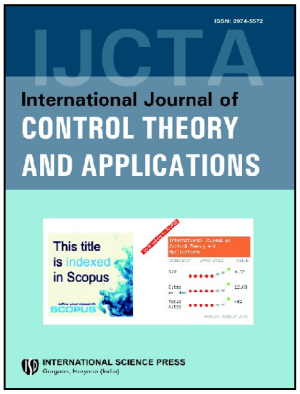

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A Study of Ground Water Quality in the Slum Area Appughar of Visakhapatnam By Nemerow's Pollution Index Method During Post-Monsoon

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Abstract: In the present study, the ground water quality in the slum area of Visakhapatnam i.e., Appu-Ghar has been surveyed. The samples are collected from the dug wells and bore wells for physico-chemical analysis, which has been carried out in the Environmental Engineering Laboratory. The physico-chemical parameters evaluated through standard test procedures include pH, conductivity, calcium, magnesium, total hardness, total dissolved solids, chlorides and sulphates. Quality of water is interpreted through Nemerow's Pollution Index (NPI) method using the experimental values. The study aims in evaluating ground water quality status in the study area and its portability during Post-Monsoon.

Keywords: Appu-Ghar, water samples, physico-chemical analysis, post monsoon, Nemerow's Pollution Index method (NPI).

1. INTRODUCTION

Water is an important source for life on the earth. Many people depend only on groundwater for drinking and other purposes [9]. In the present days, increase in population, rapid industrialization, unplanned urbanization, improper use of fertilizers and pesticides can contaminate the ground water. Deprived quality of water not only effects the plant growth but also shows impact on the human health.

In the present scenario, increase in population, rapid industrialization, unplanned urbanization, improper use of fertilizers and pesticides can contaminate the ground water.

There is a pressing global problem of increasing freshwater scarcity. The other side to the problem is diminishing water quality. Scarcity and quality problems will be made much worse with the twin challenges of a growing world population and climate change; both these factors are expected to increase the frequency and severity of droughts in mid-latitudes.

(A) Necessity of the study

Slum urbanization could affect many water processes. For example, the range of materials dumped in-stream, including household rubbish and appliances, sewage, chemical, grease and oils, could affect channel-bed composition. Housing which does not comply with more important requirements as to sanitation or which is in urgent need of repairs is known as "substandard" housing. An area in which substandard housing predominates, frequently accompanied by overcrowding is known as "slum".

Any dwelling having four or more such deficiencies like

a) Polluted water supply

b) Water supply for outside living unit or structure

c) Toilet shared or outside the structure

d) Bath shared or outside the structure

e) More than 1.5 persons per habitable room

f) Over crowding of sleeping rooms

g) Sleeping area is less than 40 sq ft per person

h) Rooms lacking a window and

i) Serious deterioration.

The slum area Appu-Ghar of Visakhapatnam city is taken as the area of study. Groundwater samples are collected from the bore wells and hand pumps. Suitable conclusions are drawn from the results related to difference in water quality in Pre-Monsoon season and the pollutants present [4].

The main purpose of analyzing water samples is to help the public health authorities to arrive at a reasonable conclusion regarding the suitability of water for public use.

Usha Madhuri., *et al.,* [10] assessed a ground water quality survey in commercial areas of Visakhapatnam, (e.g. RTC Complex, Police barex, Jagadamba etc) has been carried out. Samples have been collected from dug wells or bore wells and were analysed for physio- chemical parameters like pH, Cl- , TDS, TH, Ca, Nitrates, Sulphates and Iron. The impurities in ground water samples collected are assessed using Nemerow's Pollution Index to identify the status of aquifers. Important pollutants noticed are nitrate concentration at police barex, gurudwara junction. Iron is a pollutant at RTC Complex, Police barex and Jagadamba. Hardness is important pollutant found in all the areas analysed.

Chaudhari *et al.,* [1] assessed the ground water quality index near industrial area at Jalgaon (Maharashtra). The physio-chemical characteristics for the collected samples were determined before and after the rainy seasons for 11 parameters taking seven sampling sites into consideration. These water quality index studies suggested that the water is not suitable for direct consumption. In view of the above, it was observed that the samples of all the sites were not suitable for drinking and can be used only for irrigation purposes.

