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Assessment of Physico-Chemical Parameters of Groundwater For Drinking Purpose With Reference to Resettlement Area, Vavuniya

PRADIP SHAH, A. NANTHAKUMARAN and KEN KAWAMOTO

Abstract

This study deals with Physico-chemical of groundwater and surface water that are degraded by geological structure, poor sanitation, solid waste dumping and cultivation in this area have led surface and groundwater pollution with organic and inorganic substances through surface runoff, excessive irrigation and open grazing of cattle. The study was focused to analyze physico-chemical parameters of groundwater and comparing the suitability of village tank water with purpose to reduce the peak demand of drinking water. Monthly changes in physico-chemical parameters such as pH, EC, turbidity,phosphate, nitrates and total hardness were analyzed and tested parameters were within the permissible limits of World Health Organization except for EC (671 -6180 μS/cm) and total hardness (58-1396 mg/l).The tube wells water had low level of hardness (h=258 mg/l). Similarly, a high level of nitrate fluctuation was also recorded in wells close to agricultural land. The level of hardness was significantly (P- value <0.05) decreased with increasing the depth of groundwater sources, implying that the soil filtration and buffering may contribute to the natural water treatment. On the basis of findings, it was concluded that increasing level of EC and hardness in groundwater was not found to be suitable for drinking purpose and public health.However, it is recommended that water treatment system such as filtration and boiling should be used for reducing a level of hardness prior to utilization as portable water.

Key words: Groundwater, Village tank, EC and Hardness

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The development activities and water pollution are highly interconnected with rapid growth in population. Vavuniya is a place of dry zone having burning issue of pure drinking water. Wijesundara W. *et al.,* (2013) examinedan acute shortage of drinking water during the dry season triggered to deteriorate the quality of drinking water. The drastic change in climate and increasing warming is caused to shrinking of water level in various groundwater as well as surface water sources. Ravi K.G. *et. al.,* (2013) concluded that the discharge of domestic and industrial wastewater and other anthropogenic activities were the main causes for contamination of surface water sources.

After the prolong civil war, the study area is suddenly inhabited by increase human population. The people residing inside the area consuming groundwater from different sources such as dug well, tube well and borehole without bothering it quality and any treatment. The community having the least waste management strategy instead of that the solid waste dumping site of Vavuniya is closely established with village. The dumping site has created detrimental impact on health of community people. The improper solid waste management and lack of waste treatment plantleachate from dumping site and spread of solid wastes by insects, birds and mammals caused the contamination of groundwater by various kinds of organic, inorganic and toxic pollutants (Sugirtharan M., 2015).

Besides this, the clearance of vegetation for housing and agricultural purpose cause to damage the natural water filtration system. The deterioration of physical quality of soil and addition of soil abatement isallowing infiltration of calcium ions and other chemical compounds in the water table. The nature and amount of dissolved species in groundwater is strongly influenced by solubility of rock forming minerals (Tripathi AK. *et.al*., 2012). Moreover, the heavy cattle farming is also one of rising issue to incorporate organic matters in groundwater. The excessive use of nitrogen containing fertilizers for agriculture and improper functioning of sand beds caused addition of nitrate nitrogen in groundwater sourcesLoganathanP., (2011), Singh Asha Lata., (2012) and Ward. M.H. *et al*, (2005).

Dug wells are in shallow depth ranges from 20 feet to 50 feet, tube wells and borehole are above 100 feet. Most of the shallow dug wells are allocated near agriculture fields. The management and protection of groundwater became great concern and caused various kinds of health issues in study area such as kidney stone, diarrhoea, gastrointestinal problems and dental fluorosis (Chandrajith *et al*., 2011). During rainy season dug wells situated near to dumping site produced offensive smell with addition of taste in water. Regarding the water quality, calcium is one of the rising issues in study area.Ravi V.*et. al*., (2016), determined that most of the groundwater is polluted by human activities after the thriving of population. Hence, it is necessary to confirm the level of pollutants in groundwater sources for domestic usages.

Aim and objectives

The main objective of this study was to investigate physico-chemical parameters of groundwater with specific objective to compare the groundwater quality parameters with village tank water. This will help to reduce the burden of water scarcity during dry season by bringing the village tank water in drinking water supply scheme by installing proper water treatment method.

