# Assessment of Godavari River Water Quality in and Around Rajamahendravaram

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***Abstract:*** ***Surface water is by far the most important nutrient for the human body next to oxygen. Rivers plays an important role in the development of our country and sustenance of life, which are being polluted due to development activities like rapid industrialization, urbanization, etc. The main objective of this work is to analyse and classify water quality of river Godavari in and around Rajamahendravaram in order to determine the degree of pollution and ascertain the required treatment level before usage. The samples are collected from Pushkarghat, Gowthami ghat, Kovvur, Katheru, Katheru oxidation ponds integrated samples from top to bottom in the middle of river. Parameters of the Godavari river water determined include pH, ammonia, total dissolved solids (TDS), turbidity, total alkalinity, salinity, total hardness, electrical conductivity,etc. using both in in-situ and standard laboratory procedures. The samples are analysed, then results of the water parameters are compared with the prescribed Pollution Control Board standards. If the parameters are exceeding the prescribed standards then suitable methods of treatment are suggested for the eradication or minimization of pollution. From the present study we came to know that Turbidity, Total Alkalinity, Total Hardness, Calcium, Magnesium, Iron, Ammonia parameters are found to be in excess. So treatment methods like coagulation followed by Flocculation, Softening techniques like lime soda process and reverse osmosis, Oxidation ponds, De-nitrification techniques are used in order to preserve the quality of the river water for Drinking, Industrial and Agricultural purposes. Based on the Water Quality Index(WQI) calculated for the samples, it is found that Sample 3 (WQI-17.84) can be classified as 'Excellent' quality of water to be used for drinking, irrigation and industrial consumption. Sample 1 (WQI-32.43) & Sample 2 (WQI-28.63) can be designated as 'Good 'quality' of water which can be used for various above said purposes. Coming to Sample 4 (WQI-205.4) - the various parameters concentration is beyond the permissible limits specified by IS-10500 as well as CPCB and is classified as water 'unfit for human consumption'. Sample 5(WQI-70.93) - in spite of treatment measures taken by the industry, it is designated as water is'Fair' in quality and still needs to be treated carefully to bring down the concentration of various parameters within the concentration of limits and make it suitable for consumption. In order to observe the effect of pollutants in the sample-5 ( WQI=70.93) on growth of plants and in order to know the extent of care taken by paper mill to remove pollutants, growth in a small plant is observed by watering the potted plant continuously for 15 days with the treated effluent. The plant is observed to show the normal growth indicating that the industrial management is taking care of the treatment of the effluent waste water. Finally, it is observed that in the study area, the impact of human activities on the river is existing even though the magnitude may be less, there is a danger in the near future, if proper care is not taken by respective authorities.***

***Index Terms: Analyse, Degree of Pollution, Treatment, Water Quality Index***

## I. INTRODUCTION

The quality of drinking water is an environmental determinant of health. Drinking-water quality management has been key work for over 150 years and it continuous to be the foundation of prevention and control of waterborne diseases. Safe drinking-water, as defined by the Guidelines, does not represent any significant risk to health over a lifetime of consumption. The nature and form of drinking-water standards may vary among countries and regions. There is no single approach that is universally applicable. It is essential in the development and implementation of standards that the current or planned legislation relating to water, health and local government is taken into account and that the capacity of regulators in the country is assessed. The main objective of this study is to assess and characterize the quality of Godavari river water in and around Rajamahendravaram Municipal water supply.

By collecting the samples from different locations and analysing the various parameters in the laboratory, the impact of human activities on the quality of water can be identified. The results of analysis are compared with IS standards and the quality of water is classified at various points of Godavari River. The River Godavari is the second largest river in the Indian Union. Starting from a trickle from the lips of a cow at Triambak, the width of the river grows till it is nearly 6.5km wide at Dowleswaram. It is always spoken of as the Southern Ganga and Vriddha Ganga. At Papikonda, it is narrow as 200-300 m for about 3 km. The Godavari rises in the Western Ghats at Triambak near Nasik, about 113 km northeast of Bombay and only 80 km from the Arabian Sea. After descending the Western Ghats, it takes a south easterly course across the southern part of Indian peninsula and flows through 1,230 km and falls into the Bay of Bengal about 80km east of Rajahmundry. The total catchment area drained by the river is 312,812 km, or nearly one tenth of India. The catchment in Maharashtra is about 152,199 km. The average annual flow (50% dependable flow) of the Godavari basin has been estimated as 110.5 km., whereas the utilizable flow (75% dependable flow) is about 76.3 km. The present utilization is only about 39 km3, which is hardly 50%. The annual rainfalls are moderate, from 700 mm at Nasik to 1,000 mm at Nizamabad.

