

Impact Assessment of Check Dams at Melakkal and Kochadai using Remote Sensing and GIS in Madurai District, Tamilnadu, India

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Abstract— In present scenario, water quality and water level is becoming very worse due to inadequate rainfall, over exploitation and anthropogenic activities. In order to increase water quality and water level, check dams have to be introduced. In our study area, we used two important factors for studying the impact of the check dams. In this paper, water quality and water level was analysed for the years 2008 and 2013 in the GIS environment in order to check the impact of the check dam. In the year 2013, a drastic change was noticed in Viraganoor and upper part of the study area. Water quality was rapidly increased almost in the study area.

Key Words: Check Dams, Water Levels and Water Quality, and Madurai District

INTRODUCTION

Water is a common resource and it is the right of every person in the community to conserve it. Several years before it seemed improbable, but today we pay more for water. In a survey it is estimated that one person in six lives is without regular access to safe drinking water. Central Ground water Board estimate that, the Reservoir of ground water will dry up by 2005, in as many as fifteen states in India and by 2050 more than 50% of Population is expected to shift to the cities and getting fresh water is very scarce. The per capita water availability in the country which was 5000cum. has dropped to 2200 cum. Rainfall, the only recharge potential in India is temporal and the same is also unevenly distributed. Due to lack awareness of Ground water potential and considerable quantity of water available against requirement in the earlier days, over exploitation of ground water potential could not be avoided. If run of water and surplus river water and surplus water into sea judiciously managed, ground water potential could be maintained in future. It is well known that the groundwater is the largest source of fresh water available in the world. Consistently increasing demand for water has led to over exploitation of groundwater in several regions. Excessive extraction of groundwater for irrigation where it is slowly renewed is the main cause of the depletion and climate change has the potential to exacerbate the problem in some regions.

Study area

Vaigai river originates in Varusanadu Hills, the Periyar Plateau of the Western Ghats range, and flows northeast through the Kambam Valley, which lies between the Palni Hills to the north and the Varushanad Hills to the south. As it rounds the eastern corner of the Varushanad Hills, the river turns southeast, running through the region of Pandya Nadu. Madurai, the largest city in the Pandya Nadu region and its ancient capital, lies on the Vaigai. The river empties into the Palk Strait in Ramanathapuram District. The Vaigai is 258 kilometres long, with a drainage basin 7,031 square kilometres large. Our study area is located in the vaigai river.

Graphical Interpretation

In the study area the Water Level and the water quality details for five years from 2008 to 2013 were studied and imported to the ArcGis software. The Water levels were classified into 3 categories based on the minimum and the maximum water levels as 0-2m, 2-7m and >7m. They are converted to maps with suitable colours as green, pink and red respectively. The water quality is also checked for various parameters such as pH, TDS, Ca, Mg, F, etc. They were also converted into maps giving suitable results as desirable, permissible and not permissible.

METHODS

The preliminary data for the assessment of Check Dams is collected from the TamilNadu Public Works Department, Chennai. Then they were given as input to the ArcGis Software. The Various procedures were carried out using this software to obtain the maps for the study area. The two overall maps were made each for the years 2008 and 2013 respectively for the water quality parameter and analyzed.

III. PREPARATION OF THEMATIC MAPS

A. Water level map

In the given study area of 304 square kilometers, the year 2008 map shows that the major area is above 7m. The average area is from 2-7m. The least area is 0-2 m. In the year 2010 the maximum area is above 7m. The average area is from 2-7m. Also, the year 2013 map is as same as the 2010 map but there is a slight increase of water level in the year

2013 in the region of viraganoor. From these maps it is understood that after the construction of Check dam the water level has not increased but not dropped down much.

sufficiently upto the permissible limits. hence, it is suitable for drinking and irrigation purpose.

