

EFFECT OF GOURNDWATER CONTAMINATION ON SITE SPECIFIC ZONES OF PUDUCHERRY STATE

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Abstract

Groundwater is the only source of drinking water for residents of Puducherry State. This study examines the presence of hazardous ions in the open wells, dug wells and bore wells of Puducherry state. The hazardous ions were determined using standard operating methods for the examination of water. The result of the analysis shows that metals such as pH, TDS, Alkalinity, TDS, Total Hardness, Calcium, Magnesium and Iron were not found in most of the observation water samples, while other traces such as Chloride, Sulpahte, Fluoride and Nitrite are within the permissible limits as prescribed by W.H.O. This study suggests that monitoring of the quality of groundwater should be undertaken regularly to identify the magnitude and source of toxic pollutants, which are responsible for the contamination of groundwater quality in the study area.

Key words: Contamination, Hazardous ions, ground water.

I. INTRODUCTION

In the recent past Puducherry State is rapidly industrializing due to its geographic location, near sea shore, highly skilled man power, resource availability in the near districts like Cuddalore near and Villupuram of Tamil Nadu. Industrialization has caused a lot detrimental effects on the natural resources such as ground water being polluted with hazardous ions. Such ions are spatially migrated through ground water aquifers. Such migration of ions gets unnoticed as people gets used to it. Hazardous ions like iron, calcium, magnesium cause health hazards to public. Along with human and economic loss there were serious changes in the ecology and environment. There was already a serious risk of contamination by fecal matter, salinity with the lack of proper sanitation infrastructure and hygiene knowledge.

There were major damages after the Industrilization to the drinking water sources for the communities affected as it is often seen in disasters that contaminated drinking water leads to more deaths (Khaleq et al 2005). As per international reports, diseases are at more than 80% from water origin in India, and 40% of death come also from water related aspect. The immediate need was to assess the changes in the quality of potable water.

A key concern is the nature and extent of the Industrial impact on the water supply and, in more

general, the water resources of these areas. In the coastal areas of Pondicherry, the majority of the population, which is rural or semi-urban, is relying on groundwater for their domestic and agricultural activities, most predominantly through traditional private shallow open dug wells in the sandy aquifers. As the industries destroyed practically all wells within the reach of the Industrial waste discharges, as such overburden occur as loose aggregate as sands, it allows percolation of water into it so the extent of such overlying materials, thus indicate the amount of groundwater in the subsurface (Olurunfemi, et. al, (1999). Therefore, access to freshwater for these people was suddenly cut off and interim alternatives had to be sought urgently in the form of freshwater trucked in from unaffected areas. Based on indications that these efforts were uncoordinated, inadequate, in efficient and at the extreme harmful to the water quality and the well functioning and therefore treatment of Ground water is essential because of their high toxicity to humans and other organisms Chowdhury and Chandra,1987.

Groundwater is often used as a resource for drinking water (WHO, 1996) revealed that in developing countries in 1970, only 40% of the people in rural area had access to safe water. As such, Puducherry state is possessed with major environmental problems like pollution and its effect on public health hazard etc.,

therefore this study is undertaken with the following objectives.

II. OBJECTIVES

- (i) To study the groundwater water quality prospects of Puducherry State using Remote Sensing and field sampling techniques.
- (ii) To establish concentration of hazardous ions and its distribution spatially keeping in view of a well monitoring program (for water quality) in representative affected areas coast by the regular collection of data, with special emphasis on salinity, and some water supply and health relevant parameters pertaining to wells.
- (iii) To suggest remedial measures in treating such hazardous water by taking up feasibility analysis to secure the long-term quality and sustainable exploitation of the groundwater resources, to support the needs of the water supply in the coast.

III. STUDY AREA

Pondicherry is located on the eastern coast of India between $11^{\circ} 46'$ and $12^{\circ} 30'$ of north latitude and $79^{\circ} 36'$ and $79^{\circ} 52'$ of east longitude. It is 162 kms South of Chennai. Pondicherry city is the Capital which comprises of 4 coastal regions viz- Pondicherry, Karaikal, Mahe and Yanam, which are not contiguous but interspersed with some parts of Cuddalore and Villupuram districts of Tamil Nadu State.

Water samples were collected from the wells and deep bore wells in the Coastal area of Pondicherry. The Villages that are covered are (i) Kalapet, (ii) Boomianpalayam, (iii) Puthupet, (iv) kanagasettikulam, etc. (v) Ariyankuppam, (vi) Arikanmedu, & (vii) Virampattinam.

