# Impacts of effluents from two dyeing units on the groundwater quality in Nemili village, Vellore District, Tamilnadu

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**ABSTRACT:** *Raw and treated effluent water samples from Raman dyeing unit and Society dyeing unit and well water adjacent to these units in the Nemili village, Arakkonam Taluk, Vellore district during March and June 2010 (summer) were collected and analyzed for twelve water quality parameters. The higher turbidity of 9NTU; higher EC of 2350umhos/cm$^2$; higher TDS of 1645mg/l; higher hardness of 626mg/l; higher value of ammonia of 0.14mg/l; higher nitrate value of 49mg/l; higher fluoride value of 1.4mg/l in the treated effluent at the Society dyeing unit reveals the fact that this unit pollutes the environment when compared to Raman dyeing unit in Nemili village. The effluent water letting out from the Society dyeing unit should be treated properly. However, the well water is well within the potable limits. Since the groundwater development in Nemili village is said to be in the critical condition, strict and stringent measures have to be adopted in regulating the discharge of effluents / treated effluents to the environment to minimize the health risk for the end users.*

**Keywords:***Dyeing units, Raw and treated effluent water quality, Well water quality, Nemili village*

## 1.INTRODUCTION

Much of the ill health in the developing and under-developed countries is largely due to the lack of safe drinking water. Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove the harmful compounds. More than 600 organic substances, known to be carcinogenic and mutagenic, have been identified in drinking water.

The most serious aspect of water pollution is caused by sewage, industrial / trade wastes, drainage from agricultural areas which are the results of human activity, urbanization and industrialization. Due to these activities, the surface and ground water are subjected to frequent contamination which has contributed to high levels of nitrate, pesticides in ground water systems. The physical, chemical and bacteriological quality of water should confirm to the acceptable standards i.e. clear and colorless, agreeable taste and odour [1]. There is a growing need to protect drinking water due to increasing problem of water pollution.

India is the second largest producer of cotton yarn and silk and third largest producer of cotton and cellulose fiber. Most of the garment manufacturers, bleaching and dyeing industries in Indiaare concentrated at Surat in Gujarat; Ludiyana in Punjab; Tirupur and Karur in Tamil Nadu. About 712 dyeing and bleaching industries are in Tirupur that generate 87,000m$^3$/day of wastewater [2]. Out of this a total of 281 industries are attached with common effluent treatment plants (CETP) and others are having their individual effluent treatment plants. Presently adopted technology is able to remove the color and other organic impurities to the stipulated standards but failed to arrest the inorganic contaminants.

Dyeing is a combined process of bleaching and colouring, which generates voluminous quantities of wastewaters and in turn causes environmental degradation. The effluents consist of high total dissolved solids (TDS), hardness, sodium, chloride, sulphate, and carcinogenic dye ingredients etc. The dyeing industrial effluents offer the alteration of physical, chemical and biological properties of aquatic environment that is harmful to public health, livestock, wildlife, fish and other biodiversity. The presence of dyes in surface and subsurface water makes them not only aesthetically objectionable and also causes nausea, hemorrhage, ulceration of skin, dermatitis and severe irritation of the respiratory tract. Hence, the present work was undertaken to find out the quality of the effluent from two dyeing units and their impacts on the ground water quality adjacent to these dyeing units at Nemili village.

## 2. MATERIALS / METHODOLOGY

Three water samples (1.raw effluent, 2.treated effluent and 3. well water at the water logging site) from two dyeing units i.e 1. Raman dyeing unit and 2. Society dyeing unit, Nemili village, Arakkonam Taluk, Vellore district was collected during March and June 2010 (Figure 1).

