



Assessment of Ground Water Quality, Health, Sanitation and Hygiene Conditions in slum area of Jalgaon City, Maharashtra, India

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Abstract

Tambapura area is a slum area of Jalgaon city, characterized by a densely populated area marked by heavy crowding, dirty run-down housing, poverty, and social disorganization. Large quantities of solid waste generated from the residences, commercial, municipal and hospitals are dumped in open land areas. Such dumping causes environmental pollution by deteriorating the ground water quality, encourage the breeding of disease-vector insects, animal scavengers and rodents resulting in spreading of air and water borne diseases. The present study was conducted to assess the health and hygiene conditions due to open solid waste dumping in Tambapura area. To carry out the study, the ground water samples were collected and analyzed for various physical, chemical and biological parameters to assess the contamination due to solid waste dumping. The health impacts were studied by systematic review of water borne and vector borne diseases that had affected adults and children's in this region. The results reviewed that due to poor sanitation, unhygienic conditions and unsecured drinking water people of slum area are prone to much water borne and vector borne diseases.

Keywords: Slum, dumping, health, hygiene, diseases.

Introduction

Groundwater is a water source present beneath the earth surface. Groundwater is nothing but the availability of water under the earth surface, generated from percolation of surface water. Groundwater is utilized by open well and bore well for different purposes. There are fewer chances to contaminate the GW as compare to surface water, as the surface water is open to surrounding environment. GW can become contaminated in many ways. If rain water or surface water comes into contact with polluted soil containing hazardous pollutants, such percolation into the ground causes the GW pollution¹. Groundwater can also become contaminated when liquid hazardous substances themselves soak down through the soil or rock into the groundwater. Some liquid hazardous substances do not mix with the groundwater but remain pooled within the soil or bedrock. Poor sanitation, open dumping of municipal solid waste near sources of water also causes the GW contamination^{2,3}. The present investigation is focus on such problems found in slum area of Jalgaon city. The collected municipal solid waste is lay down near residential area and nearby; namely Tambapura Area for land filling which generate leachate. Seeping of leachate in to GW sources of this area may contaminate the water. Besides this, the poor sanitation condition is found in this area. As the main source of drinking water is bore well water in this area, the effect of solid waste dumping on ground water quality is emphasized. The obtained data is helpful to create the awareness among the people living in this area regarding the ground water quality and its

effect on their health, adopt good sanitation practices and maintained proper hygiene conditions in this area⁴⁻⁸.

Objectives of the study: To assess the physical, chemical and biological characteristics of ground water in the area to assess its portability. To review the status of water borne and vector borne diseases in study area. Age wise study of the patients suffering from water borne and vector borne diseases. To create awareness among the people living near open dumping site regarding the ground water quality, Sanitation, hygiene condition and its effect on their health.

Study Area: Tambapura area is a slum area, situated near National Highway No. 6 having a population of 5000 approximately. Figure-1 shows the ward wise map of Jalgaon city. Ward No.12 is shown by red indicator location of Tambapura area. The municipal solid waste collection vehicle passes through this highway. Some of the vehicles dump the solid waste material openly near and around this area. Tambapura area itself also a major contributor to generate municipal solid waste material. Figure-2 and figure-3 shows the heavy open solid waste dumping along the roads in the area.

Material and Methods

Tambapura area of Jalgaon city was selected for the present study. A detailed survey of hospitals was carried out to collect patient data and ground water samples were collected from study area for physico chemical and biological analysis.

