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

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Abstract: Quality of groundwater guarantees the healthiness, prosperity and development of the civilization. The exiting humanoid demands clean water for daily consumption as drinking, different domestic usages and for agricultural activities. It is a known fact that groundwater is the only source of freshwater in 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 1995 which was 22.509.km for this block. Present study targets at examining different 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 in terms of drinking water quality.

Key Words : Groundwater, Water Quality Parameters, Spatial Distribution, Urbanization.

Introduction :

Groundwater is the most important of fresh water for major part of the world. The uncontrolled growth of population, many fold growth of urbanization and industrialization, demands hasty and non-judicial development of available source of groundwater. The other major threat for groundwater is the dumping of untreated solid wastes, which because of leaching and other processes affects groundwater. Again unprocessed industrial effluent and other anthropogenic sources embrace a major influence for the deteriorating 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 (Krishna Kumar et al 2009).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 previous to reaching the aquifers (Zuane 1990).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 Index (WQI) based methodology has been used 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 concentration for different elements and to demarcate the high concentration zones.

Knowing the immense importance of groundwater on drinking and agriculture various studies has been taken at various parts of the country (Khurshid *et al.* 2002; Elango *et al.* 2003; Rajmohan and Elango, 2004; Sreedevi, 2004; Subba Rao and John Devadas, 2005; Singh *et al.* 2006; Rao 2006; Raju 2007; Rashid and Izrar 2007; Brindha *et al*. 2010; Mondal and Singh, 2011; Tamma Rao *et al.* 2012; Sridhar *et al.* 2013; Kanagaraj *et al.* 2013 and Tamilarasi *et al.* 2015). 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 major drainage of the block and is flowing along the southern part of the block neighboring Chengalpattu. Many small-scale industries for auto ancillaries, engineering, wood works, electrical and electronic works, manufacturing sector like clay articles along with automobile industries are functioning in the block, which are discharging their untreated effluents to the barren open lands, nearby small and bigger water bodies and wetlands, which in turn affecting the groundwater regime. There are more than 60 clay units worth turnover of 50 lakh is present in the block. 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. This is 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 twofold rise in the areal extent. This upsurge in uncontrolled urbanization is bringing a threat to quantity as well as quality of ground water. Groundwater potential is decreasing because of the unplanned construction and unattended uses of groundwater along with improper planning of conservation of available water. Also the quality is deteriorating by means of untreated dumping which are possible sources of contamination.

