Evaluation of Water quality of Kuakhai River by Water Quality Index Analysis using C++ Program

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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 Kuakhai 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. It was found that WQI is below 100 in winter in all locations. In summer and rainy seasons the WQI increases many fold making the water not suitable for drinking and other purposes. It was also found that all the parameters are in increasing trend towards D/S as compared to U/S except DO content. It shows the water quality of river is deteriorating towards D/S. Also decrease of DO content indicates the increase in pollution load towards D/S. From the above study it was observed that the water quality towards D/S is deteriorating due to discharge of domestic waste and waste water into the river Kuakhai. The present status shows that the water towards D/S is not meeting the prescribed standard for drinking water quality for river water (Class-A).**

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

I. 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	Excell ent	Good	Poor	Very Poor	Unsuita ble

II. 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 Kuakhai and to use this method to assess the general water suitability for drinking purposes . Monitoring water quality parameter and calculate overall water quality index (WQI) to evaluate River water by using C++ program.

III. MATERIALS AND METHODS

3.1. Study Area

River Kuakhai is a distributor of river Mahanadi and the main source of water for Bhubaneswar (the capital city of Odisha) and its adjourning areas. River Kuakhai receives immense amount of domestic waste and waste water along with untreated sewerage generated from the city. Due to rapid urbanization the river is contaminated with the discharge of effluents. To ascertain the quality and physico – chemical characteristics of river Kuakhai a thorough study has been conducted through out the years 2011, 2012, 2013. The detail locations of sampling are described in table -02.

Table-02 location of sampling points

SN	Location of sampling points
01	Upstream near mancheswar
02	Near intake point Palasuni
03	Near down stream at Pandra
04	Down stream near Kanti after mixing with Gangua Nala

3.2. 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

3.3. Application of C++ Program

3.3.1. 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].

3.3.2. 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.

3.3.2. 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 – Vio]/[Sn – Vn]

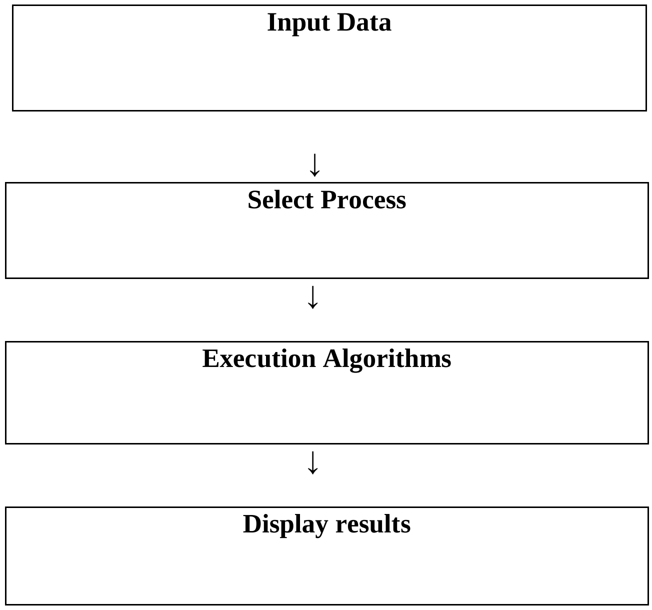


Figure -01 C++ diagram.

(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.

Vio = 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 .

IV. RESULTS AND DISCUSSION

The permissible limit of WQI for drinking water is 100. It was found that WQI is below 100 in winter in all locations except near Kanti after mixing with Gangua

Nala. In summer and rainy seasons the WQI increases many fold making the water not suitable for drinking and other purposes. It was also found that all the parameters are in increasing trend towards D/S as compared to U/S except DO content. It shows the water quality of river is deteriorating towards D/S. Also decrease of DO content indicates the increase in pollution load towards D/S. From the above study it was observed that the water quality towards D/S is deteriorating due to discharge of domestic waste and waste water into the river Kuakhai. The present status shows that the water towards D/S is not meeting the prescribed standard for drinking water quality for river water (Class-A)

V. CONCLUSION

River kuakhai is getting polluted due to domestic waste and waste water discharge at various points i.e at mancheswar and at Kanti. The total domestic waste of Bhubneswar having population 8.8 lakhs(2011) is discharged to river Kuakhai by making river water unfit for drinking as well as bathing and other activities which has been already proved by sample analysis at upstream and downstream of discharge points. In order to restore river water quality intact we must set up the septic tank of each household and the over flow of the septic tanks should be connected to the common drain carrying waste water. The waste water should be treated in the sewage treatment plant consists of grid chamber, primary clarifier, aeration tank and secondary clarifier. The result of the outlet should be satisfy the general waste water discharge to inland surface water. At river Kuakhai two S.T.P (sewage treatment plant) should be made , one at Mancheswar and another at Kanti. The most important factor is awareness among public regarding domestic pollution and the practice of open depiction on river bed should be stopped. Government should take necessary steps to construct latrines in the villages to curve the pollution.

