Global Journal of Science Frontier Research
Environment & Earth Science
Volume 13 Issue 2 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Water Pollution Status of Hiranyakeshi River from India

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GJSFR-H Classification : FOR Code: 899899, 700401p

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Strictly as per the compliance and regulations of :

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I. Introduction

Freshwater is essential for agriculture, industry and human existence; it is a finite resource of earth. Without adequate quality and quantity of freshwater, sustainable development will not be possible (Kumar, 2000; Mahananda *et. al.*, 2005). Freshwater resource are becoming deteriorate day-by-day at very faster rate. Now water quality is a global problem (Mahananda *et. al.*, 2005). The healthy aquatic system is dependent on the biological diversity and physicochemical characteristics (Venkateshraju *et. al.*, 2010).

Water is one of the important natural resources useful for development purposes in both urban as well as rural areas. Most of the rural communities depends upon rivers, streams, water reservoirs, ponds, lakes etc. for their domestic as well as agricultural needs, whereas urban people depends on these water sources for domestic and industrial purposes. But on the other hand the domestic, agricultural and industrial wastes have been discharged back to these water sources, from which these water resources get polluted and ultimately lead to different types of diseases and toxic effects. Most of surface water resources accessible to household use in rural areas are subjected to chemical and biological contaminations which may come from animals, septic tanks, storm water runoff. There are various sources which are responsible to change the biodiversity of particular area (Ingole *et. al,* 2011). In hydro biological studies Ganapati (1960), Sinha and Srivastava (1997) have shown that urbanization is the root cause of water pollution. Nevondo and Cloete (1991) observed that in area where potable water supply are provided the supplies are unreliable and insufficient, forcing residence to reverse to traditional contaminated water resources. It is therefore essential to monitor the physico-chemical and microbiological quality of water supply in rural areas in order to highlight the quality of water supply to sustained government intervention. The present study has been carried out to analyze physico-chemical parameters of water from Hiranyakeshi River which flows from two important states of India viz. Maharashtra and Karnataka and joins Ghataprabha River in Karnataka state.

II. Materials and Methods

a) *Study area and sampling*

Hiranyakeshi River (Figure I) is one of the important Rivers flowing intwo states of India (Maharashtra and Karnataka). The River originates at Amboli hill station from Sindhudurg district of Maharashtra and within a fewkilometers it enters into Kolhapur district of Maharashtra. From this district itenters into Belgaum district of Karnataka, overall it travels about 140 KM sdistance and finally meets to Ghataprabha River. Geographically the area is flat except some part of Sawantwadi and Ajara Tahsil.

The climate is moderate subtropical with average rainfall 1500 mmannually. Major area of the basin of River is under agricultural practice whereas remaining is forest covered. The quantity and quality of water from this Riveris affected by municipal, industrial as well as agricultural discharge. Foranalysis, six different sampling sites have been selected as shown in picture I. Site no. I is birth place of this river at Amboli (N $15^0$57'30" E $74^0$01'65"). Site No. II is at Medhewadi (N $16^0$07'60" E $74^0$07'37") where effluent from Ajara Sugar mill, Gavase has being discharged. Site No. III is at Hajgoli (N $16^0$08'62"E $74^0$13'58"). Site No. IV is at Harali (N $16^0$14'03" E $74^0$23'22"). At this siteeffluent from Gadhinglaj sugar mill as well as municipal waste of Gadhinglajcity has being discharged. Site No. V is at Chikalgud (N $16^0$12'40" E$74^0$31'10"). Municipal waste of Sankeshwar city and effluent of Hira sugarmills,

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Sankeshwar has being added into river water at this site. Site No. VI is at Sultanpur (N $16^0$10'90" E $74^0$39'18"). This is last site before joining of Gathaprabha River. At all sites except Site No. I agricultural waste being added.

b) Collection of Samples

The samples of surface water were collected seasonally from six differentsites of Hiranyakeshi River during January 2010 to December 2010. The samples were collected in plastic container in the morning hours and brought to the laboratory for further analysis.

c) Analysis Analysis of physico-chemical properties

For the analysis, standard methods were used. Some parameters like Temperature and pH were done at the investigation sites. The sample for DO as fixed in the BOD bottle at the sites and then brought to the Laboratory for analysis. Winkler's method was followed for this analysis, while remaining analysis was made by the standard methods of APHA (2005) and Trivedy and Goel (1984).

