International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 237-243 www.ijaem.net ISSN: 2395-5252

A Study on Comparison of Water Quality Index in Vijayawada, NTR District

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Date of Submission: 01-05-2023 Date of Acceptance: 10-05-2023

ABSTRACT:
Groundwater properties vary spatially and temporally with number of factors. Urbanization and agriculture activities have a lot of impacts on the groundwater quality. The present study focuses on the hydrochemistry of groundwater in Vijayawada of NTR district. The samples were collected from 20 bore wells during this project. The collected samples were tested for various water quality parameters such as to assess the quality of groundwater for determining its suitability for drinking purpose. Water samples collected from sampling points are tested for several physio chemical parameters pH, alkalinity, electrical conductivity (EC), total hardness (TH), calcium hardness (CaH), chlorides (Cl), sulphates (SO_4), fluorides (F) and indirectly estimated parameters like total dissolved solids (TDS), magnesium hardness (MgH), carbonates plus bicarbonates (CO_3+HCO_3) by adopting standard methods and compared with the Bureau of Indian Standards (BIS). The water quality status was identified at those selected 20 locations of Vijayawada to know whether the ground water at those locations is suitable for drinking or not. The results of this study will be helpful in designing an effective strategy to utilize the ground water for various purposes such as drinking and agricultural practices in the district.

KEYWORDS: Groundwater, Physio chemical, water, Water quality index, Drinking

I. INTRODUCTION

Water plays an important role in domestic and industrial usage. The quality of drinking water is a powerful environmental determinant of health. Assessment of water quality of drinking water supplies has always been paramount in the field of environmental quality management. Assurance of drinking water safety is a foundation for the prevention and control of water borne diseases. The suitability of drinking water has many requisite potable conditions.

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. Groundwater is an inevitable source of drinking water for both urban and rural India. Besides, it is a vital source of water for the drinking, agricultural and the industrial sector. The quality of ground water varies from place to place along with the depth of water table. It also varies with seasonal changes and is primarily governed by the extent and composition of dissolved solids present in it. The quality of groundwater is the resultant of all the processes and reactions that have acted on the water from moment it condensed in the atmosphere to the time it is discharged by a well. This is not only a problem of developed countries and urban areas but has also become an uncontrollable problem of developing countries as well as several areas. Water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and usable by the public. Water Quality Index (WQI) is a tool developed by scientists to evaluate the quality of water in the streams and rivers. It summarizes large amounts of water quality data into a single score from 1 to 100.

Water Quality Index

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information that is understandable and usable by the public. A single number cannot tell the whole story of water quality there are many other water quality parameters that are not included in the index. However, a water quality index based on some very important parameters can provide a simple indicator of water quality. In general water quality indices incorporate data from multiple water quality parameters into mathematical equation that rates the health of water body with number.

Necessity of the study

Due to dumping of industrial wastes into streams, lakes, rivers not only the surface waters, but the ground water is also affected. This making water bodies the final resting place of various materials that cause water pollution as they contain harmful chemicals. Due to infiltration of surface water, the ground water is contaminating with chemicals. Most of the people depended on groundwater for their drinking purpose. So, the health of people depends on consumption of water. If the water is polluted with chemicals, or if the water is not as per standards prescribed by WHO, ISI, ICMR, the health of people who consumed the contaminated water will be seriously affected. So, there is needed to take preventive steps to prevent the ground water contamination. The rapid growth of urban areas not only affecting the surface environment like deforestation, but it also affecting the groundwater quality due to over exploitation of resources and improper waste disposal practices. The rapid growth of industrialization not only affecting the surface environment, but it also affects the sub surface environment by polluting ground water. Hence, there is need to concern over the protection and management of groundwater quality considering the above aspects of groundwater contamination. As prevention is better than cure, the dumping of industrial wastes should be abandoned to reduce the ground water contamination.

STUDY AREA

The ground water sample at the following 20 location of Vijayawada NTR district, Andhra Pradesh were Collected and the water quality status at those location were examined during this project.

1.Ibrahimpatnam
2. Kanuru
3. Ayyappa Nagar
4. Ramchandra Nagar
5. Penamaluru
6. Patamata
7. Enikepadu
8. Benz circle
9. Kandrika
10. Suryaraopeta
11. Kotha Peta
12. Prasadampadu
13. Singh Nagar
14. Gunadala
15. Madhura Nagar
16. Kamayyathopu
17. Vinchipeta
18. Satyanarayana Puram
19. Auto Nagar
20. Tadigadapa

WATER QUALITY INDEX[WQI]

Water quality index is a quality rating, reflecting the effect of each water quality parameter on the overall water quality. In general water quality indices incorporate data from multiple water quality parameters into mathematical equation that rates the health of water body with number. Water quality index provides a single number that expresses overall quality at a certain location and time, based on several water quality parameters. The objective of the water quality index is to turn complex water quality data into information that is understandable and usable by the public. water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public.