Material and Method

The study area was Sopalapuliyankulum at Pampaimadu. Sopalapuliyankulum is a fourth-order administrative division and is located in Northern Province. The latitude, longitude and elevation are 8o46’16.32”, 80024’44.28” and 103 meters respectively. The distance from dumping site to village, tank is 298 m and 1458 meters.

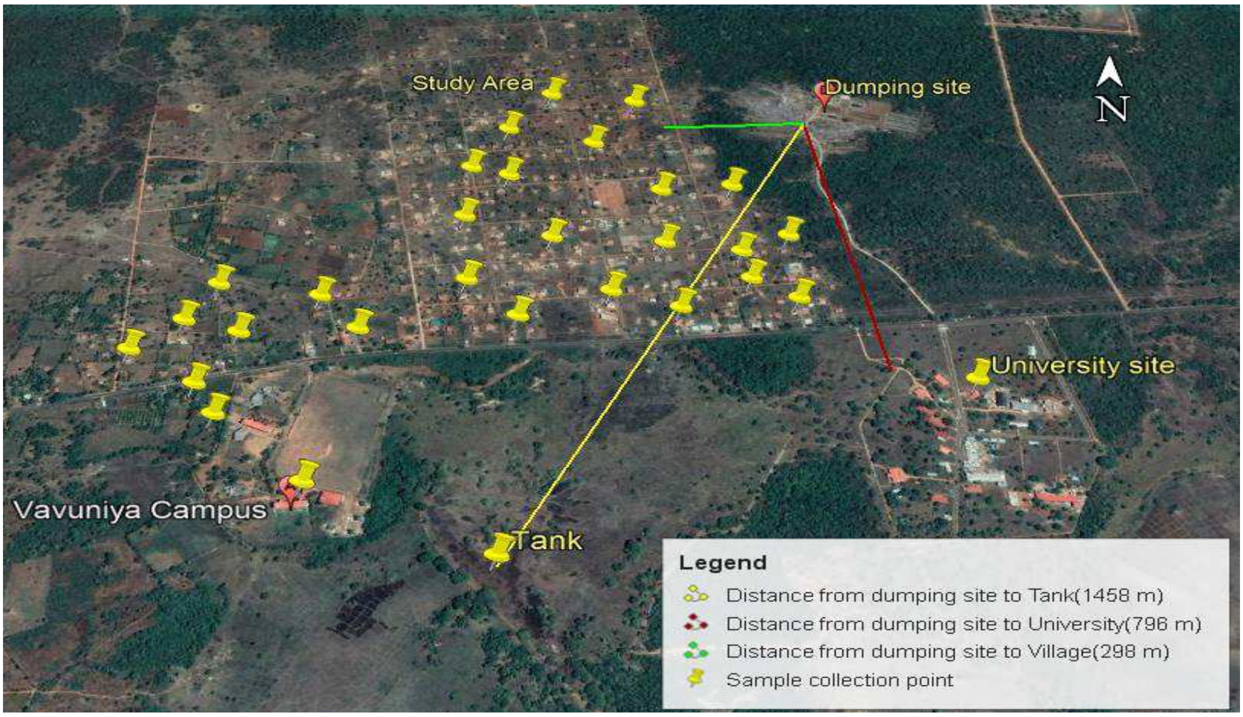

Figure: 3.0:Spatial distribution of sampling points

Collection of water sample and physico-chemical analysis

Thirty samples were collected during dry season followed by heavy rainfall *(Maha Season*) from shallow dug wells, tube-wells, bore- holes and village tank by simple random method of sampling to analyzed pH, electrical conductivity, turbidity, biological oxygen demands, total hardness, nitrate, phosphate. The samples were drawn from dug wells and tank approximately 50 cm level below water surface and from tube well and borehole by electrical pump. The analysis of physiochemical parameters such as pH, EC and turbidity were done by portable environmental probes, Biological oxygen demands by Winkler method, Nitrate by Phenol disulphonic Acid method, Phosphate by Ascorbic acid method and Hardness by Complexometric titration Ethylene-Diamine-Tetra-Acetic acid (EDTA) method.

