Analysis of Ground Water Quality by Using Water Quality Index: A Review

Hemanshu K. Rana[1] Dr. Neeraj D Sharma[2]
[1]Research Scholar [2]Manager (EIA)
[1,2]En-Vision Enviro Technologies Pvt. Ltd, Surat, Gujarat, India

Abstract — Groundwater is the most precious resource on the earth as it is the basic necessity among all forms of life on the earth for sustainability, we all have to very strongly depend on this source of water for our daily domestic, Agricultural, industrial, Commercial, etc water requirements. In the area of Navsari District especially in the coastal region, it was found from the past data that water is getting polluted periodically, and as a result of that it was decided to assess the groundwater quality of Navsari District. The present study mainly aimed at the assessment of groundwater quality based on the Water Quality Index of different physico-chemical parameters of selected sampling locations of Navsari District. To fulfill the requirements for the determination of the Water Quality Index, samples were collected from selected 48 locations within Navsari District. Mainly for the assessment of groundwater quality purpose pH, Electrical Conductivity, TDS, Chlorides, Total Hardness, and Nitrates were considered as quality parameters. Finally, the determination of the water quality index for the Pre-Monsoon and Post-Monsoon period of each year for three consequent years is decided. After assessment based on contamination results suggests the proper method of artificial recharge for the improvement of Ground water quality of that region.

Keywords: Groundwater, Groundwater Quality, Water Quality Index (WQI), pH, TDS

I. INTRODUCTION

Nowadays Groundwater is the most useful and valuable resource than the surface water available. In the whole world at present, nearly about more than 20% of all water requirements are fulfilled by groundwater resources. So Ground water become the most important source of water supply around the world because of the increase in water demand resulting from the rapid growth in population throughout the World. Life on the earth is almost impossible without water. As per WHO-World Health Organization regarding the quality of water Access to safe drinking water is important to as a Health and Development issue at a national and Local level. So, the contamination of Groundwater can never be accepted in any condition. So, the assessment of groundwater quality is very much essential to keep a record of its contamination periodically, and also people around the world must be aware of it. The Groundwater Index is a Single number that can be easily determined from Various Water Quality parameters and is very useful in describing the overall quality of Water to be used by the consumers and its suitability mainly for drinking purposes. The Water Quality Index is determined by using a formula that contains Assigning Weight to the water quality parameters selected for study purposes based on the relative importance concentration of each quality parameter and its Indian standard of drinking water in mg/l (IS:10500-2012-Guideline for the potable water quality). For any researcher or analyst Water Quality Index will become a simple solution that provides a very easy and quick method to identify the overall quality of water samples at a Single Aggregate Number- WQI- and it can be easily understood by any expert in that study area.

II. LITERATURE REVIEW

Various research papers on the assessment of quality parameters of river water have been presented at the research level from which I referred a few research papers for study. These technical papers are presented below.

Jigna Desai and Tank S.K.[1] studied on "Water Quality Index (WQI) of river Tapti-Surat, Gujarat-India". This study deals with with study of various physico-chemical parameters of water samples from a Total 5 locations of River Tapti, Surat, Gujarat state, India. The water samples were collected at regular intervals of 30 days for two consecutive years 2008-2009. The Water Quality Index (WQI) was also calculated for all locations to identify the overall water quality. The data were analyzed statistically to identify those parameters that are responsible for variation in the Water Quality Index (WQI). Also in this study, the Experimental values were matched & compared with standard values Provided by WHO.

Saziya Barodawala and P.R. Parmar [2] studied on, the Groundwater Quality Index of Vadodara City In this study groundwater quality was monitored and assessed for various Monitoring stations in the urban area of Vadodara. Water quality parameters such as Electrical conductivity, TDS, turbidity, and alkalinity were found. The groundwater quality index was computed as per BIS standards for drinking water specification Which range from 41 to 193. In this study results of GWQI show that the quality of Groundwater monitoring stations was found and categorized from good water to Poor water. In this study, it was recommended that some treatment be given to water before its consumption and also give some protection to the source of water from contamination.

Rita N. Kumar, Rajul Solanki, et al [3] have studied and described spatiotemporal variation in the water of river Sabarmati and Kharikal canal at Ahmedabad. In this study, five monitoring stations were selected and a Total 8 different water quality parameters - pH, Temperature, Dissolved Oxygen (D.O.), Hardness, Phosphate, Sulphate, Nitrate, and Chemical Oxygen Demand (C.O.D.) were measured. From these results, the Water Quality Index (WQI) was calculated to know the type of water quality. Study results show that spatial and temporal variation was observed in the river with higher values of various water quality parameters from upstream to downstream and relatively high pollution load at both sites of Kharikal canal is observed.

P. Shroff, et al, [4] studied, "Assessment of Water Quality Index for Groundwater of Valsad District of South

Gujarat (India)". In this study Total of seventeen water quality parameters were determined for the purpose of determining of Water quality index. This study uses the Canadian Council of Ministers of the Environment –CCME consideration for the Determination of Water Quality Index. Results of the study show that some monitoring locations fall under the good category, some of them under the fair category while few monitoring location shows the excellent category of water. This study suggested that the groundwater of the Valsad region requires some treatment before use for drinking purposes.