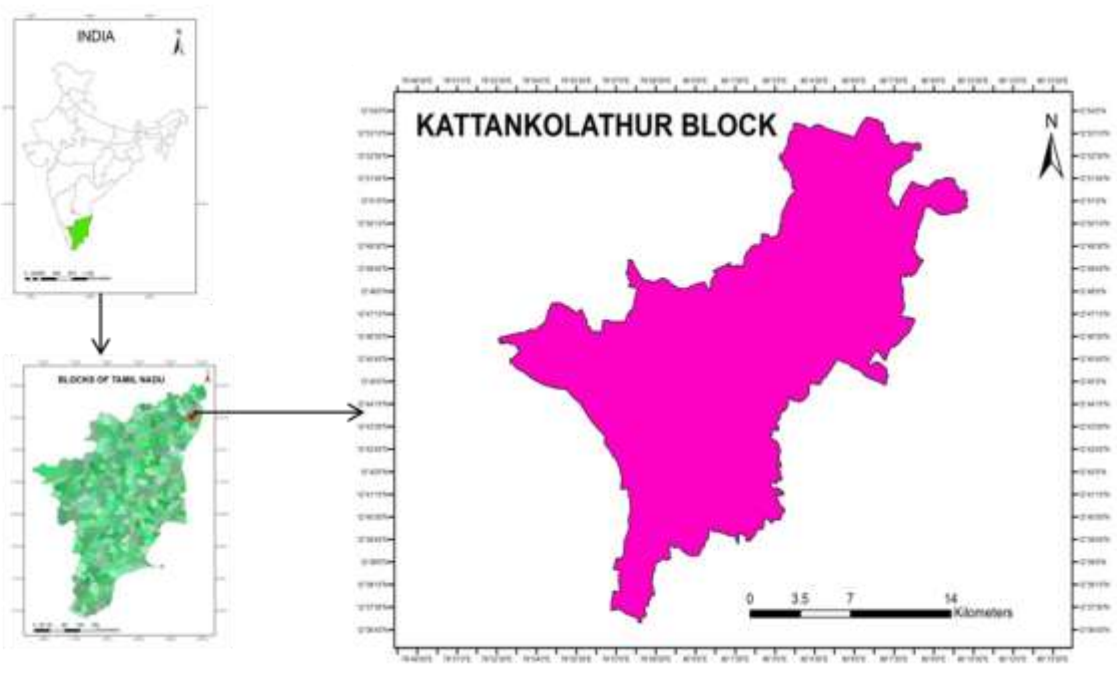

Figure 01:Location map of the Kattankolathur Block

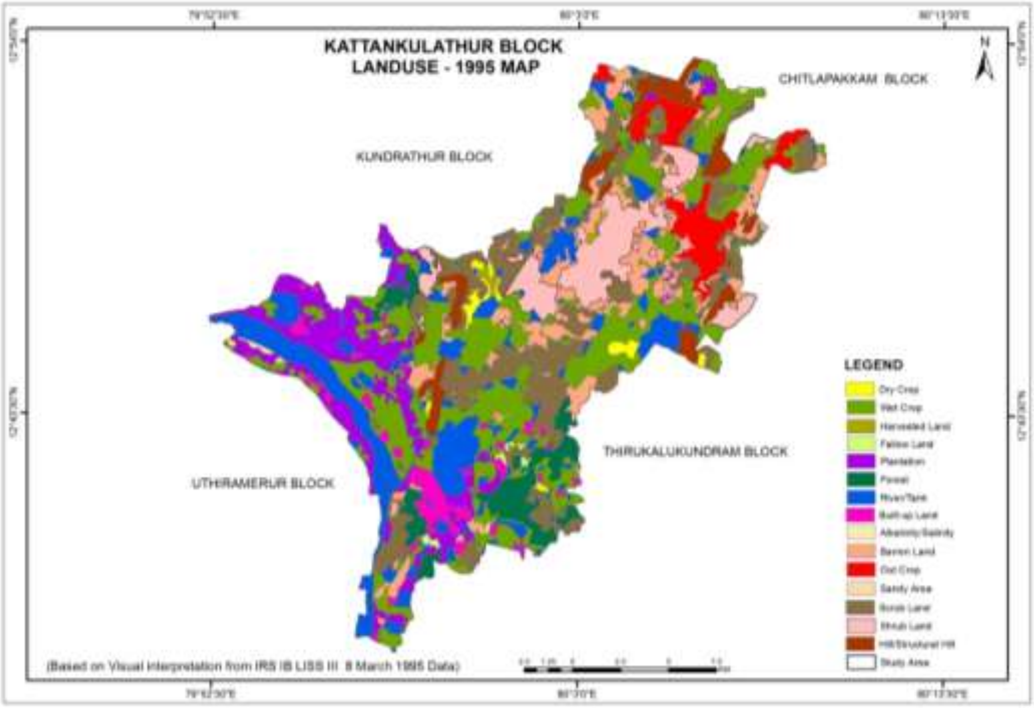

Figure 02: Landuse and land cover map of Kattankulathur block for the year 1995

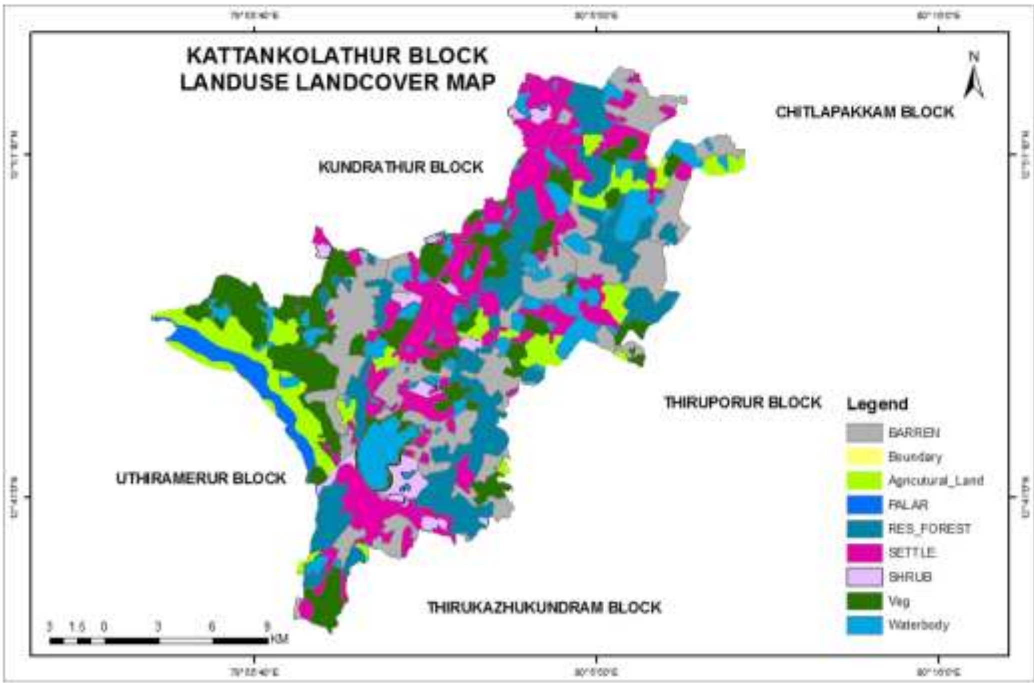

Figure 03: Landuse and land cover map of Kattankulathur block for the year 2014

Chloride (Cl^-)

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 (Stallard and Edmond, 1987).

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 spatial distribution of chloride for the year 1995 in the study area during both the seasons is shown in the Figure 04andFigure 05.The premonsoon 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.

