EVALUATION OF WATER QUALITY OF KATHAJODI RIVER BY WATER QUALITY INDEX ANALYSIS USING C++ PROGRAM

G.Sunpriya Achary* , S.K.Panda[1] , R.B.Panda[2].

*Assistant Professor, Dept of Chemistry, KIST, Jatni, Bhubaneswar

[1]Student, KIIT, Biotechnology, Bhubaneswar

[2]Professor and Head, Dept of Chemistry, VSSUT, BURLA.

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ABSTRACT

In this study an attempt has been made to devise a methodology to integrate the WQI with C++ program for an effective interpretation of the quality status of River water. River Kathajodi has been taken as a case study and the physical, chemical and microbial analysis has been interpreted using WQI. From WQI analysis it was found that the water quality of the river is deteriorating each year. Not a single location was found suitable for drinking purposes in any seasons. The condition is worst in rainy and summer seasons when the WQI increases many fold in all locations. The location at upstream was found to be least polluted. The contamination starts downstream near Govt press due to dumping of waste and waste water. The pollution load decreases towards the last patch of the river within the study area as a result of dilution.

Key words: water quality index, physico-chemical parameters, C++ program.

No: of Tables : 5 **No: of Figures: 4** **No: of References:15**

INTRODUCTION

In recent years because of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposals, the rate of discharge of the pollutants into the environment is far higher than the rates of their purification. The implications of deteriorating quality of the receiving water are considerable both in the immediate situation and over the longer term. In this context, water quality assessment is critical for pollution control and the protection of surface and ground water. In India disposal of untreated domestic sewage from cities, towns and villages is the major source of pollution of surface water bodies leading to the outbreak of water borne diseases. Biodegradable organic matter is the contaminant of concern for dissolved oxygen concentration which is the principal indicator of pollution of surface water. According to world health organization (WHO) estimates, about 80% of water pollution in developing countries like India is caused by domestic waste[1] . In India numbers of studies have been carried out to assess the water quality in terms of various physico-chemical / biological characteristics and heavy metals of surface and ground water at various places[2 - 6] . The growth in numbers lacking access to safe water and sanitation will be driven in large part by the growth rate of the people living in urban areas[7].Since 1965 when Horton (1965) proposed the first water quality index (WQI) a great deal of consideration has been given to the development of "water quality index" methods with the intent of providing a tool for simplifying the reporting of water quality data. WQI is a set of standards used to measure changes in water quality in a particular river reach over time and make comparisons from different reaches of a river. This index allows for a general analysis of water quality on many levels that affect a stream's ability to host life[4] . WQI is an arithmetical tool used to transform large quantities of water quality data into a single cumulatively derived number. It represents a certain level of water quality while eliminating the subjective assessments of such quality[5-7]. It is intended as a simple, readily understandable tool for managers and decision makers to convey information on the quality and potential uses of a given water body based on various criteria[6] . Water Quality Index (WQI) is a very useful and efficient method for assessing the suitability of water quality. Table-0 1 showing Water Quality Index Ranges .

Table -01. Water quality index categories.

WQI	0 - 25	26 - 50	51 – 75	76 - 100	>100
Water Quality	Excellent	Good	Poor	Very Poor	Unsuitable

Objectives and Approach

The objectives are important tools used in a framework of environmental assessment, risk management and the application of best available treatment technology which support the management, protection and enhancement of the surface water resources .The main objective of this paper is to develop an index method for assessing water quality of river Kathajodi and to use this method to assess the general water suitability for drinking purposes . Monitoring water quality parameters and calculate overall water quality index (WQI) to evaluate River water by using C++ program.

3. Materials and Methods

3.1. Study Area

River Kathajodi serves as the vital source of potable water for the people of Cuttack as well as numerous villages located down stream . Cuttack is the second highest populated city after the capital city Bhubaneswar in Odisha. It comprises an area of 192.5 s kms having population of 6.1lakhs (2011). It is situated at the deltaic position of river Mahanadi and Kathajodi . The waste and waste water generated from Cuttack is dumped into the river Kathajodi without any treatment .

