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Impact of Waste Water on River Kathajodi for the Year 2009-10

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Abstract

A study was carried out to evaluate the impact of domestic waste generated from Cuttack city on river Kathajodi. Grab samples were collected in three seasons for two consecutive years both at upstream and at downstream. The results obtained in different seasons has been compared graphically. From analysis it was observed that almost all parameters are in increasing trend (except DO) towards D/S. The stations located upstream of the river was found to be less polluted but the contamination of the river starts from downstream near Govt press due to dumping of waste and waste water. The water of the river assumed a dark hue due to discharge of raw domestic sewage. The pollution load decreases towards the last patch of the river within the study area as a result of dilution. Quality rating for different parameters has been calculated. From that water quality index was found out and compared. It was concluded that due to domestic waste water discharge water quality of river Kathajodi is deteriorating and the results are not meeting the prescribed standard for drinking water under class-C. .

Keywords: *Waste water, Water quality*

Introduction

Waste water generated from urban areas is one of the major causes of pollutions of surface water in our country. The fast growth of urban economy and menial job opportunities in and around urban centers has encouraged migration of rural population to urban areas resulting of mushrooming of settlements and satellite towns. Consequently environmental problems related to water supply, effluent generation and disposal raise their ugly heads. Domestic sewage creates more serious problems so far as microbial contamination is concerned. This is primarily responsible for the spread of water born diseases. Besides microbials, various inorganic ions also contaminates the receiving water bodies which causes serious health disorders.

Cuttack is the second highest populated city after the capital city,Bhubaneswa in Odisha. It comprises an area of 192.5 sq.km having population of 5.35 lakhs as per provisional census report of 2001. It is situated at the deltaic position of river Mahanadi and Kathajodi. The waste generated from Cuttack is dumped into the river Kathajodi . The river Kathajodi serves as the vital source of potable water for the people of the city as well as numerous villages located downstream. So it is the high time to investigate systematically as regards to their water quality.

A systematic study was undertaken for a period of two years covering all the three major seasons. Different points were chosen according to their source of contamination. The study include various physico-chemical and microbiological parameters.

Locations of sampling points

In order to assess the water quality and physiochemical characteristic of river Kathajodi three different sampling points were selected to assess the impact of discharged waste on the river water. The locations were chosen according to their proximity of major Municipal Township which is expected to make significant contributions to the pollution load. The detail locations of sampling are described in table-01.

Table-01 (Location Points)

SN	LOCATION OF THE SAMPLING POINTS	CODE NO
01	Upstream of near High court area	K-01
02	Downstream near Govt press	K-02
03	Further downstream at Sankhataras	K-03

Material and methods

Grab samples were collected from the selected locations during different seasons (winter, summer, rainy) over a period of two years 2009 and 2010. The samples were collected in plastic and glass bottle 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 -02. 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-02 (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^{0}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 $CaCO_3$	Titrometric Method by using EDTA
15	Iron	1,10 Phenanthroline Colorimetric Method

pH: The overall pH of the water taken from the river was slightly alkaline. The pH ranged from 6.5 to 7.8 . From yearly average it was found that the pH value is in decreasing order. Towards downstream the water becomes more acidic compared to upstream in all the seasons.

TSS:TSS ranged from 4.0 to 38.1.From yearly average it was found that TSS is in increasing order . It was also found that towards downstream TSS of water increases during rainy seasons and show higher values compared to summer and winter. This may be due to addition of waste along with rain water..

TDS: The TDS ranged from 48 to 136. From yearly average it was clear that the TDS value is in increasing trend . All the stations during summer show higher values compared to rainy and winter seasons. This may be due to low water level of river during summer month. It is clear the upstream of the river is free from municipal sewage contamination exhibit lower TDS values compared to stations at downstream. There was a sharp rise in the TDS value at downstream which receive the municipal sewage directly.

Alkalinity: The Alkalinity of the water samples ranged between 35 to 68. From yearly average it was found that in all the stations the alkaline increases. There is sudden increase of alkaline value during rainy seasons in all stations, it may be due to addition of waste water along with rain water.

BOD: The BOD of water samples varied between 2.0 to 6.8.Yearly average shows BOD increases from the year 2009 to 2010. All the stations show a sudden hike of BOD in summer. However the stiffness of the hike decreased to a large extent during rainy seasons. The BOD value of water increases manifold towards downstream indicating that the water is grossly polluted by organic matter. The problem was acute during summer seasons as the metabolic activities of various aerobic and anaerobic microorganisms accelerated with the increase in water temperature (Mishra,1996)..

COD: The COD of water samples varies from 9.0 to 26.0..Yearly average shows COD increases from the year 2009 to 2010. All the stations show a sharp hike in summer. However the values are decreased to a large extent during rainy season.

DO: The DO content of water samples varies from 5.0 to 7.8 mg/l . From yearly average it was found that there is slight decrease in DO content from the year 2009 to 2010. Sudden depletion of DO was found during summer. There was a sudden depletion of DO at station-02 and it continues till the last station.

Phosphate: The PO_4^{3-}concentration of water samples varies between 0.01 to 1.48 mg/l, Yearly average shows the phosphate content of water bodies is in increasing order from the year 2009 to 2010. The values obtained at stations located at upstream were lower compared to other stations.

