Drinking Water Quality Index

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***Abstract*- This paper presents the analysis of drinking water quality by the help of Water Quality Index. The water quality analysis is calculated through Weighted Arithmetic Water Quality Index Method. For calculating the WQI, 11parameters have been considered. Physical properties: Alkalinity, pH, Total Hardness, Calcium, Magnesium, Total Dissolved Solids, Turbidity. For inorganic non-metallic constituents:Nitrate, Fluoride, chloride and for Microbial examination: Most Probable Number Test (MPN). Types and Location of sampling is decided by the methods recommended by WHO drinking water sampling guidelines. The experimental analysis will be conducted as per APHA, Standard Methods for The Examination of Water and Waste Water and the standard code for reference will be IS10500:2012, DRINKING WATER — SPECIFICATION.**

***Keywords*-Water quality, Analysis, Parameters, Weighted Arithmetic Water Quality Index Method, Physico-chemical analysis.**

I. INTRODUCTION

One of the main natural treasure of any country is water. Water is remedy for all the living creatures. "without water there is no life" is a typical saying relying on the way that water is the one of the normally used for all day to day fundamental activities which supports life [21]. Fresh water is a limited, vulnerable, sustainable asset on the earth and depicts significant part in our environment. Water is an unique asset since it is basic for all life and it consistently cycles between the earth and the air [1]. A water that is utilized for flora and fauna generation is likewise being imparted to the people and the marine, biological communities. Steady increment in water usage and exploitation because of increasing development and population has brought about rocketing demand in use of groundwater table as compared to surface water which has prompted groundwater decrease. The groundwater quality is deteriorating because of mining exercises and transfer of immense modern effluents [17].

II. DRINKING WATER QUALITY INDEX

Water Quality Index is a mathematical expression which converts large numbers of sets of water quality data into a single form and the obtained single number displays the overall drinking water quality characteristics[3]. WQI is a useful tool for quick and efficient estimation of any water resource and its suitability of use [7]. Water quality index (WQI) is a useful tool for quick estimation of any water resources health [31]

A. Water Quality Indices are calculated in two different steps:
   1. First is analysis of raw data for selected water quality parameters, having dissimilar units of measurement and are converted into unit less sub index values.
   2. Next is to calculate sub-indices and then aggregation of sub-indices using some type of mathematical function to calculate a WQI value. [8]-[26]

B. Examples of WQI [1]- [30]:
   1. National Sanitation Foundation Water Quality Index (NSFWQI)
   2. Oregon Water Quality Index (OWQI)
   3. Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI)
   4. Weighted Arithmetic Water Quality Index Method

III. MATERIALS AND METHODS

A. Selection Of Parameters:

For a drinking water quality analysis, first priority should be given to those elements which are important and effects the health and potability. Second priority is given to the substances which are present in drinking water in about appropriate concentrations [10]

Some of the important parameters which affects the drinking water quality from the above noted criteria, and are prescribed by IS -10500 code [34] for drinking water are given below in TABLE-1 and mostly and commonly used for WQI calculation in the papers – [2]-[5]-[17]-[19]-[20]-[21]-[23]-[24].

TABLE -I : PARAMETERS

Parameter	BACKGROUND INFORMATION
ALKALINITY	Alkalinity is the reference for measuring buffering capacitance of the water. This is the ability of the base to neutralize acid in any operation. Alkalinity is measured for determining the capacity of streams to neutralize contamination from rainfall or wastewater which is generally acidic. It shows the capacity of water