N.D.Sharma et.al.[5] studied on "Evaluation of Groundwater Quality Index of the Urban Segments of Surat City, India". In this study, the author has determined the Groundwater quality index for the urban area of Surat City. For this study purpose Groundwater samples were collected from various locations and water quality analysis was done for five groundwater quality parameters for some consecutive years. The outcome of the study showed that the groundwater of the study area needs a few degrees of improvement through artificial groundwater recharging.

Patel Vaishali and Parikh Punita [6] have studied to investigate the Assessment of seasonal variation in the water quality of River Mini at Sindhrot, Vadodara. For that purpose of study, two sampling stations were selected and 12 different water quality parameters were analyzed during summer, monsoon, and winter in the year 2010-2011. The final results show deterioration in water quality with seasonal changes. Water quality data measured were compared with CPCB and GPCB standards. Results obtained show increased levels of TDS, Ammonia, chloride, sulfate, BOD, COD, EC, Total Alkalinity, Total Hardness, and decreased levels of turbidity and D.O. during the winter season. Increased contamination levels in winter indicated the increase in organic matter in the water of Mini River during the season.

J Sirajudeen et al. [7] studied on "Water quality index of groundwater around Ampikapuram area near Uyyakondan channel Tiruchirappalli District, Tamil Nadu, India" In this study author collected water samples from the study area for Physicochemical analysis. For the purpose of determination of WQI, Various water quality parameters such as pH, Total Hardness, TDS, EC, BOD, COD, DO, Mg, NO3, and Cl were considered. The obtained results showed that the WQI of these ten samples ranged from 244 to 383.8. The author suggested giving proper treatment before consumption.

Akosh Choker et. al [8] studied on Assessment of groundwater quality using physicochemical parameters and water quality index around running mines of Dhanbad district, Jharkhand. In this study total of Twenty-five groundwater samples were collected during the post-monsoon (2015). This study reveals considerable variation in different physico-chemical parameters due to metamorphic impact but they were found within the permissible limit prescribed by IS 10500: 2012. Obtained Water Quality Index (WQI) value ranged from 23.9 to 260.3. Final results showed Out of all samples analyzed 48% of samples fall in the good water category and 52% of samples fall in the poor water category The groundwater needs some treatment before its use for drinking purposes.

Namita Saxena et al [9] studied WQI evaluation in and Around Tekanpur, Madhya Pradesh, India. In this study, the Physicochemical parameters of groundwater samples were collected from 5 sample monitoring stations within the study area for its suitability for public use. The water quality index was determined. The obtained results were compared with standard results recommended by WHO and ISI. The water quality index of samples collected and analyzed ranged from 58.66 to 93.75 which are safe for public use. The authors suggested some degree of treatment before consumption.

S. Selvakumar et.al [10] studied on "Groundwater quality and its suitability for drinking and irrigational use in the Southern Tiruchirapalli district, Tamil Nadu, India. The author has selected 20 locations for groundwater quality monitoring purposes in the present study. Then Various physicochemical parameters were analyzed. Analyzed sample results showed that 55% of samples are good for drinking purposes while other samples are not suitable for drinking purposes and therefore recommended to protect from contamination.

K. Sundarakumar et al. [11] Studied on Assessment of Groundwater Quality Using WQI. Water Quality has ten different parameters from various locations in 27 villages from Bapulapadu Mandal. These samples were analyzed. The data obtained were used as attribute data for the preparation of a thematic map of the water quality index. Studies showed that water quality in a few villages like Ampapuram, Dantaguntala, R.A.Peta, and Arugolanu was unfit for drinking purposes.

Dhanaji Kanase G. et al [12] studied on physicochemical parameters of Drinking Water of different places in Kadegaon, Maharashtra. The author compared two different scenarios – Well water and bore well water in this study. Various water quality parameters – pH, temperature, TDS, EC, Hardness, DO, Alkalinity, BOD, COD, and Chlorides were analyzed and determined for the year 2016. The final results obtained were found that water was not suitable for drinking.

III. ASSESSMENT OF WATER QUALITY:

A. Groundwater Quality parameters to be analyzed:

Sources of surface water available on the earth are not sufficient to fulfill the requirement of water due to urbanization. To fulfill the requirement of water very much essential to depend more on Groundwater sources which is safe for drinking and other purposes in day-to-day life. Therefore, research or studies related to monitoring and assessment of the quality of water from Groundwater sources and its improvement will be given more importance which will be more useful for drinking purposes around the world.

B. Water Quality Parameters to be considered in Water Quality assessment:

For the purpose of monitoring of Groundwater quality of the various monitoring stations selected within the Study area - Navasari District, the following Groundwater quality parameters to be analyzed:

C. pH:

pH Value of the water sample can be defined as a negative logarithm of hydrogen ion concentration present in a water sample. This hydrogen ion concentration is an important water quality parameter. The pH of natural water is mainly lies in the range of 6.0 to 8.5 (WHO). The pH value of natural water changes due to temperature, biological activities, and disposal of industrial waste into the river or other natural water bodies.