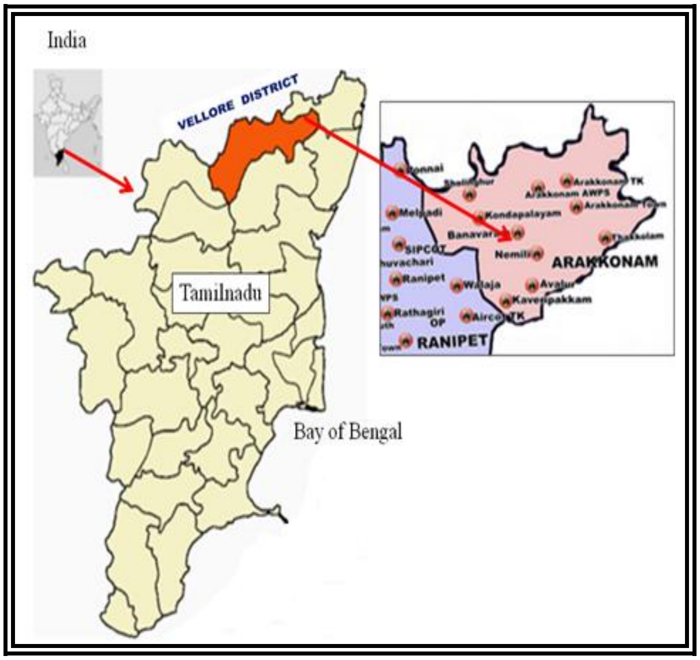


Figure 1: Study area – Nemili Village

The treated effluent water was discharged into open sewers and the water seeps all through the entire habitation without any drainage constructions. Twelve physico-chemical water quality parameters i.e Turbidity; Electrical Conductivity; Total Dissolved Solids; Total Hardness; pH; Alkalinity; Chloride; Ammonia; Nitrate; Sulphate; Iron and Fluoride were taken for the analysis of the samples [3] to ascertain the pollution level contributed by the industries and to study the influence of these discharges on the groundwater. The results of the analysis along with mean are shown in the Tables 1 and 2 and in the Figures 2-13.

## 3. RESULTS AND DISCUSSION

The careless disposal of industrial effluents and other wastes may contribute greatly to the poor quality of the water. The collected raw effluent samples were dark black/blue in colour which could be due to the presence of different salts used in dyeing process. This raw effluent water was more turbid than the treated samples.

### 3.1. Turbidity

The turbidity of the water samples of Raman dyeing unit ranged from 1 to 8 NTU and the turbidity of the water samples of Society dyeing unit ranged from 2 to 20 NTU. The well water samples were within the limits of less than 5NTU(Figure 2).

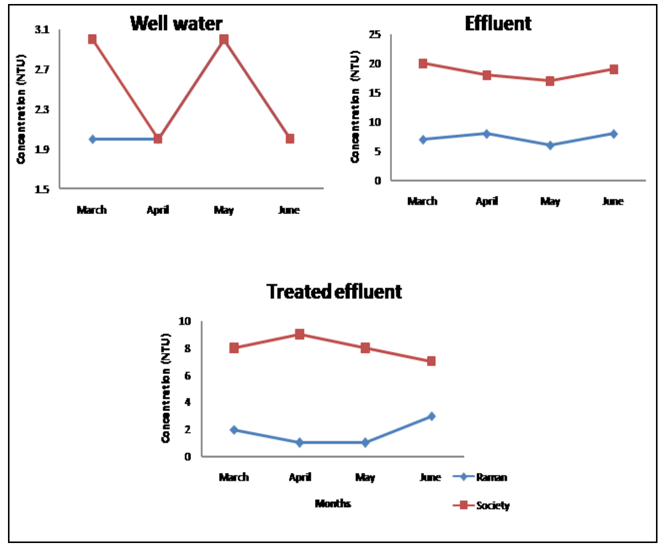


Figure.2. Turbidity

The values were more or less on the increase in May in the well water. The mean values of 1. Well water, 2. Effluent and 3. Treated effluent at Raman dyeing unit was 2.25, 7.25 and 1.75 respectively. Similarly the mean values of the three samples at Society dyeing unit were 2.5, 18.5 and 8 respectively. Hence the samples of Society dyeing unit is more polluted than the Raman dyeing unit. This study not only reveals the nature of the effluent samples and well water but also presence of pollution which indirectly reflects the performance of the treatment plants.