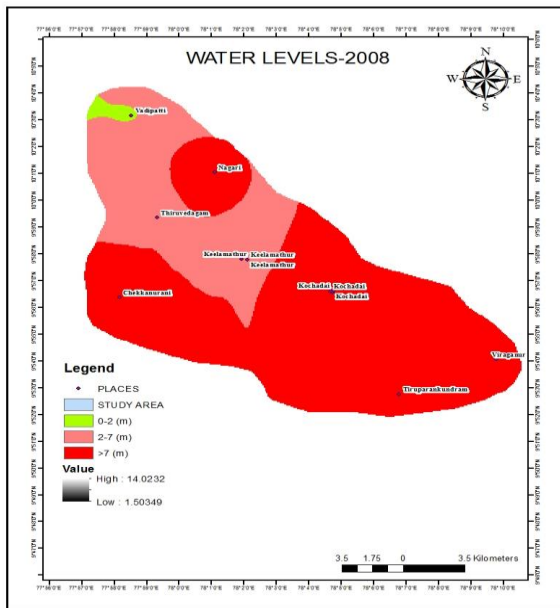


Fig.2 Water levels-2008

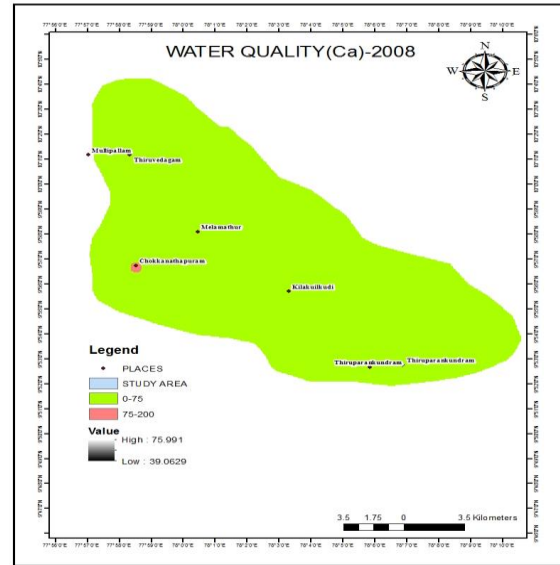


Fig-4 Calcium Ion Map-2008

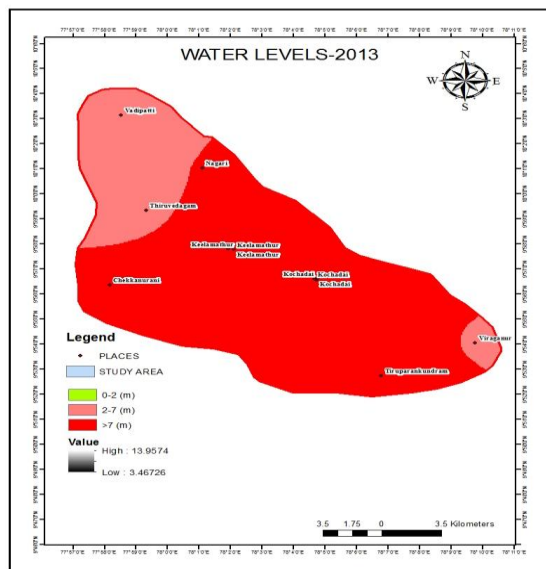


Fig-3: Water levels-2013

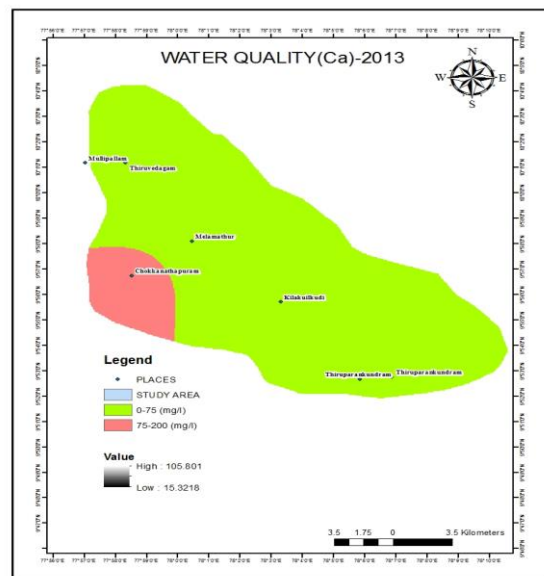


Fig-5: Calcium Ion Map-2013

B. Calcium Ion Map

The desirable limit for Ca⁺ ion is 75 mg/L and can be extendable to 200 mg/L. The value if obtained exceeding the desirable limit causes encrustation in water supply structure and adverse effects on domestical use. The value obtained in our study area in the year 2008 is 39 to 76 mg/L. In the year 2010 the calcium ranges from 18 to 77mg/L. In the year 2013 the value is between 12 to 106 mg/L. From these maps it is understood that the calcium range has increased

C. Sulphate Ion Map

The maximum desirable limit for sulphate in water for domestic use is 200 mg/l. Beyond this causes gastro intentional irritation when magnesium or sodium are present. The extendable limit is 400 mg/L. The value obtained in our study area in the year 2008 is 25 to 187 mg/L. In the year 2010 the sulphate ranges from 19 to 120 mg/L. In the year 2013 the value is between 37 to 163 mg/L. From these maps it is understood that sulphate range is quiet decreasing and increasing but it is upto the desirable limit. so, it is safe.