III. Result and Discussion

The seasonal physico-chemical parameters of six different sites of Hiranykeshi River has been analyzed from January 2010 to December 2010 and shown in Table I, II and III along with the mean and standard deviation.

a) Temperature

Air temperature (Graph I) values ranged from 20^0C to 33^0C. Water temperature (Graph II) values ranged from 19^0C to 27^0 C. In present study it has been found that air and water temperature goes more or less parallel proving the fact that the atmospheric temperature governs the water temperature (Welch,1952; Naik & Purohit, 1996; Mishra & Patel, 2001; Yadav, 2003).

b) Electric Conductivity

The electrical conductivity values (Graph III) ranged between 0.03mS cm^{-1} to 0.58 $mScm^{-1}$. It was minimum during winter season at site I and maximum during summer season at site VI. Conductivity gives an idea of the total solids content of water. The electric conductivity was low at birth place of river. This was due to low salts as there were no polluted areas. Higher valuerecorded during summer months may be due to the accumulation of ions owingto evaporation, biological turn over and interaction with sediments. These findings are in agreement with statement of Payne (1986). EC values at site VIduring winter and summer seasons were exceeding the limits of WHO. Elevatedlevel of conductivity along with high dissolved solids can cause certain physiological effects on desirable food plants and habitat forming plant species, gives a mineral taste in drinking water and can be a problem in water used forirrigation (Sikder *et. al,* 2012).

c) pH

The pH concentration values (Graph IV) ranged between 4.91 and 7.80. It was minimum during winter at site I and maximum during winter at site V. Inall seasons it was acidic at site I. The pH is an important factor in determining productivity of an ecosystem. The indirect effects of pH are more important than the direct effects (Singh *et. al.* 2009). Most of the biochemical parametersof aquatic bodies are influenced by pH (Davis, 1955; Singh & Swarup, 1979). Nair *et. al* (1989) and Sugunan (1980) recorded maximum pH values duringwinter followed by summer and monsoon season. Similar results were found by Fadtare *et. al.* (2007) from Mula, Mutha and Pawana River from Pune.

d) Free CO_2

The concentration of free carbon dioxide values (Graph V) ranged between 4.4 mg L^{-1} to 30.8 mg L^{-1}. It was maximum during winter season at site IIIand minimum during all seasons at site I and during rainy season at site VI. Similar results were observed by Chanu and Devi (2008). Lower level of freecarbon dioxide during summer months might be due to high photosyntheticactivity utilizing free CO2, which is in agreement with the work of Yusuf *et.al.* (1996).

e) Total Alkalinity

The total alkalinity values (Graph VI) ranged between 04 mg L^{-1} to 76 mg L^{-1}. It was minimum during rainy season at site I and maximum during summer season at site VI. The values having 40 mg $L^{-1}$and more levels of total alkalinityare considered to be more productive than the water with low alkalinity (Sonawane *et. al.*, 2009). According to Durrani (1993), withdrawal of CO2 from bicarbonates for photosynthesis by algae may increase total alkalinity. To talalkalinity may be used as a tool for measurement of productivity.

f) Total Hardness

The total hardness (Graph VII) ranged from16 mg L^{-1} to192 mg L^{-1}. It was minimum during winter and rainy seasons at site I and maximum during summer season at site V. Kannan (1991) has classified wateron the basis of hardness values in the following manner, 0-60 mg L^{-1} soft, 61-120mg L^{-1} moderately hard, 121-180 mg L^{-1} hard and above 180 mg L^{-1} very hard. Total hardness of water is not a pollution parameter but indicates water quality interms of Ca^{++} and Mg^{++} cations. Hardness of the Hiranyakeshi River was within the permissible limit of WHO. Hardness below 300 mg L^{-1} is consideredpotable but beyond this limits cause gastrointestinal irritation (ICMR, 1975).Normal water hardness does not pose any direct health problems. Due to addition of sewage and large scale human use, this might cause elevation of hardness (Dakshini & Soni, 1997; Kumar, 2000; Mohanta & Patra, 2000). The total hardness above 200 mg L^{-1} is not suitable for domestic use like drinking and cleaning.