IV. SAMPLING PROCEDURE

Groundwater samples were collected from open and bore wells of coastal area of Puducherry. Wells, which are not in continuous use for water supply, the quality of water in the well may not be the same as that of water in the aquifer and therefore stagnant water was pumped out in the well and ensured that recharging water from the aquifer of the well was sampled using purging process.

The water quality parameters such as, Electrical Conductivity (EC), pH, Oxidation-Reduction Potential (ORP) of the water and other parameters were analysed using Standard Operating Procedures (SOP). Once these readings are constant for some minutes and the amount of water purged approaches the estimated required volume for purging, the samples were taken. Special care was taken in (open) shallow wells, not equipped with a pump, are sampled manually. In this situation the sample were collected by lowering a sampling can into the well. Care taken that the can was not allowed to touch the sides or bottom of the well as this will contaminate the sample with solid matter.

(a) Physical And Chemical Analysis Of Water

The Organoleptic properties such as Turbidity, pH, Alkanity to Methylorange Total hardness, Calcium, Magnesium, Iron, Chloride, Sulphate, Nitrate and Fluoride were analysed using Standard Operating Procedures and are given in Table 1 and subsequently in figures 1-6.

V. RESULTS AND DISCUSSION

(i) Turbidity

Suspension of particles in water interfering with passage of light was called turbidity. Turbidity was caused by wide variety of suspended matter which range in size from colloidal to coarse dispersions depending upon the degree of turbulence and also range from pure inorganic substances to those that are highly organic in nature.

(ii) pH

The pH of aqueous solutions can be taken as negative logarithm of hydrogen ion activity. pH values from 0 to 7 are diminishingly acidic, 7 to 14 increasingly alkaline and 7 is neutral. The pH is determined by measurement of the electromotive force of a cell comprising an indicator electrode immersed in the test solution and a reference electrode. The emf of this cell was measured with pH meter. The observed pH value were high all along the regions of Ariyankuppam referring serial numbers of 13,14,16,17, and 18 in table 1. The places of Ariyankuppam possessing higher pH refer to saline/ alkaline nature of the water. A continuous pH monitoring will certainly useful to ascertain the fluctuation across the monsoon seasons.

(iii) Alkalinity

The alkalinity of waters is predominantly due to the salts of carbonates, bicarbonates, borates, silicates and phosphates along with the hydroxyl ions in the free state. However, the major portion of the alkalinity in waters is caused by hydroxide, carbonate and bicarbonates which may be ranked in order of their association with high pH values. Alkalinity values provide guidance in applying proper doses of chemicals in water and waste water treatment processes, particularly in coagulation, softening and operational control of anaerobic digestion. The pH above 8.5 refers to alkalinity and was observed for the well of Ariyankuppam of Puducherry. Reddy, K. R et al.1997 have reported that increase in alkalinity level will have the influence of Arsenic and Chromium ions in the Ground water.

(iv) Hardness

Water hardness is the traditional measure of the capacity of water to react with soap, hard water requiring a considerable amount of soap to produce lather. Hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. It is caused by dissolved polyvalent metallic ions. In fresh water, the principal hardness causing ions are calcium and magnesium that were observed for the wells of Pudupet and Arikanmedu.

(v) Chloride

The presence of chloride in natural waters can be attributed to dissolution of salt deposits, discharges of effluents from chemical industries, oil well operations, sewage discharges, irrigation drainage, contamination from refuse leachates, and seawater intrusion in coastal areas. Each of these sources may result in local contamination of both surface water and ground-water. Higher chloride concentration was recorded at Rainbow nagar 3rd cross street of Muthialpet in Puducherry. In such cases treatment is necessary to nullify the effect of chloride level on the potable water.

(vi) Fluorides

Fluoride ions have dual significance in water supplies. High Concentration of F causes dental fluorosis (Disfigurement of the teeth). At the same time, a concentration less than 0.8 mg/l results in 'dental

carries in children. Hence, it is essential to maintain the F concentration between 0.8 to 1.0mg/l in drinking water. The fluoride concentration was below the acceptable limit invariably for all the wells.

(vii) Nitrate

Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters, because it is the product of the aerobic decomposition of organic nitrogenous matter. Excessive concentration in drinking water is considered hazardous for infants as it may affect their intestinal system.