Iron : The iron content of water samples varies from 1.8 to 4.8 mg/l. Higher values were observed during rainy seasons . Iron content in water bodies are in increasing order from the year 2009 to 2010. Enrichment of iron at downstream during rainy seasons might be attributed of stratified condition in the water which was enriched with organic matter under depleted oxygen conditions. Under this condition Fe^{2+} can be retained in water up to parts per million levels(Livingstone, 1963). The iron content can also be influenced by aquatic vegetation (Oborn and Hem, 1962).

Chloride: The chloride content of water samples varied from 3.9 to 28.4 mg/l . From yearly average it was found that the chloride content is in increasing order. Maximum concentration was found during summer seasons. The stations located upstream recorded lower values compared to other stations may be due to the water at this stations are relatively free from anthropogenic activities. But towards downstream the value increases due to dumping of untreated waste water.

Nitrate: The concentration of NO_3^- ion in water samples varies from 0.34 to 3.8 mg/l . Yearly average values shows the NO_3^- concentration of water increases from the year 2009 to 2010. The samples collected in rainy seasons registered the maximum concentration of the ions. The variation in NO_3^- concentrations among the stations were less in the rainy season compared to winter and summer seasons.

Sulphate: Thesulphate content of the water samples varies from 1.4 to 6.6 mg/l during the study period. From yearly average it was noticed that the SO_4^{2-} concentration was in increasing order from the year 2009 to 2010. Summer and winter recorded less concentration compared to rainy season. The SO_4^{2-} concentration increases rapidly towards downstream

TH: The hardness of the water samples varied from 24 to 69 mg/l during the study period. Yearly average shows that total hardness is in increasing order from the year 2009 to 2010. Higher values were recorded during rainy seasons. Slight increase in the values noticed at summer season, but no remarkable variation was observed among rest of the stations. The difference was found to be very prominent during the rainy season.

TC : The TC count of the water samples varied from 440 to 22,000 per 100 ml during study period.. From yearly average it was found that TC counts were in increasing order from the year 2009 to 2010. There was an increase towards downstream throughout the year. The stations which were located at upstream showed very less counts during winter season.

FC: The FC of water samples varied from 80 to 11,000 per 100 ml during study period. Yearly average shows the FC counts were in increasing order from the year 2009 to 2010. There is sudden increase in the value towards downstream in all seasons. All the stations during rainy seasons showed higher counts compared to other seasons.

Statistical Analysis

Water Quality Index (WQI)

WQI is an excellent tool to communicate water quality of an areaThe mathematical expression for WQI is given by

$$WQI = \sum_{i=1}^{P} W_i q_i$$

Where q_i is the sub-index for i^{th}water quality parameters.

W_i is the weight associated with i^{th} water quality parameters.

'P' is the number of water quality parameters.

The permissible limit of WQI for drinking water is 100. From yearly average it was found that the water quality of the water bodies is deteriorating from the year 2009 to 2010. The water of L-01 is suitable for drinking purpose only in winter season, but in rest of the seasons the water is not suitable for drinking. Other locations were found not suitable for drinking purposes in any season . The condition is worst in rainy season when the WQI increases in all locations.The WQI were calculated taking the standard values for drinking water

Conclusion and Discussions

The stations located upstream the river Kathajodi 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 sewage. 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 diution.

The water body have been found to be highly polluted in summer seasons followed by the rainy and winter season. So far as the microbial characteristic is concerned the environmental temperature plays an dominating role. Higher summer temperatures 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 increasing in the disposal of various wastes.

Some Controlling Measures to Check Pollution

From the study it was revealed that domestic pollution load on river Kathajodi is much higher .It is as because 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 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.

Physico-chemical and microbiological characteristics of surface water

Table- 03 pH

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	7.8	7.0	7.4	7.6	6.8	7.3
02	K-02	7.5	7.1	7.8	7.4	7.1	7.4
03	K-03	6.9	6.5	7.6	7.3	6.6	7.2

Table-04 TSS

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	4.0	18.1	11.6	5.5	20.6	18.2
02	K-02	8.6	26.0	34	10.2	28.4	38.1
03	K-03	6.2	21.0	26	7.4	24.6	33.8

Table-05 TDS

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	48	60	58	52	70	62
02	K-02	108	136	120	118	136	124
03	K-03	66	120	100	84	94	98

Table-06 Alkalinity

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	39	35	46	42	38	40
02	K-02	58	61	52	64	56	66
03	K-03	42	37	68	58	48	58

Table-07 BOD

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	2.0	3.8	2.5	2.2	4.0	2.9
02	K-02	2.8	5.6	4.0	5.4	6.8	5.4
03	K-03	4.6	4.4	3.0	4.0	5.0	3.6

Table-08 COD

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	12.0	11.0	9.0	16.0	12.0	12.0
02	K-02	22.0	16.0	22.0	26.0	22.0	22.0
03	K-03	16.0	12.0	16.0	20.0	14.0	16.0

Table-09 DO

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	7.8	6.9	7.4	7.6	6.6	7.4
02	K-02	6.0	5.6	6.2	5.8	5.0	6.0
03	K-03	6.8	6.0	6.8	6.2	6.0	6.6