### 3.2. Electrical Conductivity (EC)

The EC of the water samples of Raman dyeing unit ranged from 915 to 1910umhos/cm$^2$ and the EC of the water samples of Society dyeing unit fluctuated between 815 to 3390umhos/cm$^2$. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 1027.5, 1801.25, 1132.5umhos/cm$^2$ respectively. Similarly the mean values of the three samples at Society dyeing unit were 938.75, 2962.5, 2170umhos/cm$^2$ respectively. Hence the samples of Society dyeing unit is more polluted than the Raman dyeing unit (Figure 3).

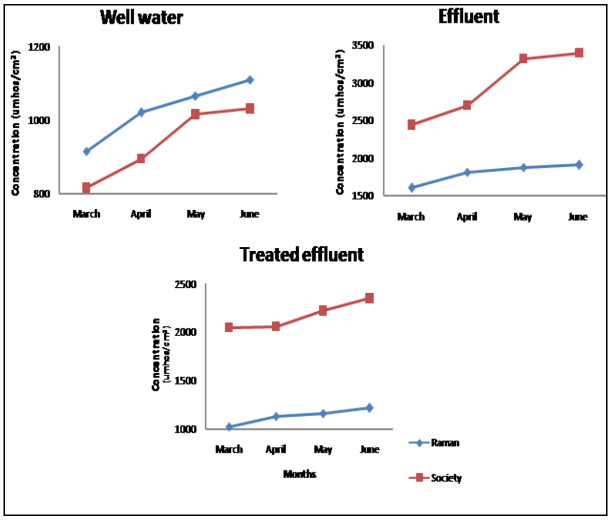


Figure 3. Electrical Conductivity

### 3.3.Total Dissolved Solids (TDS)

The TDS of the water samples of Raman dyeing unit ranged from 640 to 1337mg/l and the TDS of the water samples of Society dyeing unit fluctuated between 570 to 2375mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 718.75, 1261.75, 792.5mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 656.25, 2058.75, 1518.5mg/l respectively. Hence the samples of Society dyeing unit is more polluted than the Raman dyeing unit. Society dyeing unit samples show a high TDS (Figure 4).

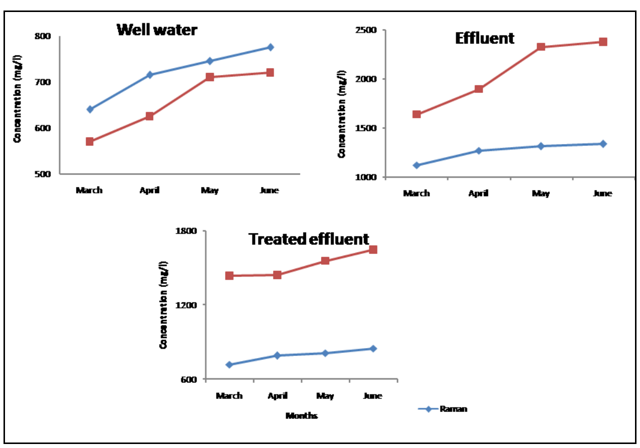


Figure 4. Total Dissolved Solids

The TDS of well water of Raman dyeing unit was ranging from 640 to 775 mg/l whereas it was from 570 to 720 for well water of Society dyeing unit. Since the TDS concentration exceeds the permissible concentration for drinking purposes (500mg/l), the quality of the well water is also deteriorating slowly.

The present work is in line with the work of CPCB whereinthe water quality of the downstream of river Noyyal has become unfit for irrigation due to the continuance of effluent discharges that has caused gross damages to the nearby aquatic systems like Orathupalayam dam [4]. The reservoir water's TDS was reported to be as high as 5054mg/l [4]. A high TDS (49,700mg/l) was noted by Sultana *et.al* (2009) [5]. In 2010, Rajkumar and Nagan[6] noted a higher TDS level in the Noyyal river water (upto 6600 mg/l).