Calcium hardness (Graph VIII) ranged between 2.4 mg L^{-1} to 64.10 mg L^{-1}. It was minimum during rainy season at site I while maximum during summer season at site V. Magnesium hardness values (Graph IX) ranged between 1.02 mg L^{-1} to 31 mg L^{-1}. It was minimum and maximum in summer season at site VI and site Vrespectively.

g) Sodium

Sodium ion concentration (Graph X) ranged between 00 mg L^{-1} to 90 mg L^{-1}. It wasnil at site I during summer season while maximum at site V during winter season.

h) Potassium

Potassium ion concentration (Graph XI) ranged between 00 mg L^{-1} to 10 mg L^{-1}. It was near about totally absent during summer and rainy seasons at all the sites and it was recorded highest during winter at site V. Similar range was noted by Azadeh *et. al.* (2009) at sediments of Kabini River. The similar trend of increased sodium and potassium in winter season anddecreased range in summer season were also observed by Chanu *et. al* (2008).

In general, concentration of sodium remains quite higher than the potassium innatural water, thus high values being an indication of pollution by domesticsewage (Trivedi & Goel, 1984). The concentration of sodium is higher than thatof potassium in the present study.

i) Chloride

The concentration of chloride values (Graph XII) ranged from 7.44 mg L^{-1} to 86.8 mg L^{-1}. It was minimum during rainy season at site I while maximum during summer atsite V. In site V the trend of chloride concentration is high in all the seasons because the municipal sewage as well as effluent of Hira Sugar Factory was released in river water. Chloride is reported to be an indication of pollution when present in higher concentration. The suggestions of Royal Commission that water having 30 mg L^{-1} of chloride is reported to be fairly clean. Sources of chloride pollution in water include fertilizers, sewage, effluents from drainage, salts and human as well as animal wastes. High chloride content cause highblood pressure in people (Subin *et. al.* 2011). Similar trend was observed by Gunale (1981) and he has reported chloride concentration ranged between 11.4 mg L^{-1} and 36.4 mg L^{-1} for various sites in Pune. Chlorides are toxic to most plants so they should be checked for irrigation water. The tolerance limit for surface water used for irrigation is 600 mg L^{-1} (Fadtare *et. al.* 2007). The values obtained from above investigation from river Hiranykeshi for all the sites can be suitably used for irrigation without any hazardous effect.

j) Nitrate

The nitrate concentration values (Graph XIII) ranged from 00 mg L^{-1} to0.114 mg L^{-1}. It was maximum during winter at site V and was nil during summerand rainy at all the sites except site V & VI. The similar trend was observed by Rita Kumari *et. al.* (2011) which was ranged between 0.038 mg L^{-1} and 0.28 mg L^{-1}.

k) Phosphate

The phosphate concentration values (Graph XIV) ranged from 00 mg L^{-1} to 0.165 mg L^{-1}. It was maximum during winter at site VI because of agricultural runoffand nil during summer and rainy at site I, II and III. Similar results were observed by Gunale (1981), who found the range in 0.113 mg L^{-1} to 0.912 mg L^{-1}. Inriver Bhavani at Erode region. Kulandaivel *et. al.* (2009) shown similar range of 0.06 mg L^{-1} to 0.24 mg L^{-1}. The total phosphates in river are due to mixing up of agricultural runoff. From above investigation it reflects that on the both the sites of river banks, the agricultural activities results in flowing of excess fertilizersinto the river streams.

l) Sulfate

The sulfate concentration values (Graph XV) ranged between 00 mg L^{-1} to 20 mg L^{-1}. It was maximum during winter at site V and it was nil during summer at site I, II, III and IV. Similar results were observed by In gole *et. al* (2011) at Sipna river, Melgh at. The tolerance limit for sulfate in surface waters used forirrigation is 1000 mg L^{-1}. Values of sulfates for the river are low hence suitable for irrigation.