Srinivas *et al.,* (2004) assessed a ground water quality survey in commercial areas of Visakhapatnam has been carried out. Samples have been collected from dug wells or bore wells and were analysed for physio-chemical parameters like pH, Cl-, TDS, TH, Ca, Nitrates, Sulphates and Iron. The impurities in ground water samples collected are assessed using Nemerow's Pollution Index to identify the status of aquifers. Important pollutants noticed are nitrate concentration at police barex, gurudwara junction. Iron is a pollutant at RTC Complex, Police barex and Jagadamba. Hardness is important pollutant found in all the areas analysed.

Sandhya [7] assessed portability of the groundwater in various localities in Bollaram area. For experiments, 24 samples were considered totally from different bore wells and it was analyzed for determining water quality of the study area for 18 different parameters. In most of the cases it was observed that except pH, all the other parameters like hardness, alkalinity, electrical conductivity, calcium, magnesium, chloride, sulphate, nitrate, sodium, potassium and fluoride were not meeting the drinking water standards. In heavy metal analysis it was observed that arsenic, copper, cadmium and lead were below detectable level, whereas chromium, manganese in few samples were exceeding the desirable limits whereas zinc and iron were meeting the norms.

Rama Krishna, Mallikarjuna Rao, Subbarao and Srinivas (2009) assesed portability of ground water in Slums of Visakhapatnam city Sampled data were analysed based on water quality index for various parameters like pH, Chlorides, TDS, Total hardness, Calcium, Nitrates, Sulphates, iron and DO.

Swarna Latha and Nageshwara Rao [10] made a study which are evaluated on calculation and quality of groundwater in the area of Greater Visakhapatnam. The GIS technology utility was combined laboratory analysis to evaluate and groundwater quality mapping in urban region.

Sarojini *et al.,* (2013) assessed portability of the groundwater in various localities in Visakhapatnam area. A total of 24 samples from different bore wells were collected and analyzed for different parameters to determine the water quality of the study area. In most of the cases it was observed that except pH, all the other parameters like hardness, alkalinity, electrical conductivity, calcium, sulphate, nitrate, sodium, potassium and fluoride were not meeting the drinking water standards. In heavy metal analysis it was observed that arsenic, copper, cadmium and lead were below detectable level, whereas chromium, manganese in few samples were exceeding the desirable limits whereas zinc and iron were meeting the norms.

Devendra Dohare, Shriram Deshpande and Atul Kotiya (2014) analysed ground water quality in different wards of indore city.

2. EXPERIMENTAL METHODOLOGY

(A) Study area

The slum area Peda Jalaripeta is taken into consideration for the present study. For this, Groundwater samples were collected from the bore wells at different locations of the study area. Different physico-chemical parameters are determined like pH, Electrical Conductivity, Total Dissolved Solids, Total Alkalinity, Total Hardness, Chloride, Calcium, Magnesium and sulphates.

On selected household, water pollution is studied as descriptive variable to estimate the impact of water pollution. If the pollution is increased in water then it leads to chronic disease.

Groundwater samples are collected from the bore wells at different locations of the study area.

Table 1
Analytical methods adopted for physico-chemical analysis

Analysis	*Method/instrument*
pH	Digital pH meter
Electrical conductivity (EC)	Digital conductivity meter
Total dissolved solids (TDS)	Indirectmethod (Raghunath, 2003[9])0.64*ECμs/cm
Total hardness (TH)	EDTA-Titrimetry
Chlorides (Cl)	Mohr's-Titrimetry
Calcium hardness (CaH)	EDTA-Titrimetry
Magnesium hardness (MgH)	Indirect method Total hardness- Calcium hardness
Sulphates (SO_4)	Gravimetric method

(B) p^H

p^H of solution commonly considered as a negative logarithm of H_z ions. Scale of $p^{H\ ranges}$ from 0 to 14 and it is acidic when it ranges as 0 to 7, it is alkaline if ranges from 7 to 14 and neutral if its value is 7. Most commonly pH of drinking water ranges from 6.5 to 8.5. It is known that pH of water ranging from 6.5 to 8.5, does not have any direct effect on health. But lower value below 5.0 produces sore taste and higher value above 8.5 gives alkaline taste.

The electrode(s) are regulated by the pH procedure with two standard buffer p^H solutions ranges from 4.0 and 9.2. Buffer solution offers resistance to change in p^H when its value is known. At this time, sample temperatures also determined. Electrode is dipped into sample solution, spin and waited for one minute for steady reading. When constant indicated value is obtained the reading is taken for nearly one minute.

