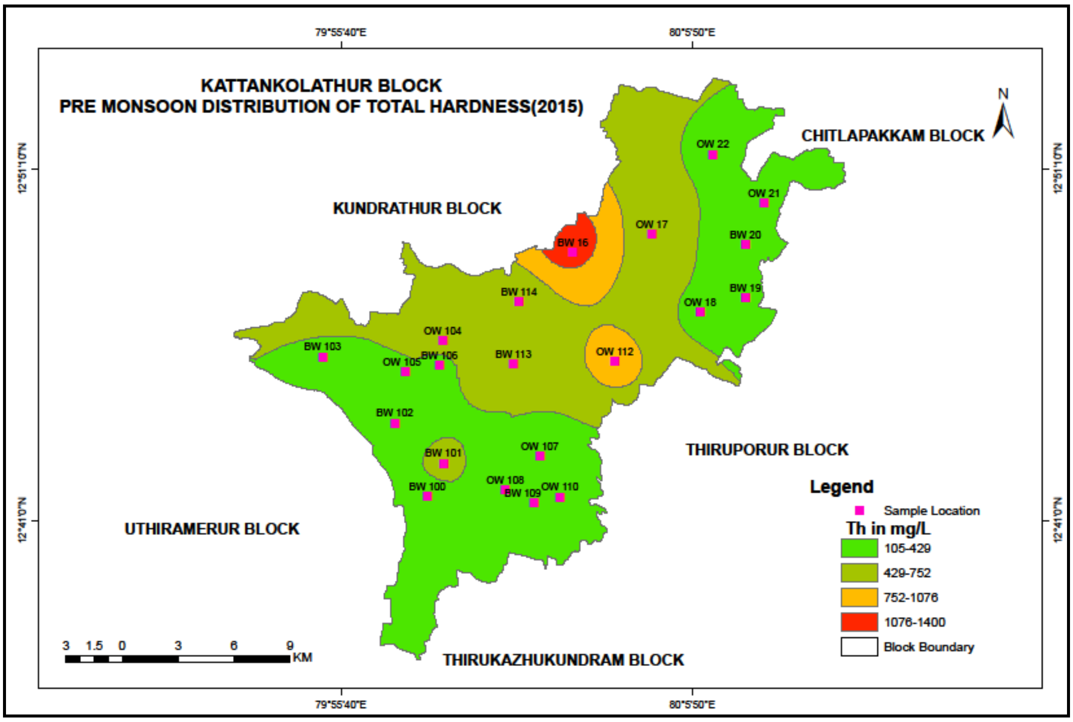

Figure 14: Spatial Distribution ofTH Pre-monsoon 2015

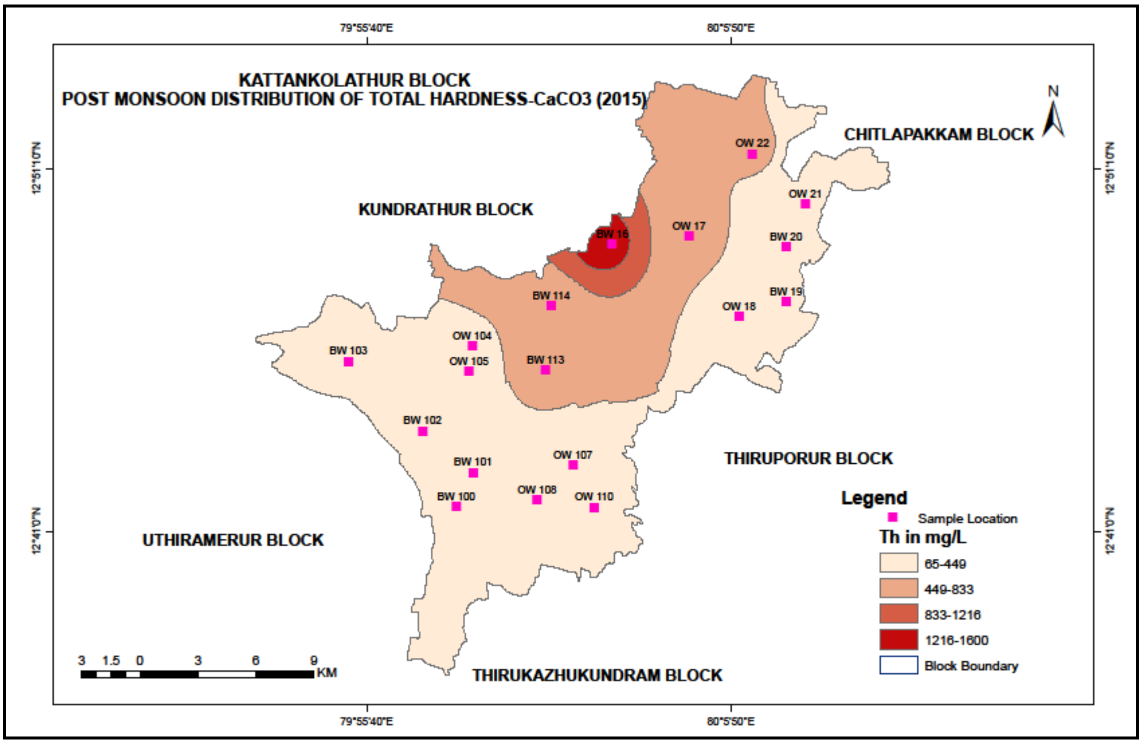

Figure 15: Spatial Distribution ofTH Post monsoon 2015

The total hardness shows 80% of the samples are suitable for irrigation during both the seasons. The spatial distribution of total hardness values in the study area during both the seasons are shown in Figure 14 and Figure 15.

Conclusion:

The present study clearly shows that there is a drastic change in the value of Cl, TDS, and TH for pre and post monsoon seasons of 1995 and 2015. From landuse and land cover map it is clearly understood , a twofold increase in urbanization which is mainly responsible for deteriorating water quality for drinking purpose. The areasfor which are water quality is coming under stress conditions are Kattankulathur, Vandalur, Singaperumal Koil and Guduvanchery, which is significantly showing extreme change in urbanization for the year 2015.The study shows higher hardness is present in 80 to 85% of the sub-basin area in both the seasons for the year 2015 and moderate to very hard in both the years 1995 and 2015.

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