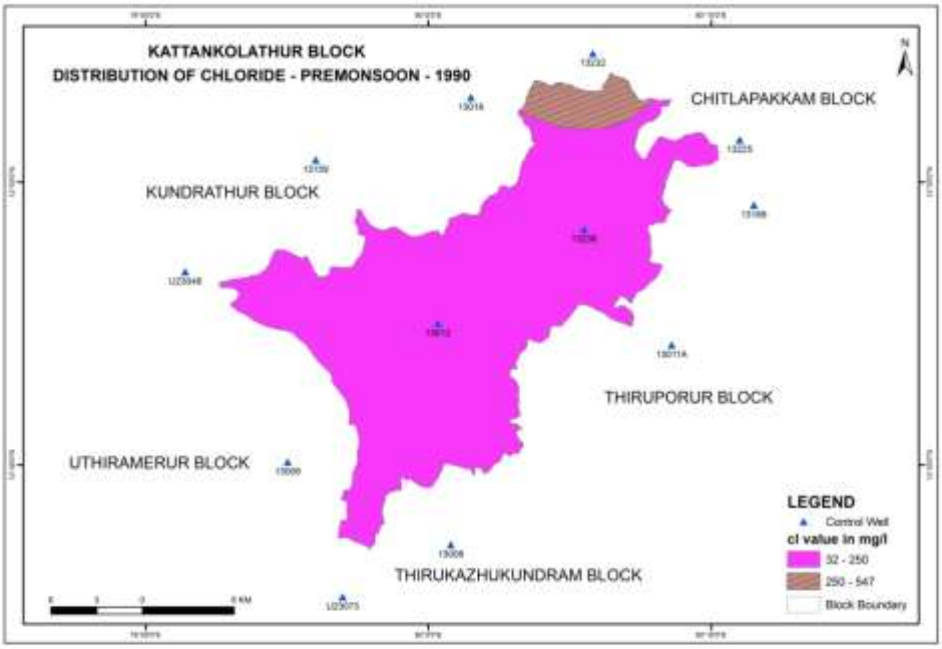

Figure 04: Spatial Distribution of chloride - Pre monsoon 1990

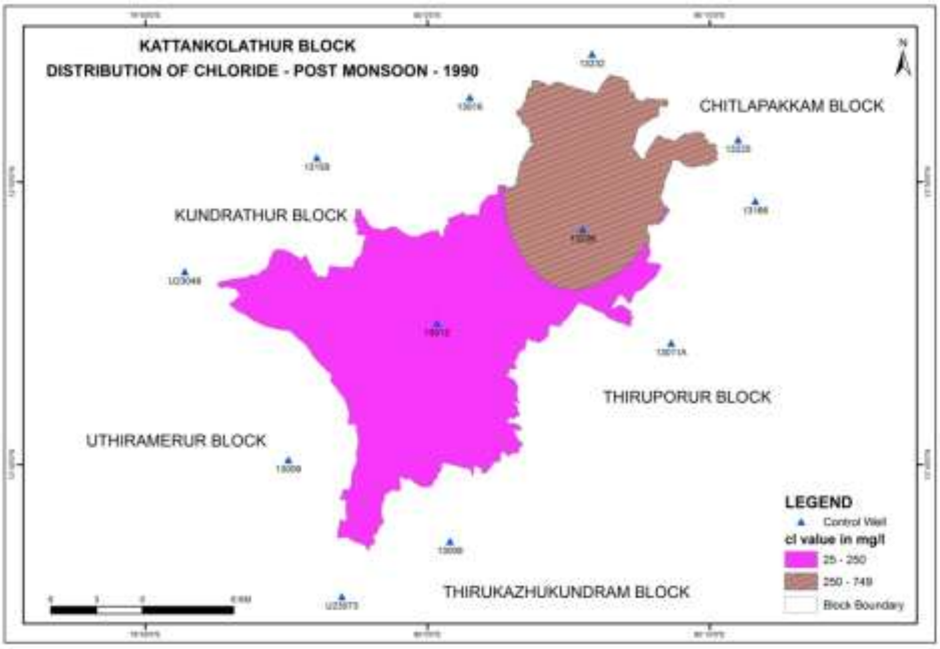

Figure 05: Spatial Distribution of chloride - Post monsoon 1990

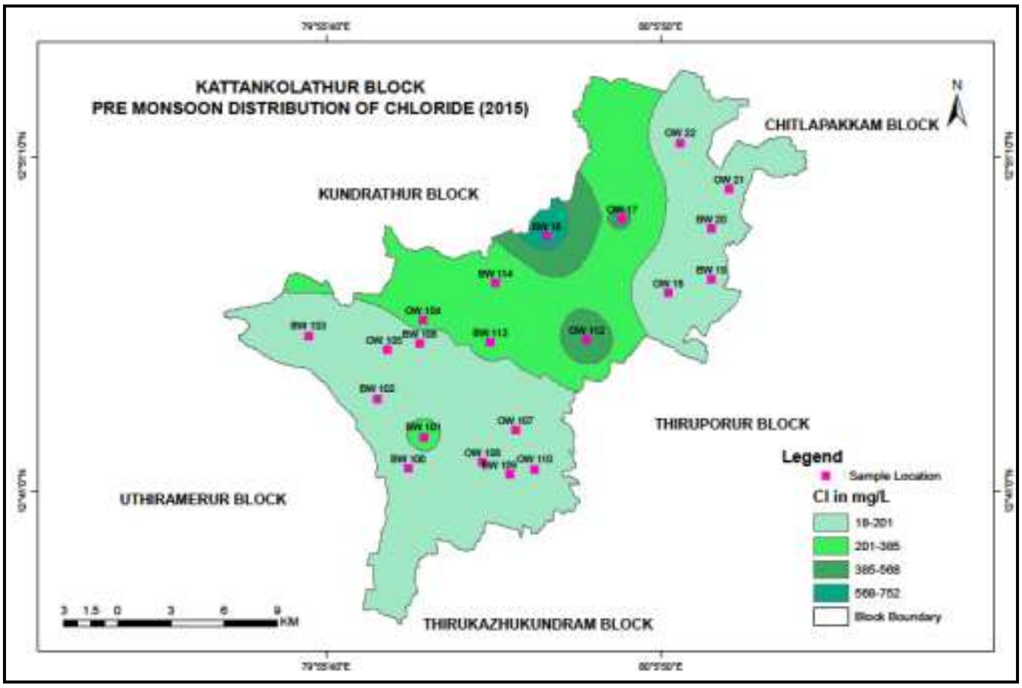

Figure 06: Spatial Distribution of chloride Post monsoon 2015