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**Figure 1: Distribution of Godavari River**

## II. PRESENT STUDY

The water samples from the water body were collected at an interval of 7 days (in the month of November 2018) and analysed. The various sampling stations for which water quality parameters as indicators for the measurement of water quality index calculated for the river are-

Station- 1 (S1) Pushkarghat, at Rajamahendravaram

Dropping flowers, fruits, turmeric and vermillion may not disturb. But cloths, papers, polythene bags, shampoos, soaps, detergents, in such high proportions would certainly effect the quality. It is a disrespect, disturbance and pollution.

Station- 2 (S2) Gowthami ghat, at Rajamahendravaram

Being a tourist spot it has been dumped with plastics, garbage, and human waste. It is nearer to dhobi ghat and is being polluted.

Station- 3 (S3) Kovvuru- is situated on the west bank of the Godavari River, at a distance of 92 km from the district headquarters, Eluru. It is located at 17.0167 $^0$N 81.7333 $^0$ E and at an average elevation of 10m. Kovvuru is the most peaceful town in the district and devotional town " Goshpada Kshetram" very well-known tourist place where Godavari Pushkaralu takes place.

Station- 4 (S4) Katheru oxidation ponds- The effluents from the nearby paper mill beside the river Godavari. But due to permeability of that particular soil present in the oxidation ponds, the water is directly gets contacted with the river water. So the near the ponds, the water is highly polluted.

Station-5 (S5) Katheru- is a village panchayat located in the east Godavari district of Andhra Pradesh state, India. The latitude 17.4 and longitude 78.48 are the geocoordinate of the Katheru.

## III. ANALYSES

ANALYSES OF VARIOUS PARAMETERS IN THE WATER SAMPLES

Parameters of the Godavari river water determined include pH, turbidity, hardness, Iron, Sulphate, Ammonia, Nitrate etc. both in in-situ and standard laboratory procedures.The analysis of various samples has given the results and the Water quality index of various samples is calculated and compared to designate the quality of water. Based on which the treatment methods are suggested. A plant is taken as a case study on its growth by watering it for a period of 15 days with the water from Station 5 (Katheru) and its results are also included.

**Table 1 : WQI Calculations For Station-1 (S1) Pushkarghat**

| S. No | Parameter | Observed Value | Standard Value ($S_n$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_n q_n$ |
|---|---|---|---|---|---|---|
| 1 | Turbidity | 9.2 | 5 | 0.08303 | 184 | 15.2775 |
| 2 | pH | 8.23 | 6.5-8.5 | 0.04884 | 123 | 6.0078 |
| 3 | Total Alkalinity | 60 | 120 | 0.003459 | 50 | 0.1729 |
| 4 | Total Hardness | 300 | 300 | 0.0013839 | 100 | 0.1383 |
| 5 | Electrical Conductivity | 105 | 300 | 0.0013839 | 35 | 0.04843 |
| 6 | Total Dissolved solids | 48 | 500 | 0.0008303 | 9.6 | 0.00797 |
| 7 | Calcium | 48 | 75 | 0.005535 | 64 | 0.35424 |
| 8 | Magnesium | 43 | 30 | 0.013839 | 143.33 | 1.9835 |
| 9 | Iron | 0 | 1 | 0.415189 | 0 | 0 |
| 10 | Sulphates | 8.3 | 200 | 0.002075 | 4.15 | 0.008614 |
| 11 | Ammonia | 0.2 | 1 | 0.415189 | 20 | 8.3037 |
| 12 | Nitrate | 6.3 | 45 | 0.009226 | 14 | 0.12916 |
| | | | | ΣWn =0.99981 | | ΣWnqn =32.4318 |
| Water Quality Index =Σ q n Wn/ ΣWn = 32.438 | | | | | | |