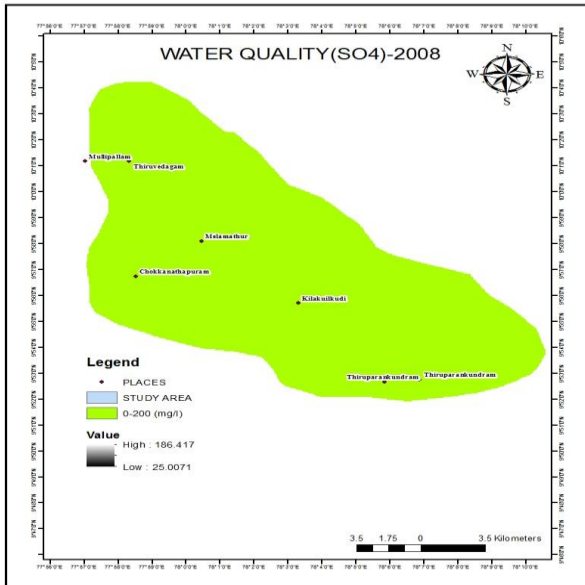


Fig-6: Sulphates Ion Map-2008

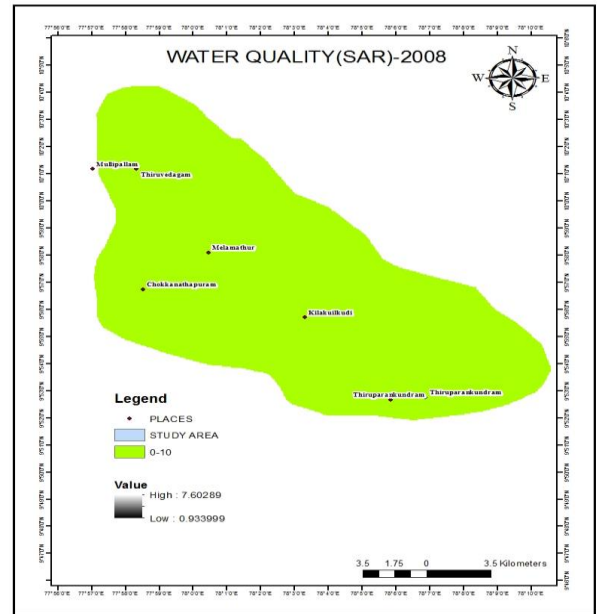


Fig-8: SAR Map-2008

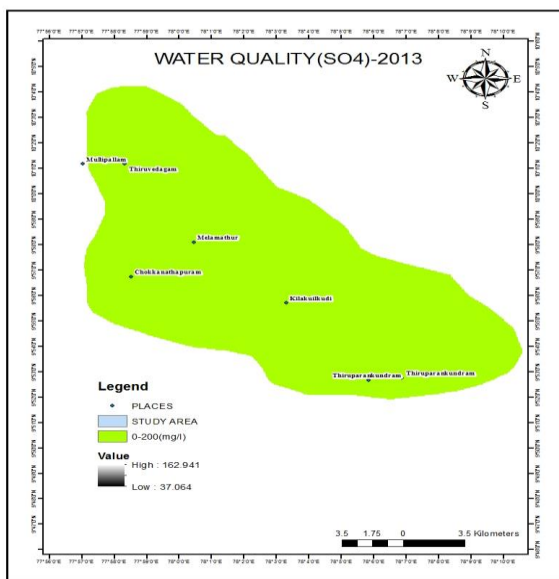


Fig-7: Sulphates Ion Map-2013

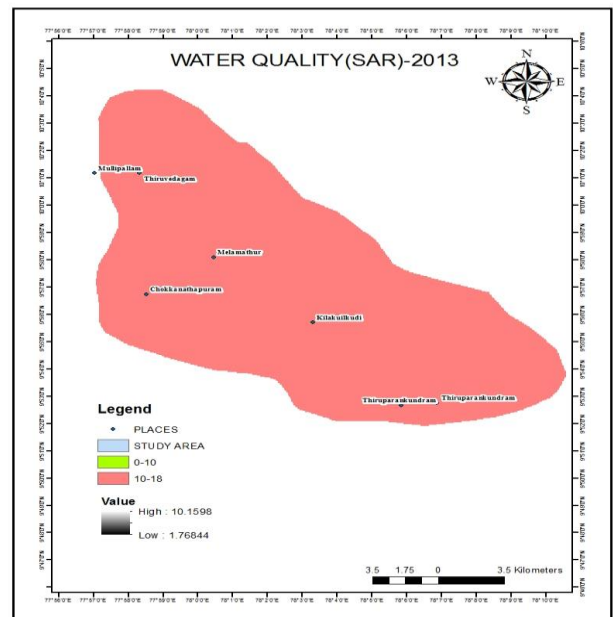


Fig-9: SAR Map-2013

D. SAR Map

The value obtained in our study area in the year 2008 is 0.88 to 7.66 mg/L. In the year 2010 the calcium ranges from 0.87 to 8.84mg/L. In the year 2013 the value is between 1.72 to 9.497 mg/L. From these maps it is understood that SAR ranges has increased quietly and within desirable limit. Hence, it is suitable for drinking

E. RSC Map

The value obtained in our study area in the year 2008 is 0 to 1.45 mg/L. In the year 2010 the calcium ranges from 0 to 2.9 mg/L. In the year 2013 the value is between 0 to 3.9 mg/L. From these maps it is understood that RSC increases gradually and extends beyond the permissible limit. Hence, it is unsuitable.