		to withstand the action or effect of change in its pH [4]. *Effects Of Alkalinity*: If the alkalinity is low the water is more likely to be corrosive in nature. Alkalinity is involved in the consequential effects of eutrophication of waters. Where a high degree of photosynthesis occurs due to high consumption of carbon dioxide by algae, as CO_2 is dissociated by bicarbonate ions in form of carbonic acid. Water which have higher alkalinity may lead up to scaling[18]. *Normal Method(s) of Analysis*: Titration with Sodium Hydroxide [22]-[33]
2. CALCIUM and MAGNESIUM		In Water calcium and magnesium enters from decomposition of alumino-silicates and when there are higher concentrations, it comes from dissolution of limestone, magnesite, magnesium limestone gypsum and other minerals.[6] *Normal Method(s) of Analysis:* Titration (Calcium Hardness) ; Atomic Absorption Spectrometry [22]-[33]. Magnesium is mostly less present in concentration in waters as compared to calcium, as it is found deep inside crust of the earth [6]. *Normal Method(s) of Analysis:* Titration with EDTA; Atomic Absorption Spectrometry [22]-[33].
3.	HARDNESS	Source : dissolved calcium and magnesium, dissolved limestone and dolomite from soil and rock particles. Hard water up to some extend is beneficial to health but higher hardness may lead to lime buildup (scaling) in pipes and water heaters. It forms scum when reacted with soap and this decrease cleansing ability of soap and turns the white textile into greyish. Water that is naturally too soft may be corrosive in nature.[4] Normal Method(s) of Analysis: Titration with EDTA [22]-[33].
4.	Ph	It is the measure of potiental of hydrogen ion or hydrogen ion concetration in water. The pH scale ranges from 0 (very acid) to 14 (very alkaline). The natural pH is 7. The measure and control of pH is a necessary part of water treatment and distribution, as it influences the the effectiveness of coagulation and disinfection.[4] SOURCES: Low values of pH are more commonly caused by absence of carbonate minerals, like calcium and magnesium found in limestone and dolomite rocks. Leachate from a landfill may also lower pH.[18] Normal Method(s) of Analysis: Electrometry [pH electrode] [22]-[33].
5.	TOTAL DISSOLVED SOLID (TDS)	Solids which are present in water and they passes through any filter are called total dissolved solids. it is quantity of organics and inorganics dissolved in water. This include bicarbonate, carbonate, sulphate, chloride, phosphate, magnesium, nitrate, , sodium, organic ions, and calcium. It is necessary to maintain certain amount of TDS in water for survival of aquatic life. Variations in TDS concentrations can possess danger because the density of the water shows the flow of water entry and exit of an organism's cells. laxative effect and bad taste is resulted. when TDS is high.[18] Normal Method (s) o f Analysis: Gravimetric (Dried at stated temperature after filtration) [22]-[33].
6.	TURBIDITY	Turbidity is a expression of the amount of light which is scattered by the particles present in water when a light is passed through it and represents the relative clarity of water. Turbidity will be higher if the light is scattered more. Source: clay, finely divided inorganic and organic matter, plankton, silts, and other microscopic organisms. soluble colored organic compounds, algae. [32] Normal Method(s) of Analysis: Turbidimeter or Nephelometer[22]-[33].
7.	CHLORIDE	Chloride can occur from natural sources such as saltwater intrusion in coastal sources but can be present in sewage and industrial effluents and thus can be an indicator of pollution from these sources [4]. Normal Method (s) of Analysis: Titration (Mohr Method: Silver Nitrate)[22]—[33].
8.	NITRATE	Nitrate nitrogen is a generally consumed as fertilizer. It is also a chemically when waste material decomposes. Likely to cause methemoglobinemia, a disease which interferes with oxygen transport in the blood to the infant which are below 6 months and it should also be avoided by pregnant women as latest research suggest relations of high-nitrate water and birth defects or miscarriages. SOURCES: Fertilizer, animal wastes and septic system effluent[4]. Normal Methods of Analysis: Manual/Automated Colorimetry [A/B]; Specific Ion Electrode [22]-[33].
9.	FLOURIDE	Fluoride occurs from fluoridation of public water supplies and from industrial effluents but it occurs rarely and Naturally. Less amount of fluoridein drinking water may lead to tooth decay in growing children [4]. Normal Method(s) of Analysis: Colorimetric (after distillation) ; Specific Ion Electrode [22]-[33].
10.	MOST PROBABLE NUMBER (MPN)	The *E. coli* bacteria is present in high numbers in human beings and animal excreta and is very rarely found in the absence of sewage pollution. However,its presence in potable water is a good indicator to know that either the source of the water is polluted or that the remediation process at the r treatment plant is not operating efficiently [18]. Normal Method(s) of Analysis: Multiple tubes method[22]-[33].