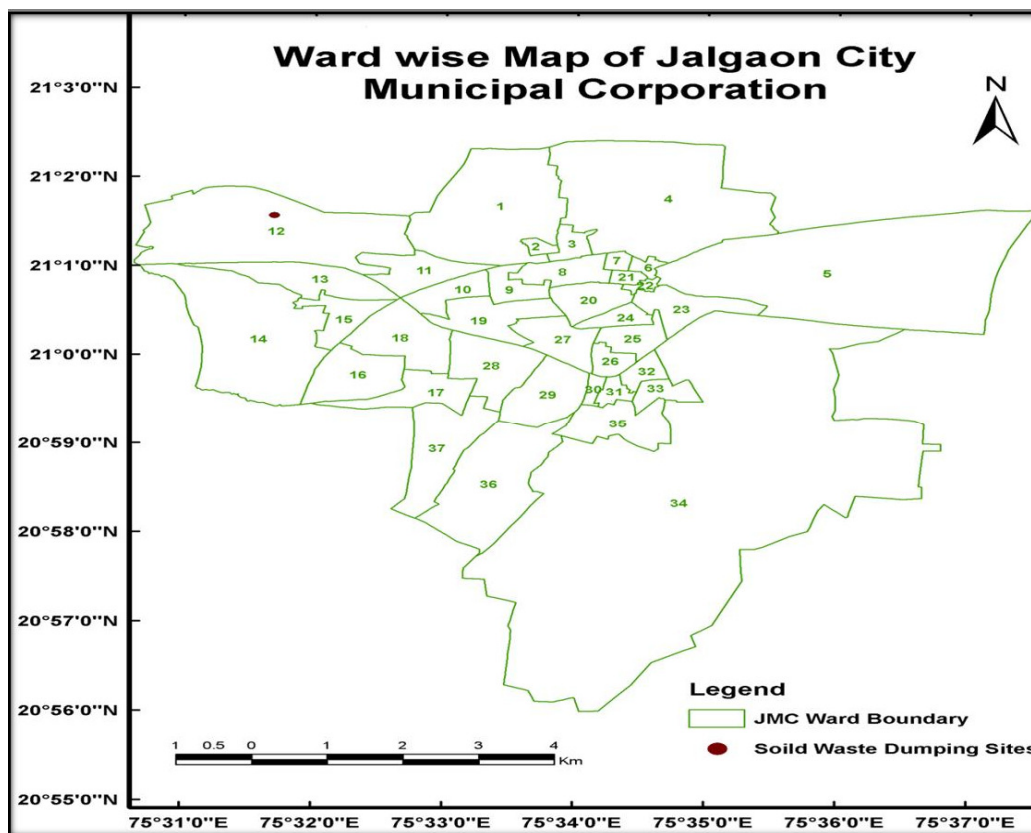


Figure-1
 Ward wise map of Jalgaon city showing open solid waste dumping site

Survey of Hospitals, collection and analysis of patient data:

Hospital Survey: Four hospitals were selected from nearby and surrounding area of study location. Out of four two were child specialist hospitals while remaining two were M.D. Physicians with adult specialist.

Collection and analysis of patient data: After brief discussion with doctors of respective hospitals, the information related to people’s lives in study area was recorded. The data collected includes patient’s name, Age, Gender, place of residence and diagnosed disease. Based on this data, patients were categorized as follows: according to age, child patients were categorized in to 0-5 yrs, 5-10 yrs and 10-15 yrs, where as adult patients were categorized into 15-45 yrs and above 45 yrs.

Collection and analysis of Ground water Quality:

Collection of water samples: Tambapura is an area which has no sufficient municipal supply for drinking water from Jalgaon Municiple Corporation. Hence peoples in the area are depends upon ground water source for drinking and domestic purpose. Water samples from groundwater sources that are extensively used for drinking purposes by the local residents in the area were collected randomly by adopting grab sampling technique. Total 5 samples were collected from study area to evaluate the effect of open solid waste dumping on groundwater quality⁵.



Figure-2
 Open solid waste dumping in the area

The plastic container having 2 liter capacities was used for collection and storage of water samples. The containers were thoroughly washed and rinsed before collection. All the samples were properly labeled with bore well numbers and some important details which include sampling date, time and locations. Sample containers for bacteriological examinations were sterilized before use². The details of ground water sampling are shown in table-1.



Figure-3
 Roadside open soil waste dumping

Results and Discussion

Table-2 shows the detailed information of type of disease, no of patient's age wise and total no of patients affected from different location of area. The summary indicates that all areas were disease prone area causing both, vector borne (figure-4a and 4b) and water borne diseases (figure-5a and 5b). Maximum numbers of patients were recorded from Gautam Nagar (T-4) because all the collected solid waste is dumped near this area, while minimum number of patients was found at Bismillah Nagar (T-3) of study area. The obtained data may vary as per the season.