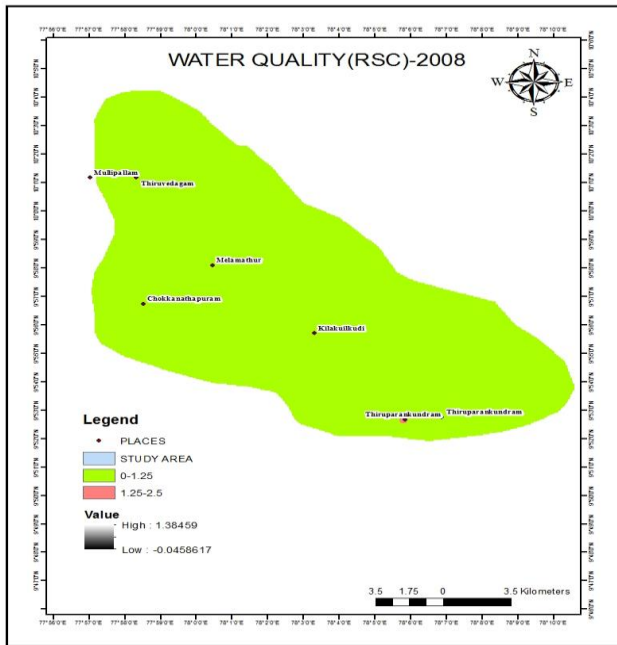


Fig-10: RSC Map-2008

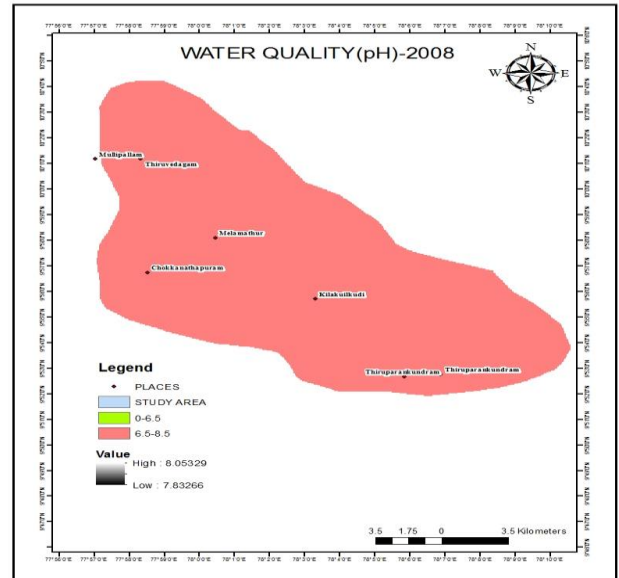


Fig-12: pH Map-2008

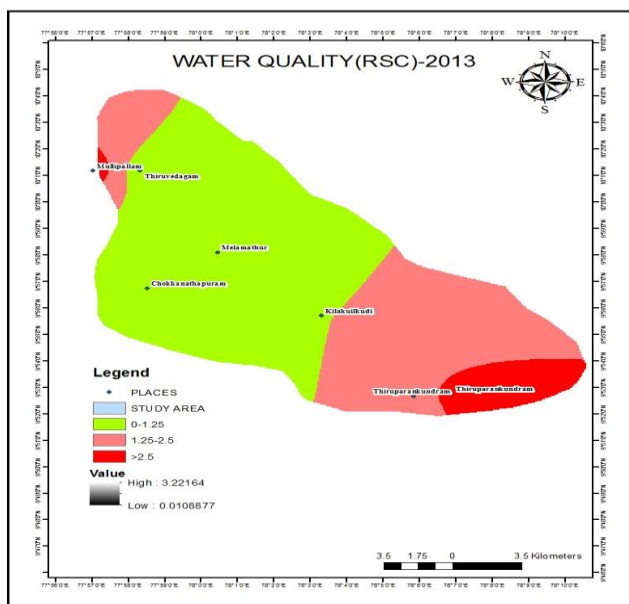


Fig-11: RSC Map-2013

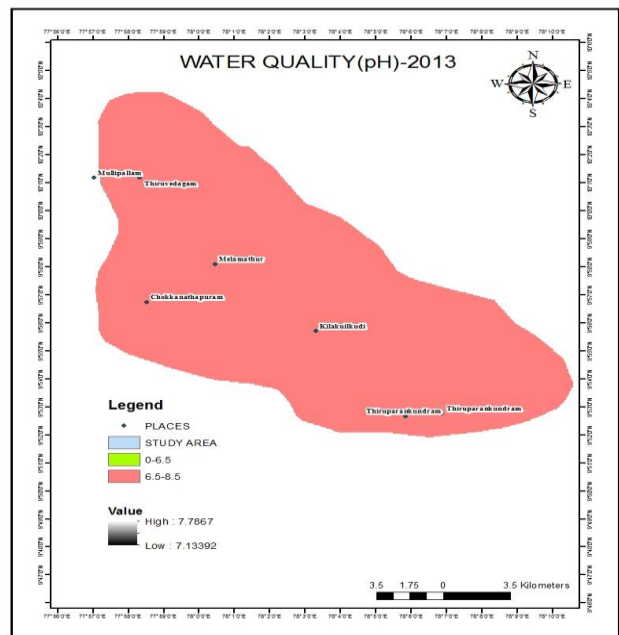


Fig-13: pH Map-2013

F. pH Map

pH is the figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values more alkaline. The requirement desirable limit of pH is 6.5 to 8.5. The value obtained in our study area in the year 2008 is 7.8 to 8.1 mg/L. In the year 2010 the pH ranges from 7.6 to 8.3 mg/L. In the year 2013 the value is between 7.1 to 7.9 mg/L. From these maps it is understood that pH range is suitable for drinking.

G. Nitrates Ion Map

Nitrate is a salt of ester of nitric acid, containing the anion NO₃. The amount of nitrate content in the past decade has not changed and is constant i.e. 45mg/L and it is extendable up to 100 mg/L. The value obtained in our study area in the year 2008 is 1 to 14 mg/L. In the year 2010 the calcium ranges from 5 to 47mg/L. In the year 2013 the value is between 2 to 16 mg/L. From these maps it is understood that the ranges are upto the desirable limit. Hence, it is safe

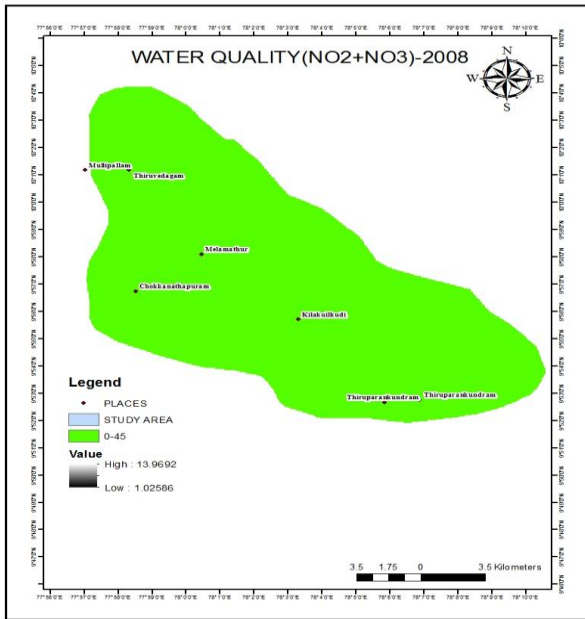


Fig-14: Nitrates Ion Map-2008

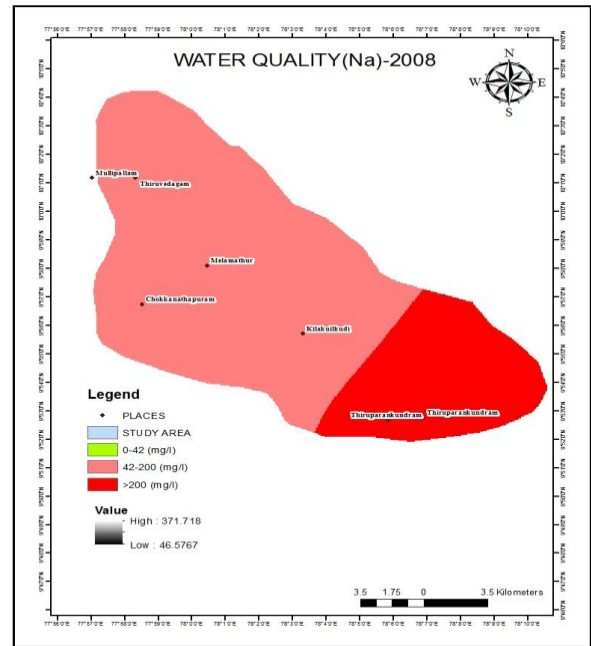


Fig-16: Sodium Ion Map-2008

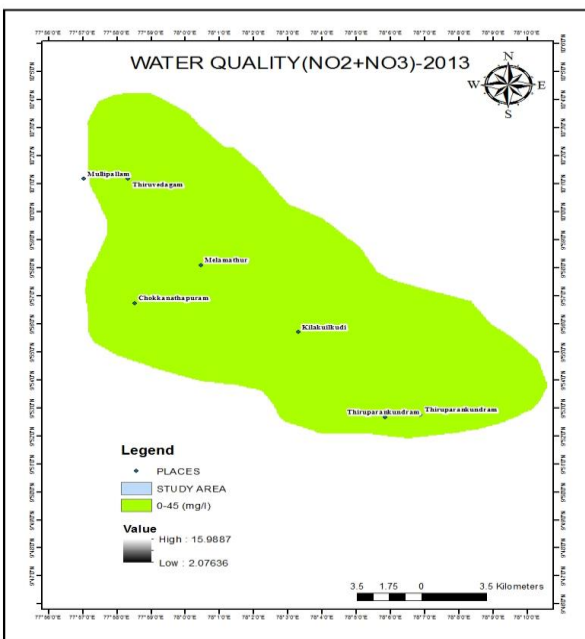


Fig-15: Nitrates Ion Map-2013

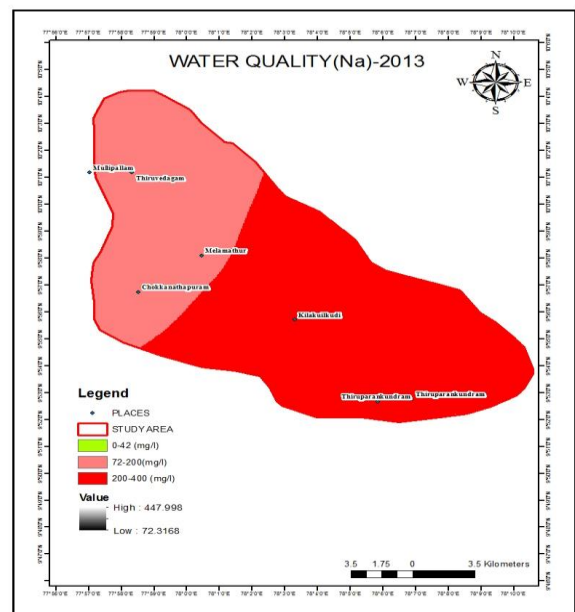


Fig-17: Sodium Ion Map-2013

H. Sodium Ion Map

Sodium naturally occurs in water up to 200 mg/l (Todd 1980) and the WHO (2004) has also recommended this as permissible limit of sodium to be present in water for domestic purposes. The value obtained in our study area in the year 2008 is 46 to 372 mg/L. In the year 2010 the sodium ranges from 38 to 400 mg/L. In the year 2013 the value is between 72 to 448 mg/L. From these maps it is understood that the sodium range is increasing rapidly and beyond the permissible limit and it's unsafe.

