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# DETERMINATION OF GROUND WATER QUALITY INDEX IN COASTAL AREA OF MUMBAI

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**ABSTRACT**

Ground water quality can be adversely affected or degraded as a result of human activities that introduce contamination into the environment. In industrial and coastal location, the saline water intrusion resulted in contamination of the potable ground water aquifers. The influence of environmental parameter on the water quality of ground in coastal region is a crucial issue for its use of various purposes. Assessment of Ground water quality status was done by using water quality Index method, which is an effective tool to assess spatial and temporal changes in ground water quality. Various parameters were selected as indicators of the groundwater quality which include pH, Hardness, Chlorides, Sulphate Dissolved Solids, Calcium, Alkalinity, Magnesium and Metals etc. to determine water quality index. The monitoring of ground water quality was done on the basis of experimentation by standard sampling methods, for different locations for consecutive three years from 2016 to 2018. The present study intends to calculate water quality index (WQI) of the coastal ground water.

**Keywords:** water quality index, ground water quality, coastal area, parameters.

## 1. INTRODUCTION

Water is a necessary and important component for our life support system. With fluctuating and increasing contamination of surface water, ground water is considered as one of the primary resources for development activities. The extraction of excessive quantities of ground water has resulted in drying up of wells, damaged ecosystems, land subsidence, salt water intrusion and depletion of the resources. Ground water quality is increasingly getting affected by industrial, agriculture and urban wastes, which leach or are injected into underlying aquifers. The rate of depletion of ground water levels and deterioration of ground water quality is of concern in major cities and towns of the country. Chembur is a coastal area located in Mumbai. The CEPI (comprehensive environmental pollution index) score of 63.2 comes under the criteria of severely polluted areas which shall be kept under surveillance and pollution contro lmeasures are to be efficiently implemented. In order to find out current status of the pollution in the area, due to the increasing trend in the industrial activities, it is very much essential to identify the various sources of pollution. Being industrial and coastal location, the saline water intrusion resulted in contamination of the potable ground water aquifers. Water quality index provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. Water Quality Index, indicating the water quality in terms of index number which represents quality of water for public use and for management of pollution abatement programmes.

Gurdeep Singh (2012) has done assessment of ground water quality in mining areas of Goa. The monitoring of ground water quality was done at forty five ground water sampling location on seasonal basis (i.e. post- monsoon, winter, summer and monsoon) from October 2011 to September 2012). Based on the descriptive categories of WQI values observed, all (110% sampling locations in the study area were observed with very good categories. K.Yogendra and E.T.Puttaiah (2008) studied determination of water quality index and suitability of an urban waterbody in Shimoga Town, Karnataka. This study shows that the waterbody is eutrphic and it is unsuitable for the human uses. It is also observed that the pollution load is relatively high during summer season when compared to the winter and rainy season. Abegunlin studied roof age effect on the quality of harvested rainwater and its health implication at the selected location of Southwest Nigeria. Khwajam Anwar and Vanita Aggarwal (2014) also did analysis of ground water quality of Aligarh city using water quality index. The water quality index of these samples ranges from 18.92 to 74.67 pre - monsoon and 16,82 to 70.34 during post - monsoon. The study reveals that 50% of the area under study falls in moderately polluted category. The ground water of Aligarh city needs some treatment before consumption and it also needs to be protected from contamination.

## 2. STUDY AREA

Chembur is a suburb in Eastern Mumbai, Maharashtra, India, having many major petrochemical industry, Oil refineries, Fertilizer plants and Power industry situated in the region. The Latitude is 19.01794 and longitude is 72. 90321. The average rainfall of this area is 2800 mm. The rainfall in Chembur area is confined to the month June, July, August and September (i.e. 90%) and rest of the 10% in the other nine months namely- February, March, April, May while October and November goes dry. Chembur was ranked 46$^{th}$ in a list of the most polluted industrial clusters in India. Being industrial and coastal location, the saline water intrusion resulted in contamination of the potable ground water aquifers. The Refinery is spread over vast area of 321 acres of land at Mahul road Chembur Mumbai which is situated in coastal area. This Refinery is facing acute scarcity of fresh water since last few years due to addition of new processing units. The deficit in daily fresh water supply is being mitigated by outsourcing of water. The un-interrupted supply of this outsourced water is also not guaranteed, and many a times leads to emergency situations resulting in shutdowns and slowdowns. Refining process of plants also depleting the quality of ground water. The location map of the study area is shown in Figure-1.