(viii) Sulphate

Most of sulphate originates from the oxidation of sulphite ores, the solution of gypsum and anhydrite, the presence of shales, particularly those rich in organic compounds, and the existence of industrial wastes. Atmospheric sulphur dioxide formed by the combustion of fossil fuels and emitted by the metallurgical roasting processes may also contribute to the sulphate compounds of water. In this study the sulphate content from the observed wells are lower than the acceptable limit.

(ix) Calcium

The presence of calcium in water results from deposits of limestone, dolomite, gypsum, and gypsiferous shale as ores interspersed with groundwater. The calcium content may range from zero to several hundred milligrams per litre; depending on the source available in water and it was high 100 mg/l at Arikanmedu of the observation well no 10. As the alkalinity was high might be the influence of calcium inducing the increase in alkalinity as well the concentrations of TDS were high at the same location.

(x) Magnesium

Magnesium is abundant and is a common constitution of water. Concentrations greater than 125 mg/l can also exert a cathartic and diuretic osmosis, electro dialysis, or ion exchange reduces the magnesium and associated hardness to acceptable levels. The magnesium concentration may vary from; zero to several hundred milligrams per litre, depending on the source and treatment of the water. The magnesium concentration was higher in Muthialpet and Arikanmedu region were the combined effect of Alkalinity and TDS were beyond the acceptable limit.

Table 1. A detailed report on the water quality parameters of Puducherry State

Sl.No.	Well Location	Characteristics (mg/l)										
		pH	TDS	Alkalinity	Total Hardness	Ca	Mg	Fe	Cl ₂	SO ₄	NO ₃	F
1	Rice mill street, Pudupet	6.6	580	141	269	75	21	0.2	169	64	5	0.1
2	Pungavanam chettiyar st	7.1	670	203	306	80	26	0.2	183	59	9	0.1
3	Gopal chettiyar st, Periya Kalapet	6.7	540	81	181	32	26	0.2	150	73	5	0.15
4	Boomaiyapalayam street	6.9	540	182	271	64	28	0.2	136	67	7	0.1
5	Boomaiyapalayam street	6.8	550	208	254	67	22	0.2	169	32	9	0.1
6	Sri Senganiramman, Ariyankuppam	7.4	410	217	214	60	16	0.4	86	20	5	0.1
7	Sri Senganiramman, Ariyankuppam	7.5	430	229	237	66	18	0.44	99	20	5	0.1
8	Sundara Vinayagar Temple, Virampattinam	7.1	440	345	322	89	25	1.2	56	4	5	0.1
9	Bramman koil street, Ariyankuppam	7.2	300	180	162	34	19	0.4	59	11	5	0.1
10	Arikanmedu	7.4	730	400	426	100	44	0.3	212	32	5	0.1
11	Arikanmedu	7.4	470	259	195	39	24	0.3	86	22	5	0.1
12	Selliyamman thopu, Ariyankuppam	7.4	500	304	250	57	27	0.2	96	23	5	0.15
13	Rainbow nagar 3rd cross street, Ariyankuppam	8.8	510	104	216	38	30	0.3	168	110	5	0.25
14	Rainbow nagar 4th cross street, Ariyankuppam	8.8	490	140	224	40	31	0.3	114	110	5	0.25
15	Rainbow nagar 6th cross street (Muthiyalpet)	6.6	1553	108	480	64	41	0.45	460	122	5	0.2
16	Rainbow nagar 8th cross street, Ariyankuppam	8.6	329	148	110	20	14	0.8	52	53	5	0.25
17	Subbaiya Nagar, Ariyankuppam	8.7	280	152	120	22	16	0.75	46	32	5	0.25
18	Sri Ram Nagar, Ariyankuppam	9.0	270	156	64	11	9	0.6	44	60	5	0.25
Acceptable limit			6.5-8	500200	300	75	30	0.3	250	200	45	1