**Table 2 : WQI calculations for Station-2 (S2) Gowthami ghat**

| S. No | Parameter | Observed Value | Standard Value ($S_n$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_nq_n$ |
|---|---|---|---|---|---|---|
| 1 | Turbidity | 8.9 | 5 | 0.08303 | 178 | 14.77 |
| 2 | pH | 7.85 | 6.5 -8.5 | 0.04884 | 56.66 | 2.767 |
| 3 | Total Alkalinity | 80 | 120 | 0.003459 | 66.66 | 0.23 |
| 4 | Total Hardness | 260 | 300 | 0.0013839 | 86.66 | 0.119 |
| 5 | Electrical Conductivity | 110 | 300 | 0.0013839 | 36.66 | 0.05 |
| 6 | Total Dissolved solids | 50 | 500 | 0.0008303 | 10 | 0.0083 |
| 7 | Calcium | 32 | 75 | 0.005535 | 42.66 | 0.236 |
| 8 | Magnesium | 43 | 30 | 0.013839 | 143.33 | 1.983 |
| 9 | Iron | 0 | 1 | 0.415189 | 0 | 0 |
| 10 | Sulphates | 8.4 | 200 | 0.002075 | 4.2 | 0.00871 |
| 11 | Ammonia | 0.2 | 1 | 0.415189 | 20 | 8.303 |
| 12 | Nitrate | 7.1 | 45 | 0.009226 | 15.77 | 0.1455 |
| | | | | ΣWn 0.99981 | | ΣWnqn 28.63 |
| Water Quality Index =Σ q n Wn/ ΣWn = 28.638 | | | | | | |

For the purpose of calculation of WQI for the study area, eleven water quality parameters have been selected. They are Total Dissolved Solids, pH, Total Alkalinity, Total Hardness, Nitrate, Calcium, Magnesium, Iron and Sulphate. The values of these parameters are found high above the permissible limits in some of the samples of the study area. The higher values of these parameters would increase WQI value.

The WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR). The weighted arithmetic index method (Brown et.al,) has been used for the calculation of WQI of the water body

**Table 3: WQI calculations station-3 (S3) Kovvuru**

| S.No | Parameter | Observed Value | Standard Value ($S_n$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_nq_n$ |
|---|---|---|---|---|---|---|
| 1 | Turbidity | 8.3 | 5 | 0.08303 | 166 | 13.782 |
| 2 | pH | 7.71 | 6.5 -8.5 | 0.04884 | 47.33 | 2.311 |
| 3 | Total Alkalinity | 70 | 120 | 0.003459 | 58.33 | 0.201 |
| 4 | Total Hardness | 200 | 300 | 0.001384 | 66.66 | 0.092 |
| 5 | Electrical Conductivity | 101 | 300 | 0.001384 | 33.66 | 0.046 |
| 6 | Total Dissolved solids | 48 | 500 | 0.00083 | 9.6 | 0.0079 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Calcium | 48 | 75 | 0.005535 | 64 | 0.354 |
| 8 | Magnesium | 19 | 30 | 0.013839 | 63.33 | 0.876 |
| 9 | Iron | 0 | 1 | 0.415189 | 0 | 0 |
| 10 | Sulphates | 8 | 200 | 0.002075 | 4 | 0.0083 |
| 11 | Ammonia | 0.1 | 1 | 0.415189 | 10 | 0.02075 |
| 12 | Nitrate | 11 | 45 | 0.009226 | 24.44 | 0.2254 |
| | | | | ΣWn 0.99981 | | ΣWnqn 17.845 |
| Water Quality Index =Σ q n Wn/ ΣWn = 17.848 | | | | | | |

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

$$WQI=\sum qn\ Wn/\sum Wn$$

Further, quality rating or sub index (qn) was calculated using the following expression.

$$qn = 100[Vn - Vio] / [Sn - Vio]$$

(Let there be n water quality parameters and quality rating or sub index (qn) corresponding to nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.)

q n =Quality rating for the nth Water quality parameter

Vn=Estimated value of the nth parameter at a given sampling station.

Sn =Standard permissible value of the nth parameter.