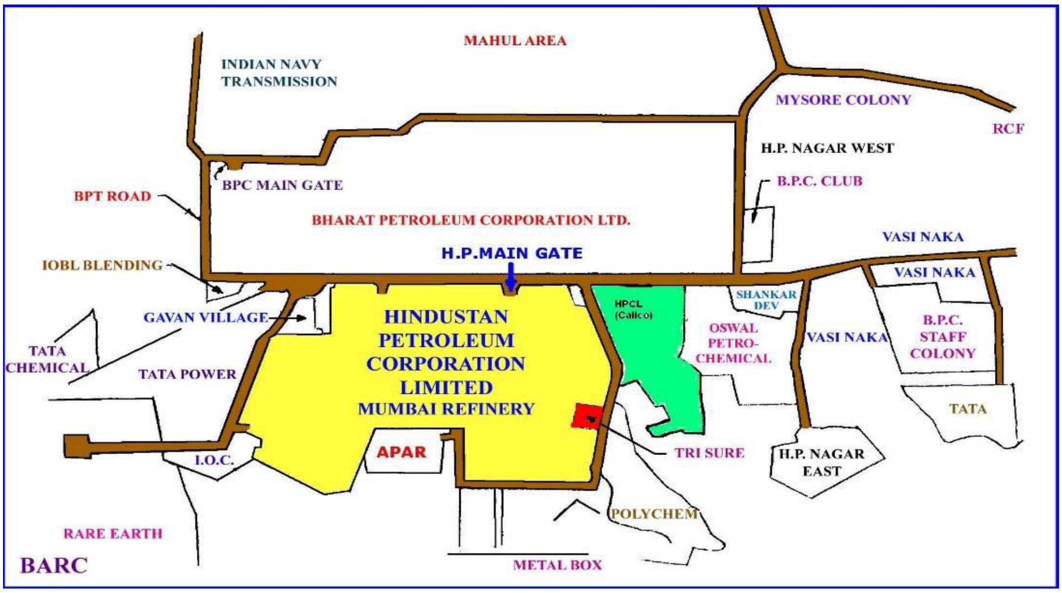


**Figure-1.** Location map of the study area.

## 3. MATERIALS AND METHODS

The objective of the study is to calculate the groundwater quality index of the coastal areas at different locations by using different parameters for the calculation of water index of groundwater quality of the coastal area. Three years data of three different locations were collected to know the analytical status of the groundwater quality in the area. The Samples were collected in the month of February to June for the year 2016 to 2018 and analysed. The twelve parameters were selected and quality analysis has been carried out by standard method prescribed as per IS 10500-1994.This reveal the overall impact on groundwater quality.

### 3.1 Water Quality Index Method

A Water Quality Index (WQI) describes the general situation of water bodies by changing water quality parameters levels into a numerical score using mathematical tools. WQI can be evaluated on the basis of physical, chemical and biological parameters has been calculated by using the standards of drinking water quality recommended by the World Health Organisation (WHO), Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR).

### 3.2 WQI Calculation

WQI is carried out by using Horton's method. The WQI is calculated by using the expression given in Equation (1.1).

$$WQI = \Sigma\, Q_n W_n / \Sigma W_n \qquad (1.1)$$

Where, $Q_n$ = Quality rating of $n^{th}$ water quality parameter.
$W_n$= Unit weight of $n^{th}$ water quality parameter.