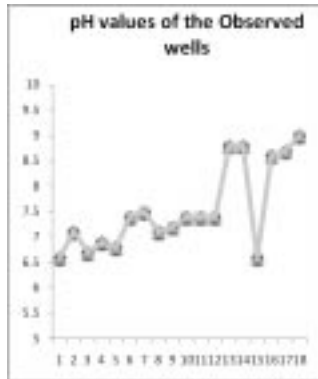


Fig. 1 pH of water in Puducherry

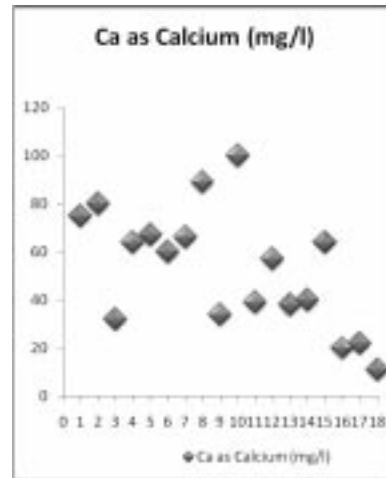


Fig. 4 Ca in water samples

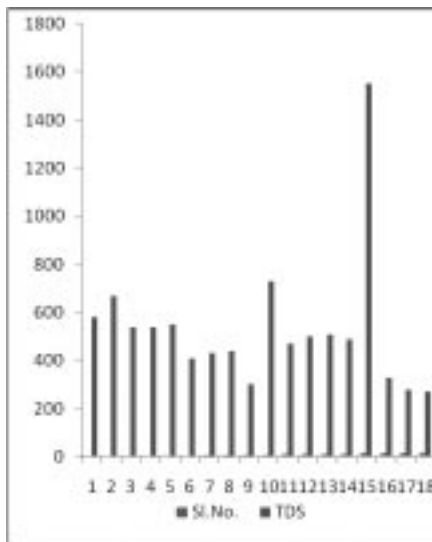


Fig. 2 TDS of water in Puducherry

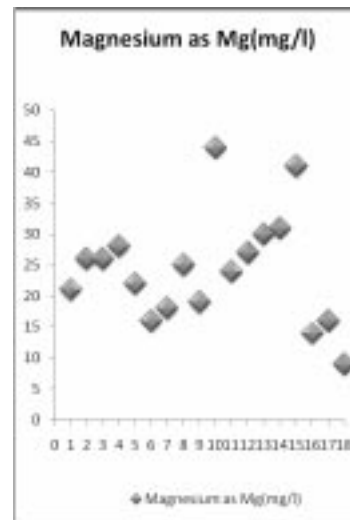


Fig. 5 Mg in water samples

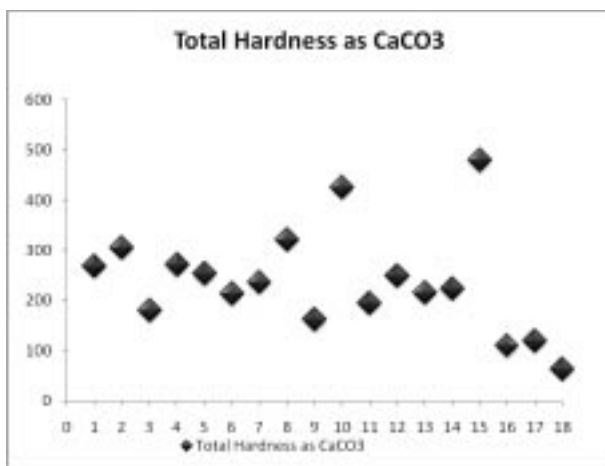


Fig. 3 Total hardness of water in Puducherry

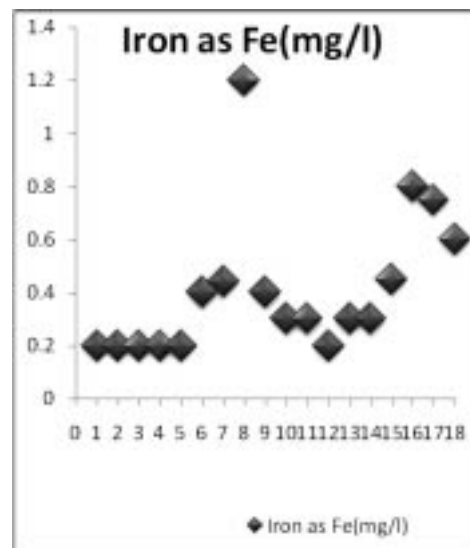


Fig. 6 Fe in water samples

(xi) Iron

Silt and clay in suspension may contain acid-soluble iron. Iron oxide particles sometimes are collected with a water sample as a result of flaking of rust from pipes. Iron may come from a metal cap used to close the sample bottle.