A systematic study was undertaken to assess the impact of discharged waste and waste water on the river water for **a** period of three years covering all the three major seasons. Different points were chosen according to their sources of contamination(Table-02). The study include various physico – chemical and microbiological parameters.

Table-02 Location of sampling points

SN	Location of sampling points
01	Up stream near High Court area
02	Down stream near Govt press
03	Further down stream at Sankhataras

Samples Collection

Grab samples were collected from the selected locations during different seasons (winter, summer, rainy) over a period of three years (2011, 2012 and 2013). The samples were collected in plastic and glass bottles as per requirement. Water for DO (Dissolved Oxygen) was collected in BOD bottles and the oxygen content of water was fixed on the spot. Temperature and pH were also recorded immediately. Similarly samples were collected separately in bacteriological bottles for Total Coli form and Fecal Coli form. Preservatives were added to keep the samples healthy till estimation in the laboratory. Different physical, chemical and biological parameters such as pH, TSS(Total Suspended Solid), TDS(Total Dissolved Solid), Alkalinity, BOD (Biological Oxygen Demand), COD(Chemical Oxygen Demand),DO(Dissolved Oxygen), Phosphate, TC(Total Coli form), FC(Fecal Coli form), Iron, Chloride, Nitrate, Sulphate , TH(Total Hardness), Ca-H(Calcium Hardness), Mg-H(Magnesium Hardness) of the samples were analyzed in the laboratory by the following procedure as given in the table - 03. The analysis was done by following ANALYSIS OF WATER AND WASTE WATER, 20th EDITION, APHA-2000. All chemicals and reagents used were of analytical reagent grade.

Table-03 Methods of Analysis

SN	PARAMETERS	METHOD OF ANALYSIS
01	pH Value	pH Meter
02	Total Suspended Solids	Gravimetric method.
03	Total Dissolved Solids	Gravimetric method.
04	Alkalinity	Titration Method.
05	BOD	Three day at 27 celcius.
06	COD	Open Reflux Method
07	Dissolved Oxygen	Iodometry Method
08	Phosphate	Stannous Chloride Method.
09	TC	MPN Method
10	FC	MPN Method
11	Chloride	Argentometric Method
12	Nitrate	Cadmium reduction method.
13	Sulphate	Nephloturbidity method
14	Total Hardness as CaCO3	Titrometric Method by using EDTA
15	Iron	1,10 Phenanthroline Colorimetric Method

Application of C++ Program

Introduction

C++ is a statically typed, free-form, multi-paradigm, compiled, general-purpose programming language. C++ is sometimes called a hybrid language. It is regarded as an intermediate-level language, as it comprises a combination of both high-level and low-level language features[8] . It was developed by Bjarne Stroustrup starting in 1979 at Bell Labs as an enhancement to the C language. Originally named C with Classes, the language was renamed C++ in 1983 [9]. C++ is one of the most popular programming languages[10,11] with application domains including systems software, application software, device drivers, embedded software, high-performance server and client applications, and entertainment software such as video games [12]. Several groups provide both free and proprietary C++ compiler software. C++ has greatly influenced many other popular programming languages, most notably C# and Java. After years of development, the C++ programming language standard was ratified in 1998 as ISO/IEC 14882:1998. The standard was amended by the 2003 technical corrigendum, ISO/ IEC 14882:2003. The current standard extending C++ with new features was ratified and published by ISO in September 2011 as ISO/IEC 14882:2011 (informally known as C++11)[13,14].

