International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161
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Research Article

Evaluation of Ground Water Quality for its Drinking Suitability- A Case Study for Pusad Town (India)

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Accepted 01 May 2014, Available online 01 June2014, **Vol.4, No.3 (June 2014)**

Abstract

Providing clean and affordable water to meet human needs is a grand challenge of the 21st century. Worldwide, water supply struggles to keep up with the fast growing demand, which is exacerbated by population growth, global climate change, and water quality deterioration. The need for technological innovation to enable integrated water management cannot be overstated. World will face a major fresh water crisis in the coming decades due to high contaminants in surface and subsurface water. Groundwater is ultimate and most suitable fresh water resource for human consumption in both urban as well as rural areas. The groundwater quality reflects the information about the natural and anthropogenic source of pollution. A study has been carried out in Pusad city of Yavatmal district, India to ascertain the ground water quality for the parameter viz.TDS, hardness, pH, chloride, fluoride and nitrate content in water. An experimental analysis shows that fluorides, chlorides, and hardness though found within limit, pH, TDS and nitrates are beyond acceptable limit, which has degraded the quality of ground water causing various diseases like Cardiovascular damage, Immune deficiency, hormone concerns, premature aging, cancer, coronary heart disease, arteriosclerotic heart disease and cardiovascular disease, Methaemoglobinemia, Blue baby syndrome, etc. in the study area. Necessity of close monitoring of ground water quality for accessing the sources with reference to land use, land covering activities is emphasized in the present study area to protect the ground water resources from the pollution.

Keywords: *TDS, Ph, Water pollution, Ground water*

1. Introduction

Water is vital for the existence for all life forms and is essential for all activities for human beings. Drinking water finds an important role in the human body. A demand from general public is to get a potable water which is safe to drink and pleasant to taste.

Due to urban growth and rapid increase in population, it has induced tremendous pressure on natural resources. This urbanization resulted into land, water pollution, etc. The major source of water is ground water. Ground water which occurs below the earth surface is considered free from contamination hence usable, however some natural factors affect the quality of valuable resources. Water chemistry defers depending upon source of water, the degree to which it has been evaporated, the types of rock and minerals it has encountered and the time it has been in contact with reactive minerals & land covering activities. Understanding the potential influence of human activity on ground water quality is important for protection and suitable use of ground water resources.

Ground water consumption has also been increasing continuously to keep pace with agricultural development in rural areas as well as to fulfill the domestic requirement of urban rural areas.

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It is estimated that 80% of the diseases of the world population and more than 1/3rd of the death in the developing countries are due to contaminated water. (WHO). These elements are essential for human health, but the excess concentration of such elements causes health disorders. Most of the small urban and rural areas use the ground water for drinking and other purposes. Numbers of dug wells and tube wells have been constructed to meet the drinking water requirement. It is a general scenario that such public wells, tube wells are located to the vicinity of the open sewerage (drainage) system, which carries high potency of inorganic and microbiological contaminants. Unfortunately such age old sever line are also not cleaned or properly maintained by the local authorities and thereby there is every possibility of contamination of ground water by the leakages of sewage through the badly damaged walls and bottom of sever lines. River water is also one of the sources to meet out the demand of domestic supply. It is a very peculiar scenario that all the sewerage lines are use to disposal of the domestic waste of town to either upstream side of river or downstream side of river, there by contaminating the river water too. Such untreated disposal either in the river or allowing percolating in the wells and the tube well is very dangerous as for as the quality of ground water is concerned.

The analysis of groundwater chemical characteristics provides much important information useful in water resources management. Assessing the water quality status for special use is the main objective of any water monitoring studies.

Keeping this aspect in to mind a study of evaluation of ground water quality and its suitability for drinking purpose is carried out in the Pusad city of Yavatmal district. 3 public wells, 11 tube wells covering entire Pusad town and 2 river samples are collected, tested and analyzed to understand the quality of water.

Water is essential for existence of man and all living things. Ground water occurs almost everywhere below the surface not only in single aquifers but also in thousands of aquifer systems. Man's activities such as food production, new tradition and mostly demand of water availability in adequate quantities and good quality. A lot of research work to analyze the quality of water, surface, and ground water in different part of country has been carried out. Some of the research work and their outcome are cited below.