Vio = Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/L respectively)

**Table 4 : WQI of Station-4 (S4) Katheru Oxidation Pond**

| S.No | Parameter | Observed Value | Standard Value ($S_n$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_nq_n$ |
|---|---|---|---|---|---|---|
| 1 | Turbidity | 45 | 5 | 0.08303 | 900 | 74.727 |
| 2 | pH | 8.45 | 6.5 -8.5 | 0.04884 | 96.66 | 4.72 |
| 3 | Total Alkalinity | 340 | 120 | 0.003459 | 300 | 1.037 |
| 4 | Total Hardness | 520 | 300 | 0.001384 | 173.33 | 0.239 |
| 5 | Electrical Conductivity | 340 | 300 | 0.001384 | 113.33 | 0.156 |
| 6 | Total Dissolved solids | 165 | 500 | 0.00083 | 33 | 0.027 |
| 7 | Calcium | 128 | 75 | 0.005535 | 170.66 | 0.944 |
| 8 | Magnesium | 48 | 30 | 0.013839 | 160 | 2.214 |
| 9 | Iron | 0.3 | 1 | 0.415189 | 30 | 12.455 |
| 10 | Sulphates | 96 | 200 | 0.002075 | 48 | 0.099 |
| 11 | Ammonia | 2.6 | 1 | 0.415189 | 260 | 107.941 |
| 12 | Nitrate | 41 | 45 | 0.009226 | 91.11 | 0.8405 |
| | | | | ΣWn | | ΣWnqn |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 0.99981 | | 205.405 |
| Water Quality Index =Σ q n Wn/ ΣWn = 205.409 | | | | | | |

**Table 5: WQI of Station-5 (S5) Katheru**

| S.No | Parameter | Observed Value | Standard Value ($S_n$) | Unit Weight ($W_n$) | Quality Rating ($q_n$) | $W_nq_n$ |
|---|---|---|---|---|---|---|
| 1 | Turbidity | 14.3 | 5 | 0.08303 | 286 | 23.746 |
| 2 | pH | 8.23 | 6.5 -8.5 | 0.04884 | 82 | 4.004 |
| 3 | Total Alkalinity | 110 | 120 | 0.003459 | 91.66 | 0.317 |
| 4 | Total Hardness | 340 | 300 | 0.001384 | 113.33 | 0.1568 |
| 5 | Electrical Conductivity | 360 | 300 | 0.001384 | 120 | 0.166 |
| 6 | Total Dissolved solids | 177 | 500 | 0.00083 | 35.4 | 0.029 |
| 7 | Calcium | 48 | 75 | 0.005535 | 64 | 0.3542 |
| 8 | Magnesium | 52 | 30 | 0.013839 | 173.3 | 2.3987 |
| 9 | Iron | 0.05 | 1 | 0.415189 | 5 | 2.075 |
| 10 | Sulphates | 8.5 | 200 | 0.002075 | 4.25 | 0.0088 |
| 11 | Ammonia | 0.9 | 1 | 0.415189 | 90 | 37.36 |
| 12 | Nitrate | 14.4 | 45 | 0.009226 | 32 | 0.2952 |
| | | | | ΣWn 0.99981 | | ΣWnqn 70.919 |
| Water Quality Index =Σ q n Wn/ ΣWn = 70.933 | | | | | | |

Unit weight was calculated by a value inversely proportional to the recommended standard value $S_n$ of the corresponding parameter.

$$W_n = K/S_n$$

$W_n$= unit weight for the $n^{th}$ parameters, $S_n$ = Standard value for $n^{th}$ parameters, K = Prportionality Constant.

**Table 6: WQI valuesand 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. |

## IV. RESULTS AND DISCUSSIONS

It is found that the concentration levels of the parameters are compared for various samples individually against standard permissible and desirable limits and the results are depicted in graphical representation as follows. The various parameters showing values beyond permissible limits altering the quality are considered for all the sampling stations are shown in the following figures