### 3.4.pH

The pH of the water samples of Raman dyeing unit ranged from 7.25 to 8.3 and the pH of the water samples of Society dyeing unit fluctuated between 7.05 and 8.25. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 7.6,8.1 and 7.7 respectively. Similarly the mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Society dyeing unit were 7.86,7.85 and 7.98 respectively (Figure 5). The samples were all alkaline in nature and the range of fluctuation is lesser in this parameter.

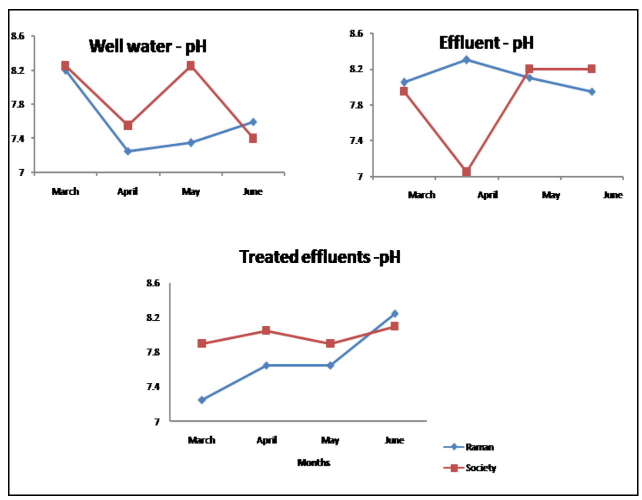


Figure. 5. pH

### 3.5.Alkalinity

The alkalinity of the water samples of Raman dyeing unit ranged from 188 to 372mg/l and the alkalinity of the water samples of Society dyeing unit fluctuated between 208 and 481mg/l.

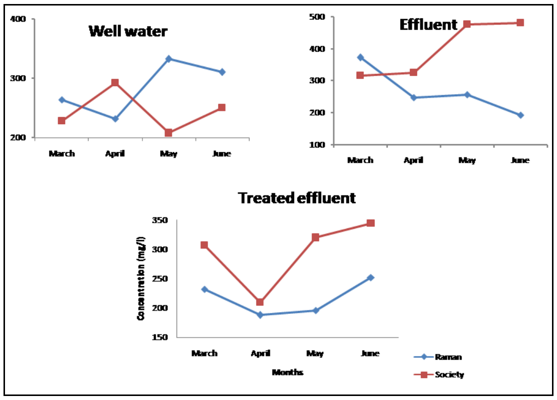


Figure 6. Alkalinity

The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 284.5, 267 and 217mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 244.5, 399.5 and 295.25mg/l respectively. Society dyeing unit samples showed higher alkalinity than Raman dyeing unit samples (Figure 6). The present investigation shows that the waters were all alkaline.

### 3.6.Total Hardness

The total hardness of the water samples of Raman dyeing unit ranged from 220 to 520mg/l and the total hardness of the water samples of Society dyeing unit fluctuated between 136 and 827mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 327.25, 430.25 and 258.75mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 242, 744.25 and 527.5 mg/l respectively. The Society dyeing unit samples showed a high total hardness (Figure 7).

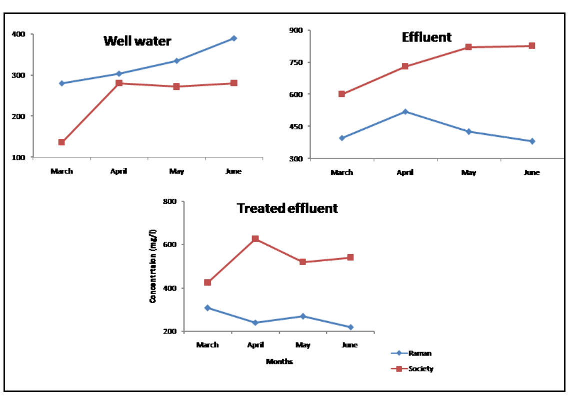


Figure. 7. Total Hardness

Hardness of water is constituted by the carbonates of calcium and magnesium salts. The maximum allowable limit is 600mg/l. The high concentration could be due to the accumulation of salts and no possible dilution of the effluents during the sampling period.