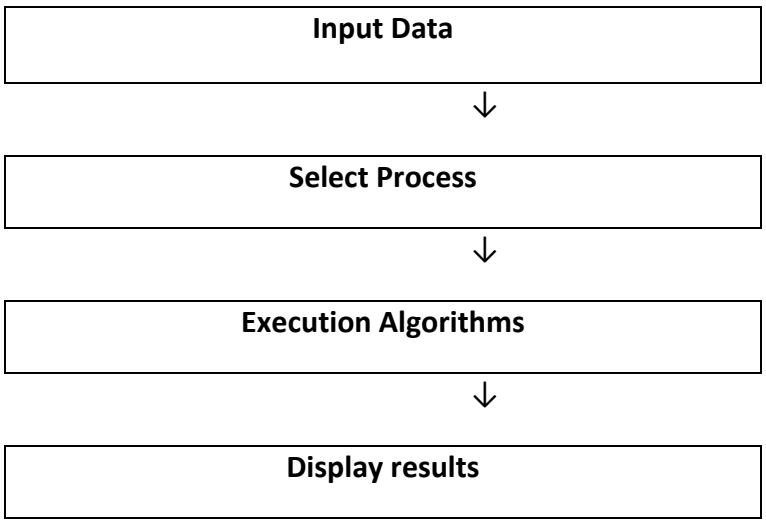
Algorithms and Steps

In our work we have used C++ language under window operating system for evaluating water quality index. Steps of using the above said program: • Create Project File consist of number of files.• Create dialog boxes for users interactions • User of all stations input data to the system • Select type of process from menu (Normality Test, Z-Test, t_Test, ANOVA (analysis of variance) Test and Water Quality Index). • Execute for calculating the index after entering data• Display Result with high speed . As is shown in Figure 01.

Water Quality Index Calculation

The WQI was calculated using the standards of drinking water quality recommended by the World Health Organization (WHO). The weighted arithmetic index method [10] was used for the calculation of WQI of the surface water. Further, quality rating or sub index (qn) was calculated using the following expression. Qn = 100 [Vn – Vi]/[Sn – Vn]

Figure -01 C++ diagram.



(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, maximum permissible value).

qn = Quality rating for the nth water quality parameter.

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

Sn = Standard permissible value of the nth parameter.

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

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

$Wn = K/Sn$.

Wn = unit weight for the nth parameters.

Sn = standard value for the nth parameters.

K = constant for proportionality.

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly.

$WQI = \sum qnWn / \sum Wn$.

Results and discussion

From WQI analysis it was found that the water quality of the river is deteriorating each year. Not a single location was found suitable for drinking purposes in any season. The condition is worst in rainy and summer season when the WQI increases many fold in all locations. (WQI was calculated taking the standard value for drinking water). The results are reflected in table-05

The stations located upstream was recorded to be least polluted. The contamination starts downstream near Govt press due to dumping of waste and waste water. The water of the river has dark hue due to discharge of raw domestic sewerage . Depletion of DO in this zone made the water incapable of supporting aquatic macro fauna but the blue-green algae and fresh water weeds were in full bloom leading to eutrophication over a small stretch of river. The pollution load decreases towards the last patch of the river within the study area as a result of dilution.

The water body has been found to be highly polluted in summer season followed by the rainy and winter season. So far as the microbial characteristic is concerned the environmental temperature plays an dominating role. Higher summer temperature accelerates natural growth of microbes pulling it to the first place exceeding the rainy and the winter seasons. The domestic sewage is found to be the major source of pollution as it carries high potentiality of chemical and microbial pollutants. The results also indicate that the water bodies cannot sustain any further discharge and its self purification capacity is also decreasing with the gradual increase in the disposal of various wastes.

Conclusion

From the study it was revealed that domestic pollution load on river Kathajodi is much higher. It is as because of unplanned town of Cuttack. Total waste water of cuttack city is divided in two parts. One part without any treatment is directly discharged in river Kathajodi near Kathajodi bridge while other part is carried to the STP (Sewage Treatment Plant) at Matagajpur where it is treated and finally discharged to river Kathajodi. It is found most of the time the waste water is discharged without any treatment. In order to restore the Kathajodi water quality intact we must take total domestic waste water of Cuttack city to Mattagajapur Sewage treatment Plant where it should be treated and satisfy general effluent standards to be discharged to inland surface water. Along with this government should take awareness campaign regarding domestic waste pollution and stop the practice of outdoor defecation on the river bank.