WEIGHTED ARITHMETIC INDEX METHOD:

The Weighted Arithmetic Water Quality Index method is a rating reflecting the composite influence different water quality parameters. It classifies water quality according to the degree of purity and provides a comprehensive picture of the quality of surface /ground water by using the most measured water quality variables. The steps in calculating the Weighted Arithmetic Water Quality Index as given as follows.

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S.no	Location	pH	NITRATE	Fe	EC	TDS	ALKANITY	Cl	Sl	TH	Ca	Mg
1	Ibrahimpatnam	7.51	30	0	2539	5000	30	474.9	595.2	575	175	400
2	Kanuru	7.86	10	0	1228	3000	20	224.9	854.4	545	235	310
3	Ayyapanagar	7.5	10	0	1039	1000	30	162.9	518.4	450	110	340
4	Ramachandra Nagar	7.12	5	0	1567	1500	15	159.9	720	525	145	380
5	Panamaluru	7.5	10	0	1200	1150	20	269.5	629.8	1367	625	742
6	Patamata	7.53	5	0	1293	3500	50	204.9	748.8	470	115	355
7	Enikapadu	6.89	20	0	1229	8500	10	1300	200.4	1360	750	610
8	Benz circle	7.58	10	0	1211	1000	15	284.9	825.6	460	115	345
9	Kandrika	7.21	5	0	1719	1500	30	244.9	594.2	600	160	440
10	Suryarao Peta	7.6	10	0	1361	1000	20	269.9	529.2	400	120	280
11	Kotha Peta	8.6	20	0	729.1	1500	10	180.4	729.6	225	145	80
12	Prasadam Padu	7.39	20	0	2866	1000	25	163.4	931.2	1160	655	505
13	Auto Nagar	7.69	30	0	1284	1000	40	237.4	489.6	1500	240	310
14	Gunadala	7.49	10	0	1245	500	20	194.9	998.4	365	152	240
15	Madhura Nagar	7.59	20	0	602.1	1000	5	169.9	480	245	65	180
16	Kamayyathopu	7.93	10	0	928.4	4500	25	279.4	451.2	390	210	180
17	Vinchipeta	7.3	5	0	844.8	1000	25	199.9	480	325	115	180
18	Satyanarayana Puram	7.3	5	0	585.4	2000	20	164.9	787.2	245	55	190
19	Autonagara	7.18	5	0	2680	4400	10	252.4	62.9	850	250	600
20	Tadigadapa	7.97	20	0	3834	1000	50	669.9	576	505	205	300

The Quality Rating Scale (Qi) for each parameter is calculated using the formula

$Q_i=\left[\frac{V_a-Vi}{V\square-Vi}\right]$

Were,

Va = Actual value of water quality parameter obtained from the data

V_i= Ideal value of water quality parameter (For pH=7)

Vs= Recommended standard value of the parameter according to IS 10500-2012

The Proportionality Constant (K) is calculated as

$$K=\frac{1}{\Sigma\frac{1}{V\square}}$$

The Unit Weight (Wi)for each parameter is calculated using the equation

$$W_i=\frac{K}{V\square}$$

pH

pH is a method of expressing Hydrogen Ion Concentration, which determines the water is acidic or alkaline in nature. The pH of natural waters ranges from 6.5 to 8.5.Deviation from the neutral pH value 7.0 is the result of interaction between acids and bases. The pH value in the study area range from 6.8 to 7.8.

Electrical Conductivity (EC)

The reason that the conductivity of water is important is because it can tell you how much dissolved substances, chemicals, and minerals are present in the water. Higher amounts of these impurities will lead to a higher conductivity. Pure water is not a good conductor of electricity. Because the electrical current is transported by the ions in solution, the conductivity increases as the concentration of ions increases.

Flourides:

All water contains some fluoride. Usually, the fluoride level in water is not enough to prevent tooth decay; however, some groundwater and natural springs can have naturally high levels of fluoride. Fluoride has been proven to protect teeth from decay. Bacteria in the mouth produce acid when a person eats sugary foods. The US Environmental Protection Agency (EPA) has set a maximum amount of fluoride allowable in drinking water of 4.0 mg/L. Long-term exposure to levels higher than this can cause a condition called skeletal

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fluorosis, in which fluoride builds up in the bones.

Nitrates:

Nitrate contamination occurs in surface water and groundwater, leaching into the soil and from there into the water supply from various sources. Irrigation water containing fertilizers is a common culprit as are septic systems, wastewater treatment plants, dairies and natural conditions. Drinking water that has high levels of nitrate can cause health effects such as: Methemoglobinemia or "blue baby syndrome," which results from nitrate decreasing the blood's capacity to carry oxygen, especially in infants who receive baby formula mixed with water containing nitrate above 10 mg/L.