The analytical results of the various physico-chemical and biological analysis of the groundwater samples of Tambapura area (T1 to T5) are tabulated in table-3.

All obtained results are compared with Bureau of Indian Standard / Specification for Drinking Water¹².

Turbidity: In the present study, turbidity values ranged from 6.3 to 15.4 NTU. All 5 samples showed higher turbidity than the prescribed limit by BIS standards. Extremely higher turbidity was recorded at location T3 and T4 i.e. 10.2 and 15.4 respectively. Figure-6 shows the turbidity graph at all locations.

pH: The pH values of the ground water samples of both areas were fluctuated between 5.94 to 6.49. The limit of pH value for drinking water is specified as 6.5 to 8.5. All reported values shows slightly acidic trend. This may be due to the chemical and acidic contents of the solid waste that reached ground water by leaching. The pH graph is shown in figure-7.

Electrical conductivity: Electrical conductivity (EC) is a measure of the capability of water to conduct an electrical current. It is concentration of soluble salts in the water. Pure water, such as distilled, water will have a very low specific conductance and sea water have a high specific conductance. The EC values in the study area vary widely from 4.32 to 9.2 mS/cm. The observed EC in Tambapura areas samples were high.

Table-1

Details of groundwater sampling locations in Tambapura Area

| Sample No. | Source | Area |
|------------|-----------|---------------------------------|
| T-1 | Hand Pump | Panchshil Nagar, Tambapura |
| T-2 | Hand Pump | Fukatpura Area, Tambapura |
| T-3 | Hand Pump | Bismillah Nagar, Tambapura |
| T-4 | Hand Pump | Gautam Nagar, Tambapura |
| T-5 | Bore Well | Chandrakant Saw Mill, Tambapura |

Physico chemical and biological analysis: Physical parameters: color, odour, taste, turbidity, Chemical Parameters: pH, electrical conductivity, total acidity, total alkalinity, total hardness, calcium hardness, magnesium hardness, calcium, magnesium, total dissolved solids, total suspended solids, total solids, chlorides, fluorides and phosphate. Biological Parameter: most probable number (MPN). All the parameters were analyzed by using standard procedures and AR grade chemicals and glassware in the laboratory⁹⁻¹¹.

Table-2
 Patient and Diseases summary

| Age Category | Nos. of Patients as per Disease Types (One Month Data) | | | | | | | | | |
|------------------------|--|-----|-----|-----|-----|----------------------|-----|-----|-----|-----|
| | Vector borne diseases | | | | | Water borne diseases | | | | |
| | T-1 | T-2 | T-3 | T-4 | T-5 | T-1 | T-2 | T-3 | T-4 | T-5 |
| Childs | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 0 | 3 | 2 |
| Adults | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 0 |
| Total Nos. of Patients | 14 | | | | | 12 | | | | |