### 3.7.Ammonia

The ammonia of the water samples of Raman dyeing unit ranged from 0.03 to 0.18mg/l and the ammonia of the water samples of Society dyeing unit fluctuated between 0.11 and 0.45mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 0.05, 0.15, 0.05mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 0.12, 0.3, 0.12mg/l respectively. Presence of ammonia, an indicator of pollution, shows the bacterial degradation of organic materials under anaerobic conditions. The samples of Society dyeing unit showed a moderate concentration of ammonia than the Raman dyeing unit (Figure 8).

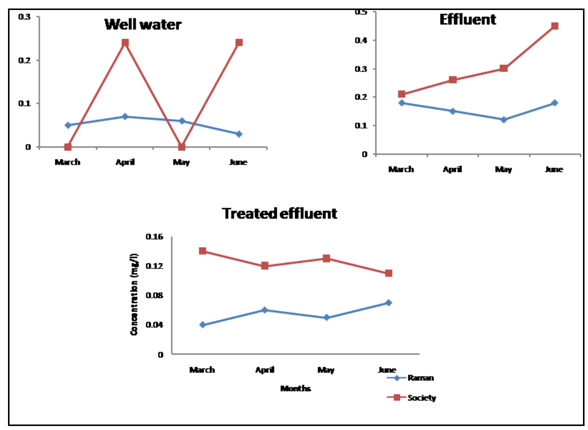


Figure 8. Ammonia

### 3.8.Nitrate

The nitrate of the water samples of Raman dyeing unit ranged from 13 to 81mg/l and the nitrate of the water samples of Society dyeing unit fluctuated between 22 and 75mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 16.5, 74 and 19mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 27,71.75 and 41.75mg/l respectively. The concentration of the nitrate in the effluent from Raman unit was found to be more than the Society unit. However, the concentration got reduced in the treated effluent. The concentration of nitrate from Society dyeing unit is more and more polluted than the Raman dyeing unit (Figure 9).

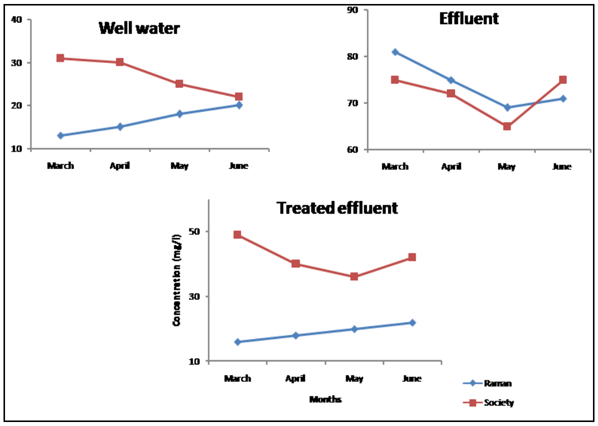


Figure 9. Nitrate

The ability of nitrate to enter well water depends on the type of soil / bedrock present and on the depth / construction of the well. All infants under six months of age are at risk of nitrate poisoning which requires immediate medical care because the condition can lead to coma and death if it is not treated promptly.

### 3.9.Chloride

The chloride of the water samples of Raman dyeing unit ranged from 145 to 340mg/l and the chloride of the water samples of Society dyeing unit fluctuated between 130 and 680mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 149.5, 307.75 and 227.5mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 138.75, 656.25 and 453.75mg/l respectively. The samples of Society dyeing unit had a high value for chloride (Figure 10.).