Table-10 Phosphate

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	0.01	0.31	0.34	0.14	0.44	0.46
02	K-02	0.34	0.54	1.48	0.48	1.38	0.84
03	K-03	0.22	0.44	0.66	0.36	0.76	0.69

Table-11 TC

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	500	700	1100	440	900	1600
02	K-02	2800	2800	11000	9000	16000	11000
03	K-03	1600	7000	22000	7600	11000	9000

Table-12 FC

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	80	130	190	220	760	900
02	K-02	340	280	1100	2200	11000	9000
03	K-03	140	500	940	1100	9000	7600

Table-13 Iron content

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	1.8	2.6	3.0	2.0	2.8	3.4
02	K-02	2.0	3.4	4.2	3.6	4.0	4.8
03	K-03	2.2	3.1	3.6	3.0	3.2	4.0

Table-14 Chloride

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	3.9	7.2	6.9	4.6	16.0	8.8
02	K-02	16.5	22.2	21.9	24.0	28.4	20.6
03	K-03	10.4	13.5	14.8	19.6	20.8	14.4

Table-15 Nitrate

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	0.34	0.45	1.8	0.44	0.86	0.69
02	K-02	0.46	0.86	3.4	2.6	3.8	3.2
03	K-03	0.38	0.64	3.0	2.0	2.9	2.6

Table-16 Sulphate

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	1.4	1.8	3.2	1.6	2.6	2.2
02	K-02	3.1	4.2	6.6	3.9	4.5	4.0
03	K-03	2.5	3.8	4.8	2.8	3.8	3.2

Table-17 TH

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	24	32	39	28	36	34
02	K-02	39	49	58	48	69	58
03	K-03	28	38	46	36	51	47

Table-18 Ca-H

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	19	18	29	19	24	22
02	K-02	21	29	36	34	42	40.0
03	K-03	18	20.0	32	24	38	36

Table-19 Mg-H

S.NO	Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
01	K-01	5.0	14.0	10.0	9.0	12.0	12.0
02	K-02	18.0	20.0	22.0	14.0	27.0	18.0
03	K-03	10.0	18.0	14.0	12.0	13.0	11.0

Table-20 Water quality Index (Seasonal Variation)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
K-01	420.2	792.5	1994.2	566.7	1339.4	1430.1
K-02	658.5	1805.4	4411.3	3063.7	3879.5	4610.3
K-03	622.9	1327.6	3318.6	2100.6	2668.5	3292.3

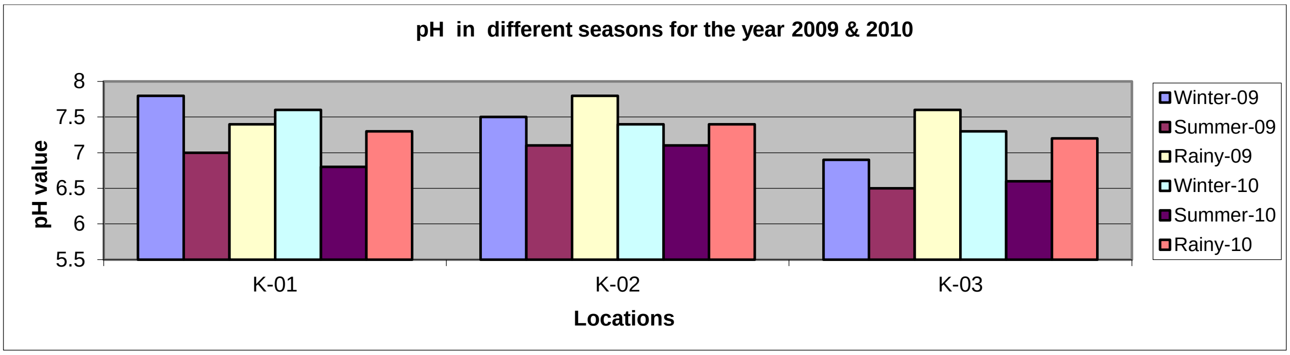
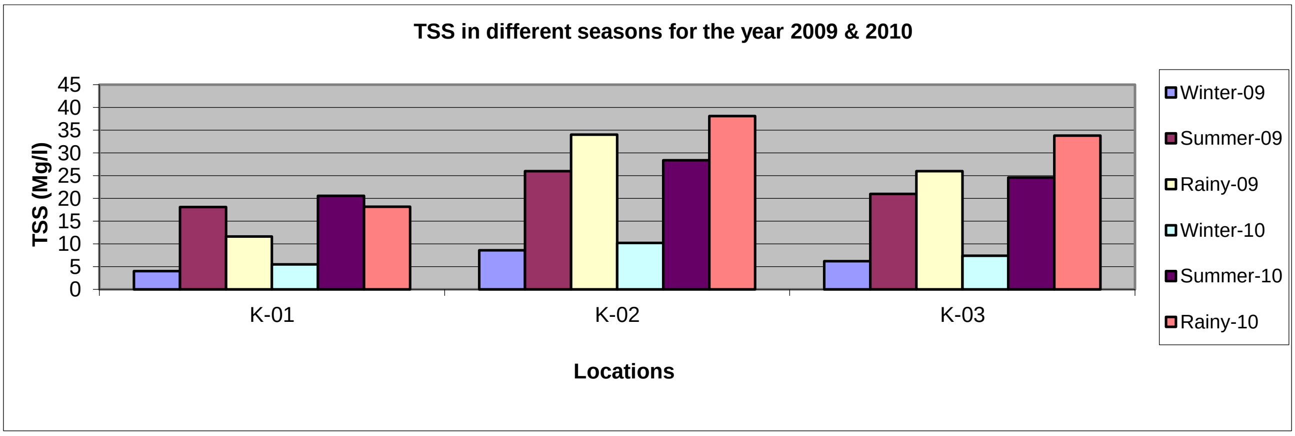