Table-3
Analytical results of ground water quality of Tambapura area

| Parameters | Units | T1 | T2 | T3 | T4 | T5 | BIS Limits |
|--|----------------|-------------------|--------|-------------------|--------|-------|-----------------|
| Colour | ----- | Clear | Clear | Clear | Clear | Clear | 5 |
| Odour | ----- | Non-objectionable | | Non-objectionable | | | Unobjectionable |
| Taste | | Agreeable | | Agreeable | | | ----- |
| Turbidity | NTU | 7 | 6.8 | 10.2 | 15.4 | 6.3 | 5 |
| pH | | 6.49 | 6.18 | 6.01 | 5.98 | 5.94 | 6.5 to 8.5 |
| Electrical Conductivity | ----- | 920.3 | 838.5 | 609.2 | 762.2 | 113.8 | ----- |
| Total Acidity | mg/l | 390 | 590 | 650 | 670 | 500 | 120 |
| Total Alkanity | mg/l | 2 | 1.8 | 1.2 | 3 | 2.8 | 200 |
| Total Hardness (as CaCO ₃) | mg/l | 420 | 460 | 290 | 430 | 790 | 300 |
| Calcium Hardness | mg/l | 290 | 370 | 230 | 350 | 570 | 200 |
| Magnesium Hardness | mg/l | 130 | 90 | 60 | 80 | 220 | 100 |
| Ca ²⁺ | mg/l | 60.9 | 77.7 | 48.3 | 73.5 | 119.7 | 75 |
| Mg ²⁺ | mg/l | 31.60 | 21.88 | 14.59 | 19.45 | 53.48 | 50 |
| Total Dissolved Solids | mg/l | 460.4 | 415.1 | 317 | 410.2 | 560 | 500 |
| Total Suspended solids | mg/l | 189.2 | 121.65 | 160.85 | 204.05 | 125 | No Standard |
| Total Solids | mg/l | 649.6 | 536.75 | 477.85 | 614.25 | 685 | 500 |
| Chloride | mg/l | 205.3 | 219.5 | 212.4 | 177 | 252.9 | 250 |
| Fluoride | mg/l | 4.9 | 4.5 | 4.6 | 4.8 | 5.4 | 1.0 |
| Phosphate | mg/l | 1.8 | 2.4 | 2.8 | 1.6 | 2 | 5 |
| MPN | MPN/ 100 ml | 130 | 50 | 8 | 4 | 2 | 0/100 ml |

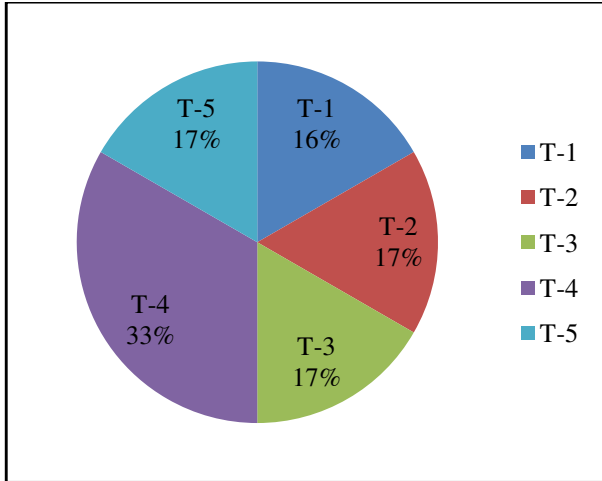


Figure-4a
 Summary of Vector borne Diseases (Childs)

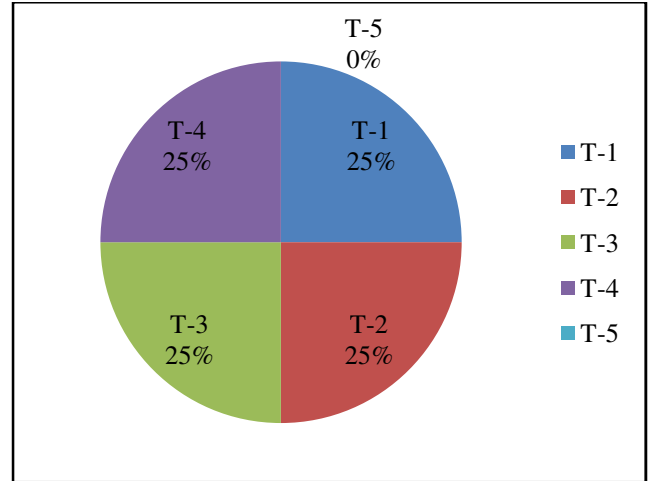


Figure-5b
 Summary of Water borne Diseases (Adults)