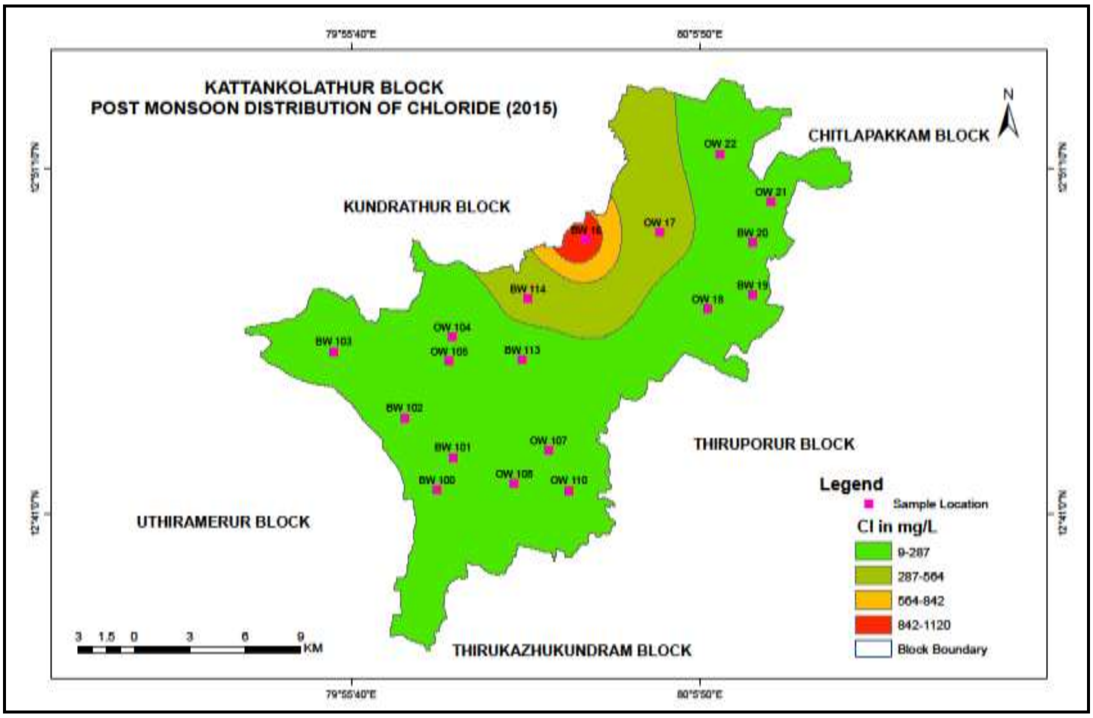

Figure 07:Spatial Distribution of Chloride Post monsoon 2015

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.

As per WHO’s standard, water with TDS concentration more than 1500 mg/L is not acceptable for drinking purpose.

The 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 .