It is high time to identify the sources of pollution i.e domestic waste and waste water discharge to river and action may be taken to treat the domestic waste and waste water before discharge to river to minimize pollution load on river.

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	Sulp	TH	Ca-H	Mg-H
L-01	Winter-11	8.1	6.2	98	54	2.4	84	8.5	0.007	1100	800	1.38	6.6	0.41	1.8	34	21	11
	Summer-11	7.3	23.4	118	53	2.8	12.4	5.5	0.349	1600	980	1.58	10.2	0.56	2.6	52	27	25
	Rainy-11	8	88	81	85	1.9	10.2	8	0.138	2100	1500	2.6	8.6	0.76	2.2	72	44	28
	Winter-12	7.9	7	100	57	2.9	9	8.6	0.009	1400	1100	1.31	7.2	0.51	1.6	46	24	22
	Summer-12	7.2	25.3	122	54	3.1	14.2	5.8	0.38	1800	1400	1.49	12.4	0.62	2.8	64	32	32
	Rainy-12	7.8	90	83	89	2	12.4	7.8	0.18	2400	1700	2.56	11.8	0.72	2.4	82	54	28
	Winter-13	7.8	7.6	99	62	2.9	10.2	8.5	0.008	1500	1400	1.37	8.4	0.48	2	52	26	126
	Summer-13	7.2	26.1	123	59	3.2	16.2	5.6	0.410	2200	1800	1.62	14.6	0.62	2.6	74	32	42
	Rainy-13	7.7	92	86	91	2.1	14.7	7.8	0.20	3000	2100	2.78	12.6	0.78	2.2	86	48	38
L-02	Winter-11	7.3	11.8	121	65	3.3	10	8	0.009	3200	2500	1.52	7.4	0.52	2.4	38	18	20
	Summer-11	6.7	28.6	136	60	4.6	18	5.8	0.385	2800	2400	1.72	16	0.68	4.6	54	39	15
	Rainy-11	7.9	146	96	86	4	18	7.3	0.386	44000	3200	4.2	15.4	1.3	6.8	78	52	36
	Winter-12	7.2	12.2	124	69	3.6	12.4	8.4	0.018	3800	2800	1.36	7.8	0.48	2.2	48	22	26
	Summer-12	6.6	29	139	62	5	20.6	6	0.428	3200	3200	1.52	18	0.72	5.2	68	38	30