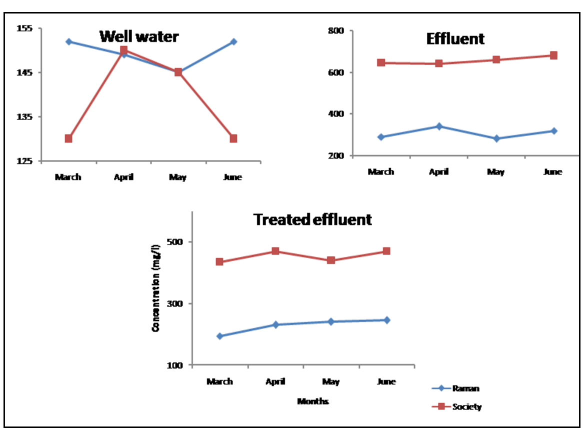


Figure 10. Chloride

However this concentration was found to be lower than the concentration in the effluent (2700mg/l, Rajkumar and Nagan, 2010) [6].Low to moderate concentrations of both chloride and sulfate ions add palatability to water. Excessive concentrations of either can make water unpleasant to drink. The EPA Secondary Drinking Water Regulations recommend a maximum concentration of 250 mg/1 for chloride ions and 250 mg/1 for sulfate ions.

### 3.10.Sulphate

The sulphate of the water samples of Raman dyeing unit ranged from 54 to 222mg/l and the sulphate of the water samples of Society dyeing unit fluctuated between 48 and 146mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 60.25, 170.75 and 58.25mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 51, 136.75 and 124 mg/l respectively. The sulphate concentration from the treated effluent samples of Society dyeing unit showed a high value than the Raman dyeing unit (Figure 11). Sulphates occur naturally in numerous minerals, including barite ($BaSO_4$), epsomite ($MgSO_4{\cdot}7H_2O$) and gypsum ($CaSO_4{\cdot}2H_2O$). These dissolved minerals contribute to the mineral content of many drinking waters.

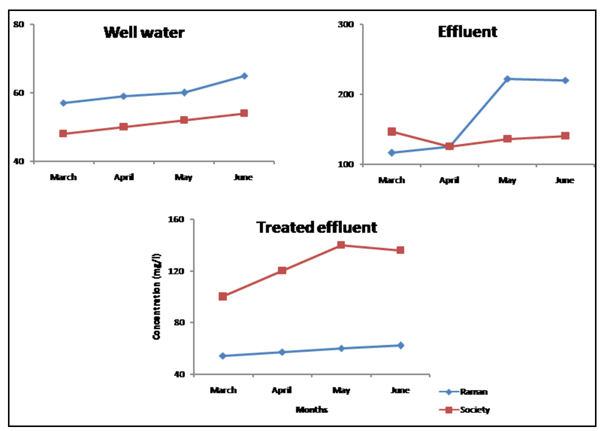


Figure.11. Sulphate

Reported taste threshold concentrations in drinking water are 250–500 mg/litre for sodium sulfate; 400–600 mg/litre for magnesium sulfate and 250–1000 mg/litre for calcium sulfate. Addition of calcium and magnesium sulfate (but not sodium sulfate) to distilled water was found to improve the taste. An optimal taste was found at 270 and 90 mg/litre for calcium and magnesium sulfate respectively. Sodium, potassium and magnesium sulfates are all highly soluble in water, whereas calcium and barium sulfates and many heavy metal sulfates are less soluble. Dehydration has been reported as a common side-effect following the ingestion of large amounts of magnesium or sodium sulfate. Sulfate may also contribute to the corrosion of distribution systems.