Total Dissolved Solids:

The Bureau of Indian Standards (BIS) fixes the upper limit of TDS in drinking water at 500 ppm. Crucially the standard also mentions that in case no alternative source of drinking water is available, then this upper limit can be relaxed to 2,000 ppm. High concentration of TDS in the groundwater sample is due to leaching of salts from soil and also domestic sewage may percolate into the groundwater, which may lead to increase in TDS values.

Alkalinity:

The alkalinity refers to the measure of the capacity of the water to neutralize the acids. It can measure the bicarbonate, carbon dioxide, hydroxide ions, and carbonate naturally present in the water. The pH level of drinking water refers to how basic or acidic it is. The pH level refers to the hydrogen ions found in the water. It stands for 'potential of hydrogen.' The pH level of the water at normal drinking level, carbonate, and bicarbonate are the main contributors to its alkalinity.

Chloride:

Chloride is a naturally occurring element that is common in most natural waters and is most often found as a component of salt (sodium chloride) or in some cases in combination with potassium or calcium.

Sulphate:

Sulphate can be found in almost all natural water. The origin of most sulphate compounds is the oxidation of sulfite ores, the presence of shales, industrial wastes. Sulphate is one of the major dissolved components of rain. High concentrations of sulfate in the water we drink can a laxative effect whaen combined with calcium and magnesium, the two most common constituents of hardness.

Total Hardness

Hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. The principal hardness causing cations are calcium magnesium, strontimium, ferrous iron and manganous ions associated with bicarbonates, carbonates, chlorides and sulphates. Hardness is expressed in terms of equivalent CaCO3 concentration. In general, hard waters are originate in areas where top soil is thick and limestone formation are present. Soft waters are originate in areas where the top soil is thin and granitic rocks are principal constituent in the earth mantle.

Calcium Hardness

The simple definition of water hardness is the amount of dissolved calcium and magnesium in the water. Hard water is high in dissolved minerals, largely calcium and magnesium. You may have felt the effects of hard water,literally,the last time you washed your hands.

Magnesium Hardness

Hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. The principal hardness causing cations are calcium magnesium, strontimium, ferrous iron and manganous ions associated with bicarbonates, carbonates, chlorides and sulphates. Hardness is expressed in terms of equivalent CaCO3 concentration. In general, hard waters are originate in areas where top soil is thick and limestone formation are present. Soft waters are originate in areas where the top soil is thin and granitic rocks are principal constituent in the earth mantle.

Remedial Measure

Ion exchange:

Ion exchange is a water treatment method where one or more undesirable ionic contaminants are removed from water by exchange with another non-objectionable, or less objectionable ionic substance. This method adopted for the removal of sulphates, nitrites& other negatively charged ions.

Reverse osmosis:

Water is move under high pressure through a membrane. The membrane contains many microscopic pores that allow only water molecules to pass through, and as such, will stop nitrate and other inorganic chemicals such as sulphates, calcium, magnesium, and Total Dissolved Solids.

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Biologica ldenitrification:

Biological denitrification is using denitrifying bacteria and microbes so that nitrate ions are converted into its elemental state of nitrogen. Nitrate can be removed by using a chemical material like ethanol. Besides special bacteria, photosynthetic algae can be used to remove nitrates from water.

Distillation:

In this process, contaminants are removed through evaporation. Water is boiled to produce vapours, which rises to the cool surface and then condenses back into the liquid form. This method is used to trat the waters having high amounts of Calcium and Magnesium.

De-ionisation(DI)System:

The water passes through a membrane with positive & negative electrodes, wherein positive ions detach themselves from the water and move towards the negative electrode, resulting in de-ionized water. Here, however, water is first passed through a RO system before it goes through the process of de-ionisation.

Activated carbon filtration:

Activated carbon filtration is a commonly used technology based on the adsorption of contaminates on to the surface of a filter. This method is effective in removing certain organics (such as unwanted taste and odours, micropollutants),chlorine, fluorine or randon form drinking water or wastewater.

S.NO	LOCATION	WQI	WATER QUALITYSATUS	GRADE
1	Ibrahimpatnam	77.307	VeryPoor	D
2	Kanuru	60.483	poor	C
3	AyyappaNagar	56.758	poor	C
4	RamachandraNagar	61.318	poor	C
5	Penamaluru	121.592	Unsuitable	E
6	Patamata	61.447	poor	C
7	Enikepadu	107.617	Unsuitable	E
8	Benzcircle	59.776	poor	C
9	Kandrika	70.492	Poor	c
10	SuryaraoPeta	50.349	Good	B
11	KothaPeta	46.392	Good	B
12	Prasadampadu	90.114	VeryPoor	D
13	SinghNagar	59.478	poor	C
14	Gunadala	34.278	Good	B
15	MadhuraNagar	29.840	Good	B
16	Kamayyathopu	43.510	Good	B
17	Vinchipeta	35.127	Good	B