RESULT AND DISCUSSION

pH

The groundwater pH ranged from 6.53- 7.87 with average of 7.38 over a period of two months. The groundwater and tank water samples showed the pH within WHO permissible limit of 6.5-8.5 before and after rainfall irrespectively of the months (Figure 4.1). The abundance of phytoplankton, aquatic weeds and their decomposition produce carbondioxide caused to slightly increased acidic(pH =6.24) of village tank.

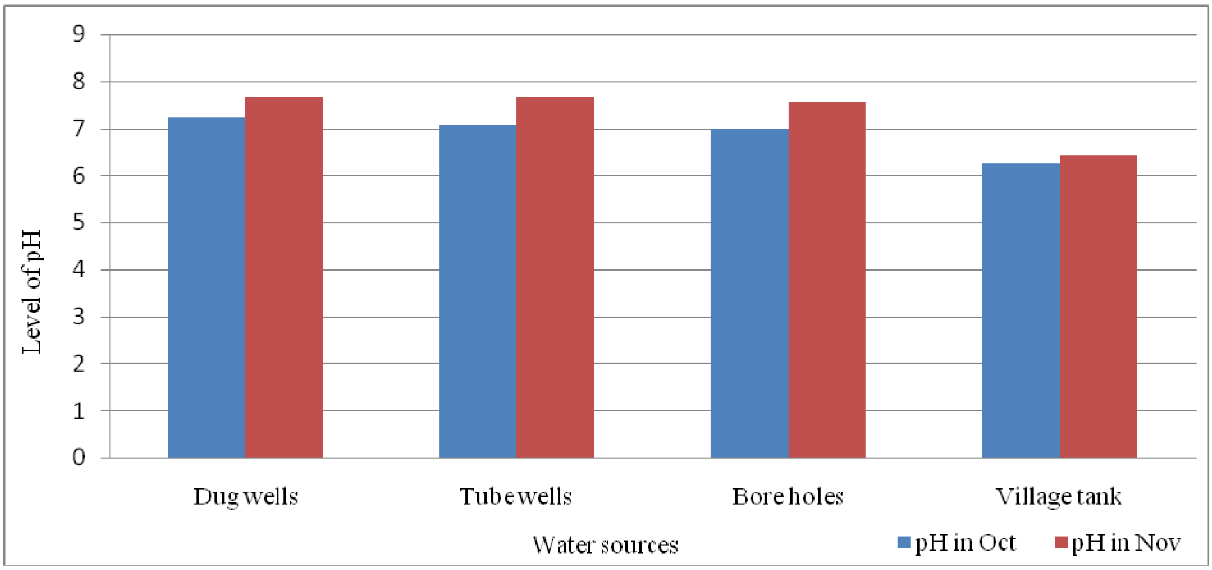

Figure 4.1 Variation of pH in groundwater andVillage tank water during study period

Electrical Conductivity (EC)

The conductivity of groundwater and village tank waterexceeded World Health Organization permissible limit of 1500µs/cm (Figure: 4.2) of mean value 1906 µs/cm over a period of two months. Before rainfall, the groundwater conductivity (1482 µs/cm) recorded below World Health Organization. While, minimum conductivityrecorded in tank water (671µs/cm). The conductivity (2789µs/cm) of groundwater sources increased immediately after heavy rainfall. The increased conductivity may be due to the runoff contribution from weathering of basic rocks, materials added as fertilizers and soil amendments and continuous open burning of solid waste from dumping site caused to addition of dust particles, ash and gases. On the other hand, the electrical conductivity tank water (633µs/cm)decreased due to dilution of tank water by rain. Meanwhile, the electrical conductivity increased with increasing in depth of groundwater sources.