Iron content in most of the ground water sample exceeds the permissible limits (0.3 mg/lit) has been found recommended for drinking purpose causing the health disorder in the Cuttack city, Odisha, (India) study area. (Dr. G. Sunpriya Achary *et al*, 2014)

Ground water sample of Vijapur dist. Aurangabad shows higher concentrating of dissolved solid (26.66%) electrical conductivity (26.66%), chloride (33.33%), total hardness (60%) and magnesium (86.66%) which indicates sign of detoriation as per WHO,BIS standards. (Deshpande. S.M. and Aher K.R, 2012)

Physico chemical test on water sample of bore wells and hand pumps in Tanda Taluka, Rampur district (U. P.) found that the fluoride concentration varies 0.46 to 4.36 mg/lit which is beyond the permissible limits. (Yadav S. S and Rajesh Kumar, 2010)

Studies on ground water pollution due to iron content and water quality in and around, Jagdalpur, Bastar district.Chattisgarh, India causing the health disorder in study area. (BhagiratiBehra, *et al*, 2012)

Muflid al-hadithi has studied "Application of water quality index to assess suitability of groundwater quality for drinking purposes in Ratmao – PathriRao watershed, Haridwar District, India. (Muflid al-hadithi *et al*, 2012)

Physico-chemical characteristics of 74 boreholes from communities within Densu Basin were assessed. The study showed that most of the physico-chemical constituents were within the WHO guideline limits. However, a few of the parameters fell outside the limits prescribed by the World Health Organization (WHO 2004) and recommended that Locations where high concentration of Fe and Mn occurred, efforts must be made to remove them to discourage the use of surface waters which may be contaminated by harmful bacteria. (J. Amoako *et al*, 2011)

Hydro-geochemistry of subsurface and surface water from bank of Jayanti stream, Kolhapur area, Maharashtra (INDIA) reveals that the contamination of groundwater system is through network of subsidiary streams. (Golekar R B, *et al* 2013)

Quality of Groundwater in the shallow Aquifers of a Paddy Dominated Agricultural River Basin, Kerala, India has been studied. The water samples (N=120) collected from various seasons, viz. monsoon-MON (August 2005), Post monsoon – POM (December, 2005)and based on major cations and anions , different hydro-chemical facies have been identified. The suitability of water for irrigation was determined by analyzing salinity hazard indicated by sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and sodium percent. Finally stress zones in the study area were delineated using Arc G/S spatial analysis and various management options were recommended to restore the ecosystem. (Kannan N *et al*, 2009)

During the second half of the 20th century, the Ganga River ecosystem has been continuously altered by several ongoing anthropogenic processes, accommodating multi-dimensional pressure due to increase of nearly four-fold human population. A bibliography containing more than 250 references on environmental studies of the Ganga River was prepared to preserve its ecosystem by providing the baseline support in this regard. (Munendra Singh &Amit K. Singh, 2007)

A preliminary investigation was made to understand the geochemical characteristics of ground water sources in Jhelum River basin of South Kashmir. A total of twenty ground water samples, representing shallow and deep sources were collected and analyzed for different geochemical parameters. The studied ground water sources have generally high alkalinity and hardness owing to the lacustrine deposits in the valley. The dominance pattern of cations in the studied ground water was as follows: Ca>Mg>Na>K and the sequence of anionic dominance was as follows: HCO3>Cl> SO4. The study showed that the regional geology as well as rock water interactions has played a dominant role in determining the concentration of various ions in ground water aquifers. (Arshid Jehangir, *et al*, 2011)

The physico-chemical parameters like temperature, pH, turbidity, total hardness, alkalinity, BOD , COD, chloride, nitrate and phosphate and fluoride content in water of Kosi River were studied to ascertain the drinking and domestic as well as irrigation water supply in Rampur district, and river water is found to be severely polluted with reference to The analyzed parameters and proved that industrialization, urbanization and modern agricultural practices have direct impact on water resources. (Yadav S.S. and Kumar Rajesh, 2011)

There is a potential risks of groundwater and surface water contamination by agricultural chemicals used in vegetable and agricultural production, (Golueke, Clarence 1995)

Data, obtained from the Campbell scientific weather station installed in the Patcham catchment and Schlumberger Water Services (SWS), were used to investigate recharge mechanism and potential contaminant flow paths through the Chalk unsaturated zone. Results showed that all the water parameters analyzed were within the WHO guideline values, thus indicating that the water in this area is quite safe for usage. (Kingsley *et al*, 2013)