Fig-1



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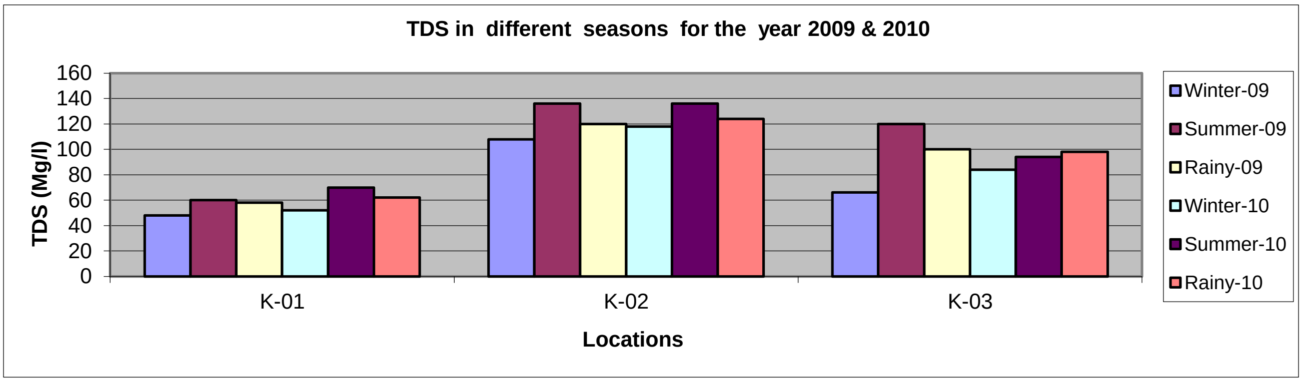

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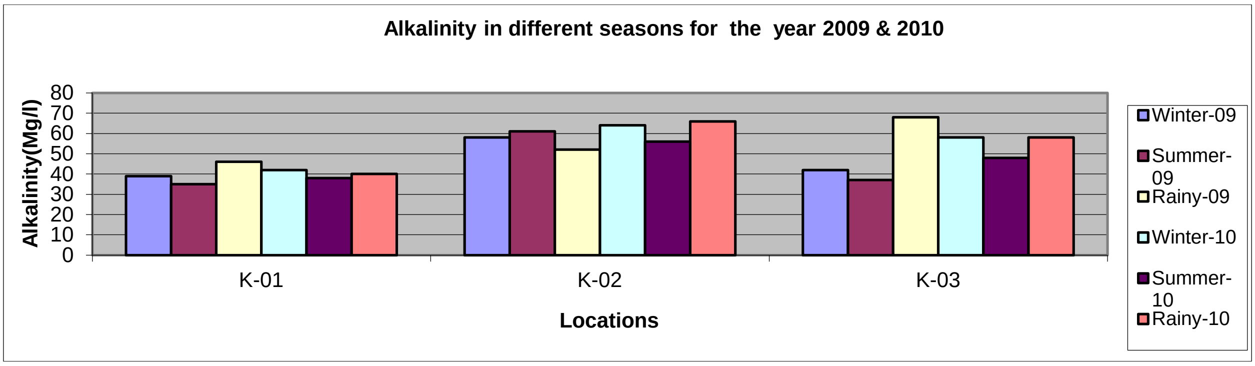

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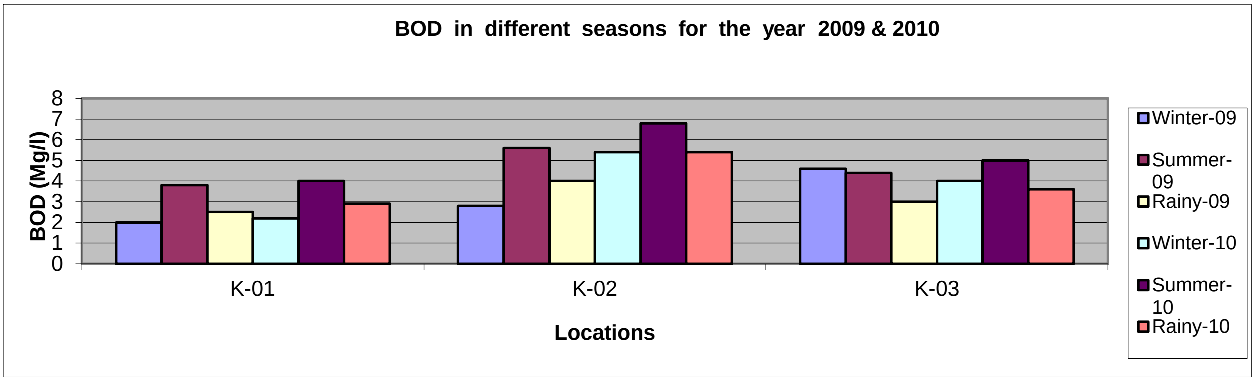