### 3.11.Iron

The iron of the water samples of Raman dyeing unit ranged from 0 to 0.40mg/l and the iron of the water samples of Society dyeing unit fluctuated between 0.01 and 0.53mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 0.03, 0.13, 0.13mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 0.25, 0.27, 0.18mg/l respectively. The treated effluent samples of both Raman dyeing unit and Society dyeing unit are polluted with iron. However, the Society unit samples are more polluted than the Raman dyeing unit (Figure 12). Iron is one of the earth's most plentiful resources, making up at least 5% of the earth's crust. Rainfall seeping through the soil dissolves iron in the earth's surface and carries it into almost every kind of natural water supply, including well water. When the level of iron in water exceeds the 0.3 mg/l limit, red, brown, or yellow staining of laundry, glassware, dishes and household fixtures such as bathtubs and sinks are expected. The water may also have a metallic taste and an offensive odor. Water system piping and fixtures can also become restricted or clogged.

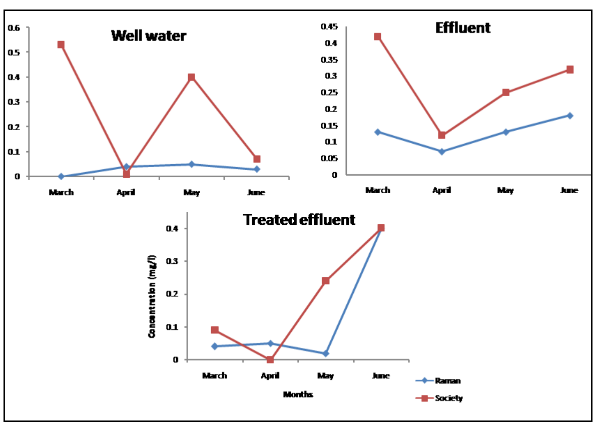


Figure. 12. Iron

### 3.12.Fluoride

The fluoride of the water samples of Raman dyeing unit ranged from 0.2 to 1.2mg/l and the fluoride of the water samples of Society dyeing unit fluctuated between 0.4 to 1.6mg/l. The mean values of the three samples (1. Well water, 2. Effluent and 3. Treated effluent) at Raman dyeing unit were 0.9, 1.05 and 0.8mg/l respectively. Similarly the mean values of the three samples at Society dyeing unit were 0.52, 1.2 and 1.2mg/l respectively. Both the samples from the dyeing units were having more or less same concentration of fluoride as far as the effluent is concerned. However, the concentration of fluoride is found to be high in society samples (Figure 13).

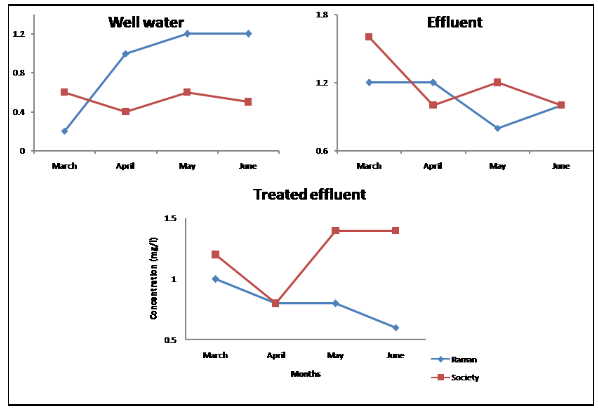


Figure 13. Fluoride

This concentration was found to be much lower than those (162mg/l) reported by Sultana *et.al* (2009) [5]. Fluorides in water can be detrimental or beneficial. Children under nine years of age exposed to levels of fluoride greater than about 2 mg/1 may develop a condition known as "endemic dental fluorosis". Exposure to drinking water levels above 4 mg/1 for many years may result in crippling skeletal fluorosis, which is a serious bone disorder.

## 4.CONCLUSIONS

Raw and treated effluent water samples from Raman dyeing unit and Society dyeing unit and well water adjacent to these units in the Nemili village, Arakkonam Taluk, Vellore district during March and June 2010 (summer) were analysed for twelve water quality parameters.The higher turbidity, EC, TDS, hardness, ammonia, nitrate, fluoride levels in the treated effluent at Society dyeing unit reveals that this unit pollutes the environment when compared to Raman dyeing unit in Nemili village. The effluent water letting out from the Society dyeing unit should be treated properly. The higher TDS in the well water also reflects its deteriorating quality. The work of Rajaguru *et.al* [7] will shed more light on the ground water contamination with substances capable of inducing DNA damage in human blood cells.