For natural and treated waters, the orthophenanthroline method has attained the greatest acceptance of simplicity and reliability. The atomic absorption spectrophotometric method is relatively easy and accurate. The precision and accuracy data developed by a collaborative study of the atomic absorption method for iron showed results that superior to those of the colorimetric method. Iron content was highest (1.2mg/l) at Virampattinam and relatively higher at places like Muthialpet and all the places of Ariyankuppam and their plate 1 are annexed in Fig.7



Fig.7 Site No. 8 of Viranpattinam

VI. IRON REMOVAL METHODS

Next to hardness, the presence of iron is probably the most common water problem faced by consumers and water treatment professionals. The secondary (aesthetic) maximum contaminant levels (MCL) for iron and manganese are 0.3 milligrams per litre (mg/l) and 0.05 mg/l, respectively

Iron is generally divided into two main forms such as soluble and insoluble form. Especially in groundwater its concentration of WHO recommended level is < 0.3 mg/l. Iron-bearing groundwater is often noticeably orange in colour, causing discoloration of laundry, and has an unpleasant taste, which is apparent in drinking and food preparation.

Biological iron removal means the bacteria responsible for the process for absorption of ferric iron. The treatment involves the following: Chlorination, retention, filtration. Activated carbon is usually used as the filter material so the excess chlorine can also be removed.

There are a variety of ways for removing ferrous iron, each with its own strengths and limitations.

Oxidation / filtration Ion Exchange (Water Softener)

Ion exchange is one of the best methods for the removal of small quantities of iron. Ion exchange involves the use of synthetic resins where a presaturant ion on the solid phase (the "adsorbent," usually sodium) is exchanged for the unwanted ions in the water. One of the major difficulties in using this method for controlling iron and manganese is that if any oxidation occurs during the process, the resulting precipitate can coat and foul the media.

Oxidation / Filtration

Oxidation followed by filtration is a relatively simple process. The oxidant chemically oxidizes the iron or manganese (forming a particle), and kills iron bacteria and any other disease-causing bacteria that may be present. The filter then removes the iron or manganese particles.

Oxidation

Before iron and manganese can be filtered; they need to be oxidized to a state in which they can form insoluble complexes. Oxidation involves the transfer of electrons from the iron, manganese, or other chemicals being treated to the oxidizing agent. Oxidation methods fall into two groups: those using additives like chlorine, ozone or air; or those using an oxidizing filter media.

Ozonation

An ozone generator is used to make ozone that is then fed by pump or by an air injector into the water stream to convert ferrous iron into ferric iron. Ozone has the greatest oxidizing potential of the common oxidizers. This is followed by a contact time tank and then by a catalytic medium or an inert multilayered filter for removal of the ferric iron.

Chlorination

Chlorine can be introduced into water in one of several forms: a gas; as calcium hypochlorite; or commonly, as sodium hypochlorite. The treated water

is then held in a retention tank where the iron precipitates out and is then removed by filtering with manganese greensand, anthracite/greensand or activated carbon. If applied this way, a dosage of one part of chlorine to each part of iron is used and 0.2 parts of potassium permanganate per part of iron is fed into the water downstream of the chlorine. The potassium permanganate and any chlorine residual serve to continuously regenerate the greensand.

Aeration

Air is also used to convert dissolved iron into a form that can be filtered. This approach mimics what happens when untreated dissolved iron comes into contact with the air after leaving a faucet. Aeration methods can be of a two-tank or a single-tank variety. In a two-tank system, air is introduced into the first tank using a pump or other injection device. The dissolved iron precipitates in the first tank and is carried into the second tank where it is filtered in a Birm or multi-media filter. The iron is oxidized at the top of the tank before falling into the filter medium at the bottom. There is no potential fouling of the head. The iron is filtered before it goes through the outlet port of the valve. For very high levels of iron, chlorination with continuous regeneration is the only practical approach.

VII. CONCLUSION

Groundwater contamination of hazardous ions is global problem. A state-wide hazardous substance ground water monitoring programme is needed to

assess the effects of hazardous substance may have the state ground water resources. It is required to assess the ground water for two monsoon seasons to know the fluctuation the in the contamination of ions between the seasons and within the seasons. It is impractical to monitor the ground water beneath all areas at the same level of detail. Therefore, a criteria should be developed to rank areas according to their potential risks to the current and future public drinking water supplies.

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