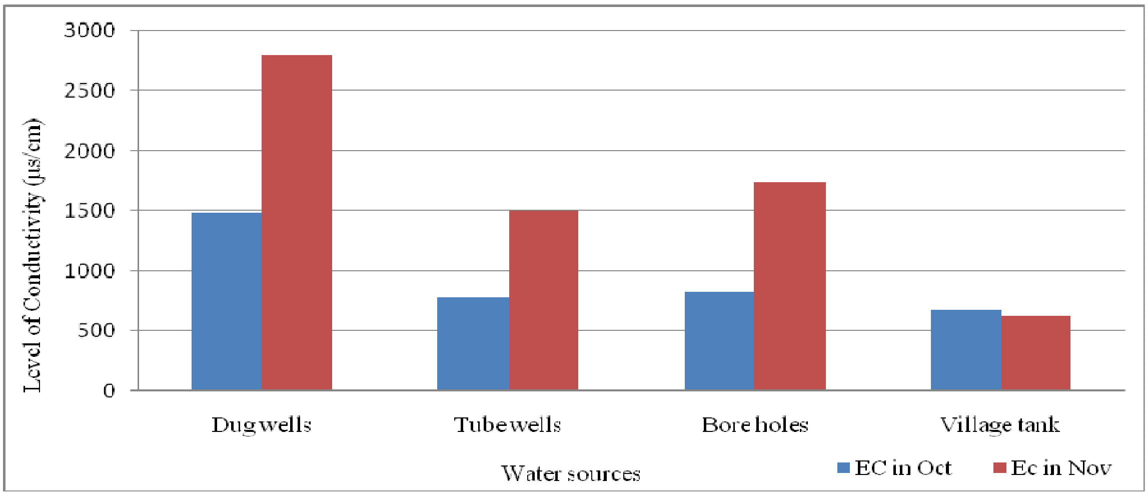

Figure 4.2 Variation of EC in groundwater and Village tank water during study period.

Turbidity

The turbidity of groundwater remained within WHO permissible limit of 5NTU irrespectively of the months (Figure 4.3) with mean value of 2.49 NTU. The highest value of turbidity (20.2 NTU) was recorded in Village tank water due to the presence of clay, silt, plankton and the microscopic organism. Besides this, among groundwater sources the maximum value of turbidity was recorded in shallow dug wells (1.44 NTU) than boreholes (0.2 NTU) and tube wells (0.11 NTU). After, continuous rainfall the soft soil and shallowness depth of groundwater sources may be contaminated by seepage and surface runoff caused to increased turbidity in groundwater sources up to 3.04 NTU. On the other hand, turbidity (16.2 NTU) of tank water decreased due to dilution by rain water.

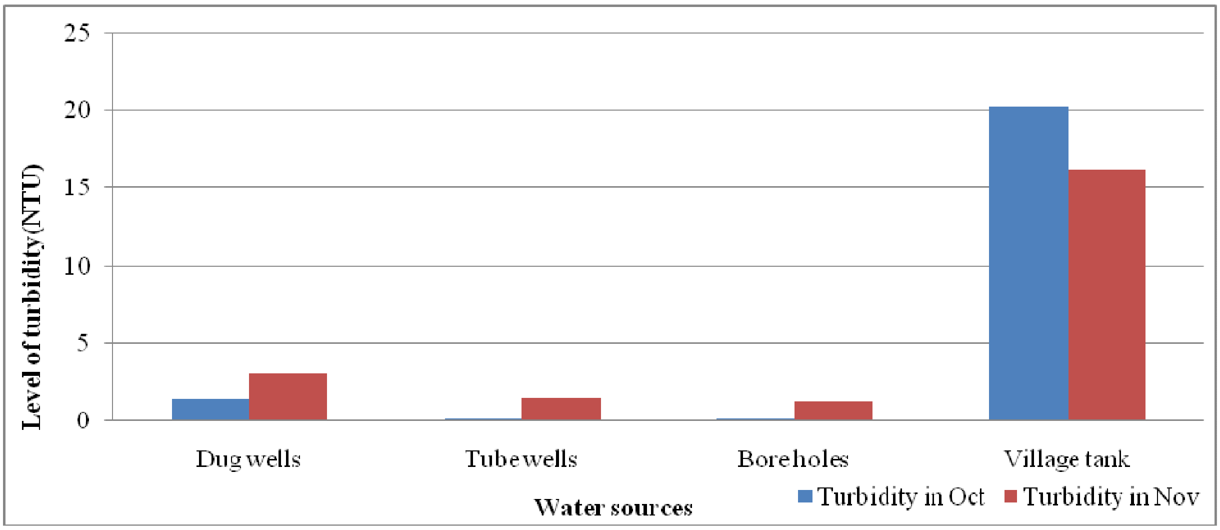

Figure 4.3 Variation of turbidity in groundwater and Village tank water during study