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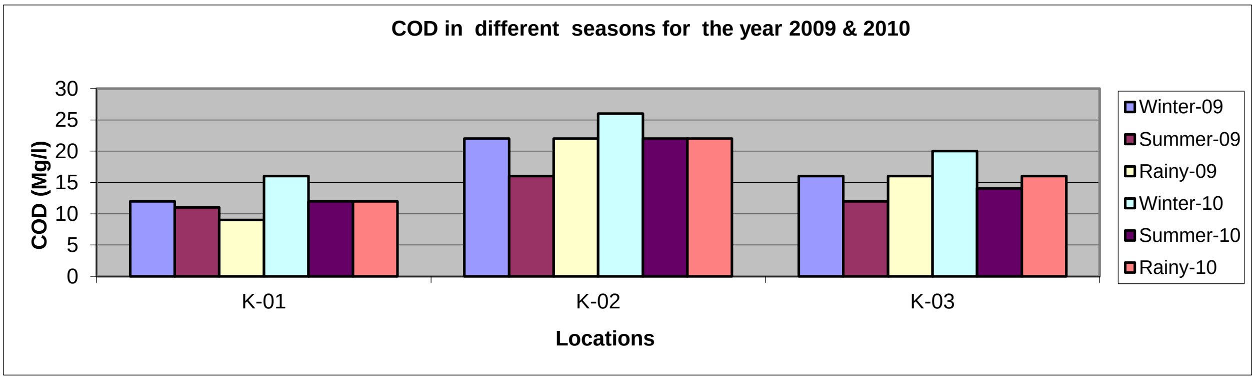

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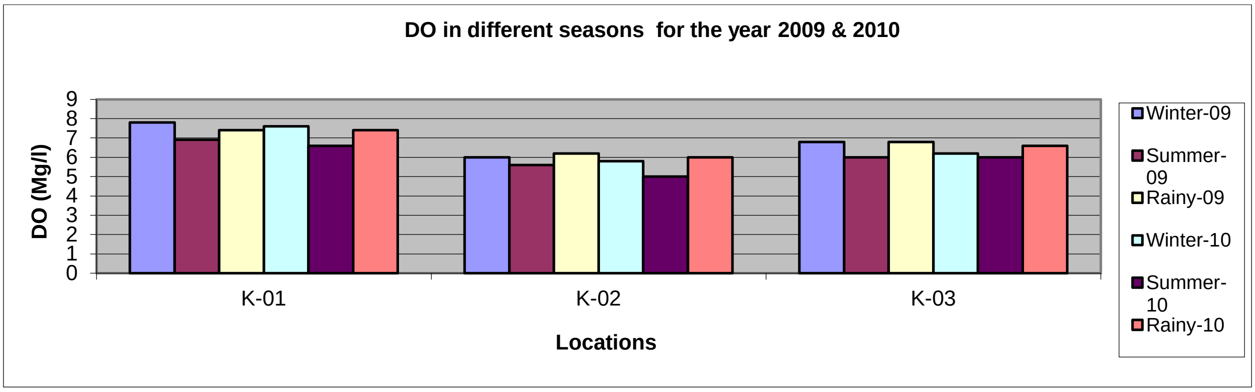

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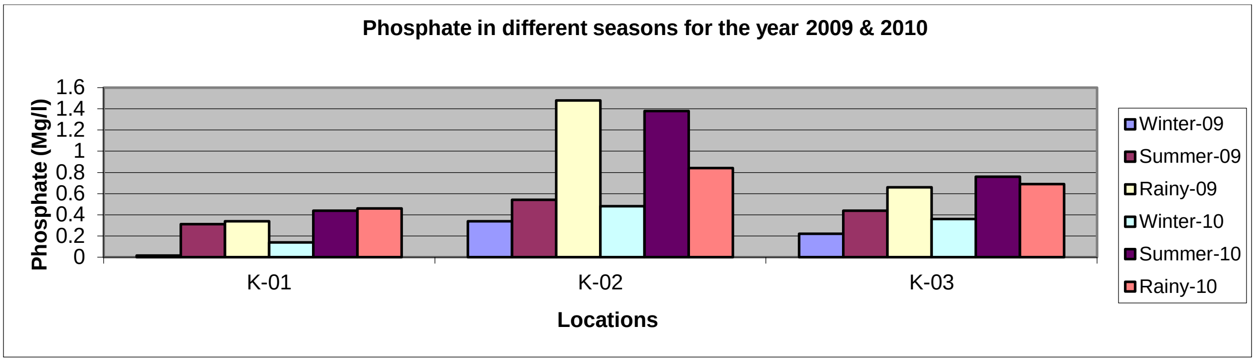