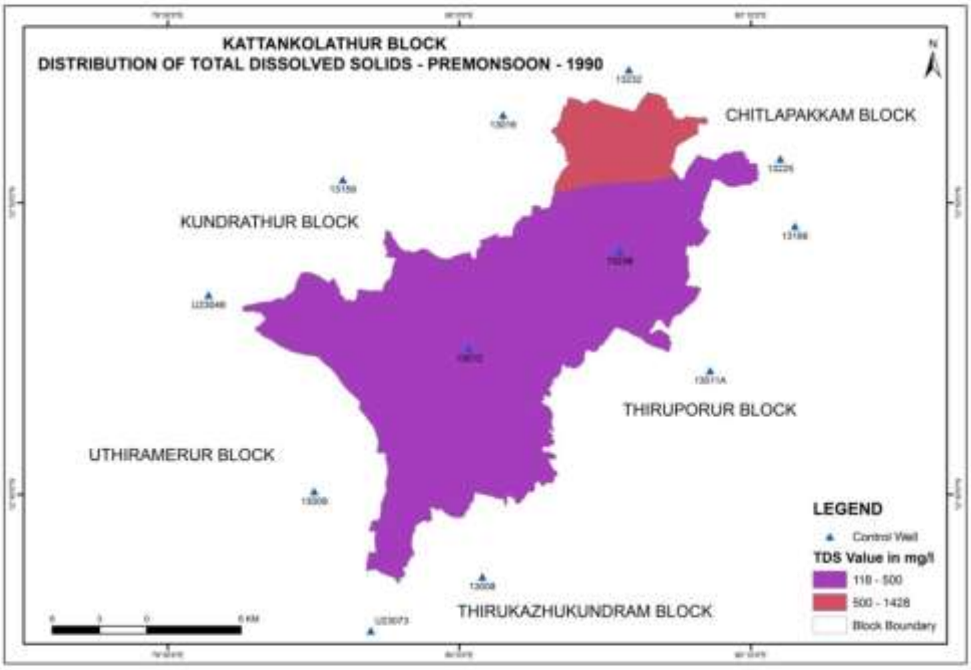

Figure 08: Spatial Distribution of TDS Pre monsoon 1990

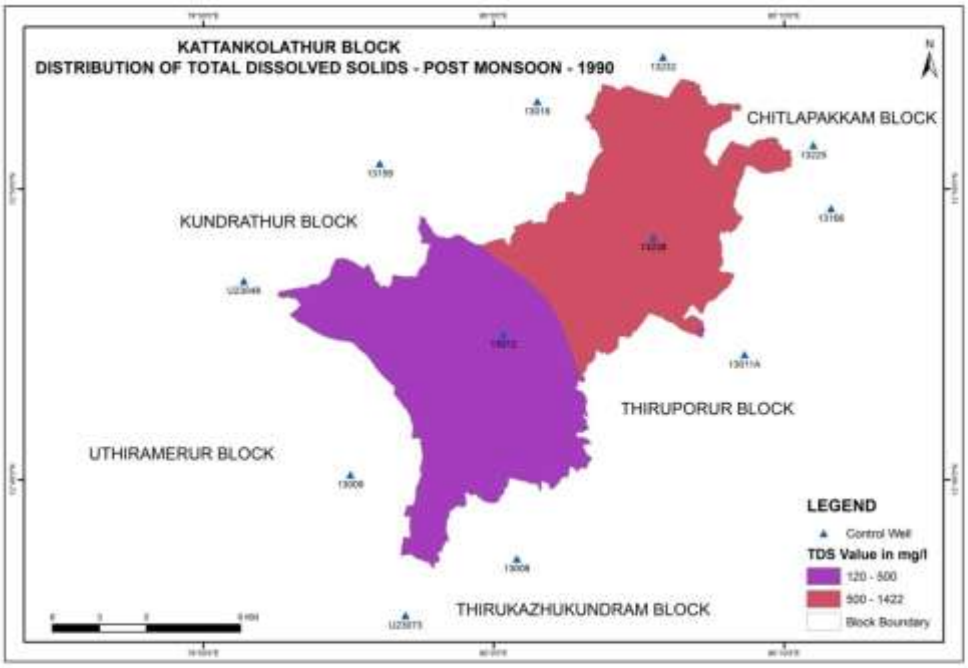

Figure 08: Spatial Distribution of TDS Post monsoon 1990

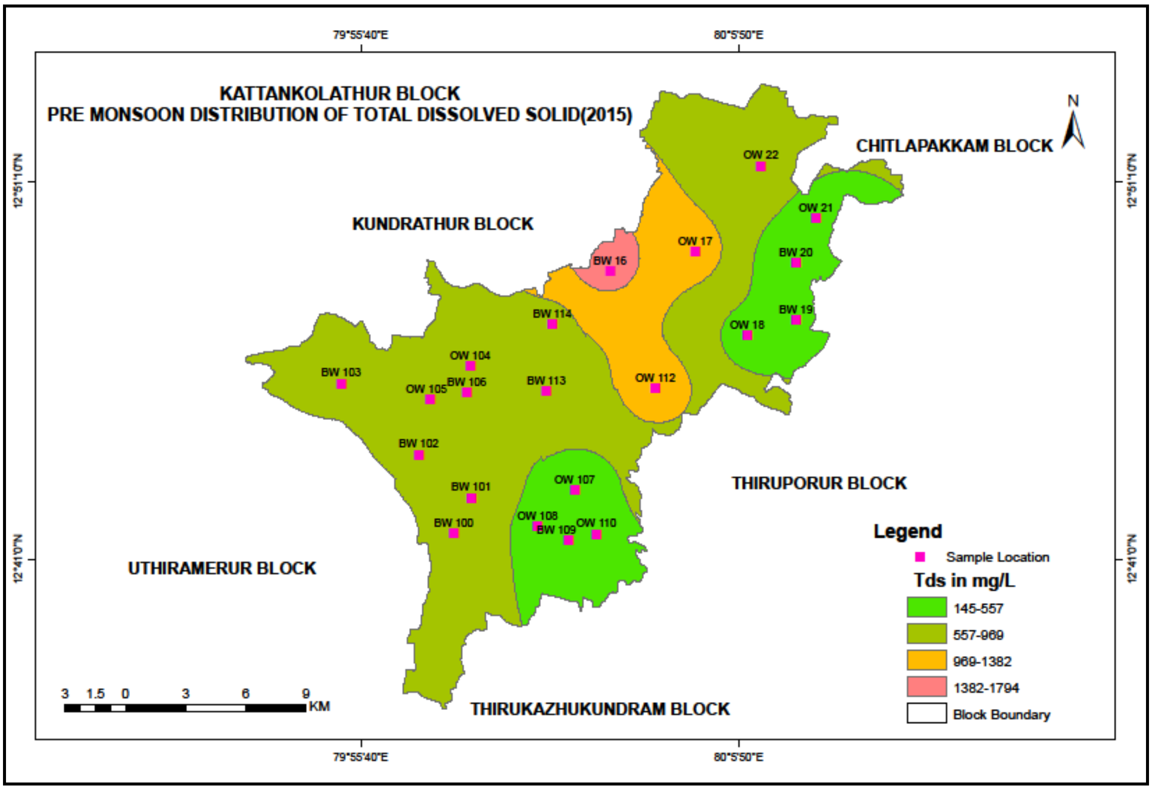

Figure 09: Spatial Distribution of TDS Pre monsoon 2015