I. Na% Map

The value obtained in our study area in the year 2008 is 15.76 to 66.66 mg/L. In the year 2010 the calcium ranges from 18.85 to 71.87mg/L. In the year 2013 the value is understood that Na% is increasing. Hence, it is unsuitable.

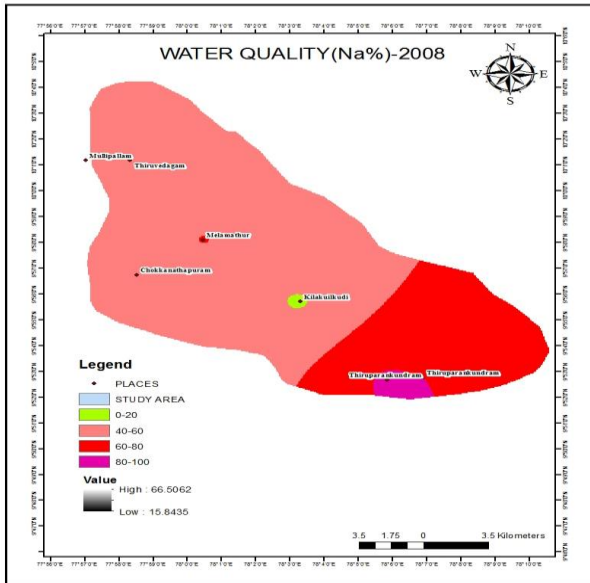


Fig-18: Sodium Percentage Ion Map-2008

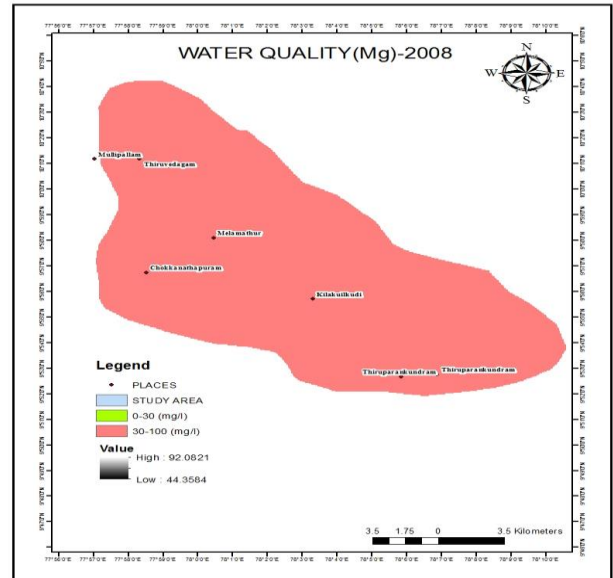


Fig-20: Magnesium Ion Map-2008

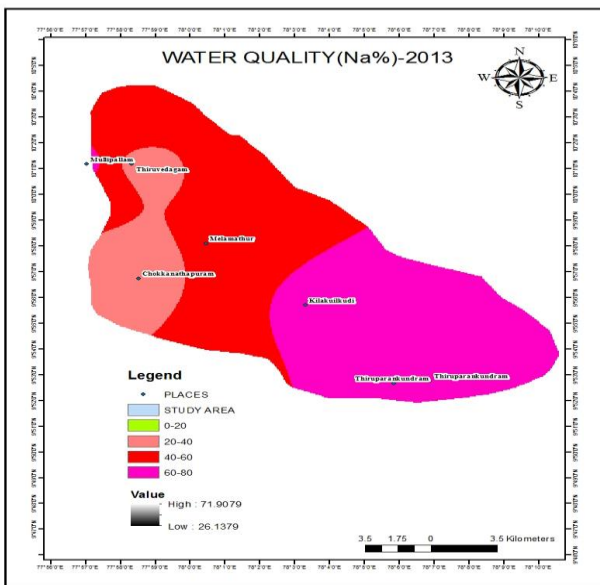


Fig-19: Sodium Percentage Ion Map-2013

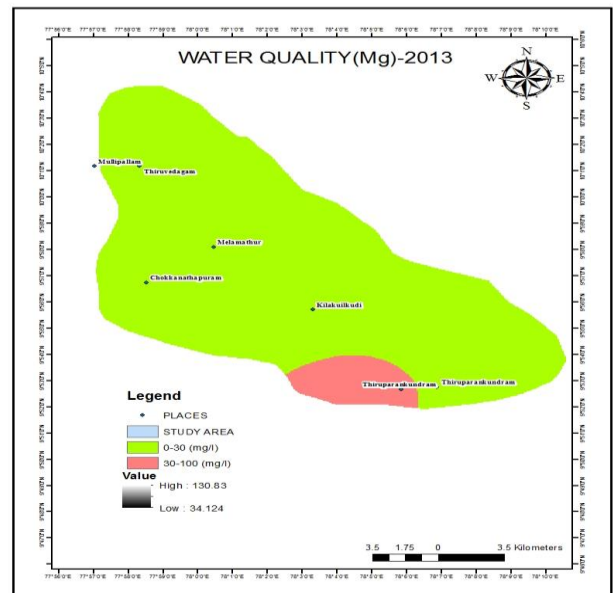


Fig-21: Magnesium Ion Map-2013

J. Magnesium Ion map

The desirable limit for Mg⁺ ion is 30 mg/L and can be extendable to 100 mg/L. The value obtained in our study area in the year 2008 is 44.34 to 92.34 mg/L. In the year 2010 the calcium ranges from 35.232 to 91.12mg/L. In the year 2013 the value is between 29.16 to 131.22 mg/L. From these maps it is understood that the mg is near to the permissible limit. Hence, it is not safe.