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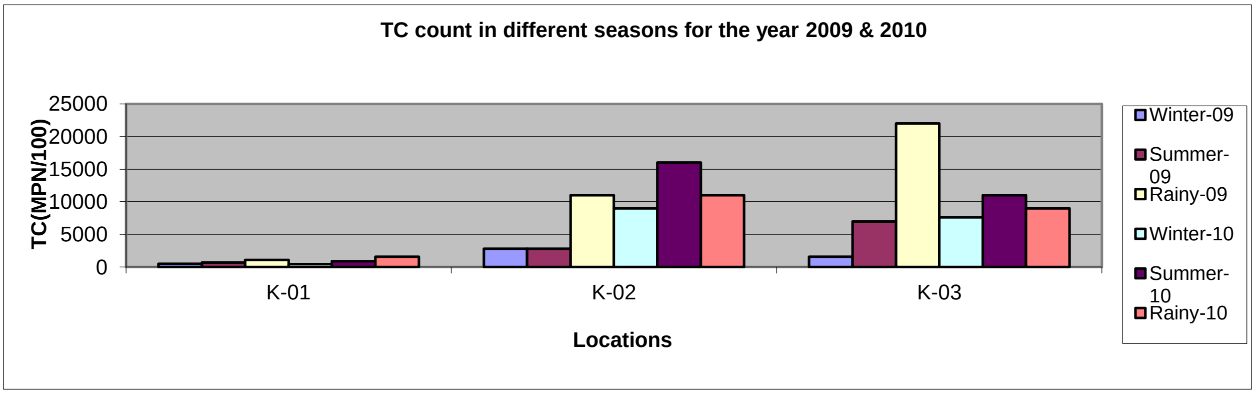

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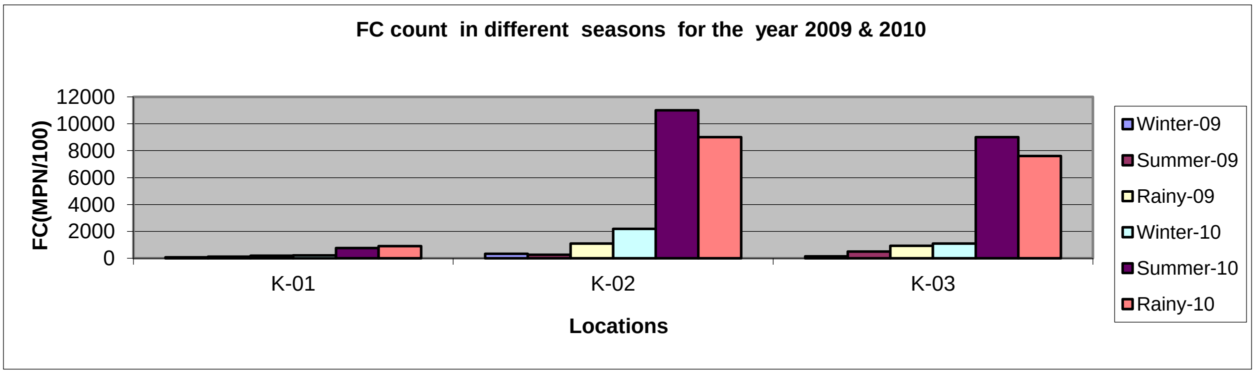

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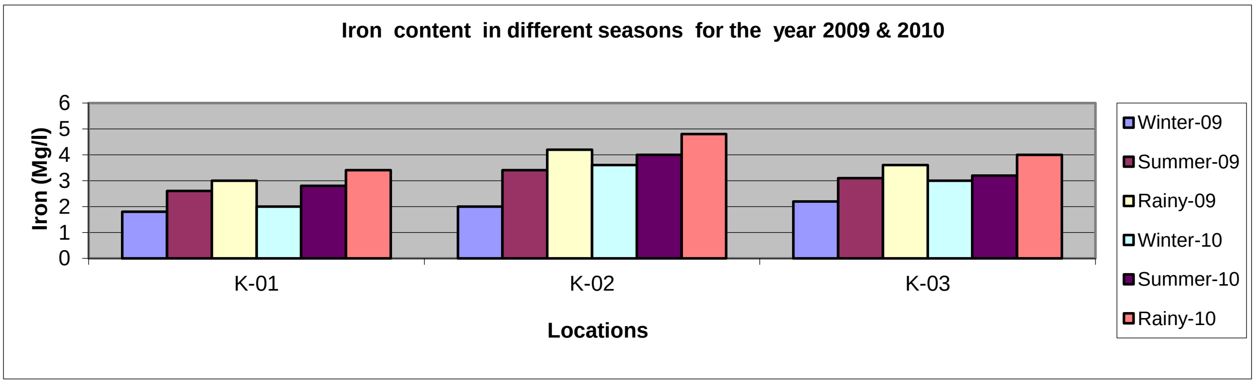