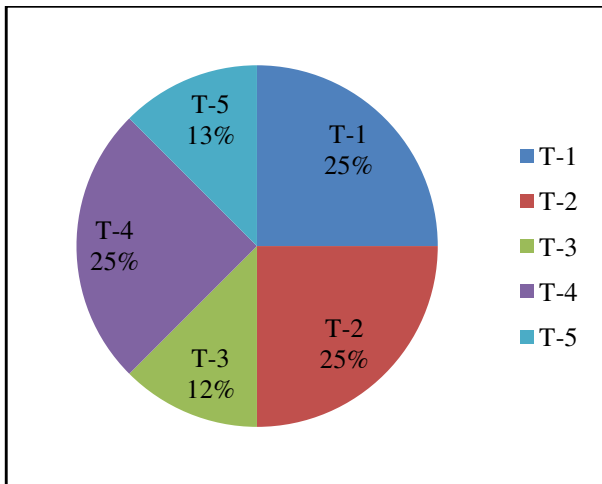


Figure-4b
 Summary of Vector borne Diseases (Adults)

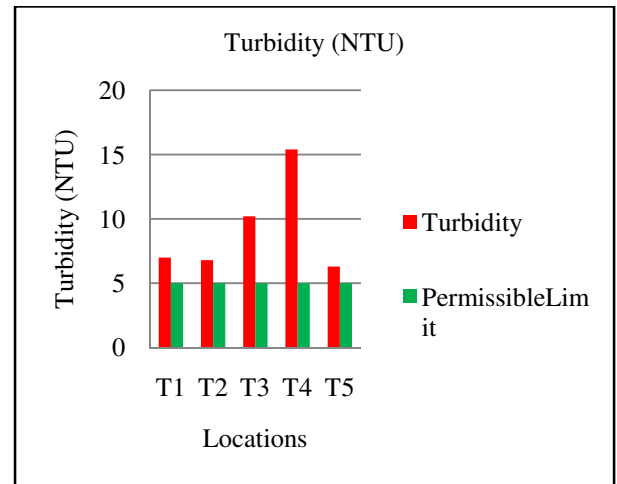


Figure-6
 Turbidity Concentration

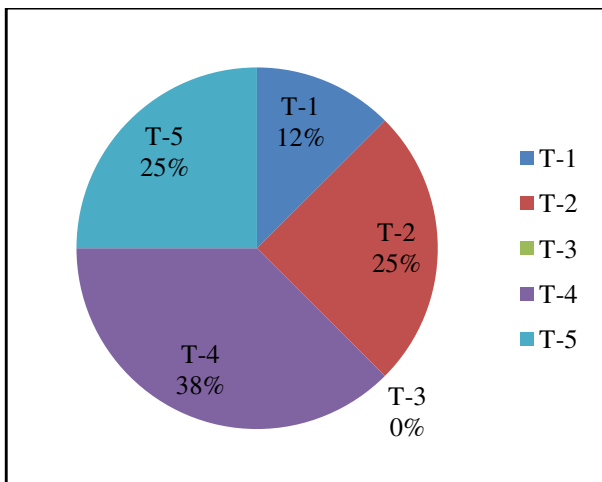


Figure-5a
 Summary of Water borne Diseases (Childs)

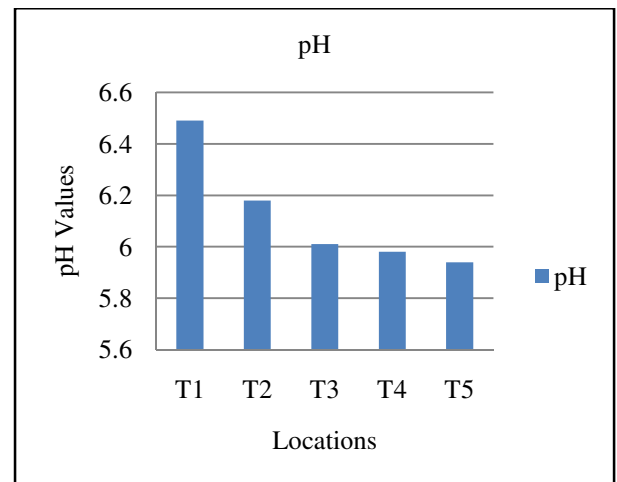


Figure-7
 pH Concentration

Total Acidity: The total acidity in the study area fluctuated

between 390 to 670 mg/L. Observed values shows, total acidity were higher at all locations. Figure-8 shows acidity graph of both study area.