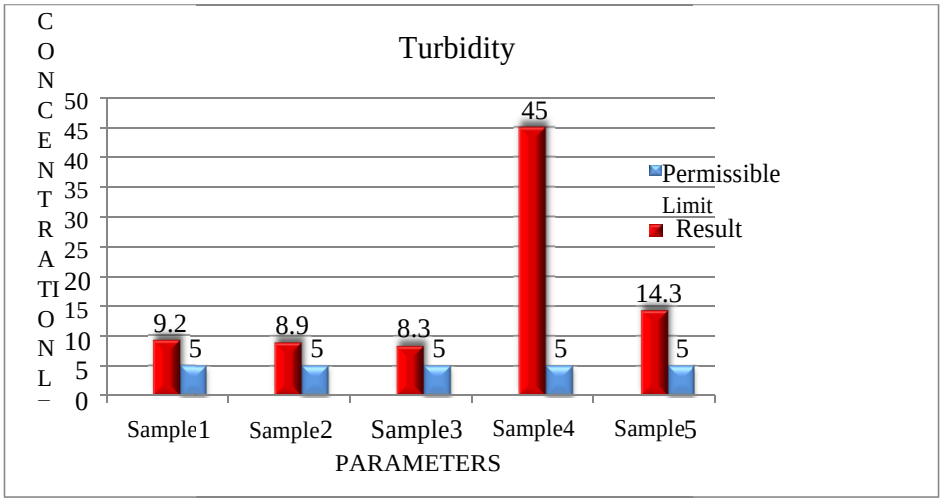


**Figure 2 : Graphical representation of Turbidity obtained from five locations against corresponding Standards**

It is found that the sample 4-result obtained is 45 NTU, which is very high as compared to the desirable and permissible limits. So, as compared to the other samples, it needs the removal of suspended impurities by Coagulation, Flocculation, Clarification using coagulants like Alum, Copperas.

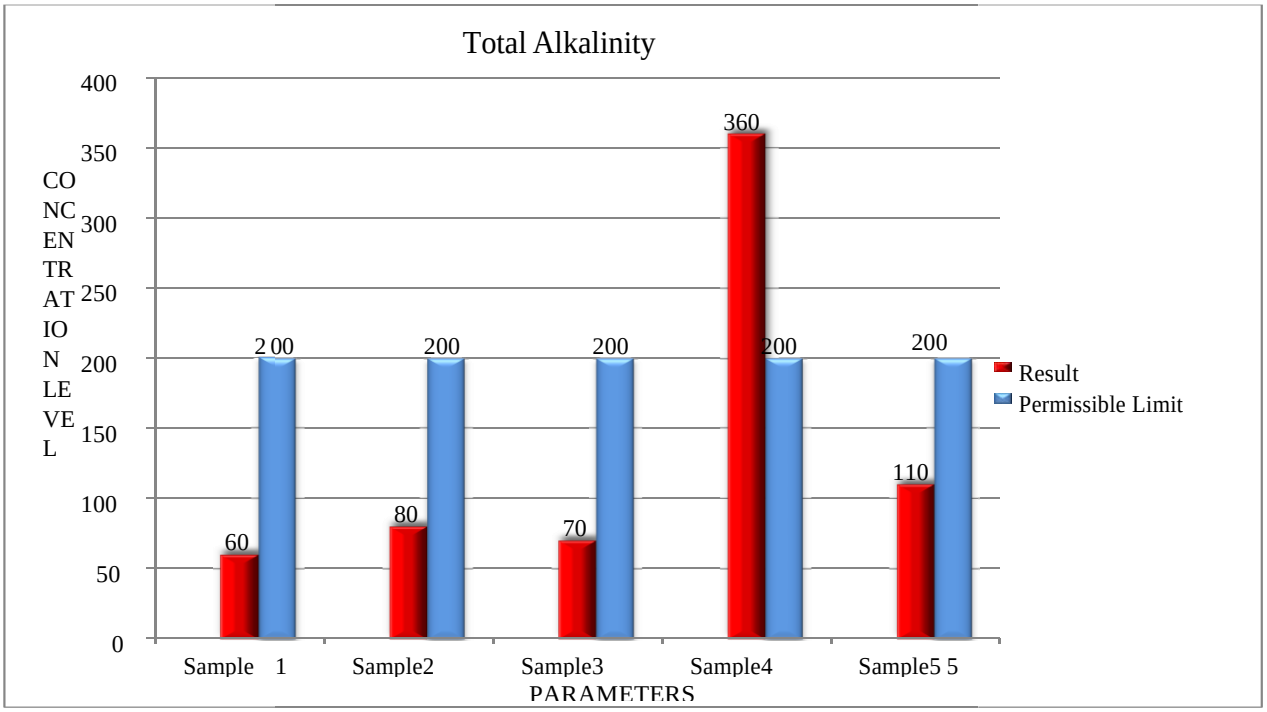


**Figure 3: Graphical representation of Total Alkalinity obtained from five locations against corresponding Standards**

From the above graph, differentiation of Alkalinity concentration of various samples to standards. It is found that in sample 4, result obtained is 360, which is very high as compared to permissible limits. Increase in treatment for reduction in Alkalinity by neutralization process in the respective locations.