### 3.3 Quality Rating($q_n$)

The quality rating ($q_n$) is calculated using the expression given in Equation (1.2), the rating scales fixed in terms of ideal values of different physio- chemical parameters. Even if they are present, these might not be the ruling factor. Hence they are assigned zero values

$$Q_n = [\,(V_n - V_{id}) / (S_n - V_{id})\,] \times 100 \qquad (1.2)$$

Where,

$V_n$= Estimated value of $n^{th}$ water quality parameter at a given sample location.
$V_{id}$= Ideal value for $n^{th}$ parameter in pure water. ($V_{id}$ for pH = 7 and 0 for all other parameters)
$S_n$= Standard permissible value of $n^{th}$ water quality parameter.

### 3.4 Unit weight

The unit weight ($W_n$) is calculated using the expression given in Equation (1.3).

$$W_n = k/S_n \qquad (1.3)$$

Where,
$S_n$= Standard permissible value of $n^{th}$ water quality parameter.
k = Constant of proportionality and it is calculated by using the expression given in Equation (1.4).

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$$k = [1 / (\Sigma 1/S_{n=1,2,..n})] \quad (1.4)$$

## 4. WQI AND STATUS

The ranges of WQI, the corresponding status of water quality and their possible usage are summarized in Table-1.1.

**Table-1.1.** WQI and corresponding water quality status.

| S.No | WQI | Status | Possible usages |
|---|---|---|---|
| 1 | 0 - 25 | Excellent | Drinking, Irrigation and Industrial |
| 2 | 25 - 50 | Good | Domestic, Irrigation and Industrial |
| 3 | 51 -75 | Fair | Irrigation and Industrial |
| 4 | 76 - 100 | Poor | Irrigation |
| 5 | 101-150 | Very Poor | Restricted use for Irrigation |
| 6 | Above 150 | Unfit for Drinking | Proper treatment required before use. |

## 5. ANALYSIS OF GROUND WATER QUALITY

The groundwater quality has been tested by collecting groundwater samples for three different locations from the existing Bore wells for the year 2016, 2017 and 2018. Twelve parameters have been considered for the test with their standard and ideal values as per IS 10500: Tables 1.2, 1.3 and 1.4 show the values of samples for different parameters with their average of three years. (Ideal value for pH is consider as 7 and for rest of the parameter it is zero)

**Table-1.2.** Analysis of ground water quality at Location 1.

| S.No. | Parameters | Year | | | Average |
|---|---|---|---|---|---|
| | | **2016** | **2017** | **2018** | |
| 1 | pH | 7.19 | 7.08 | 7.16 | 7.14 |
| 2 | Total Hardness | 1345.2 | 608 | 1034 | 996 |
| 3 | Chloride | 1079.7 | 498.99 | 919.7 | 833 |
| 4 | Sulphate | 140.2 | 79.42 | 147 | 122 |
| 5 | Dissolved Solids | 334.7 | 135.1 | 306.5 | 259 |
| 6 | Calcium | 325.7 | 190 | 286 | 267 |
| 7 | Alkalinity | 150 | 176 | 156.8 | 161 |
| 8 | Magnesium | 127.4 | 31.92 | 76.7 | 79 |
| 9 | Iron | 0.2 | 0.084 | 0.07 | 0.12 |
| 10 | Manganese | 0.23 | ND | 0.14 | 0.12 |
| 11 | Zinc | <0.05 | ND | ND | <0.05 |
| 12 | Lead | <0.01 | ND | ND | <0.01 |

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**Table-1.3.** Analysis of ground water quality at Location 2.

| S.No. | Parameters | Year | | | Average |
|---|---|---|---|---|---|
| | | **2016** | **2017** | **2018** | |
| 1 | pH | 7.14 | 7.66 | 6.89 | 7.23 |
| 2 | Total Hardness | 433 | 405.6 | 364.7 | 401 |
| 3 | Chloride | 1402.89 | 1800.2 | 166.82 | 1123 |
| 4 | Sulphate | 406.17 | 230.33 | 43.59 | 227 |
| 5 | Dissolved Solids | 100.58 | 83 | 300 | 161 |
| 6 | Calcium | 15.12 | 12.48 | 11.58 | 13 |
| 7 | Alkalinity | 53.2 | 30 | 171.6 | 85 |
| 8 | Magnesium | 132 | ND | 75.2 | 104 |
| 9 | Iron | 4.2 | 0.2 | 1.7 | 2.0 |
| 10 | Manganese | 0.46 | 0.35 | 0.41 | 0.41 |
| 11 | Zinc | ND | ND | 0.08 | 0.08 |
| 12 | Lead | ND | ND | 0.13 | |