Total Alkalinity: The standard desirable limit of alkalinity in potable water is 200mg/L. The maximum permissible level is 600 mg/L. The alkalinity in study area ranged between 1.2 to 3 mg/L. Hence, total alkalinity at all locations in study area was observed within the permissible limits¹³.

Total Hardness (TH): Total hardness in the area varied from 290 to 790 mg/L. Acceptable limit of TH for drinking is 300 mg/L. Except at T3 location, the total hardness values for all locations were found to exceed the permissible limit given by BIS. The highest hardness was observed at location T5, i.e. 790 mg/L. The higher values of hardness may be due to presence of excessive amounts of Ca and Mg salts in ground water samples. Figure-9 shows the total hardness graph indicating higher values at almost all locations. Absolutely soft water is tasteless whereas hardness above 600 mg/lit can affect the human cardiovascular and excretory system It cause the kidney and bladder strong.

Calcium Hardness: The desirable limit of Ca hardness in potable water is 200mg/L. The Ca hardness at all locations was found between 230 to 570 mg/L. The Ca hardness was observed highest site at location T5, i.e. 570 mg/L. The Ca hardness values at all locations in Tambapura area exceeded the permissible limits.

Magnesium Hardness: The Mg hardness in study area varied from 60 to 220 mg/L. Two groundwater samples T 1 and T 5 showed higher values of Mg hardness above the permissible limit prescribed by BIS. The Mg hardness of T1 and T5 were 130 and 220 mg/L respectively. Figure-11 shows graph higher values of Mg hardness at all locations.

Calcium: Calcium concentrations were found to vary from 48.3 to 119.7 mg/L. The Ca concentration was higher at T5 and T2 locations i.e. 119.2 and 77.7 mg/L respectively. Figure-12 shows the graph of Ca concentration of Ca at all study locations.

Magnesium: Magnesium content in groundwater varied from 14.59 to 53.48 mg/L. The upper limit of calcium concentration in drinking water is specified as 50 mg/L. At Tambapura site, except location T5, the Mg concentration at all other location was found within prescribed limits. The concentration of Mg at T5 location was 53.48 mg/L. Excess of Mg content present in ground water samples prove that the water is not good for drinking. Figure-13 illustrates high values of magnesium content.

Total Dissolved Solid (TDS): TDS content in groundwater varies from 317 to 560 mg/L. At Tambapura area, except T5 location, the TDS concentration at all locations found within prescribed limits. The TDS concentration at T5 location was

560 mg/L. Figure- 14 illustrates high values of TDS content.

Total Solid (TS): TS content in groundwater ranged from 477.85 to 685 mg/L. Except at T3 location, the TS concentration at all other locations was found above prescribed limits. The highest value of total solid concentration found at T5 location was 685 mg/L. Figure- 15 illustrates high values of TS content.

Chlorides: The permissible limit of chloride in drinking water is 250mg/L. The chloride values ranged from 177 to 252.9 mg/L in study area. The values of chloride observed at location T5 exceeded the permissible limits prescribed by BIS. The remaining all locations of study area show chloride concentration within permissible limits. When chlorine combined with sodium gives salty taste to drinking water, excess chlorides causes cardiovascular diseases.

Fluorides: The concentration of fluoride in groundwater samples of study area varied from 4.5 to 5.4 mg/L. The highest concentration of Fluoride was observed at T5 location, i.e. 5.4 mg/L in Tambapura area. Also it was observed that fluorides at all locations exceeded the prescribed limit in this site. The graph of fluoride concentration in groundwater is as shown in figure-16.

Phosphate: The permissible limit of phosphate in drinking water is 5 mg/L. The phosphate values ranged between 1.6 to 2.8 mg/L in Tambapura area. The observed values of phosphate concentration at all locations were found within permissible limit given by BIS.

Most Probable Number (MPN) Test: MPN Test indicates the biological contamination of water. If the MPN test is positive then its means there is presence of E-coli organisms in the water, which makes it unfit or not suitable for drinking purpose. The MPN test at all study locations was found positive showing the biological contamination of ground water in the area. The MPN concentration in groundwater is as shown in figure- 17.