(C) Electrical Conductivity

It is an important parameter for determining the water quality for drinking and agricultural purposes. In other words the Electrical conductivity can also termed as the ability of water to allow electric current through it and is expressed in micro mhos per centimetre (µ mhos/cm). E.C of water indicates whether the water is polluted with electrolytes (dissolved mineral contents) or not.

Generally E.C is determined at 25^0C by conductivity meter. In water, for total dissolved solids content fast estimation is measured by EC.

(D) Total Dissolved Solids

Sample consists of 100 ml is placed in the dish and on water bath it is evaporated at 100^0C, followed by drying in oven at 103^0C for 1 hour. Drying to a constant weight at 103^0C, cool in desiccators and weigh.

$$Total\ solids\ (mg/l) = (A - B) * 1000\ /\ V$$

A = Final weight of the dish is measured in mg.

B = Initial weight of the dish is measured in mg.

V= Volume of sample taken is measured in ml.

(E) Total Hardness

Water with Hardness above 200 mg / lit. may cause the scale deposition in the distribution system and may result in excessive soap consumption and subsequent scum formation. Soft water with hardness of less than 100 mg/ lit may have lower buffer capacity and more corrosive to water pipes.

25 ml of sample is taken in conical flask and 1-2 ml buffer solutions are added after adding two drops of Eri-Chrome Black T. it is titrated with standard EDTA (0.01M) till the colour changes from wine-red colour changes to blue. Volume of EDTA required (V) is noted.

Total hardness as $CaCO_3$ (mg/l) = V * 1000 / volume of sample taken.

Where V = Volume of EDTA required for sample.

(F) Chlorides

Industries are important sources of chloride in water. The procedure for calculation of chloride content in water is as follows.

In conical flask, 25 ml of the sample is taken and in that 1 ml of potassium chromate is added to get light yellow colour. It is titrated with standard silver nitrate solution till the colour of solution changes from yellow to brick red. Volume (V) of silver nitrate added is noted.

Chloride in (mg/l) = V * normality of $AgNO_3$ * 35.46 *1000 / volume of sample taken.

Where normality of $AgNO_3$ = 0.028

V = Volume of silver nitrate required for sample.

(G) Calcium

Take 50 ml of sample in a conical flask and add about 2 ml of NaOH to give a pH of 12 to 13. While stirring, add about 0.2 grams of the Murexide indicator. Continue the stirring and titrate against EDTA slowly until the colour of the solution turns from pink to purple at the end point. Ensure that further addition of 1 or 2 drops EDTA does not change the colour further.

Calcium hardness (mg/l) as $CaCO_3$ = V * 1000 / ml of sample.

Where V = Volume of EDTA used by sample.

(H) Magnesium

Though magnesium is an essential and beneficial metal , it is toxic at higher concentrations.

Magnesium hardness = Total hardness – Calcium hardness

(I) Sulphates

Sulphate ions are present in natural water and most ions soluble in water. Ores oxidation process is used to produce more sulphate ions and it is present in industrial wastes. UV Spectrophotometer measures the quantity of sulphate.

Take 50 ml of the sample, add 1ml of hydroxylamine chloride and then add 1 ml benzidine hydrochloride. Stir the mixture vigorously and allow the precipitate to settle. Filter the solution and wash the beaker and the filter paper with cold distilled water. Pierce the filter paper in funnel and wash the precipitate formed on the filter paper to the original beaker with 100 ml distilled water. Heat the beaker to dissolve the contents for 20-30 minutes. Add 2 drops of phenolphthalein indicator and titrate with 0.05N NaOH until pink colour is developed.

Concentration of sulphates = vol of 0.05N NaOH*38.4/vol of sample taken.

(J) Nemerow's Pollution Index (NPI)

Nemerow's pollution index is a water quality index to find out the pollutants in that particular area of sampling. A very simplified pollution index was introduced by Nemerow, which is generally known as Nemerow's Pollution Index (NPI). It is mathematically expressed as :

$NPI = C_i / L_i$

Where C_i = observed concentration of i^{th} parameter

L_i = permissible limit of i^{th} parameter (Indian standard values).

In the above expression units of C_i & L_i should be identical. NPI value of each shows the relative pollution that are contributed by a single parameter. NPI values exceeding 1.0 represent impurity in water and hence some treatment prior to use is required.