The suitability of the water from the groundwater sources for drinking and irrigation purposes was evaluated by comparing the values of different water quality

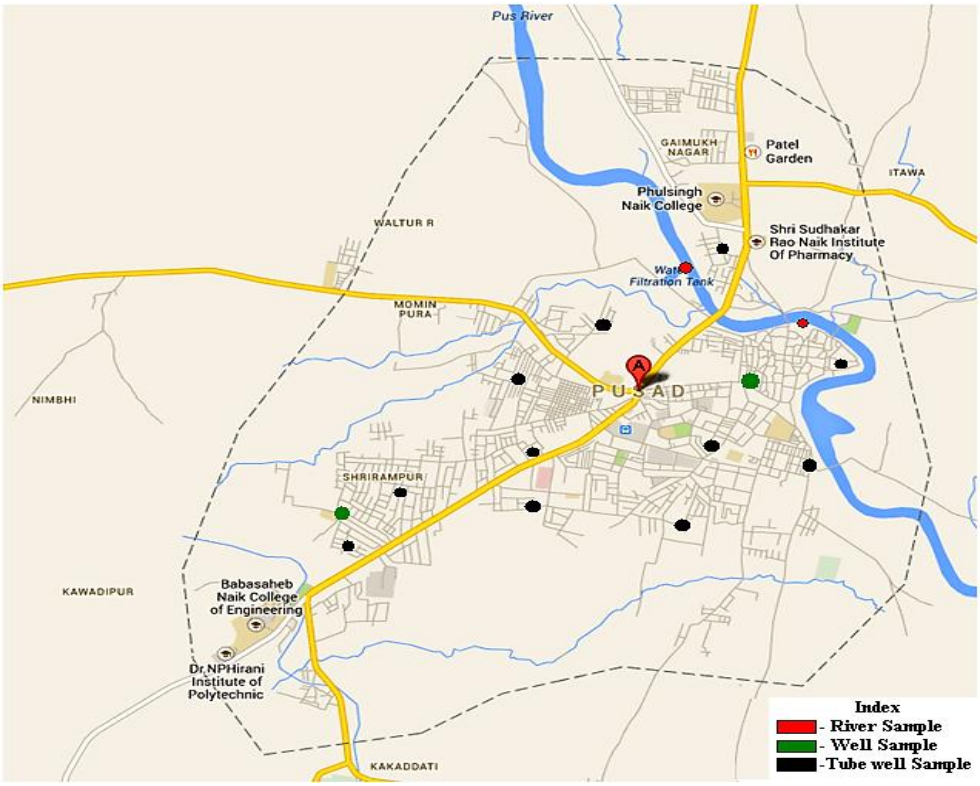

Fig.1 Location of samples

Sample No.	Location	Source
01	Bawane Layout	Public Well
02	Mr. Kishor Khorgade, Dubewar Layout	Tube well
03	Downstream Side near Dumping Site	River Water
04	Upstream Side near Intake of Water Treatment Plant	River Water
05	Mr. Haridas Boke, Green Park 2, Gandhi Nagar	Tube Well
06	Mr. Prakash Bhaware, Tirupati Park, Shrirampur	Tube Well
07	Mr. Laxman Borkar, Saptagiri Nagar	Tube Well
08	U. P. Chat Restaurant	Tube Well
09	Mr. K. K. Rathod, Banjara Colony	Tube Well
10	Mr. B. B. Mandavde, Banjara Colony	Tube Well
11	Mr. S. Yedatkar near Rest House	Tube Well
12	Mr. Namdeo Rathod, Banjara Colony	Tube Well
13	Public Well near Sate Bank, New Pusad	Public Well
14	Mr. P. D. Rathod, Mama Chowk	Tube well
15	Mr. Shinde, Laxmi Nagar	Tube Well

parameters with World Health Organization guideline values for drinking water. A preliminary hydro-chemical characterization shows that most of the groundwater samples fall in the field of calcium-magnesium-chloride-sulphate type of water. Majority of the samples are not suitable for drinking purposes and far from drinking water standards. The high EC value and the percentage of Na in most of the groundwater render it unsuitable for irrigation. Wilcox classification suggested that around 50% of both deep and shallow groundwater samples are unsuitable for irrigation. According to the US Salinity Classification, most of the groundwater is unsuitable for irrigation unless special measures are adopted. (Ketata *et al*, 2012)

Thus it is very clear that, the water is not safe on the earth. Some or the other way at different geographical location, water is found polluted on different parameters.