**Table-1.4.**Analysis of Ground water quality at Location 3.

| S.No. | Parameters | Year | | | Average |
|---|---|---|---|---|---|
| | | **2016** | **2017** | **2018** | |
| 1 | pH | 7.94 | 7.47 | 6.96 | 7.45 |
| 2 | Total Hardness | 912 | 446 | 436.16 | 598 |
| 3 | Chloride | 339.97 | 273.96 | 178.07 | 264 |
| 4 | Sulphate | 6.5 | 11.91 | 10.72 | 9.71 |
| 5 | Dissolved Solids | 121.3 | 97.2 | 86.9 | 102 |
| 6 | Calcium | 259.2 | 90.4 | 56.4 | 135 |
| 7 | Alkalinity | 392.5 | 353.4 | 502.9 | 416 |
| 8 | Magnesium | 63.36 | 52.8 | 70.84 | 62 |
| 9 | Iron | 0.37 | 0.234 | 0.2 | 0.27 |
| 10 | Manganese | 1.49 | 0.88 | 0.8 | 1.05 |
| 11 | Zinc | ND | ND | ND | ---- |
| 12 | Lead | ND | ND | ND | ----- |

## 6. WATER QUALITY INDEX (WQI) OF STUDY AREA

The WQI of the study area for three different location has been calculated on twelve selected parameters given in Tables 1.5, 1.6 and 1.7 for all the samples.

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**Table-1.5.** Water Quality Index at Location 1.

| S.No. | Parameters | Observed Values(Vn) | Standard values (Sn) | Unit Weight (Wn) | Quality Rating (Qn) | WnQn |
|---|---|---|---|---|---|---|
| 1 | pH | 7.14 | 8.5 | 0.00741 | 9.333 | 0.0691 |
| 2 | Total Hardness | 996 | 300 | 0.00021 | 332 | 0.0697 |
| 3 | Chloride | 833 | 250 | 0.000252 | 333.2 | 0.0839 |
| 4 | Sulphate | 122 | 200 | 0.000315 | 61 | 0.0192 |
| 5 | Dissolved Solids | 259 | 500 | 0.000126 | 51.8 | 0.0065 |
| 6 | Calcium | 267 | 75 | 0.00084 | 356 | 0.2990 |
| 7 | Alkalinity | 161 | 200 | 0.000315 | 80.5 | 0.0253 |
| 8 | Magnesium | 79 | 30 | 0.0021 | 263.33 | 0.5529 |
| 9 | Iron | 0.12 | 0.3 | 0.21 | 40 | 8.4 |
| 10 | Manganese | 0.12 | 0.1 | 0.63 | 120 | 75.6 |
| 11 | Zinc | <0.05 | 5 | 0.0126 | 1.0 | 0.0126 |
| 12 | Lead | <0.01 | 0.5 | 0.126 | 2.0 | 0.252 |
| | | | | ∑Wn=0.99 | ∑Qn=1650.16 | ∑WnQn=85.39 |
| Water Quality Index = ∑Wnqn/∑Wn = 86.25 | | | | | | |