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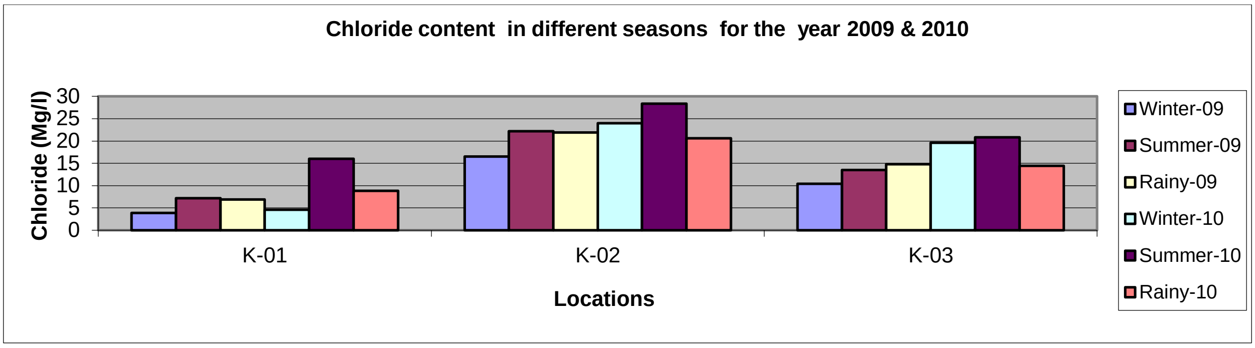

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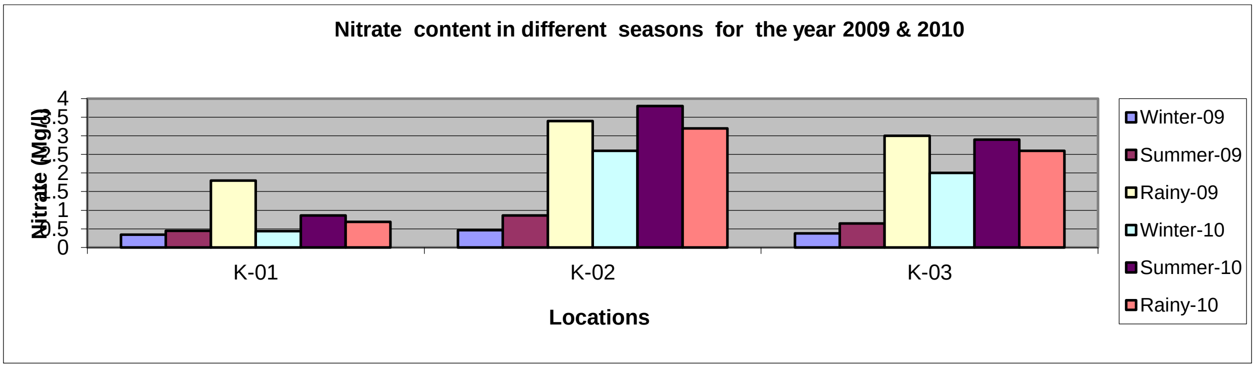

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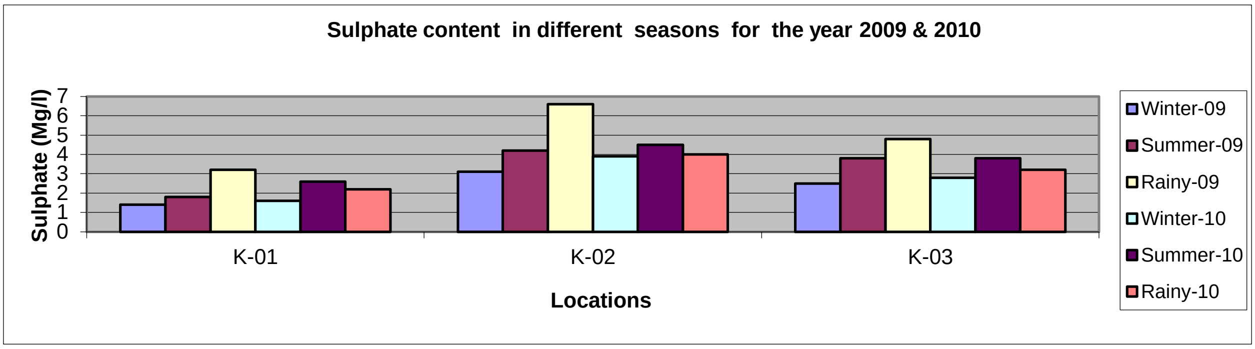

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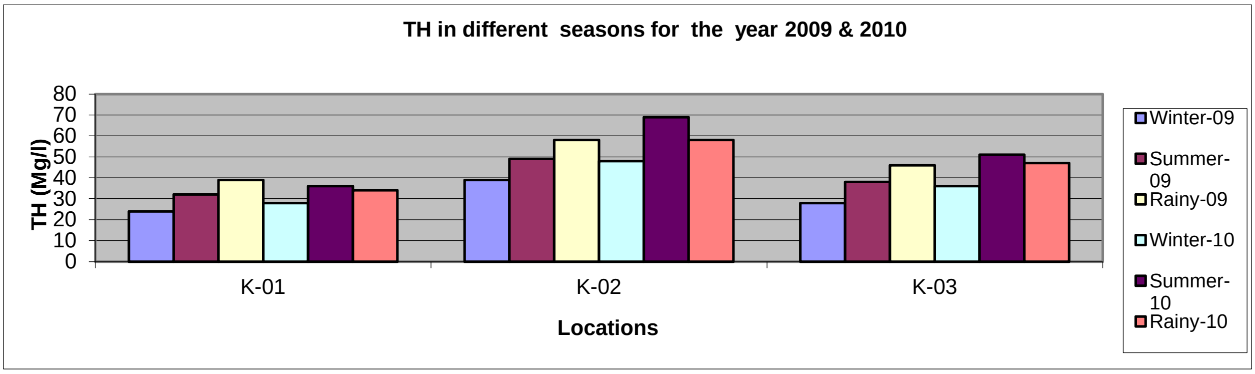