	Rainy-12	8	152	98	90	4.5	19	7.2	0.38	48000	4800	2.89	17.4	1.4	5.8	88	58	30
	Winter-13	7.2	12.8	126	72	4	14.6	8.4	0.024	4200	3400	1.58	8.6	0.56	2.6	56	32	24
	Summer-13	6.7	29.8	142	63	5.2	22.4	5.8	0.429	4000	4800	1.76	22	0.81	4.8	86	38	50
	Rainy-13	7.9	158	99	95	4.6	20.2	7.4	0.34	540000	5600	3.8	19.2	1.5	6.4	92	52	40
L-03	Winter-11	7.6	19.4	142	76	3	11	7.2	0.016	4200	4600	1.68	9	0.54	3.8	42	20	22
	Summer-11	7.2	48.2	161	67	4	18	6.2	0.312	4800	3200	1.82	17	0.58	4.2	58	31	27
	Rainy-11	8	126	89	94	5	22	7	0.158	56000	48000	4.3	16.4	0.71	3.6	80	54	24
	Winter-12	7.6	20.2	146	78	3.8	12.4	7.6	0.038	4800	5800	1.53	10.2	0.62	3.6	52	28	24
	Summer-12	7.1	50.4	165	71	4.6	24	6.2	0.32	5600	4600	1.69	16.8	0.58	4.6	72	42	30
	Rainy-12	7.9	130	91	98	5.4	26	7.2	0.52	68000	54000	3.22	18.2	0.78	3.8	94	62	32
	Winter-13	7.5	22.3	148	81	4	12.8	7.4	0.032	5200	7200	1.622	12.4	0.58	3.8	58	38	20
	Summer-13	7.1	51.3	169	76	5	28	6.4	0.328	5800	5800	1.92	17.2	0.56	4.8	92	42	50
	Rainy-13	8	138	93	102	6	30	7.4	0.56	72000	68000	4	18.8	0.82	4.2	98	68	30
L-04	Winter-11	7.1	30	169	122	7	30	6.1	0.029	7800	7000	1.94	16.4	0.81	3.8	52	25	27
	Summer-11	6.7	62	184	138	4.6	22	6.3	0.820	90000	7800	2.6	20.8	0.82	7	64	42	22
	Rainy-11	7.7	148	128	84	16.4	64	5.8	0.788	120000	98000	5.2	20.6	0.98	4.6	100	62	38
	Winter-12	7.1	30.8	172	136	7.8	40	5.9	0.084	8400	14000	1.76	18.2	0.79	3.7	64	32	32
	Summer-12	6.6	64	189	140	5.8	31	6	0.98	110000	18000	1.98	22.4	0.82	6.8	82	48	34
	Rainy-12	7.8	152	132	89	24.2	70	5.7	0.86	180000	120000	4.43	21.8	0.89	4.8	98	68	30
	Winter-13	7	32.4	170	140	8.4	50	6	0.094	9000	28000	1.8	17.4	0.84	4.2	64	42	22
	Summer-13	6.6	63	192	142	6.9	42	5.8	0.98	110000	34000	2.4	26.4	0.79	7.2	98	46	52
	Rainy-13	7.7	154	140	92	26.4	78	5.6	0.94	220000	180000	4.8	23.4	0.96	5.2	110	78	32

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

	L-01	L-02	L-03	L-04
Winter-11	16	23	43	88
Summer-11	402	518	473	1128
Rainy-11	365	1310	683	2318
Winter-12	20	42	92	217
Summer-12	421	514	466	998
Rainy-12	434	970	1119	2075
Winter-13	19	60	82	250
Summer-13	468	600	522	1183
Rainy-13	506	1161	1430	2392