Nitrate

The nitrate concentration in groundwater and Village tank illustrated within permissible limits (45 mg/l) of World Health Organization over a period of two months (Figure 4.4). The average mean value of nitrate concentration was 0.037 mg/l. In compare to groundwater sources tube-wells revealed high level nitrate (0.048 mg/l) then dug wells (0.032mg/l) and bore-holes (0.02 mg/l). Conversely, after rainfall the elevated level of nitrate recorded in dug wells (0.04 mg/l) borehole(0.028 mg/l) then tube well(0.044 mg/l). The dug wells close to agricultural field recorded as high level of nitrate. It was due to the uses of nitrogen containing fertilizer for agriculture purposes. However, similar phenomenon observed in tank, the nitrate concentrationdecreased from 0.093 mg/l to 0.083 mg/l after rainfall by dilution of tank water withrain water.

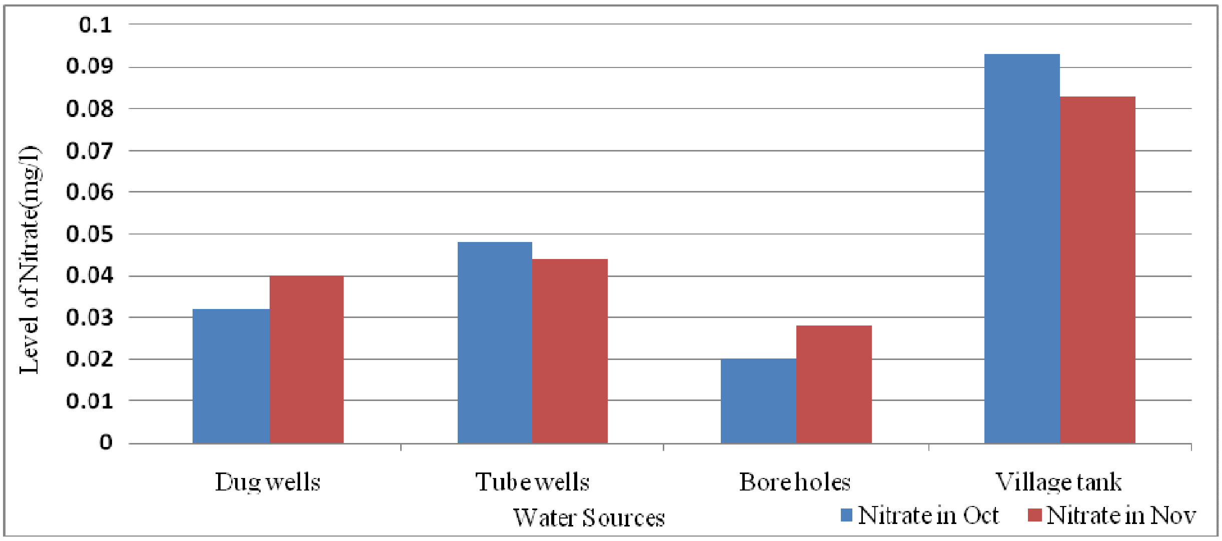

Figure 4.4 Variation of nitrate in groundwater and village tank water during study period

Phosphate

The phosphate in groundwater and village tank exposed mean value of 0.39 mg/l over a period of two months (Figure 4.5). The maximum phosphate concentration recorded in bore-holes (0.41 mg/l) than dug wells (0.405mg/l) and tube-wells (0.40mg/l). On the contrary, the phosphate level decreased after rainfall in bore-holes (0.38 mg/l) than dug wells (0.37mg/l) and tube-wells (0.35mg/l).In compare, village tank showed maximum phosphate level (0.57 mg/l) and due to dilution of tank water their level found to be decreased after rainfall.