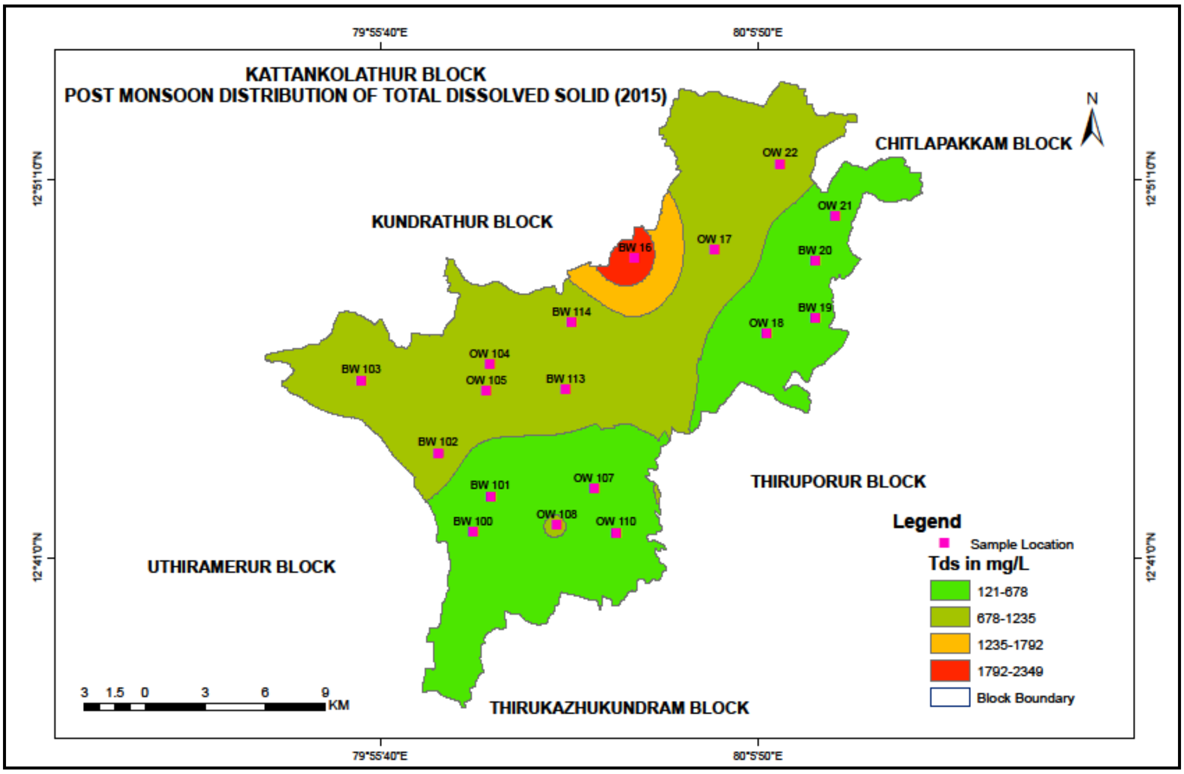

Figure 10: Spatial Distribution of TDS Post monsoon 2015

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 (Imran Ahmad Dar *et al.* 2010).

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 (Durfer and Backer, 1964).