K. Potassium Ion Map

Potassium generally appears to be within 10 mg/l in water (Todd 1980).The concentration in 0.04% of groundwater samples is exceeding the desirable limit of 12 mg/l (WHO 2004). The value obtained in our study area in the year 2008 is 1 to 21 mg/L. In the year 2010 the potassium ranges from 3 to 30 mg/L. In the year 2013 the value is between 5 to 30 mg/L. From these maps it is understood that ranges are beyond the permissible limit. Hence, it is unsuitable.

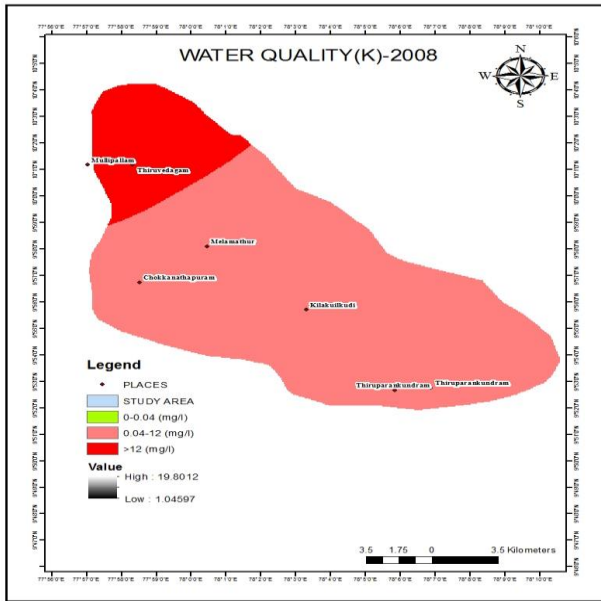


Fig-22: Potassium Ion Map-2008

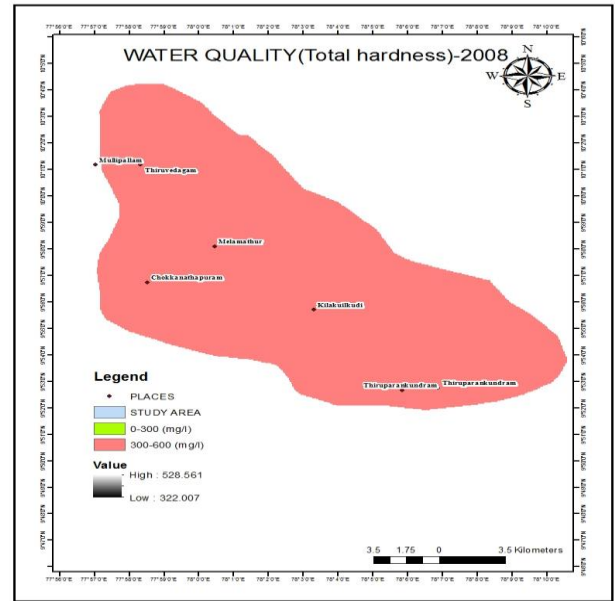


Fig-24: Total Hardness Map-2008

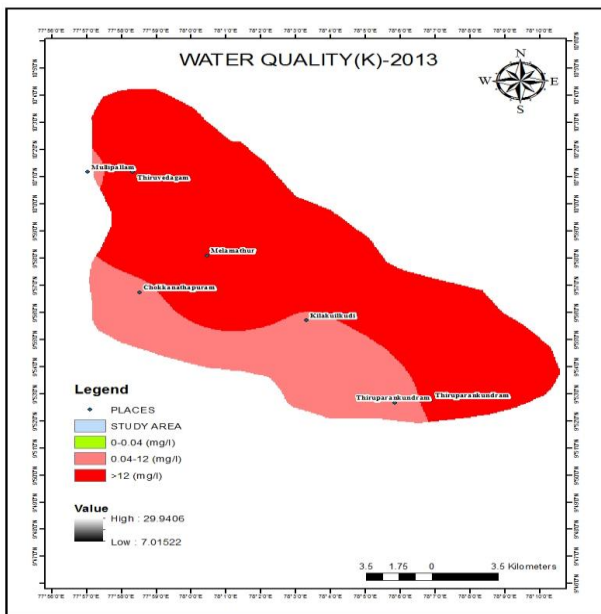


Fig-23: Potassium Ion Map-2013

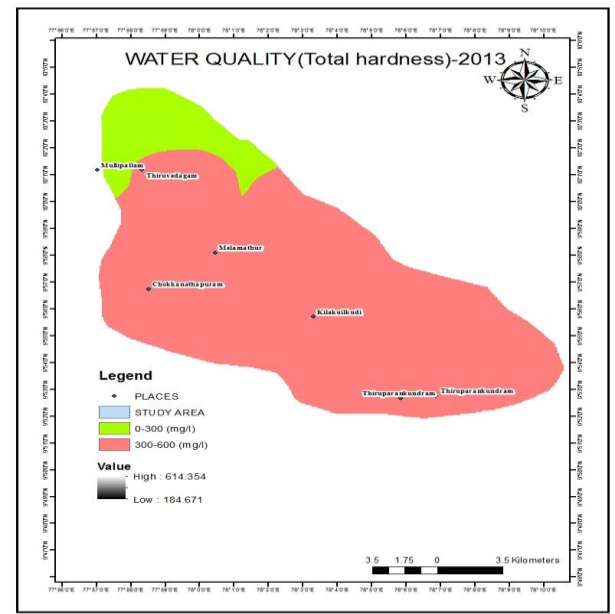


Fig-25: Total Hardness Map-2013

L. Total Hardness Map

The desirable limit for total hardness is 300 mg/L and can be extendable to 600 mg/L. The value if obtained exceeding the desirable limit causes encrustation in water supply structure and adverse effects on domestical use. The value obtained in our study area in the year 2008 is 320 to 462 mg/L. In the year 2010 the calcium ranges from 0.52 to 1.58 mg/L. In the year 2013 the value is between 152 to 615 mg/L. From these maps it is understood that it is upto the permissible limit. Hence, it is safe