Table- 04 physico- chemical and biological parameters at different locations in different seasons of 2011, 2012, 2013

		pH	Tss	TDS	alka	BOD	COD	DO	Phos	TC	FC	Fe	Cl-	Nit	SUP	TH	Ca-H	MG-H
L-01	Winter-11	7.4	6.4	54	46	2.4	18	7.6	0.16	480	280	2.2	4.4	0.48	1.8	32	19	23
	Summer-11	6.7	24	78	42	4	16	6.6	0.46	980	780	2.8	12.6	0.84	2.8	46	28	18
	Rainy-11	7.1	20.8	62	44	2.7	14	7.4	0.48	1800	900	3.2	10.8	0.64	2.6	40	24	16
	Winter-12	7.6	8.0	58	52	2.8	24	7.2	0.19	520	320	2	4.6	0.52	2	48	21	27
	Summer-12	6.8	30	82	48	4.2	22	6.4	0.50	1100	820	2.6	16.2	0.98	3.2	58	32	26
	Rainy-12	7.3	24.6	68	50	2.9	20	7	0.62	1900	880	3.4	14.2	0.78	2.8	52	28	24
	Winter-13	7.5	8.6	64	58	3.4	28	7.4	0.24	680	380	2.1	5.2	0.64	3.2	56	24	22
	Summer-13	6.4	32.8	88	52	4.5	24	6.6	0.62	1300	860	2.4	18.2	1.4	4.2	64	34	30
	Rainy-13	7.2	28.6	72	52	3.8	26	7.2	0.68	2100	920	3	16.4	0.84	3.8	58	32	26
L-02	Winter-11	7	10.8	120	68	5.6	27	5.6	0.52	8000	2400	3.2	26	2.8	4	58	36	22
	Summer-11	68	36	148	58	7	24	5	1.42	16000	11000	4	32	4	5.2	72	48	24
	Rainy-11	7.2	42	132	78	6	29	6	0.84	14000	9000	4.2	20.6	3.8	4.4	64	42	22
	Winter-12	6.8	14.6	134	72	4.8	26	5.4	0.68	12000	3200	3.6	24	3.2	5.2	64	42	22
	Summer-12	6.6	38	156	62	6.4	23	5.2	1.58	25000	14000	4.8	28	4.8	6.4	84	56	28
	Rainy-12	7	44	142	82	5.4	28	6.1	0.92	22000	9800	5.2	22.2	3.8	5.8	78	50	28
	Winter-13	6.8	18.2	142	78	5.4	32	5.4	0.72	18000	4400	4.8	28	4.6	6.4	72	54	18
	Summer-13	6.4	40.6	164	66	7.2	28	4.8	1.62	36000	18000	5	34	6.2	7.8	92	62	30
	Rainy-13	6.6	48	158	88	5.6	28	5.8	1	28000	11000	5.8	24.4	5.4	7	84	58	26
L-03	Winter-11	6.8	7.8	88	62	4.4	24	6.2	0.38	7800	1600	2.8	22	2.2	2.8	46	32	14
	Summer-11	6.5	32	94	54	5.2	20	6	0.76	14000	9000	3.2	28	3.4	3.6	64	38	26
	Rainy-11	7	36.8	108	66	3.8	22	6.6	0.69	11000	7800	3.8	16.4	2.8	4.8	52	36	16
	Winter-12	7.3	8.2	92	70	4.8	28	6	0.42	8400	2200	3.2	20.2	2.8	3.2	58	38	20
	Summer-12	6.6	36	110	62	5.8	24	5.8	0.84	16000	11000	3.8	26.8	4.2	4.2	78	42	35
	Rainy-12	7.1	38	120	74	4.4	26	6.4	0.72	18000	8800	4.2	14.4	3.4	5	64	40	24
	Winter-13	7	9.8	98	82	5.2	32	6.2	0.58	9800	2800	3	24	3.2	4.4	64	42	22
	Summer-13	6.4	38.2	118	74	6.2	28	5.8	0.98	22000	14000	3.8	30.2	4.8	6.2	84	50	34
	Rainy-13	6.4	42	132	84	4.8	30	6.4	0.84	24000	9800	4.4	18.2	4.4	5.8	78	48	30

Table-05 WQI at different locations in different seasons of 2011, 2012, 2013

	L-01	L-02	L-03
Winter-11	308	1305	902
Summer-11	815	2772	1628
Rainy-11	847	2304	1771
Winter-12	332	1711	1123
Summer-12	855	3534	2093
Rainy-12	1074	2973	2068
Winter-13	430	2454	1344
Summer-13	976	3922	2386
Rainy-13	1079	3588	2448