Table 2
Status of Water Quality Based on NPI

Nemerow's Pollution Index (NPI): (observed value/ standard value)	*Status*
<1	It is not a pollutant
>1	It is a pollutant

3. RESULTS AND DISCUSSIONS

The samples are analysed in the Environmental Engineering laboratory as per standard analytical experimental methods as mentioned above.

Table 3.1
NPI Results (sample 1)

Parameter	*Permissible limits (L_i)*	*Concentration (C_i)*	*Nemerow's pollution index (NPI)*
p^H	8.5	7.17	0.84
Chloride	250 mg/l	245	0.98
Total dissolved solids	500 mg/l	730	1.46*
Total hardness as $CaCO_3$	300 mg/l	345	1.15*
Calcium	75 mg/l	34	0.45
Magnesium	30 mg/l	62	2.06*
Sulphates	150 mg/l	35	0.23

Pollutants identified are: Total Dissolved Solids, Total Hardness, Magnesium.

Table 3.2
NPI Results (sample 2)

Parameter	*Permissible limits (L_i)*	*Concentration (C_i)*	*Nemerow's pollution index (NPI)*
p^H	8.5	7.02	0.82
Chloride	250 mg/l	236	0.94
Total dissolved solids	500 mg/l	1014	2.02*
Total hardness as $CaCO_3$	300 mg/l	380	1.26*
Calcium	75 mg/l	64	0.85
Magnesium	30 mg/l	28	0.93
Sulphates	150 mg/l	26	0.17

Pollutants identified are: Total Dissolved Solids, Total Hardness.

Table 3.3
NPI Results (sample 3)

Parameter	*Permissible limits (L_i)*	*Concentration(C_i)*	*Nemerow's pollution index (NPI)*
p^H	8.5	7.01	0.82
Chloride	250 mg/l	150	0.6
Total dissolved solids	500 mg/l	562	1.12*
Total hardness as $CaCO_3$	300 mg/l	468	1.56*
Calcium	75 mg/l	115	1.53*
Magnesium	30 mg/l	44	1.46*
Sulphates	150 mg/l	104	0.69

Pollutants identified are: Total Dissolved Solids, Total Hardness, Calcium, Magnesium.

Table 3.4
NPI Results (sample 4)

Parameter	*Permissible limits (L_i)*	*Concentration (C_i)*	*Nemerow's pollution index (NPI)*
p^H	8.5	7.16	0.84
Chloride	250 mg/l	165	0.66
Total dissolved solids	500 mg/l	695	1.39*
Total hardness as $CaCO_3$	300 mg/l	456	1.52*
Calcium	75 mg/l	96	1.28*
Magnesium	30 mg/l	54	1.8*
Sulphates	150 mg/l	54	0.36

Pollutants identified are: Total Dissolved Solids, Total Hardness, Calcium, Magnesium.

Table 3.5
NPI Results (sample 5)

Parameter	*Permissible limits (L_i)*	*Concentration (C_i)*	*Nemerow's pollution index (NPI)*
p^H	8.5	7.22	0.84
Chloride	250 mg/l	310	1.24*
Total dissolved solids	500 mg/l	1495	2.99*
Total hardness as $CaCO_3$	300 mg/l	260	0.86
Calcium	75 mg/l	72	0.96
Magnesium	30 mg/l	26	0.86
Sulphates	150 mg/l	23	0.15

Pollutants identified are: Chloride, Total Dissolved Solids.

Table 4
The pollutants identified in the study areas through Nemerow's Pollution index (NPI) during post monsoon

Sample Number	*Area*	*Pollutants Identified*
1	Appugargh, A.S.Raja College Road	Total Hardness, Total Dissolved Solids,Magnesium
2	Appugarh, Samatha College Road	Chloride, Total Hardness, Total Dissolved Solids.
3	Appugarh, beside Social Welfare Office	Total Hardness, Total Dissolved Solids, Calcium, Magnesium
4	Appugarh, near Baba Temple	Total Hardness, Total Dissolved Solids, Calcium, Magnesium.
5	Appugarh, AP Tourism Haritha Resort	Chloride,Total Dissolved Solids

4. CONCLUSION

In this study, conclusions can be drawn that the groundwater in the study area, water is not fit for drinking as the area consists of various pollutants viz., chlorides, total hardness, total dissolved solids, calcium, magnesium. However, in this area it is required that treatment like at least boiling should be done for portability. This ensures removal of hardness and Total Dissolved Solids.

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