M. Flouride Ion Map

The desirable limit as per IS code is 1.0 mg/L. Fluoride may be kept as low as possible. High fluoride may cause fluorosis. The extended limit is 1.5 mg/L. The value obtained in our study area in the year 2008 is 0.66 to 1.3 mg/L. In the year 2010 the calcium ranges from 0.52 to 1.58 mg/L. In the year 2013 the value is between 0.69 to 1.35 mg/L. From these maps it is understood that F is maintained constant. Hence, it is safe

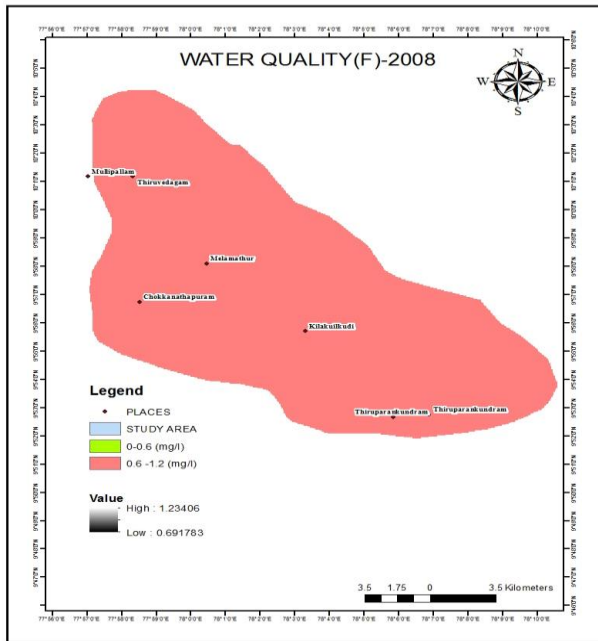


Fig-26: Flouride Ion Map-2008

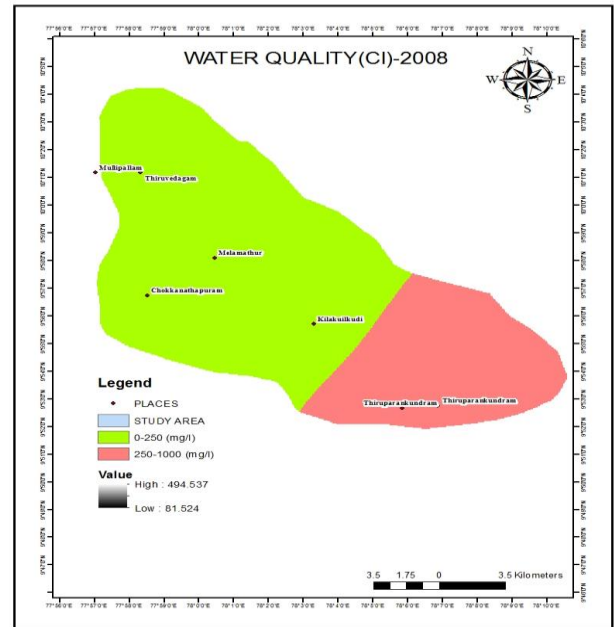


Fig-28: Chloride Ion Map-2008

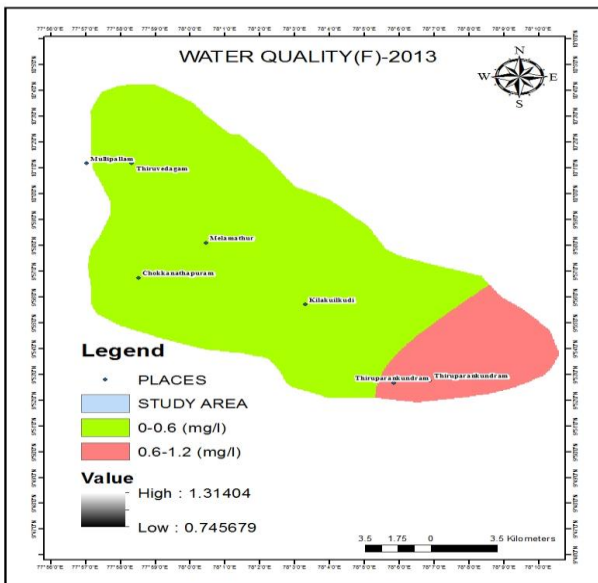


Fig-27: Flouride Ion Map-2013

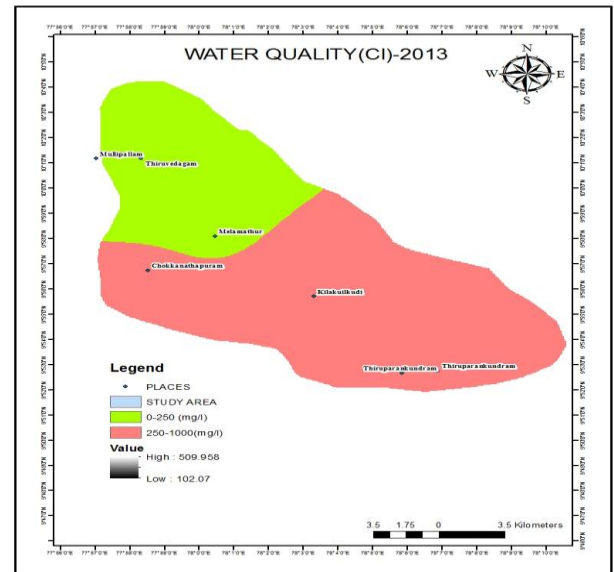


Fig-29: Chloride Ion Map-2013

N. Chloride Ion Map

Chloride in the groundwater samples of the study area varies from 16 to 558 mg/l and the maximum tolerable limit of chloride in drinking water is 1000 mg/l (BIS 2004), beyond which it imparts a salty taste to the water. The value obtained in our study area in the year 2008 is 79 to 365 mg/L. In the year 2010 the calcium ranges from 71 to 546 mg/L. In the year 2013 the value is between 102 to 510 mg/L. From these maps it is understood that it is increasing, but, it is upto the permissible limit. Hence, it is safe.

O. TDS

TDS is a measure of combined content of all inorganic and organic substances contained in a liquid molecular, ionized or micro- granular suspended form. The EPA Secondary Regulations advise a maximum contamination level (MCL) of 500mg/liter for TDS. When TDS levels exceed 1000mg/L it is generally considered unfit for human consumption. The value obtained in our study area in the year 2008 is 39 to 76 mg/L. In the year 2010 the TDS ranges from 18 to 77mg/L. In the year 2013 the value is between 12 to 106 mg/L. From these maps it is understood that TDS is within the permissible limit.