Fig-02

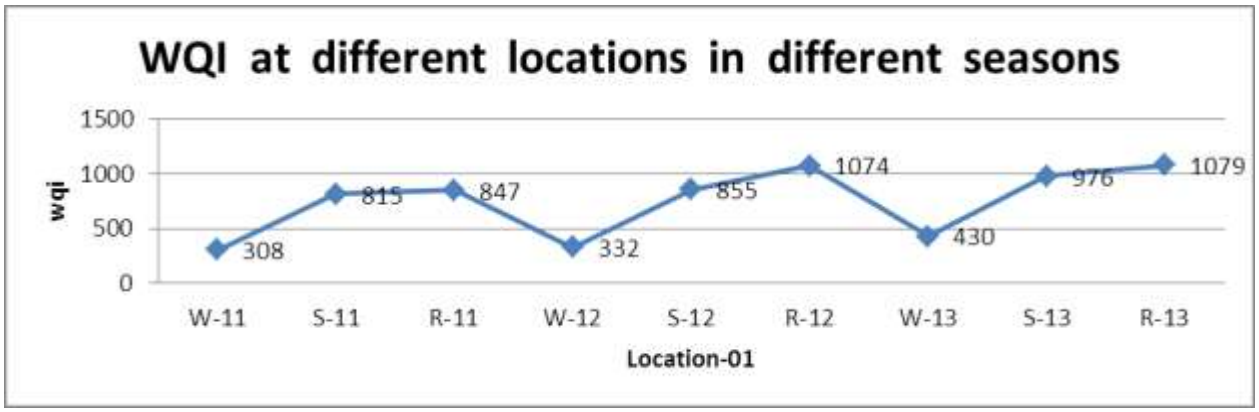


Fig-03

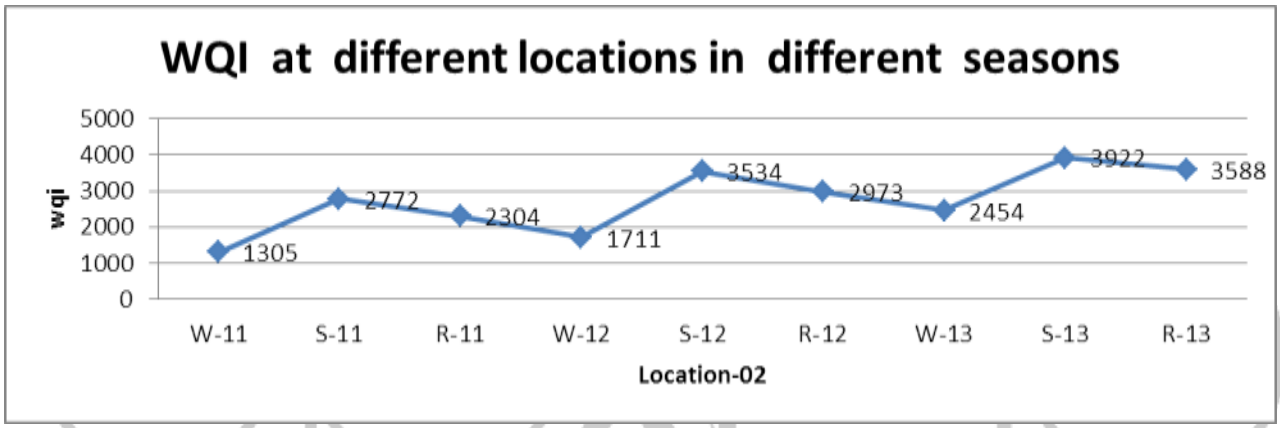
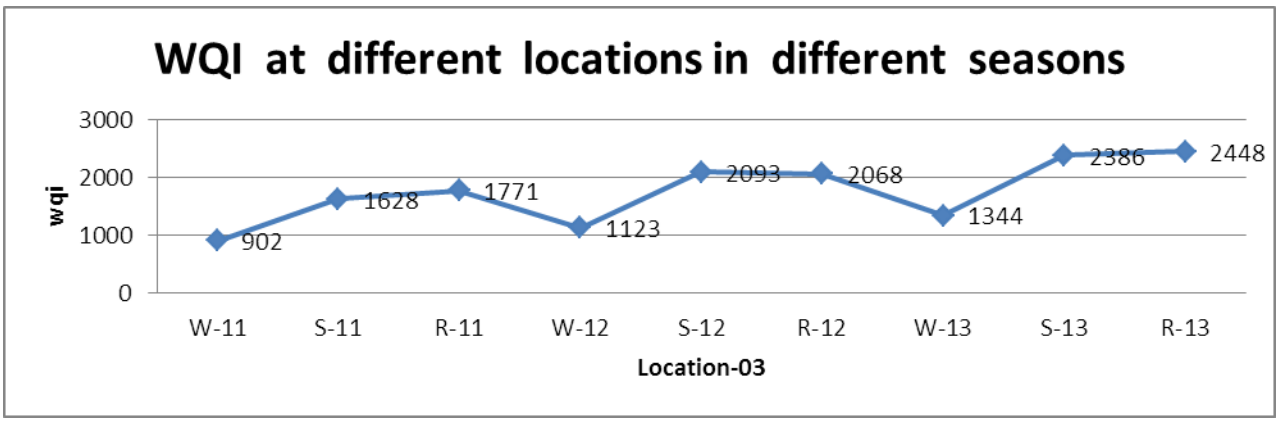