Similar trend for phosphate, sulfate and nitrates were also observed by Rita Kumari *et. al.* (2011), Sinha and Prasad (1998), Ahmad (1996) and Foy *et. al.* (2003) which were within the permissible limit suitable for fish production. From the above results it has been concluded that the increasing trend of nutrients like nitrate, sulfate and phosphate were observed only in winter season because during this season al though the agricultural runoff is there, water dilution do not takes place and during summer season because of scarcity of water, agricultural runoff might not be seen hence in winter season because of agricultural runoff and low dilution rate nutrient level increases.

m) Dissolved Oxygen

The DO concentration values (Graph XVI) ranged between 4 mg L^{-1} to 9mg L^{-1}. It was minimum during summer at site V while maximum during rainy atsite V. DO concentration more than 5 mg L^{-1} favors good growth of flora and fauna (Das, 2000). Similar results were observed by Ingole *et. al* (2011) from Sipna river. The DO was least during summer and high during monsoon season. Low D. O. level indicates that the oxygen replenishment rate is lower than that of utilization. The decomposition of organic matter and microbial activity washigh in warm weather (Morissote, *et. al* 1978). The saturation of atmosphericoxygen is more intense in running water than confined water (Singh *et. al.* 2009).

IV. Conclusion

Physico-chemical parameters at all sites were observed under the limits of WHO standards but at Site V comparatively these were increased than that of other sites because of continuous addition of domestic sewage and sugar milleffluents in heavy quantity. Although there is no direct effect might be seen at present but it might affect the quality of water and ultimate consequences would be faced in future.

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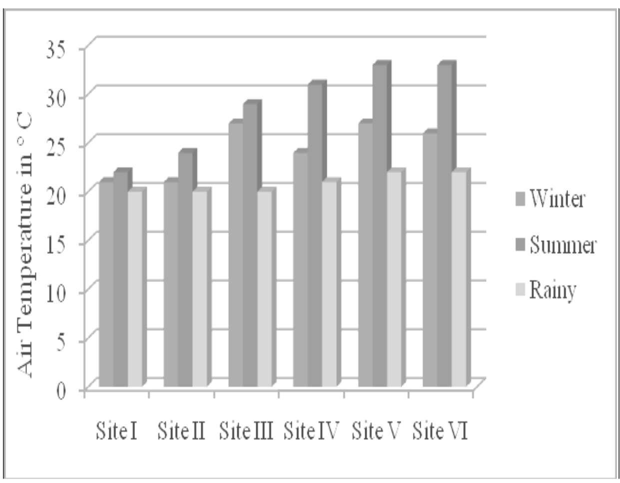
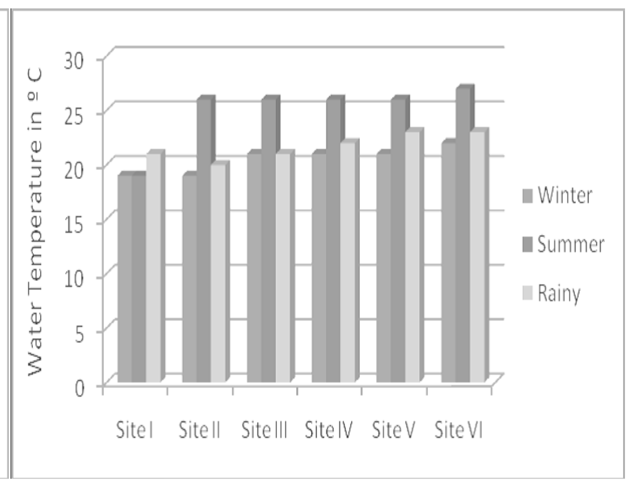
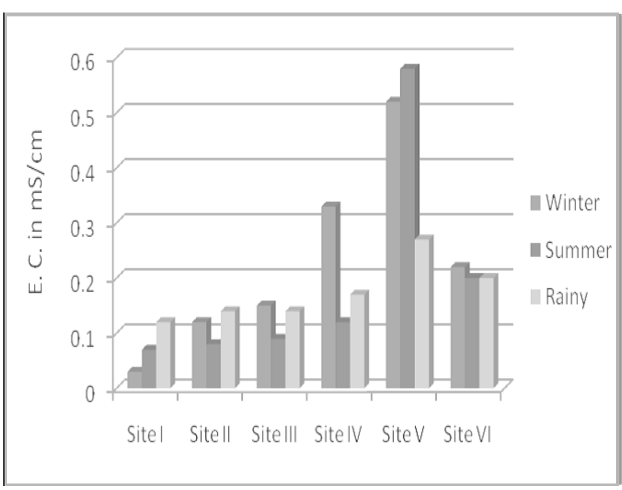
Graphical representation of physico-chemical parameters of Hiranyakeshi River