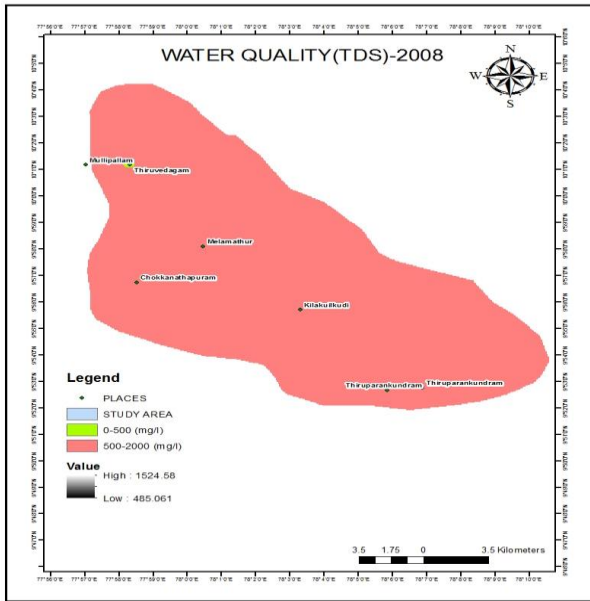


Fig-30: TDS Map-2008

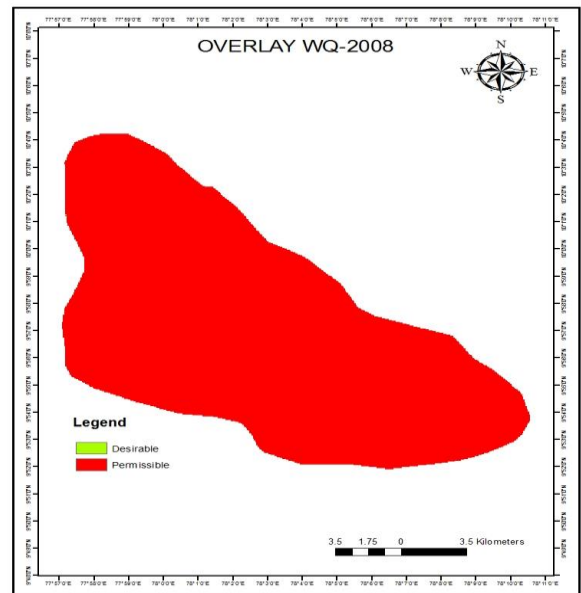


Fig-32 Overlay Water Quality Map-2008

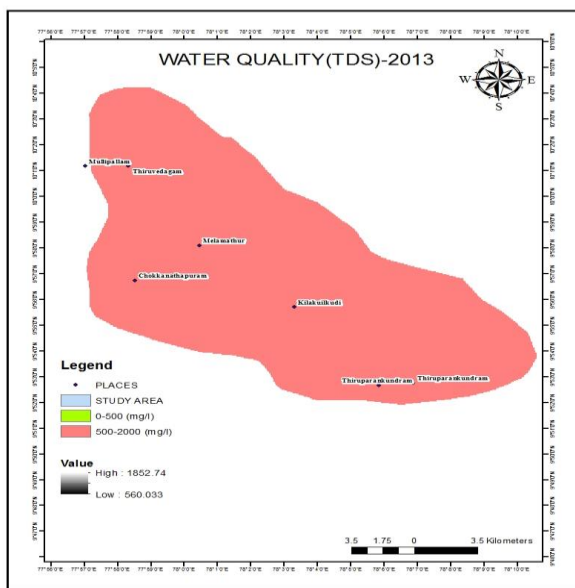


Fig-31: TDS Map-2013

Q. Overlay Water Level 2013

The overlay water level in our study area in the year 2013 reveals that the water quality is desirable in all the locations except the Tirupparankundram and Viraganoor locations after the construction of check dam. Hence, it is suitable for drinking and irrigation purposes

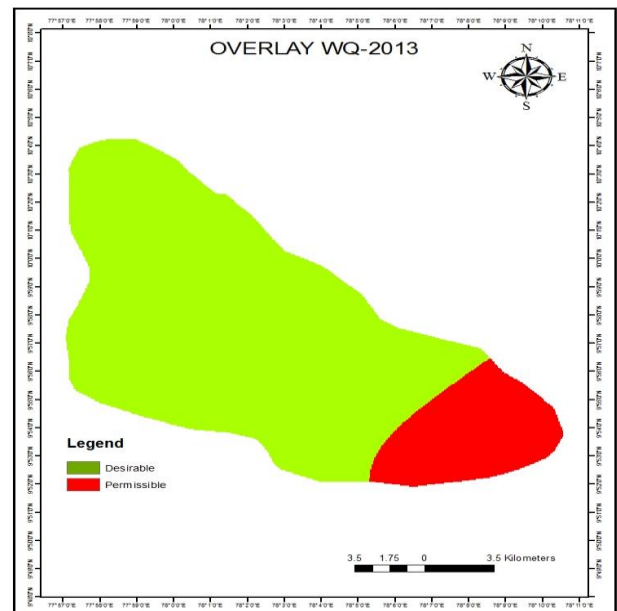


Fig-33 Overlay Water Quality Map-2013

P. Overlay Water Level 2008

The overlay water level in our study area in the year 2008 reveals that the water quality is permissible in all the locations we have taken for study. Hence, it is suitable for drinking and irrigation purposes.

IV. RESULT AND DISCUSSION

All the parameters given by the Public Works Department were analyzed using ArcGis Software and it is found that most of the parameters are within the desirable limit and the remaining parameters are within the permissible limit. Also, it should be noted that the parameter like Fluorides has a drastic effect in water if they extend beyond the limit (It should be 0.6-1.2 as per IS: 10500) and is too safe for our study area. But the water level has not raised much, however the groundwater level had been maintained even after the extraction although the year after the construction of Check Dam in 2009. Also it was observed that the areas adjacent to the Check Dam were most benefitted compared to the far areas.

V. CONCLUSION

The study was carried out at Melakkal and Kochadai Check Dams across the Vaigai river. The study revealed that in general groundwater level has increased as expected due to the storage of water in the check dam. Further, as the check dams are constructed at the interval of about 2 to 3 km there will be no upstream and downstream conflicts. The important criteria is that the Check Dams can be adopted in regions like areas which has rivers but it is drought and other regions.

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