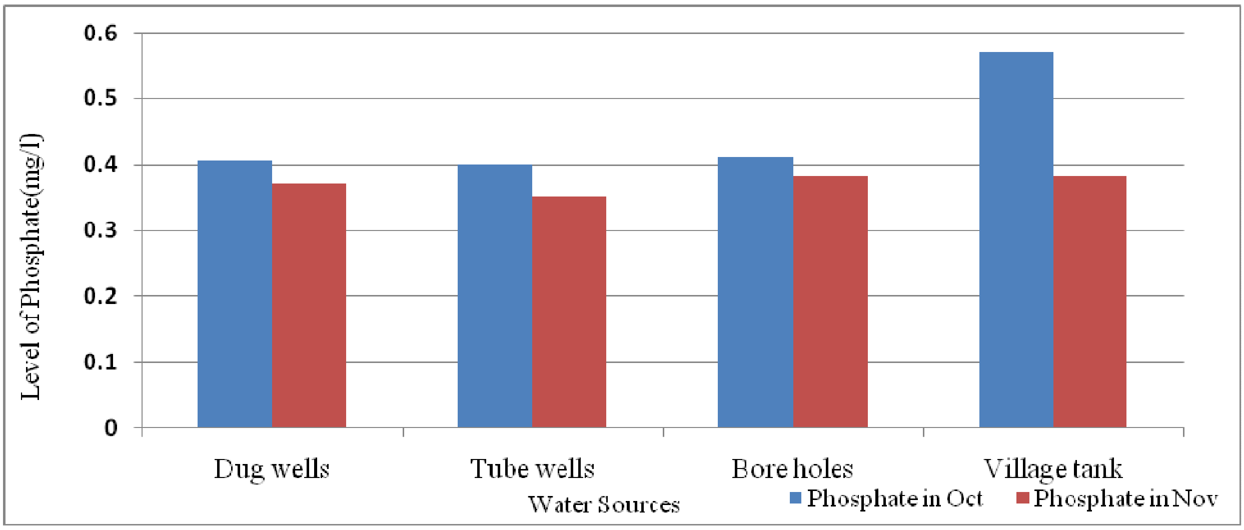

Figure 4.5 Variation of phosphate in groundwater and village tank water during study period.

Total Hardness

The mean value of 400 mg/l revealed in groundwater and Village tank ranged over a study period (Figure 4.6). The increasing level of hardness exceeded the World Health Organization desirable limits of 250 mg/l. The dug wells showed maximum level of hardness (460 mg/l) than bore-holes (257 mg/l) and tube-wells (254mg/l). The increase in hardness can be attributed to the decrease in water volume, geological condition and increase in the rate of evaporation at high temperature.

The hardness level followed by rainfall decreased in dug wells (440 mg/l), inversely increased in bole-holes (273 mg/l) and tube-wells (262 mg/l). The over extraction of water and close protective polyvinyl chloridepipe prevents the dilution and percolation of rain water in tube-wells and bore-holes caused to increased hardness. The direct collection of rain water in tank illustrated hardness level dropped from 65 mg/l to 50 mg/l.