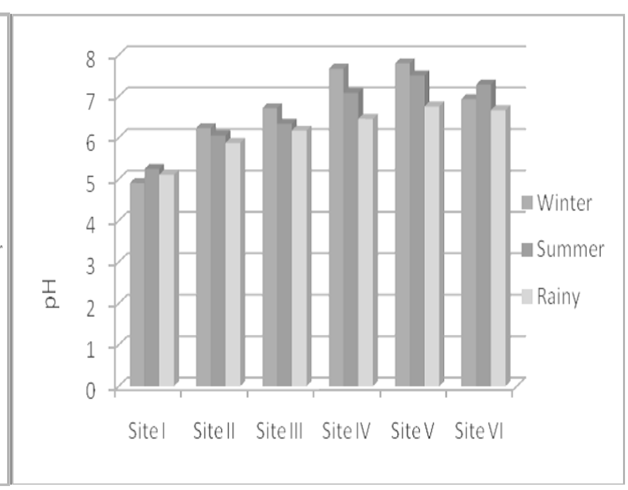
Graph. i : Seasonal variations in Air temperature



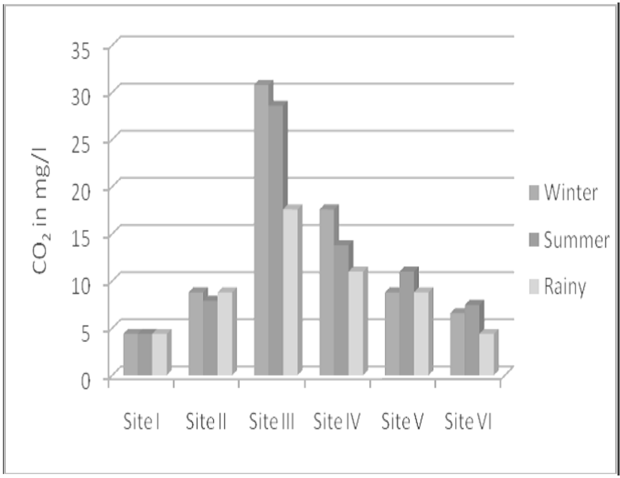
Graph. ii : Seasonal variations in Water temperature