The bar plotted between the five different samples and the value of Calcium along the X-axis and Y-axis respectively Shown in the following figure.

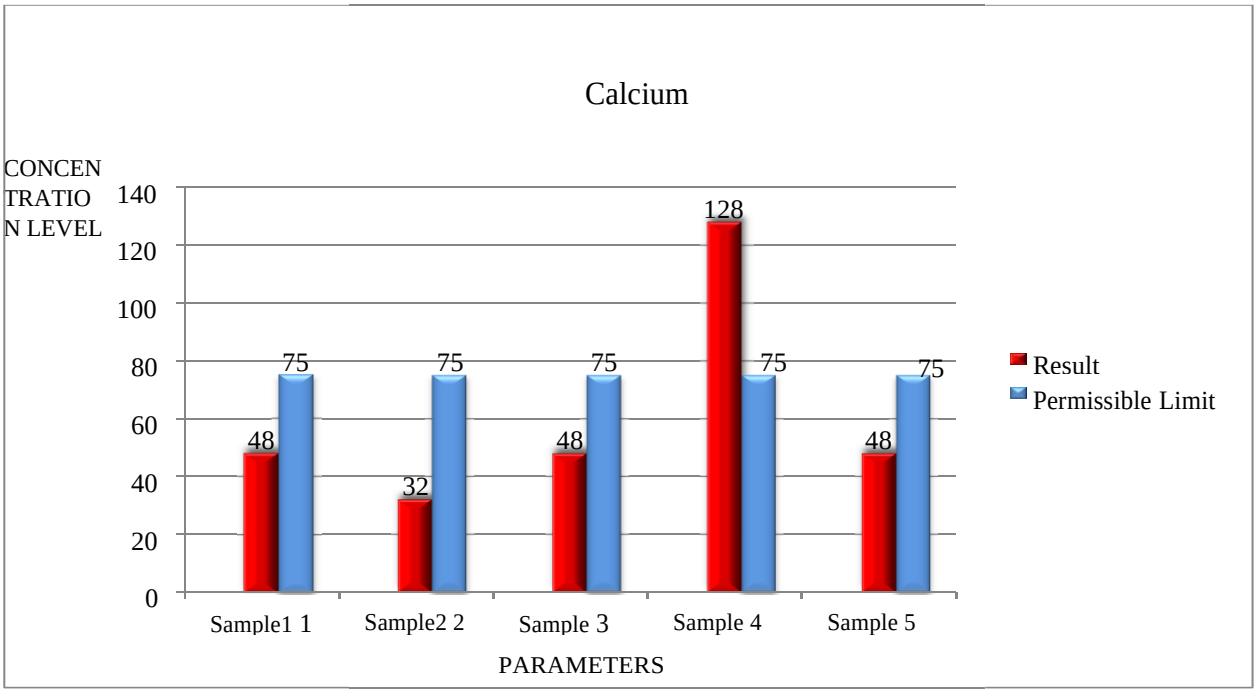


**Figure 4 : Graphical representation of Calcium obtained from five locations against corresponding Standards**

It is found that the sample 4-result obtained is 128, which is very high as compared to the desirable and permissible limits. So, as compared to the other samples, the removal of Calcium Zeolite process, Caustic soda method, Lime soda process, Ion exchange process.