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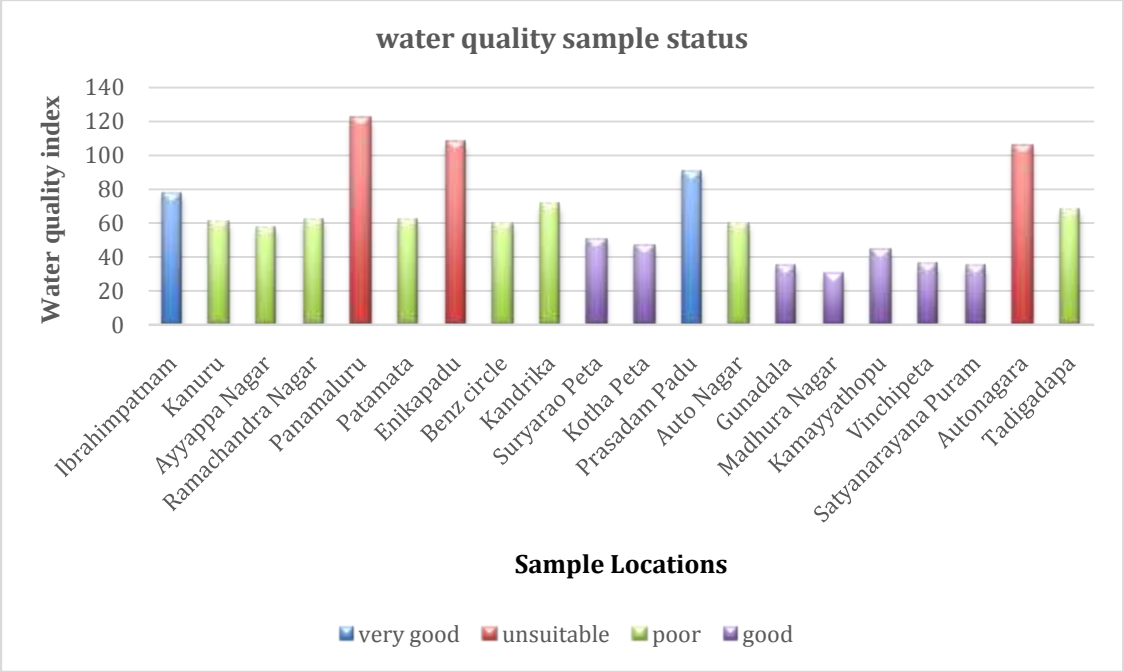
18	SatyanarayanaPuram	33.947	Good	B
19	AutoNagar	105.085	Unsuitable	E
20	Tadigadapa	67.626	poor	C

Water Quality Status

WQI	0 -25	26 -50	51 -75	76 – 100	>100
Waterqualitystatus	Excellent	Good	Poor	VeryPoor	Unsuitable
Grade	A	B	C	D	E

Water Quality status for the Tested Water Sample



II. CONCLUSIONS

● The water quality in and around Vijayawada is of major concern due to formation of new capital of Andhra Pradesh and several development activities are being taken up.

● The water quality for drinking purpose in and around Vijayawada city is examined by collecting water samples at 20 different locations.

● The Water Quality index at the observed 20 locations along with the physiochemical properties are determined.

● The results reveal that maximum value for WQI is 121.59 at Penamaluru observed at and minimum is observed at 29.84 at Madhura Nagar.

● From the results the groundwater is unsuitable for drinking at the following locations i.e Penamaluru, Auto Nagar and Enikepadu. From the results the groundwater is of very poor quality at the following locations i.e Ibrahimpatnam and Prasadampadu and at 8 locations the quality is observed poor i.e Kanuru, Ayyappa Nagar, Ramachandra Nagar, Patamata, Benz circle, Kandrika, Singh Nagar, Tadigadapa locations it is observed as poor.

● From the results water quality status is good in remaining 7 locations (i.e Suryaraopeta, Kotha Peta, Gunadala, Madhura Nagar, Kamayyathopu, Vinchepeta, Satyanaraya Puram.
● The water quality index of Enikepadu and Auto Nagar, Penamaluru is unsuitable due to the presence of industrial areas and a dump yard.
● The water is unsuitable at 3 locations (Enikepadu and Auto Nagar, Penamaluru) due to the presence of industrial areas and a dump yard.
● Electrical conductivity, Sulphate, Total hardness, Calcium hardness, Magnesium hardness is more at the locations Penamaluru, Enikepadu, Auto Nagar. So, we recommend the reverse osmosis, distillation, activated carbon filtration methods to treat the water at those locations.

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