Though the industries have treatment plants, they fail to produce acceptably safe effluent, mostly due to the lack of proper operation and maintenance of the system. Poor storage of industrial and other wastes results in the contamination of precious groundwater that will lead to health problems like ulcers, skin diseases and birth defects etc. among the user communities. The groundwater development in Nemili village is said to be critical condition [8].

Hence it is very imperative to protect the existing groundwater sources from pollution. Strict and stringent measures have to be adopted in regulating the discharge of effluents / treated effluents to the environment to minimize the risk for the end users. Zero wastewater discharge concept are found to be technically feasible and economically viable in the textile dying industries and common facility for Multistage Evaporator would be economical.

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**Table.1. Water quality analysis at Raman dyeing unit**

| Month | Sample | Turbidity (NTU) | EC (umhos/ cm$^2$) | TDS (mg/l) | pH | Alkalinity (mg/l) | T.Hardness (mg/l) | Ammonia (mg/l) | Nitrate (mg/l) | Chloride (mg/l) | Sulphate (mg/l) | Iron (mg/l) | Fluoride (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| March | Well water | 2 | 915 | 640 | 8.20 | 264 | 280 | 0.05 | 13 | 152 | 57 | 0.00 | 0.2 |
| April | Well water | 2 | 1020 | 715 | 7.25 | 232 | 304 | 0.07 | 15 | 149 | 59 | 0.04 | 1.0 |
| May | Well water | 3 | 1065 | 745 | 7.35 | 332 | 335 | 0.06 | 18 | 145 | 60 | 0.05 | 1.2 |
| June | Well water | 2 | 1110 | 775 | 7.6 | 310 | 390 | 0.03 | 20 | 152 | 65 | 0.03 | 1.2 |
| | **Mean** | 2.25 | 1027.5 | 718.75 | 7.6 | 284.5 | 327.25 | 0.05 | 16.5 | 149.5 | 60.25 | 0.03 | 0.9 |
| March | Effluent | 7 | 1605 | 1125 | 8.05 | 372 | 396 | 0.18 | 81 | 290 | 116 | 0.13 | 1.2 |
| April | Effluent | 8 | 1815 | 1270 | 8.30 | 248 | 520 | 0.15 | 75 | 340 | 125 | 0.07 | 1.2 |
| May | Effluent | 6 | 1875 | 1315 | 8.10 | 256 | 425 | 0.12 | 69 | 281 | 222 | 0.13 | 0.8 |
| June | Effluent | 8 | 1910 | 1337 | 7.95 | 192 | 380 | 0.18 | 71 | 320 | 220 | 0.18 | 1.0 |
| | **Mean** | 7.25 | 1801.25 | 1261.75 | 8.1 | 267 | 430.25 | 0.15 | 74 | 307.75 | 170.75 | 0.13 | 1.05 |
| March | Treated effluent | 2 | 1025 | 720 | 7.25 | 232 | 307 | 0.04 | 16 | 195 | 54 | 0.04 | 1.0 |
| April | Treated effluent | 1 | 1130 | 790 | 7.65 | 188 | 240 | 0.06 | 18 | 230 | 57 | 0.05 | 0.8 |
| May | Treated effluent | 1 | 1160 | 810 | 7.65 | 196 | 268 | 0.05 | 20 | 240 | 60 | 0.02 | 0.8 |
| June | Treated effluent | 3 | 1215 | 850 | 8.25 | 252 | 220 | 0.07 | 22 | 245 | 62 | 0.40 | 0.6 |
| | **Mean** | 1.75 | 1132.5 | 792.5 | 7.7 | 217 | 258.75 | 0.05 | 19 | 227.5 | 58.25 | 0.13 | 0.8 |