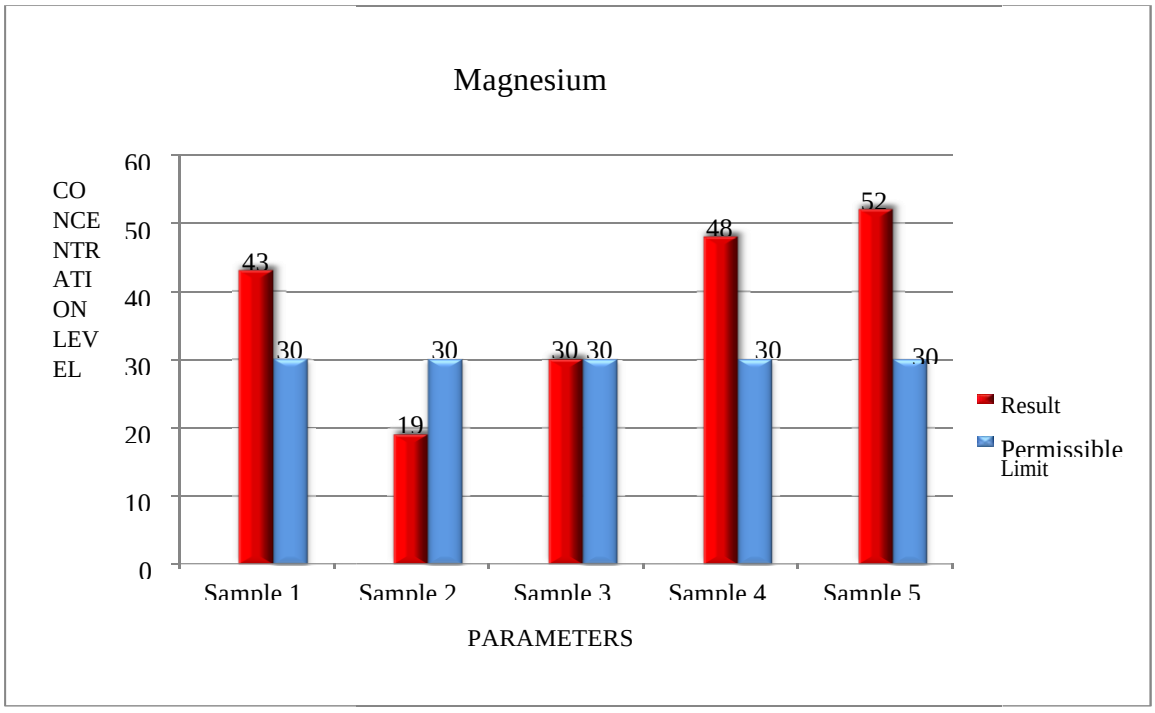


**Figure 5 : Graphical representation of Magnesium obtained from five locations against corresponding Standards**

It is found that the sample 1- result obtained is 43ppm, sample 4-result obtained is 128, and sample 5 result obtained is 52ppm, which are very high as compared to the desirable and permissible limits. So, as compared to the other samples, the removal of Calcium Zeolite process, Caustic soda method, Lime soda process, Ion exchange process.

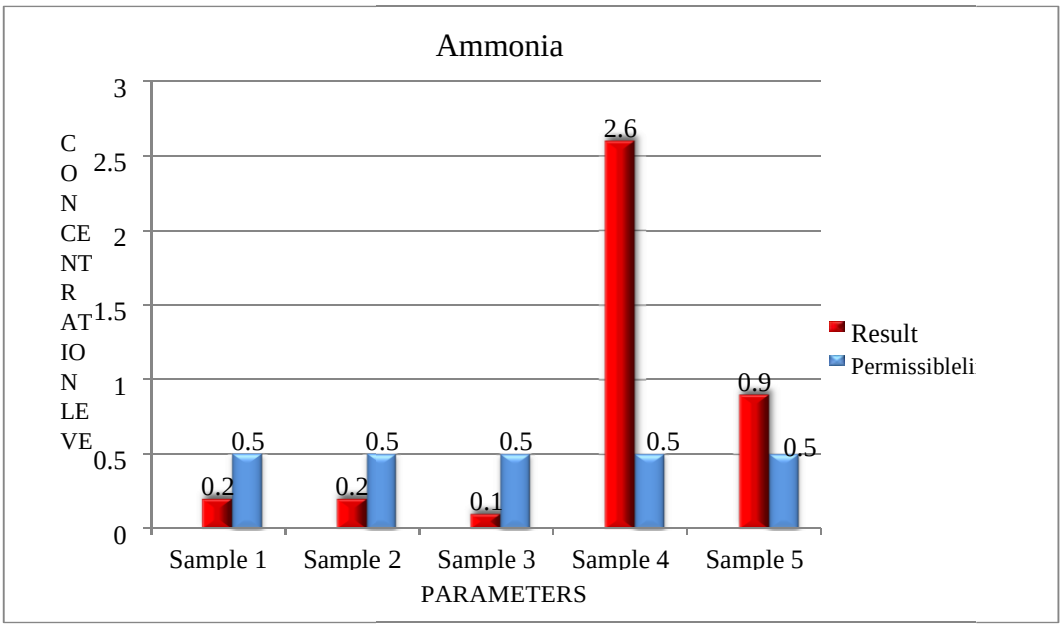


**Figure 6*:* Graphical representation of Ammonia obtained from five locations against corresponding Standards**

The above graph shows the differentiation between the Ammonia concentration in the sample to the standards proposed, when the water tended for agricultural purpose no need of reduction in ammonia concentration because the ammonia plays a major role in crop growth and yield. When this water tends for recycle and reuse in industry the concentration of ammonia has to be reduced by the application of de-nitrification technique.