Fig-04



REFERENCES

1. **Bhuvaneswaran N.G. and Rajeswari S.**, Water quality of river Adyar in Chennai city-The River a Boon or Bane, Indian J. Environ Prote., 19(6), 412-415 (1999)
2. **Haribhau M.G.**, Trace Metals Contamination of Surface Water Samples in and Around Akot City in Maharashtra, India, Res. J. Recent Sci., 1(7), 5-9 (2012)
3. **Patil S.G., Chonde S.G., Jadhav A.S. and Raut P.D.**, Impact of Physico-Chemical Characteristics of Shivaji University lakes on Phytoplankton Communities, Kolhapur, India, Res. J. Recent Sci., 1(2), 56-60 (2012)
4. **Manimaran D.**, Groundwater Geochemistry Study Using GIS in and Around Vallanadu Hills, Tamil Nadu, India, Res. J. Recent Sci., 1(7), 52-58 (2012)
5. **Parihar S.S., Kumar A., Kumar Ajay, Gupta R.N., Pathak Manoj, Shrivastav Archana and Pandey A.C.**, Physico Chemical and Microbiological Analysis of underground Water in and Around Gwalior City, MP, India, Res. J. Recent Sci., 1(6), 62-65 (2012)
6. **Ranjan R.**, Water Quality Monitoring of Groundwater Resources around Sugar Factory, Near East-West Champaran Border, Bihar, India, Res. J. Recent Sci., 2(7), 79-81 (2012)
7. **Gleick P.H.**, Water in crisis: A guide to the world's fresh water resources, Oxford University press, New York., (1993)
8. **H. Schildt**, "C++ The Complete Reference Third Edition," Osborne McGraw-Hill, 1998, pp. 23-28.
9. **B. Stroustrup**, "C++ Faq: When Was C++ Invented," 7 March 2010, Retrieved 16 September 2010, pp. 11-19. http://www2.research.att.com/~bs/bs_faq.html#invention
10. "Programming Language Popularity," 2009, Retrieved 16 January 2009, pp. 2-9. http://www.langpop.com/
11. "TIOBE Programming Community Index," 2009, Retrieved 3 August 2011, pp. 1-2. http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html
12. C++ Applications, "What's CvSDL?" Retrieved 8 March 2010, pp. 2-3. http://www.cvsdl.com/:cvsdl. http://www.cvsdl.com/
13. ISO, "ISO/IEC 14882:2011," Retrieved 3 September 2011. http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?ics1=35&ics2=60&ics3=&csnumber=50372
14. "Most Popular Programming Languages," Retrieved 7 September 2011, pp. 2-4. http://langpop.com/

15. Mohanty S.K.PhD Thesis on strategies to control Environmental Pollution in major industries at Koraput District-2001.