2. Methodology of Study

Pusad is a municipal town in Yavatmal district of Vidarbha region. The town being speedily developing, a present case study on "Evaluation of Ground Water Quality for its Drinking Suitability - A Case Study" is undertaken. Detailed methodology of work is as given below.

15 representative water samples were selected randomly by dividing Pusad town in to five zone. Locations of the spots are shown in the Fig. 1. The river samples were collected for the analysis of quality of water at upstream and downstream side of the river since domestic waste is directly disposed of in the river. Collected sample were analyzed for i) pH, ii) Total solids, iii) Chlorides, iv) Hardness, v) Fluorides and vi) Nitrates.

Table 1: pH values

Sample No.	Observations	
	By paper	**By meter**
01	5	6.92
02	5	6.77
03	6	7.26
04	6	7.44
05	5	6.22
06	6	6.47
07	7	6.97
08	6	6.07
09	6	6.51
10	5	6.10
11	6	6.32
12	7	6.67
13	6	6.27
14	7	6.89
15	6	6.13

Table 2: Observed values of Cl, Fl, Nitrates, T. S. & Hardness of samples

Sample No	Chloride (ppm)	Fluoride(mg/l)	Nitrate(mg/l)	Total solids(mg/l)	Hardness (ppm)
01	110.05	0.377	34.23	400	116
02	112.3	0.474	32.17	375	74
03	154.89	0.422	47.47	603.178	94
04	58.93	0.092	22.18	626.92	72
05	168.98	0.215	39.12	609.41	136
06	113.54	0.461	48.16	635.74	162
07	99.4	0.435	56.93	616.18	152
08	101.56	1.023	12.56	612.15	198
09	110.05	0.09	45.27	630.62	306
10	117.02	0. 187	47.47	631.71	188
11	231.81	0.36	23.14	631.77	176
12	243.53	0.124	42.32	630.42	70
13	220.1	0.87	42	617.52	150
14	235.36	0.55	36.14	616.09	206
15	351.45	0.76	43.12	616.72	82