Fig-02

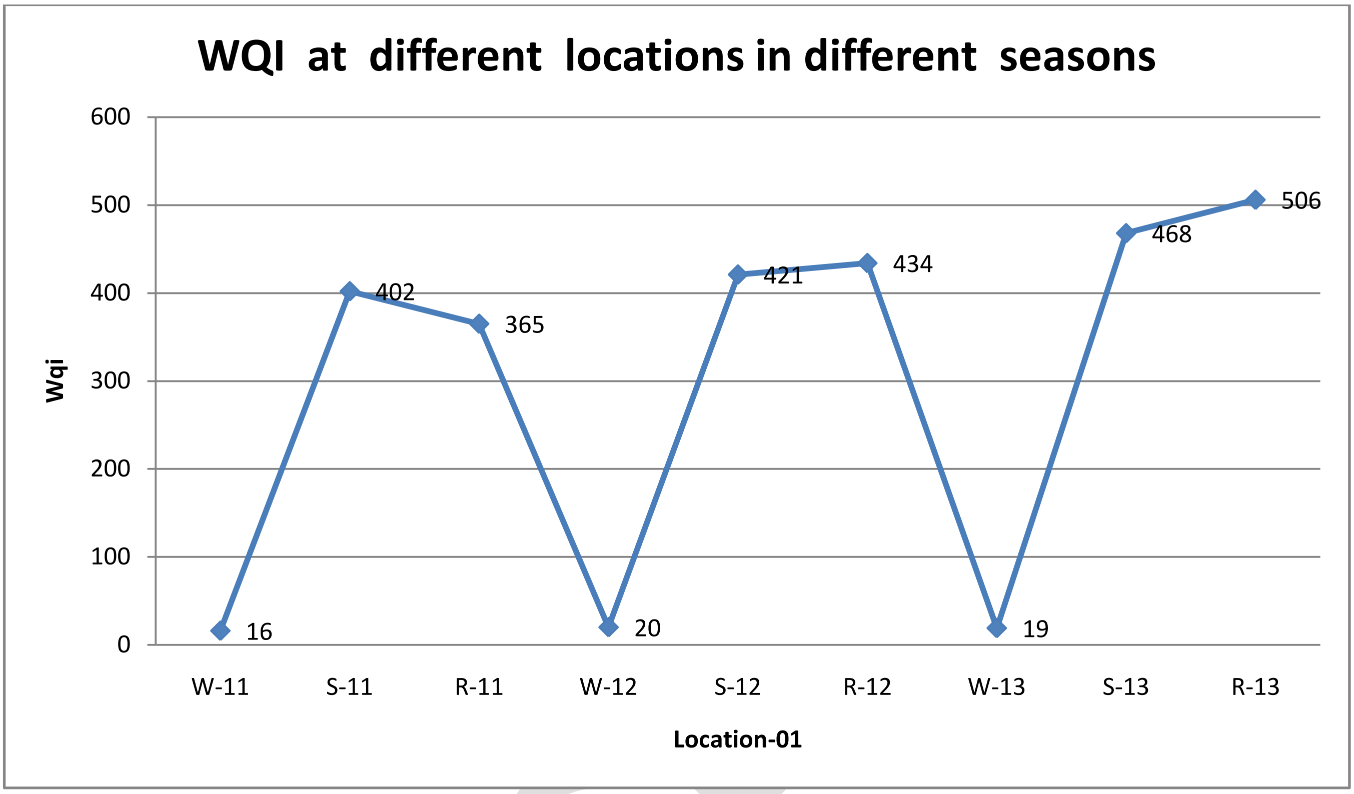

WQI at different locations in different seasons
600
500
400
300
200
100
0
Wqi
16
402
365
20
421
434
19
468
506
W-11
S-11
R-11
W-12
S-12
R-12
W-13
S-13
R-13
Location-01