## V. CONCLUSIONS

1. Based on the WQI calculated for the samples, it is found that Sample 3 (WQI-17.84) can be classified as 'Excellent' quality of water to be used for drinking, irrigation and industrial consumption.
2. Samples 1 (WQI-32.43) & Sample 2 (WQI-28.63) can be designated as 'Good' quality of water which can be used for various above said purposes.
3. Coming to Sample 4 (WQI-205.4) - the various parameters concentration is beyond the permissible limits specified by IS-10500 as well as CPCB and is classified as water 'unfit for human consumption'.
4. Sample 5 (WQI-70.93) - In spite of treatment measures taken by the industry, it is designated as water is 'Fair' in quality and still needs to be treated carefully to bring down the concentration of various parameters within the concentration of limits and make it suitable for consumption.
5. It is found that the water sample 5 used for growing a flowering plant has shown normal growth in the plant and no negative effect on its growth or survival is observed.

## REFERENCES


1. Ajay D.Chavan, M.P.Sharma and Renu Bhargava," Water Quality Assessment of the Godavari River, Hydro Nepal Journal of Water Energy and Environment · January 2010.
2. Ashok K. Jain, Arun K. Jain, B.C.Punmia, "Water supply Engineering, Laxmi publications, 2011.
3. B.C.Punmia, Pande B.B.Lal, Ashok Kumar Jain, and Arun Kumar Jain, "Irrigation and Water power engineering", Laxmi publications, 2012.
4. Basavaraj M. Kalshetty, Shobha.N, M.B.Kalashetti and Ramesh Gani," Water Quality of River
5. Tungabhadra due to the Discharge of Industrial Effluent at Harihar, District Davanagere, Karnataka State, India, American Journal of Advanced Drug Delivery.
6. BIS 1983, Standards for Water for Drinking and other purposes, Bureau of Indian Standards, New Delhi.
7. 6.Deepshikha Sharma, Arun Kansal,"Water quality analysis of River Yamuna using water quality index in the national capital territory, India (2000–2009), Appl Water Sci (2011) 1:147–157 4.
8. Horton, R.K., 1965.An index number system for rating water quality. Journal of Water Pollution.Cont.Fed. 3:300- 305.
9. Dr. KVSG Murali Krishna "Chemical Analysis of Water and Soil", ( A Laboratory Manual),3rd edition.
10. G.S.Birdie, J.s.Birdie "Water Supply and Sanitary Engineering", Dhanpat Rai and Sons, 1998.
11. Guidelines for Drinking-water Quality given by World Health Organization (WHO), 2011.
12. K. Hari Prasad, C. Anjali, M. Sridhar Reddy," Study of Physico-Chemical Characteristics of Penna River at Chennur, Cuddapah Basin, India", Indian Journal of Advances in Chemical Science.
13. Kosha A. Shah and Geeta S. Joshi, "Evaluation of water quality index for River Sabarmati, Gujarat,India, Appl Water Sci, 2017.
14. Mahesh Kumar.Akkaraboyina, Prof B.S.N.Raju, "A Comparative Study of Water Quality Indices of River Godavari" International Journal of Engineering Research and Development eISSN: 2278-067X, pISSN: 2278-800X, www.ijerd.com
15. Mithila Barabde, Shruti Danve "Real Time Water Quality Monitoring System" International Journal of Innovative Research in Computer and Communication Engineering, Vol. 3, Issue 6, June 2015.
16. Monikandon Sukumaran and Kesavan Devarayan, "Evaluation of Water Quality of Kaveri River in Tiruchirappalli District, TamilNadu by Principal ComponentAnalysis" http://dx.doi.org/10.12944/CWE.11.1.12.com.


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(!) International journal IJETR Publication in 2016, (2) UGC Approved Journal IJARSE Publication in 2018 Life member of ISTE membership, achievements, with photo that will be maximum 200-400 words.