B. Location selection:

WHO recommends that samples of water should be taken from location which represents source, treatment, storage, network for distribution of water and points at which it is delivered to the users. Every locality is to be counted as a individual. Moreover the sampling points should be equally distributed among the distribution of piped network keeping the population distribution in account. The selected sampling point should represent the quality of whole main component. Sampling point should be easy to reach for taking of samples. If there is more than one source the location of sampling point should count the number of people served by each source. Classification of piped distribution should be done by water supply authorities as 1) Fixed and agreed 2) Not agreed with the supply authorities but fixed and 3) random or variable [4].

In Gujarat,Shah et al**.** gathered the ground Water tests from bore wells of 40cities and villages of Gandhinagar taluka in May-2006. Ten villages of each directions (North, South, East and West) of the taluka were selected for the examination.so that it covers the major area of the ground water from all the side[28].

C. Sampling Frequency:

TABLE II: Minimum Sample Numbers For Piped Drinking Water In The Ditribution System

POPULATION SERVED	Number Of Monthly Samples
<5000	1
5000-100,000	1 Per 5000 Population
>10000	1 Per 10000 Population , Plus 10 Additional Samples.

Source – [4]

D. SAMPLING BOTTLES :

For Physico-chemical parameters -sampling bottle can in glass or polyethylene bottles. The sample should be stored at low temperature of about 4 °C and in the dark is recommended. Sample bottles should be clean however it does not need not be sterile. For Biological examination the sample bottle should of sterilized glass bottle of 300 ml. The box which is to be used to carry sample bottlesmust bedisinfected and cleaned after each use to avoid contaminating the surfaces of the bottles and the sampler's hands[12]- [23]-[26].

IV. WEIGHTED ARITHMETIC WATER QUALITY INDEX METHOD

The weighted arithmetic water quality index method is used to analyse the potable waters characteristics and quality.This method is widely used method for finding WQI.

For registering WQI three stages were taken after. In the initial step, each of the parameters has been aasigned a weight (wi) as indicated by its relative significance in the general nature of water for drinking reason. In the second step, the relative weight is registered.

$$\mathbf{WQI=\sum WQI/\sum Wi}$$

Where, Wi is relative weight, wi is the weight of every parameter and n is the quantity of parameter. In the third step, a quality rating scale (qi) for every parameter is appointed by dividing its concentration in each water sample by its separate standard as per the rules set around BSI and the product of result obtained into 100.

The quality rating scale (Qi) for each parameter is calculated by using below expression:

$$\mathbf{Qi=100[V_i-V_0/S_i-V_0]}$$

V_i is estimated concentration of i^{th} parameter in the analysed water.

V_0 is the ideal value of this parameter in pure water

V_0= 0 (except pH =7.0 and DO = 14.6 mg/l

Si is recommended standard value of i^{th} parameter.

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$\mathbf{W_i=K/S_i}$$

K = proportionality constant and can also be calculated by using the following equation:

$$\mathbf{K=\frac{1}{\sum\left(\frac{1}{Si}\right)}}$$

[2]- [5]-[8]-[13]- [26]-[29]- [30]

V. CONCLUSION

From the above given formula when we get a WQI value, we can check the quality and health Of water. Water quality ratings given in TABLE- III and by the grading we can conclude whether it is suitable for drinking or not.

TableIII :Water Quality Rating as per Weight Arithmetic Water Quality Index Method

WQI Value	Rating of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very Poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Source – [14]-[30]

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