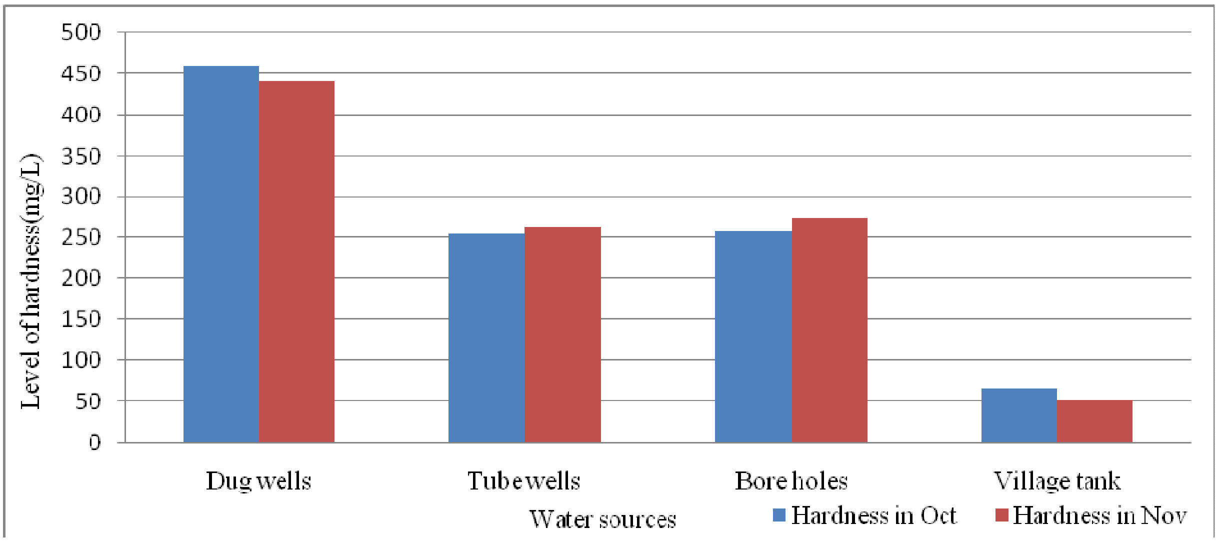

Figure 4.6 Variation of hardness in groundwater and Village tank water during study period

Total hardness is a sum of temporary hardness and permanent hardness.The study revealed that maximum level of hardness is due to temporary hardness (Figure: 4.7) and indicated that bicarbonate and carbonate ions are the main constituent of geological materials. The level permanent hardness had lower than temporary hardness in entire water sources. Furthermore, the level of hardness was significantly varied with depth of groundwater sources ((P- value <0.05). The shallow dug wells showed high levels of hardness than bore holes and tube wells.

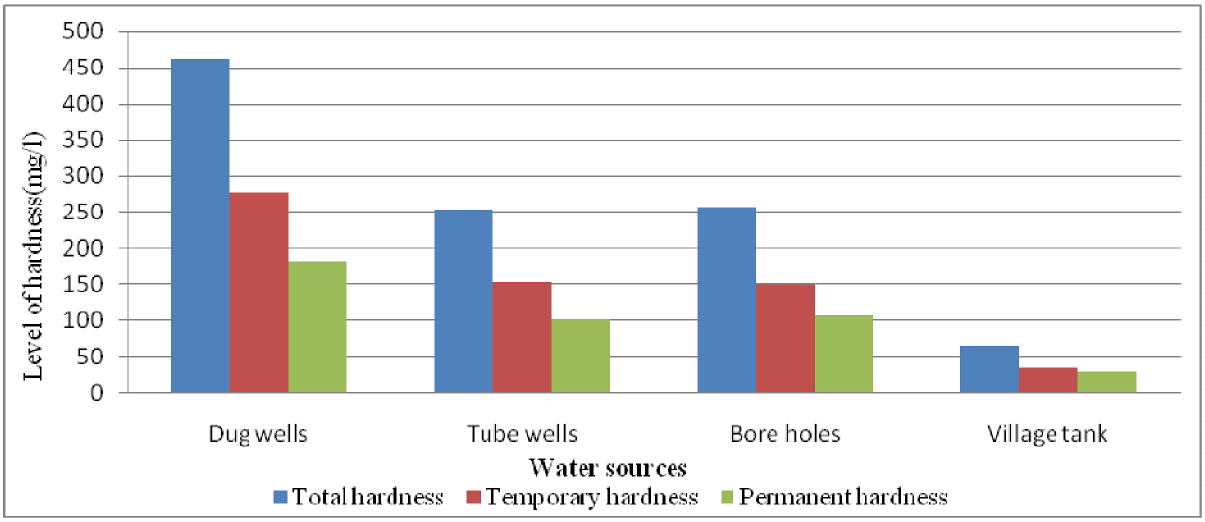

Figure: 4.7. Level of total hardness, temporary hardness and permanent hardness

CONCLUSION AND RECOMMENDATION

The outcomes of the result convey that increased level of electrical conductivity and total hardness in groundwater sources. Among the different groundwater sources in tube-wells water entire physico-chemical parameters within World Health Organization desirable as well as permissible limits considered as suitable for drinking purpose. The high level of electrical conductivity and total hardness in dug wells is completely avoidable for public health to control the possibility of chronic kidney diseases and dental problems.

In case, village tank water is directly collected from rain and having no any inter-connection with point and non-point sources is suitable to bring water in use by adopting proper water treatment method to reduce burden of peak water demand during dry season.It becomes profitable for public health and reduces the calcium associated health hazards such as Osteoporosis, colorectal cancer, hypertension, stroke, coronary artery disease, insulin resistance and obesity. In the home level such as filtration and boiling should be adapted to reduced level of hardness to improve to secure the public health.

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