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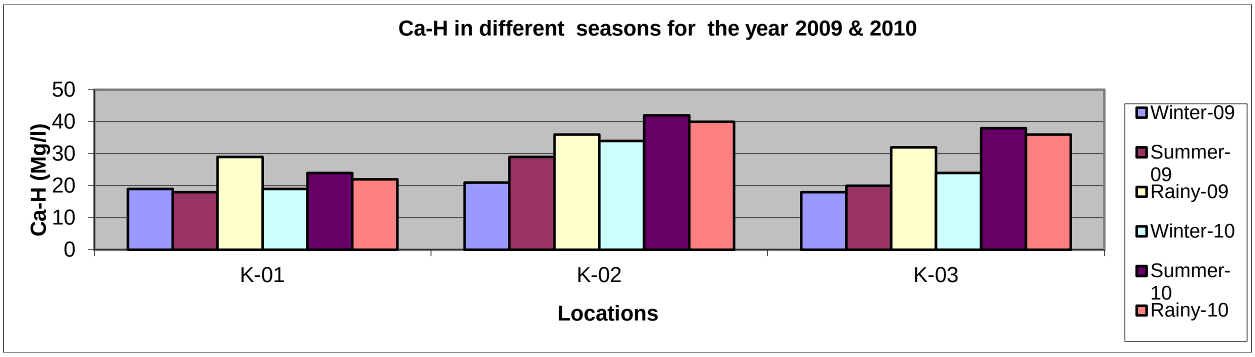

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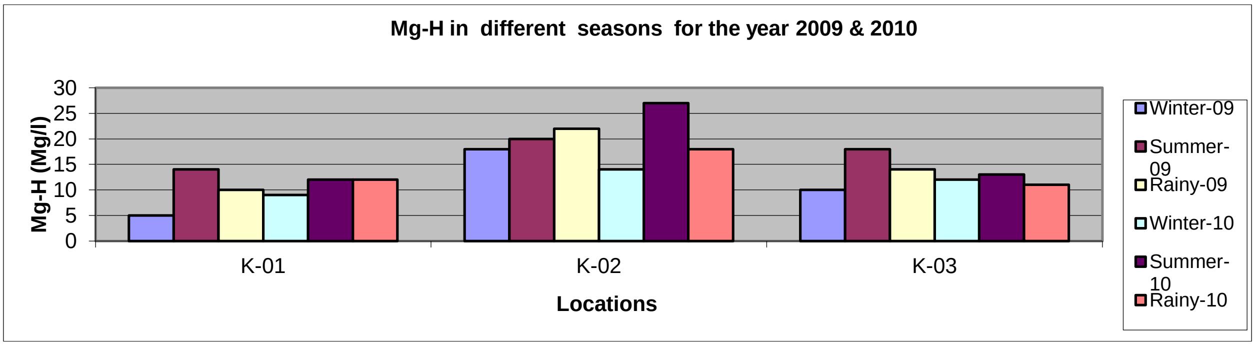

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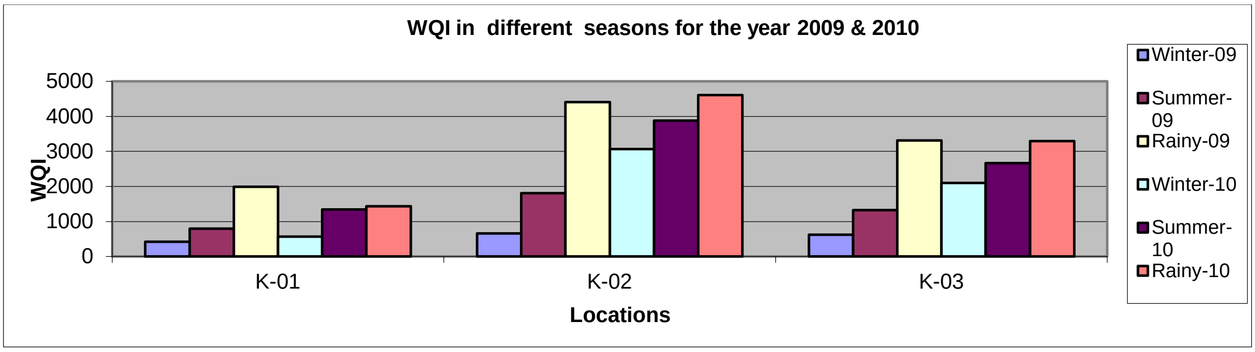

Fig-18

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