D. TDS:

Total Dissolved Solids present in surface water or groundwater mainly consist of dissolved minerals as well as inorganic solids such as carbonates, chlorides, phosphates, bicarbonates, and nitrates of Calcium, magnesium, Potassium, Sodium, ions, etc., and a very small amount of dissolved gases and organic matter. The contaminated amount of Total Dissolved Solids can be determined by a TDS meter. As per IS-10500, 2012, the Acceptable limit of TDS is 500 mg/l and the Permissible limit of TDS is 2000 mg/l.

E. Electrical Conductivity:

It is the measure of the Capacity of any solution or substance to carry an electrical current. It is the total parameter of Dissolved substances and Dissociated substances It represents the reciprocal value of Electrical resistance in ohm relative to cubic centimeters of water at a temperature of 250^0 C Contaminated amount of Electrical Conductivity can be determined by an Electrical conductivity meter.

F. Chlorides

Depending on the Geochemical condition Chloride is present in all natural water sources at a varying concentration. It is mainly present in surface water and groundwater is due to various activities carried out in agricultural areas, Industrial areas, etc. As per Drinking water standard – IS 10500, 2012, the Acceptable limit and Permissible limit of chlorides is 250 mg/l and 1000 mg/l respectively

G. Total Hardness:

Hardness is the measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solution. It is expressed in terms of equivalent $CaCO_3$ Concentration. Water from different sources may be classified if Total Hardness (as $CaCO_3$) is 0 to 50 mg/l -Soft, 50 mg/l to 100 mg/l -Moderate hard, 150 mg/l to 300 mg/l- Hard, and more than 300 mg/l - Very hard. The total Hardness of the sample can be determined by the EDTA method in the laboratory. Temporary Hardness present in the water can be removed by boiling while permanent hardness can be removed by Gan's Permutit Method, Calgon's Process or Ion Exchange Resin Method.

H. Nitrogen:

The main forms of Nitrogen present in the water are nitrate, nitrite, ammoniacal nitrogen, organic nitrogen, nitrous oxide, and molecular nitrogen. It is the main plant nutrient found in fertilizers, human and animal waste, yard waste, etc.

I. Fluoride:

It is one of the geochemical contaminants found in surface and subsurface water. In Groundwater, the concentration of fluorides depends on the solubility of fluoride-containing rock with which the water is in contact. As per IS-10500, 2012 for drinking water, the Acceptable limit and Permissible limit of Fluoride is 1.00 mg/l and 1.15 mg/l respectively. An extensive survey in the Indian community showed that about 25 million of people were consuming water having fluoride content of greater than 1.5 mg/l.

J. Sulphate:

Sulphate is a compound found in nature and occurs in water in different amounts. It is measured and determined by an Ultraviolet Spectrophotometer in the laboratory. As per IS-10500 for drinking water, 2012, the Acceptable limit and Permissible limit of Sulphate are 200 mg/l and 400 mg/l respectively

IV. WATER QUALITY INDEX:

WQI of water samples can be defined as a single number that expresses the overall quality of water based on several water quality parameters selected for the study. The Water Quality index can be calculated from the following equation.:

$$GWQ\ Index = \sum SIi \quad (1)$$

$$Sub\ index,\ SIi = (Wi)\ X\ (qi) \quad (2)$$

Relative weight, Wi= = wi/∑wi

Where, wi = weight of parameter

$$Quality\ rating,\ \ qi = (Ci/Si)\ X\ 100$$

Where Si = According to IS 10500 water Standard
For each chemical Parameter in mg/L
Ci = Concentration of each water Quality
Parameter in sample in mg/L

The type of quality of water can be categorized based on the Groundwater Quality Index value. If the range of the Groundwater Quality Index is less than 50 –Excellent water, 50 to 100 – Good water, 100 to 200 –Poor water, 200 to 300 - Very poor water, and if the GWQ Index is more than 300 – then Water is not suitable for drinking purpose.

V. CONCLUSION:

Groundwater Quality contamination is an increasing concern in the world and mainly depends on human activities by which various types of pollutants are added as well as the availability of minerals in the zone surrounding bore wells, dug wells, etc. Assessment of GWQ is done by collecting Groundwater samples from selected locations within the Navsari district. The analysis was done on collected groundwater samples in the laboratory as per standard methods given in APHA-AWWA. Finally, the Groundwater Quality Index is computed, and based on the standard values given in the table-2 the quality of groundwater is categorized/ evaluated for Pre-monsoon (April) & Post-monsoon (November). Finally, the results of the assessment of groundwater quality obtained showed that most of the groundwater quality parameter's concentration is higher during the period of Pre-monsoon than the post-monsoon. It is also suggested to apply a suitable artificial recharge method for groundwater quality improvement in the region.

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