Fig-03

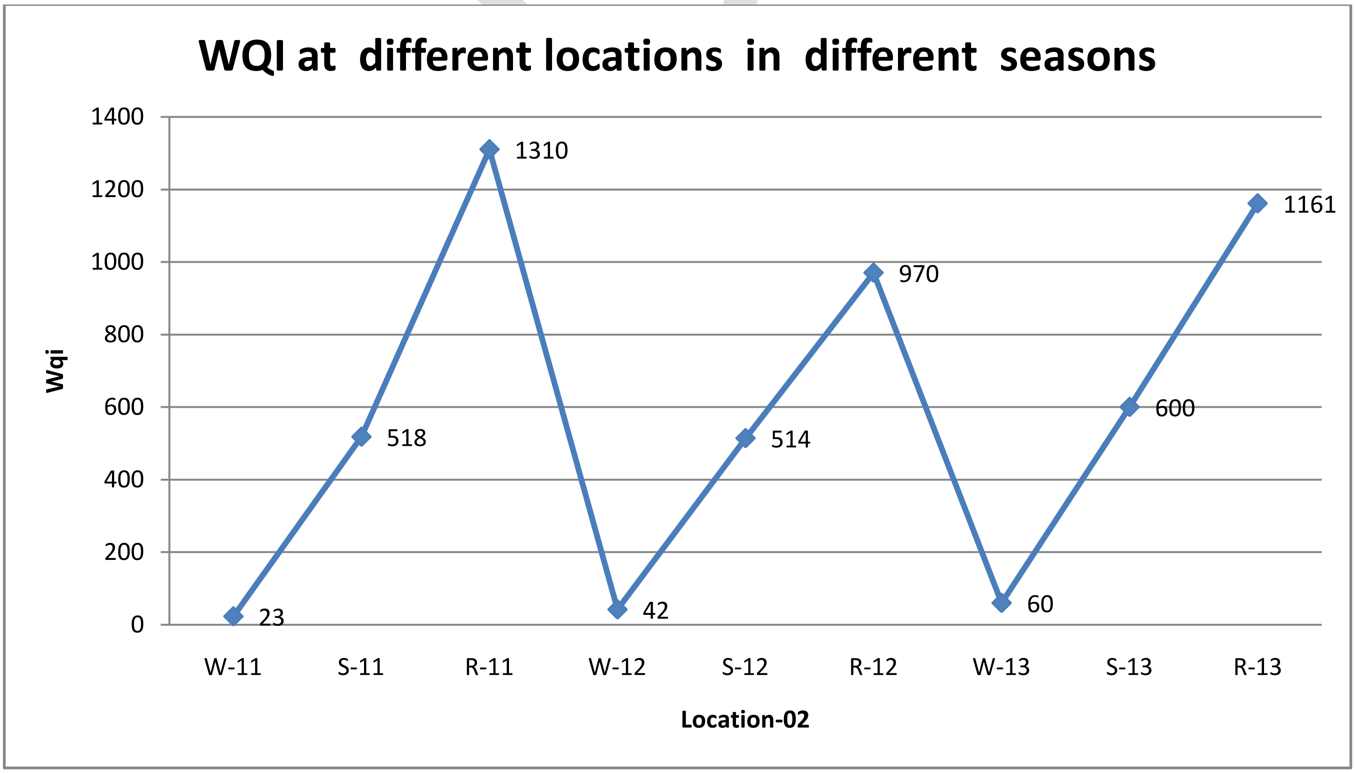

WQI at different locations in different seasons
1400
1200
1000
800
600
400
200
0
Wqi
23
518
1310
42
514
970
60
600
1161
W-11
S-11
R-11
W-12
S-12
R-12
W-13
S-13
R-13
Location-02