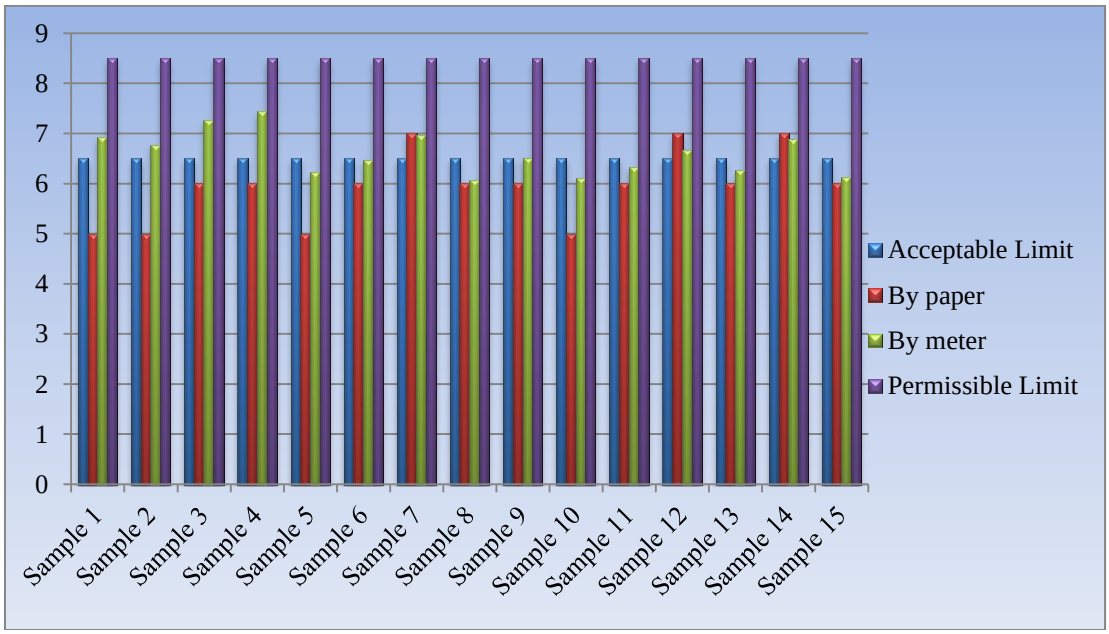

Fig. 2 Graphical representation of pH value

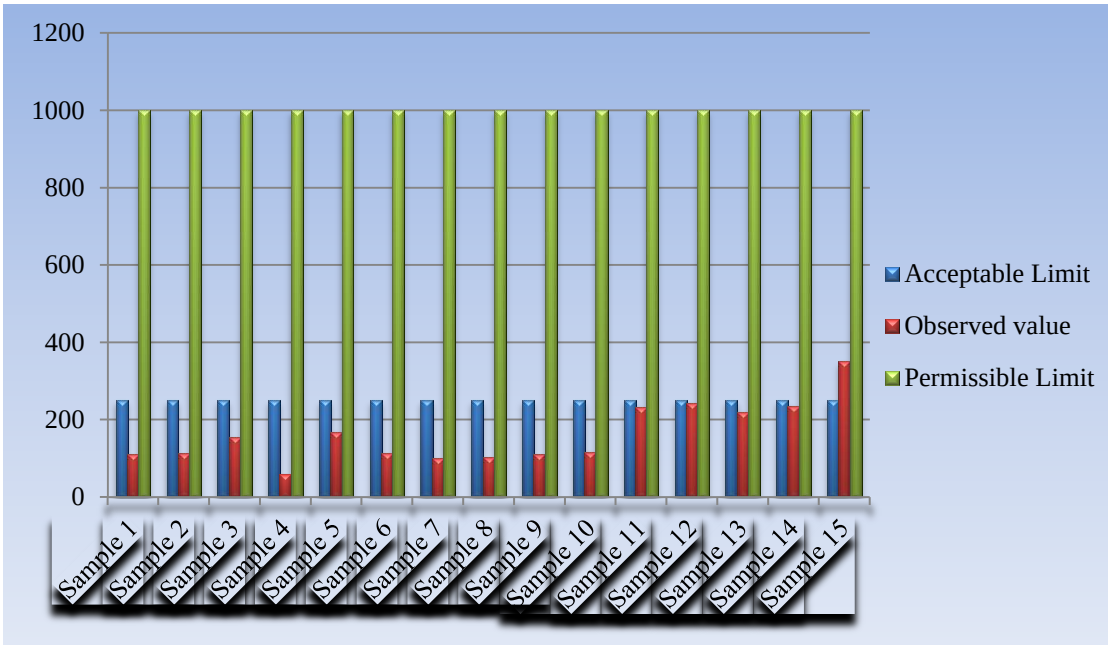

Fig.3 Graphical representation of Chloride values

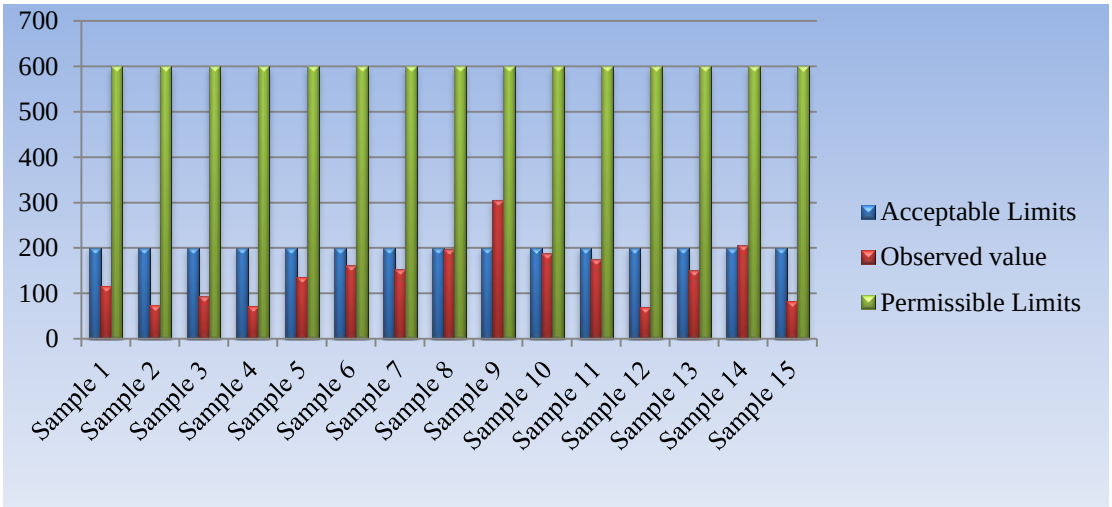

Fig.4 Graphical representation of Hardness

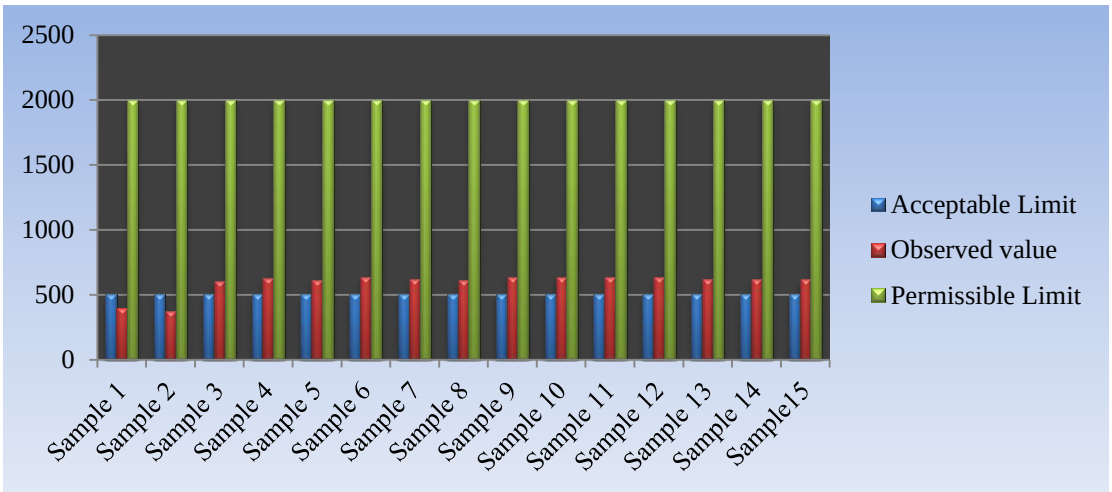

Fig.5 Graphical representation of Total Solids

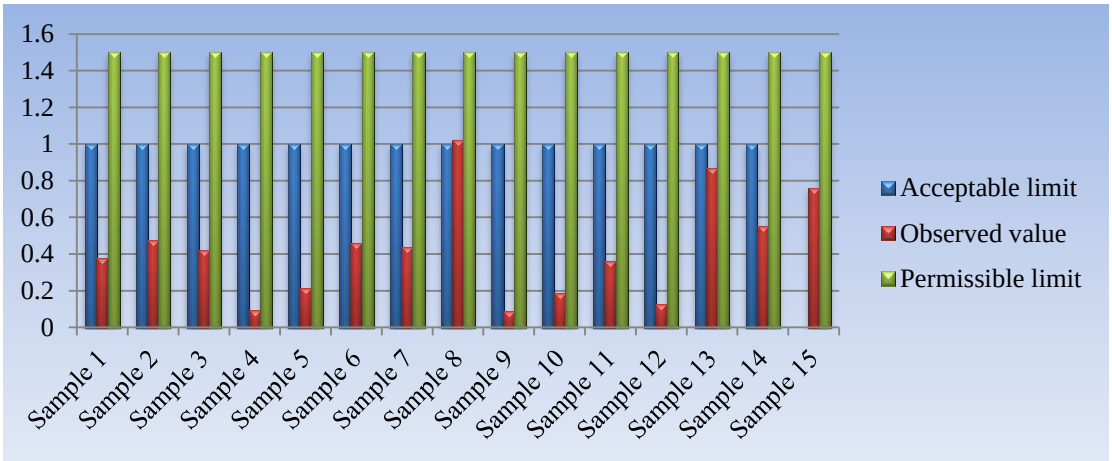

Fig.6 Graphical representation of Fluoride values

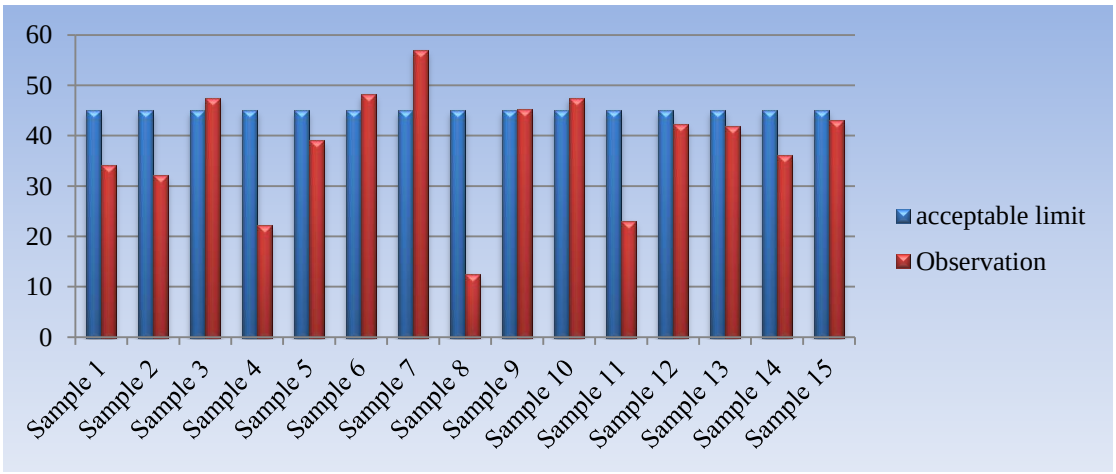

Fig.7 Graphical representation of Nitrates values

3. Observations

Different source samples collected from of Pusad town were tested for

- pH value
- Chlorides
- Hardness
- Total Solids
- Fluoride
- Nitrates

Test results are presented in Table 1& 2

From the experimental results, analyses of data by comparing with standard limits following observations are recorded almost.

- **pH values** exceed the acceptable limit in 50% areas of Pusad town (Bawane Layout (well water), Dubewar Layout, Downstream side of Pus river, Upstream of Pus river, Saptagiri Nagar, Banjara Colony and Rest House.
- **Chlorides** exceed the acceptable limit in Laxmi Nagar.
- **Hardness** exceeds the acceptable limit in Banjara Colony and Rest House.
- **Total Solids** exceed the acceptable limit in almost all the areas
- **Fluoride** exceeds the acceptable limit in the water of U. P. Chat Restaurant