**Table-1.6.** Water Quality Index at Location 2.

| S.No. | Parameters | Observed Values(Vn) | Standard values(Sn) | Unit Weight (Wn) | Quality Rating (Qn) | WnQn |
|---|---|---|---|---|---|---|
| 1 | pH | 7.23 | 8.5 | 0.0084 | 15.33 | 0.1287 |
| 2 | Total Hardness | 401 | 300 | 0.00024 | 133.66 | 0.032 |
| 3 | Chloride | 1123 | 250 | 0.000288 | 449.20 | 0.1293 |
| 4 | Sulphate | 227 | 200 | 0.00036 | 113.5 | 0.040 |
| 5 | Dissolved Solids | 161 | 500 | 0.000144 | 32.2 | 0.0046 |
| 6 | Calcium | 13 | 75 | 0.00096 | 17.33 | 0.0166 |
| 7 | Alkalinity | 85 | 200 | 0.00036 | 42.5 | 0.0153 |
| 8 | Magnesium | 104 | 30 | 0.0024 | 346.67 | 0.832 |
| 9 | Iron | 2.0 | 0.3 | 0.24 | 666.67 | 160 |
| 10 | Manganese | 0.41 | 0.1 | 0.72 | 410 | 295.2 |
| 11 | Zinc | 0.08 | 5 | 0.0144 | 1.6 | 0.023 |
| 12 | Lead | ND | | | | |
| | | | | ∑Wn=0.98 | ∑qn=2228.66 | ∑Wnqn=456.42 |
| Water Quality Index = ∑Wnqn/∑Wn = 465.73 | | | | | | |

**Table-1.7.** Water Quality Index at Location 3.

| S.No. | Parameters | Observed Values(Vn) | Standard values (Sn) | Unit Weight (Wn) | Quality Rating (Qn) | WnQn |
|---|---|---|---|---|---|---|
| 1 | pH | 7.45 | 8.5 | 0.00858 | 30 | 0.2574 |
| 2 | Total Hardness | 598 | 300 | 0.00024 | 199.33 | 0.0478 |
| 3 | Chloride | 264 | 250 | 0.00029 | 105.6 | 0.0306 |
| 4 | Sulphate | 9.71 | 200 | 0.00036 | 4.855 | 0.00174 |
| 5 | Dissolved Solids | 102 | 500 | 0.000146 | 20.4 | 0.00297 |
| 6 | Calcium | 135 | 75 | 0.00097 | 180 | 0.1746 |
| 7 | Alkalinity | 416 | 200 | 0.000365 | 208 | 0.0759 |
| 8 | Magnesium | 62 | 30 | 0.0024 | 206.67 | 0.496 |
| 9 | Iron | 0.27 | 0.3 | 0.243 | 90 | 21,87 |
| 10 | Manganese | 1.05 | 0.1 | 0.73 | 1050 | 766.5 |
| 11 | Zinc | ND | | | | |
| 12 | Lead | ND | | | | |
| | | | | ∑Wn=0.98 | ∑qn=2094.85 | ∑Wnqn=789.45 |
| Water Quality Index = ∑Wnqn/∑Wn = 805 | | | | | | |

## 7. DISCUSSIONS

WQI is commonly used for the detection and evaluation of water pollution and it may be defined as the reflection of composite influence of different quality parameters on the overall quality of water. Twelve parameters have been selected they are pH, Hardness, Chlorides, Sulphate Dissolved Solids, Calcium, Alkalinity, Magnesium and Metals The WQI of the study area for the continuous three years from 2016 to 2018 are analysed. The water quality result shows that water quality is poor at location 1and can be used for irrigation purpose only and at location 2 and location 3 water is unfit for drinking and other uses. The values of most of the parameters are found high above the permissible limits at all the location of the study area. pH is ranging from 7.14 -7.45 which shows water is alkaline in nature. The values of Hardness, chlorides Magnesium are also high. Metals are not detected in some locations The higher values of these parameters would increase WQI value.

## 8. CONCLUSIONS

In the present study ground water quality Index has been analysed to assess ground water quality in coastal region. The determination and comparison of three years data at three different location shows that out of twelve parameters values of most of the parameters were too high and not within permissible limit The WQI at location 1 better as compare location 2 and 3. Because at location 1 rain water harvesting system is installed so the study shows that after installation of harvesting structure, the values reduced as per standard limit prescribed by Bureau of Indian standards. The study portrays the urgent need for regular underground water quality monitoring to assess pollution activity. Effective management of water resources by installing rain water harvesting system at other location of study area and in the coastal region which improves the quality of water. Public awareness program should be initiated to create a sense of awareness to save water around their habitants.

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