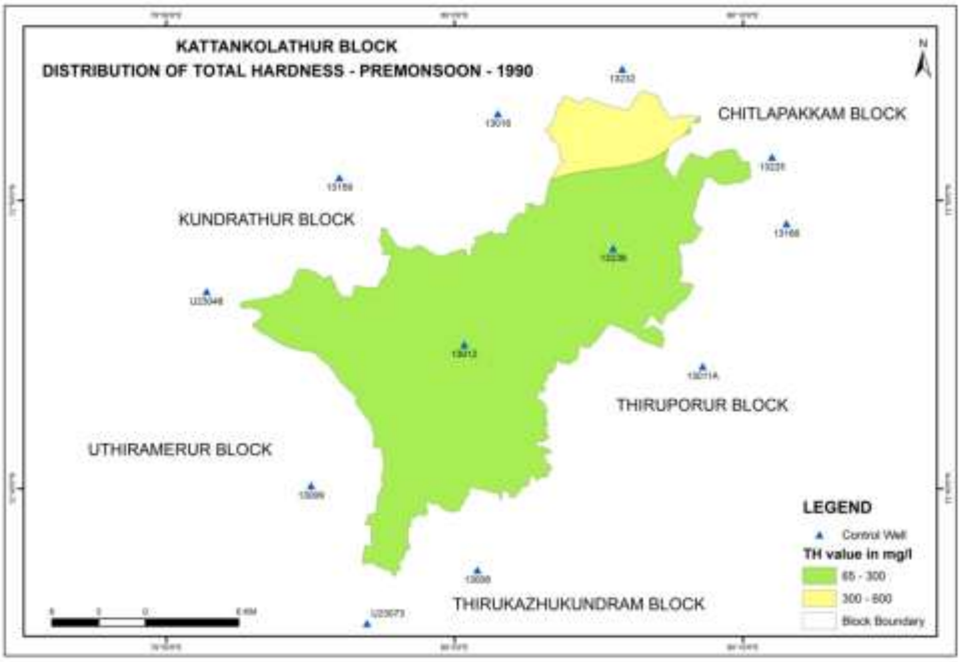

Figure 11: Spatial Distribution of TH Pre monsoon 1990

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.