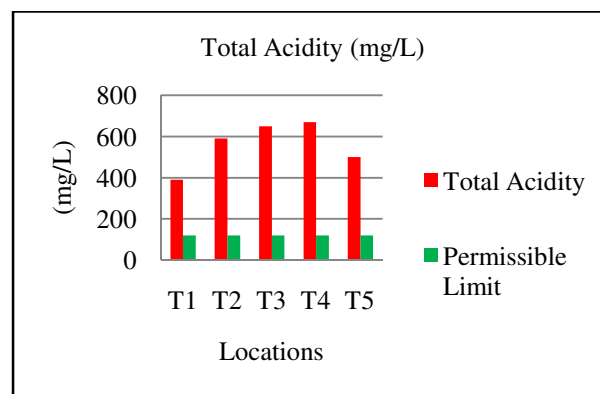


Figure-8
Total Acidity

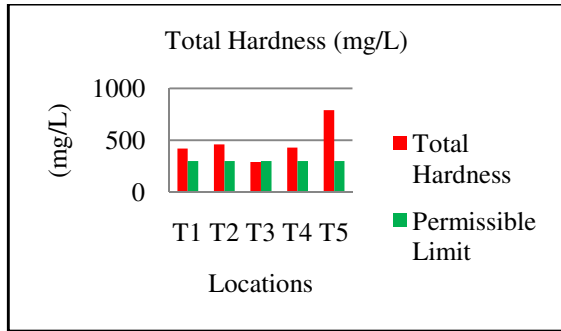


Figure-9
Total Hardness

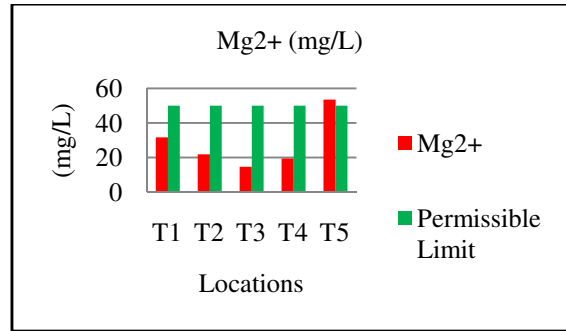


Figure-13
Conc. Of Mg²⁺

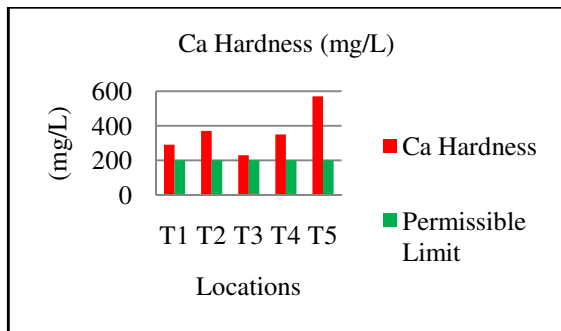


Figure-10
Calcium Hardness

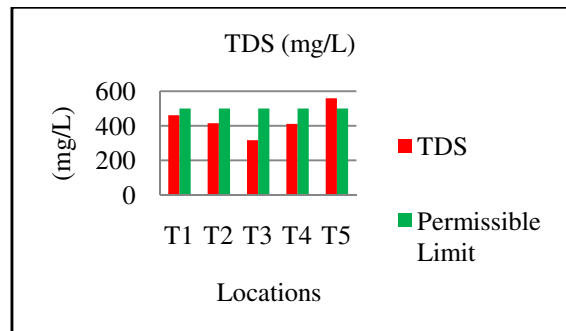


Figure-14
Total Dissolved Solids

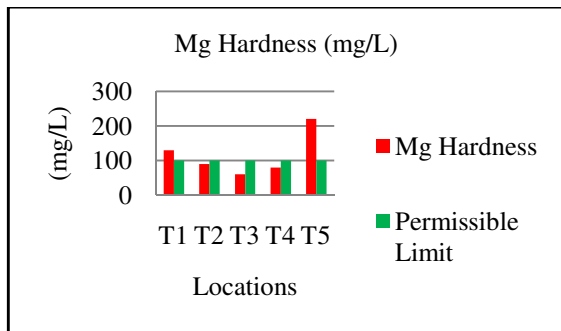


Figure-11
Magnesium Hardness

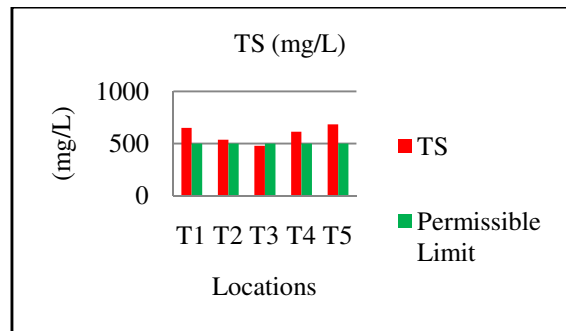


Figure-15
Total Solids

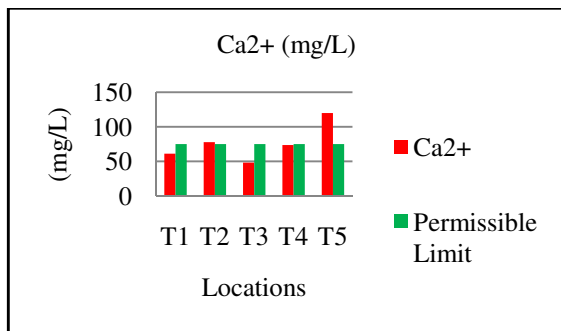


Figure-12
Conc. Of Ca²⁺

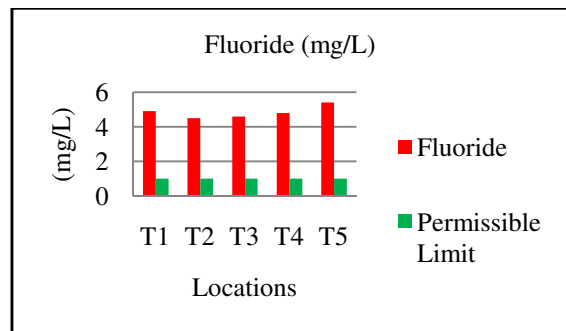


Figure-16
Conc. of Fluoride

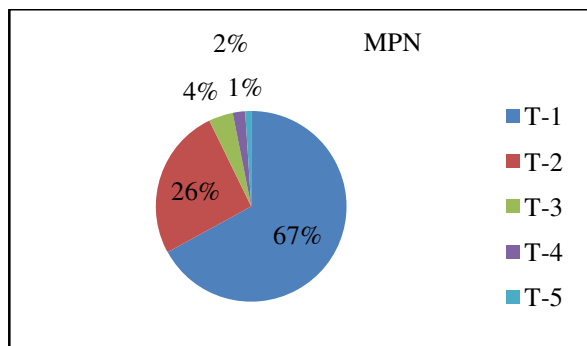


Figure-17
Most Probable Numbers

Conclusion

By observing the results it can be concluded that, the pH of all samples from Tambapura area was slightly acidic in nature. Turbidity of all ground water samples were above the prescribed limits. Total Hardness was highest at all locations except T3. Hence it can be said ground water in Tambapura area is very hard in nature. This may cause problems in digestion. Ca concentration at Tambapura area was beyond the prescribed limit. Chlorides were found higher in T5 location from Tambapura area. Remaining all locations was found within prescribed limits as per BIS standards. The desirable limit of Fluoride is 1 mg/L as per BIS standard. From the obtained results it is concluded that at all study locations from Tambapura area having high concentration of Fluorides. Excess concentration of Fluorides may cause the Dental and Skeletal Fluorosis to human being. The MPN test for all ground water samples was positive. Hence it can be concluded that there is presence of micro-organisms in all locations samples. This type of water is unfit or not suitable for drinking purpose. Use of this type of water for drinking purpose causes serious health problems.

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