- **Nitrates** exceed the acceptable limit in the areas of Tirupati Park, Saptagiri Nagar, Banjara Colony and Downstream side of river
- Photograph show in Fig 8 taken during survey shows stagnant pond of domestic waste near bore well of a private house contaminated the source water.

Fig. 8 Undrained waste disposal near source

5. Conclusion

The water samples collected from various places in the Pusad town were analyzed for various physiochemical parameters such as pH value, hardness, chlorides, total solids, fluoride, nitrates etc.

Higher percentage of fluoride, nitrates and chloride are observed in 6 samples. Bore well water is found harder than river water. Author tried to find out the reason. Contamination of river water is mainly due to direct disposal of liquid waste (gray water) on both upstream and downstream side of Pus river. Similarly disposal of solid waste on the bank of Pus river, disposal of funeral side ash (Mokshdham) and waste from slaughter house directly to river must be banned by the municipal council.

Non availability or even open drains contaminated the bore well and well sources, showing higher percentage of chlorides, nitrates and TDS. Non awareness of public about minimum distance between source of water and waste water disposal must be verified by Sanitary and Health Inspector of Municipal Council.

TDS value higher than tolerance value for almost all the bore well needs "Softener" (Filter based on activated alumina absorption) is recommended.

It is thus recommended to have regular chemical analysis of sources having higher values of different parameters than tolerance value to ensure quality of water is not further contaminated and safe water can be made available for Pusad town.

6. Recommendations

- Direct untreated waste disposal in river be immediately stopped. Municipal waste disposal management which at present neglected by council shall be taken on priority by adopting modern innovative methods like nanotechnology.
- Grey water treatment by filter and chemical treatment is necessary prior to disposal of waste in river.
- Bore well and well must be protected properly to avoid contamination by surrounding surface water near the vicinity of bore well and open well.
- Municipal council should take on priority the projects like construction of drains and existing constructed drains are to be properly maintained for free flow of waste which during survey was found to be chocked by plastic and other solid waste.
- Most of the bore well water shows higher TDS value. Owners largely depends open water of such bore well must provide softener on their bore wells to get low TDS water.
- Disposal of medical waste, domestic waste near public wells and tube wells be banned.

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