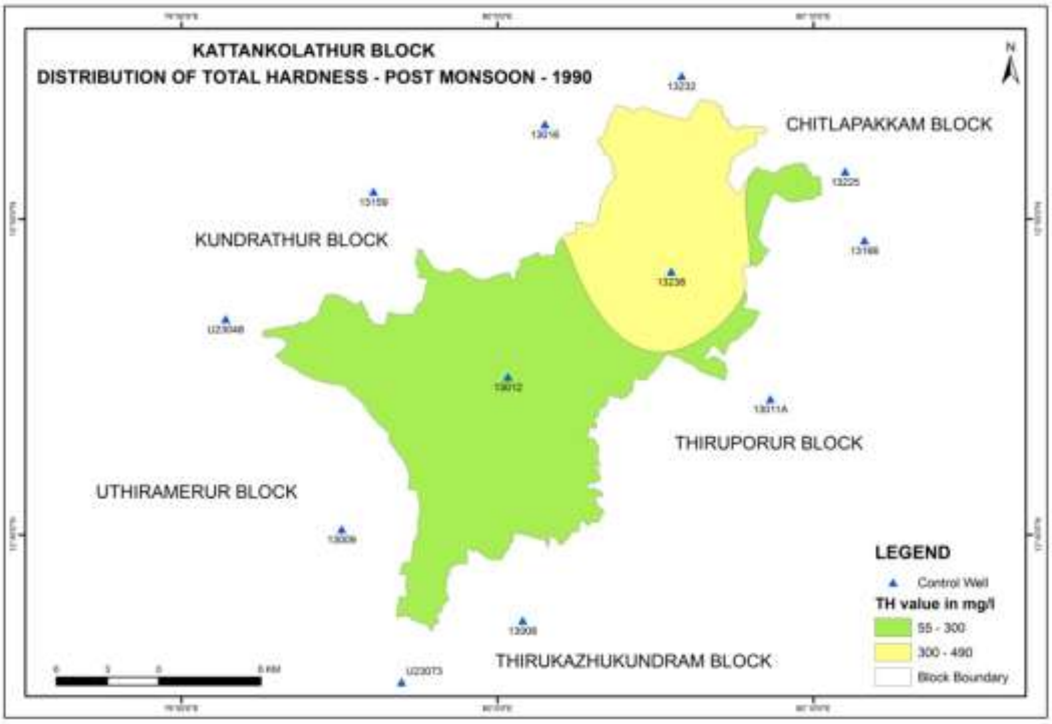

Figure 12: Spatial Distribution of TH Post monsoon 1990

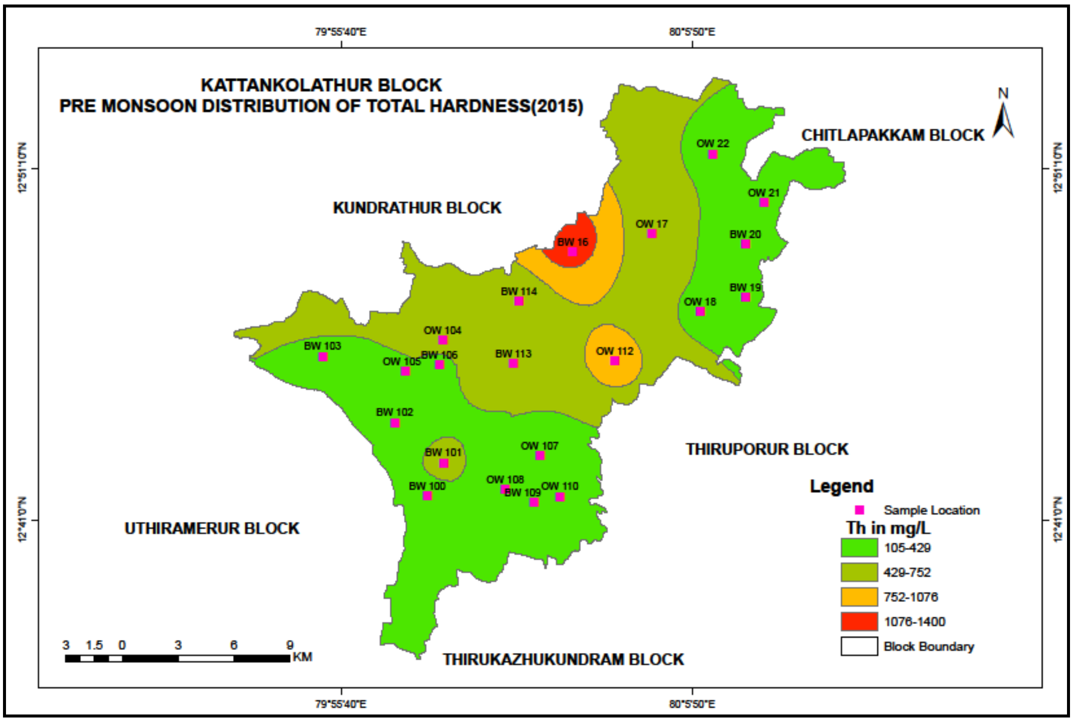

Figure 13: Spatial Distribution of TH Pre monsoon 2015

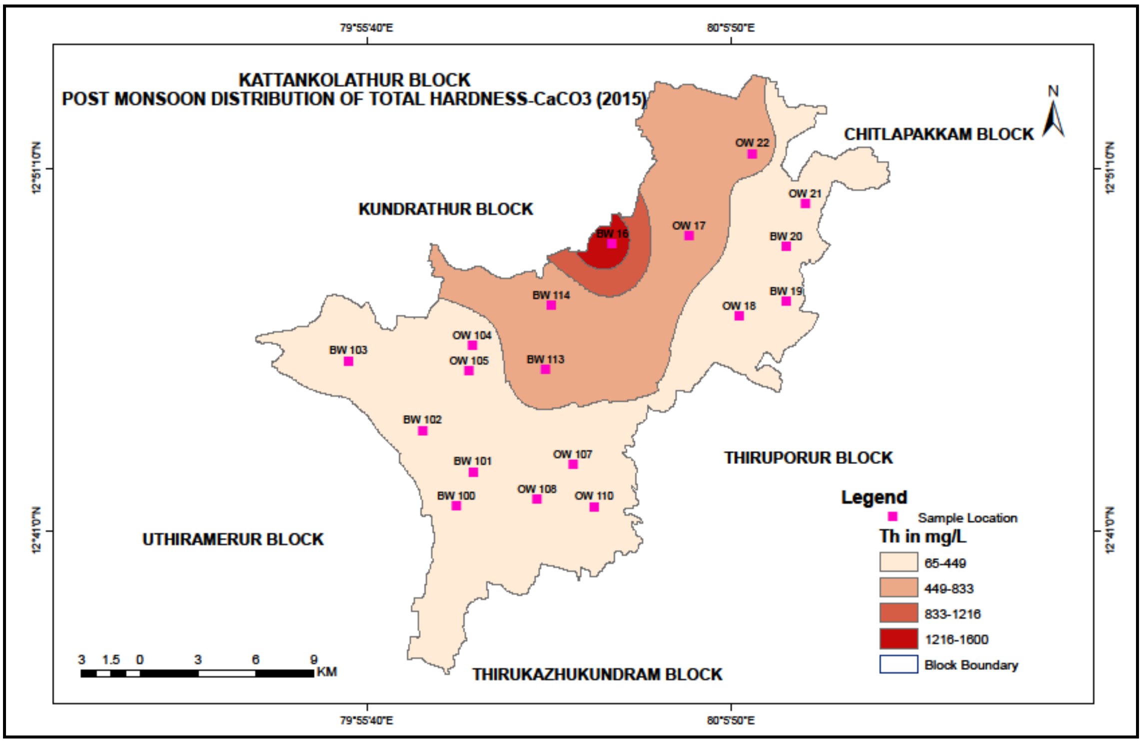

Figure 14: Spatial Distribution of TH Post monsoon 2015

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 the Figure 13 and Figure 14.

Conclusion:

The present study clearly shows that there is drastic change in the value of Cl, TDS and TH for pre and post monsoon seasons of 1995 and 2015. From land use and land cover map it is clearly shows twofold increase in urbanization which is mainly responsible for deteriorating water quality for drinking purpose. The areas for which are water quality is coming under stress conditions are Kattankulathur, Vandalur, Singaperumal Koil and Guduvanchery, which is significantly showing drastic 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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