Fig-04

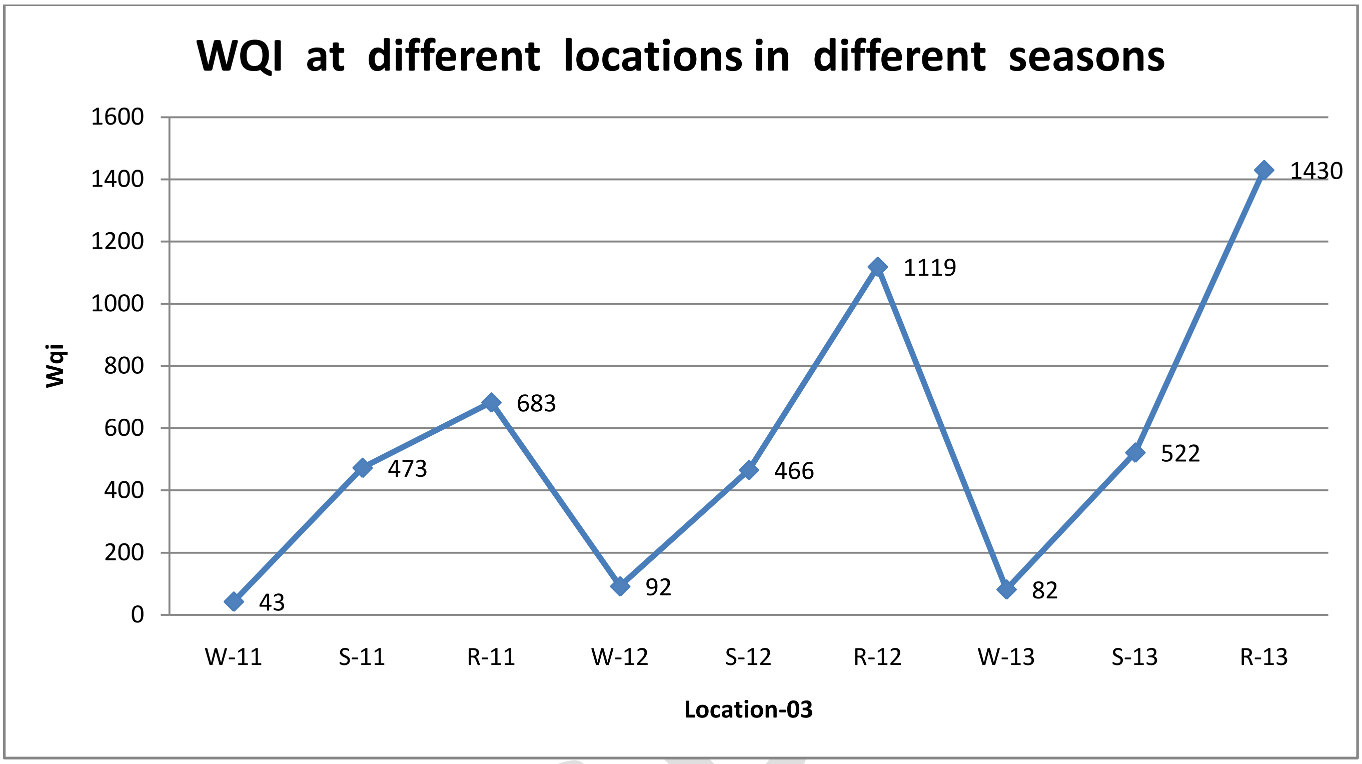
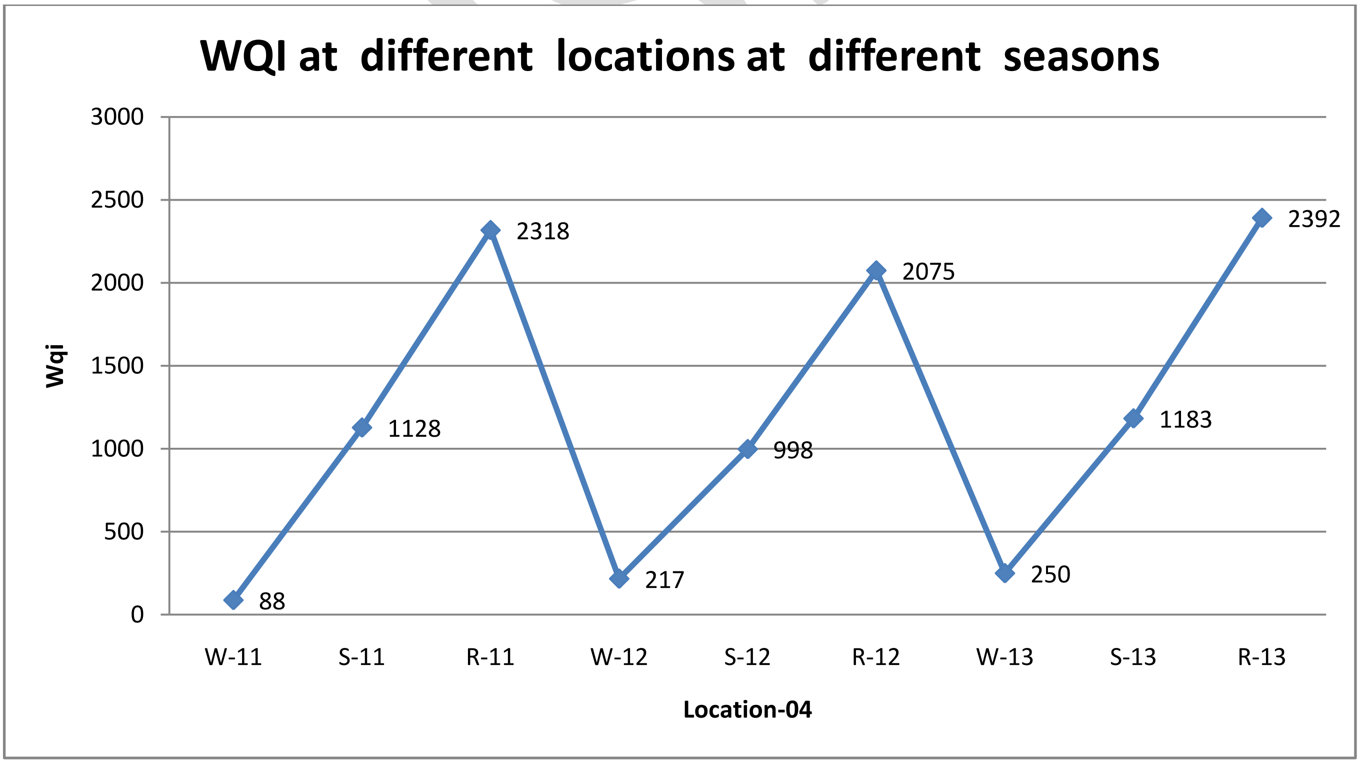

WQI at different locations in different seasons
Wqi
1600
1400
1200
1000
800
600
400
200
0
43
473
683
92
466
1119
82
522
1430
W-11
S-11
R-11
W-12
S-12
R-12
W-13
S-13
R-13
Location-03

Fig-05


WQI at different locations at different seasons
Wqi
3000
2500
2000
1500
1000
500
0
88
1128
2318
217
998
2075
250
1183
2392
W-11
S-11
R-11
W-12
S-12
R-12
W-13
S-13
R-13
Location-04

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