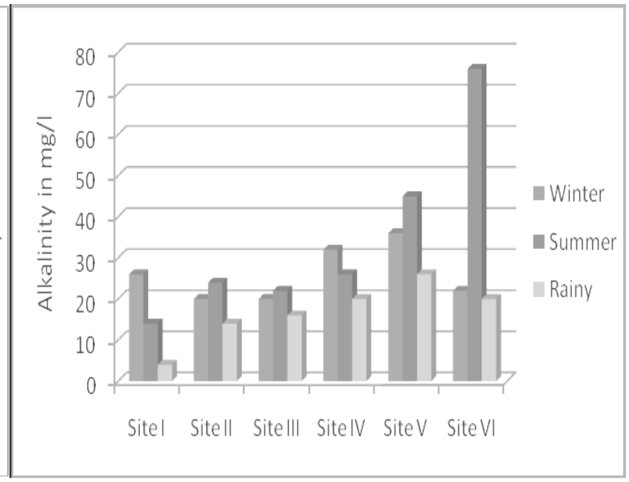
Graph. iii : Seasonal variations in E.C



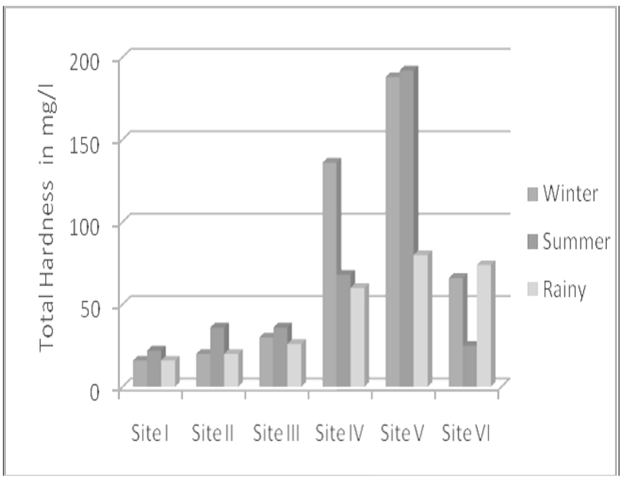
Graph. iv : Seasonal variations in pH



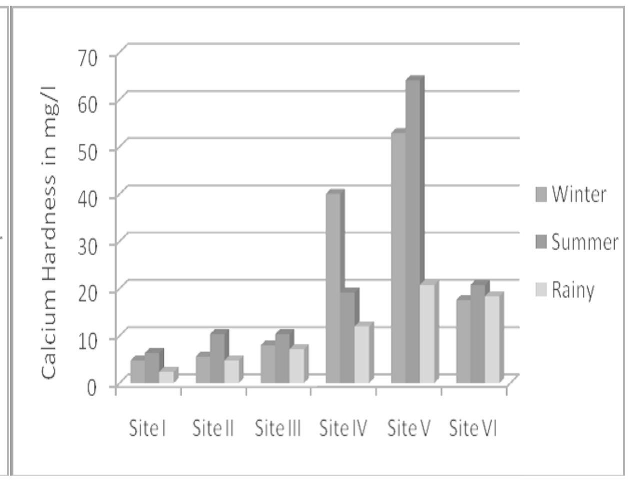
Graph. v : Seasonal variations in CO_2



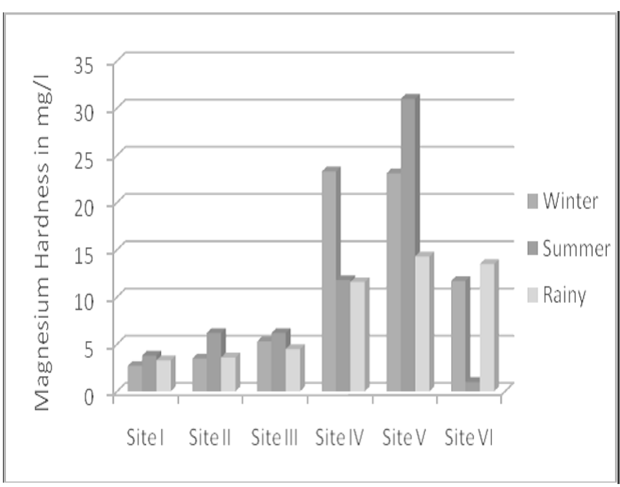
Graph. vi : Seasonal variations in Alkalinity



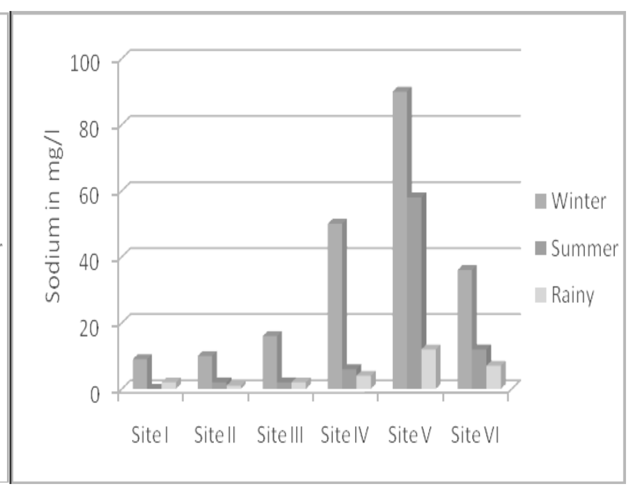
Graph. vii : Seasonal variations in Total Hardness



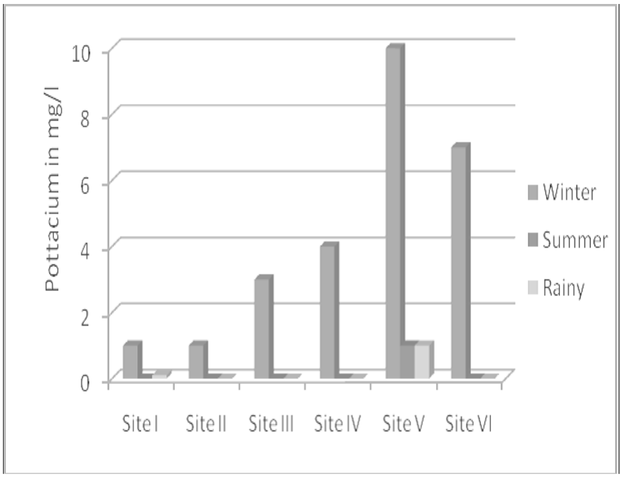
Graph. viii : Seasonal variations in Calcium Hardness



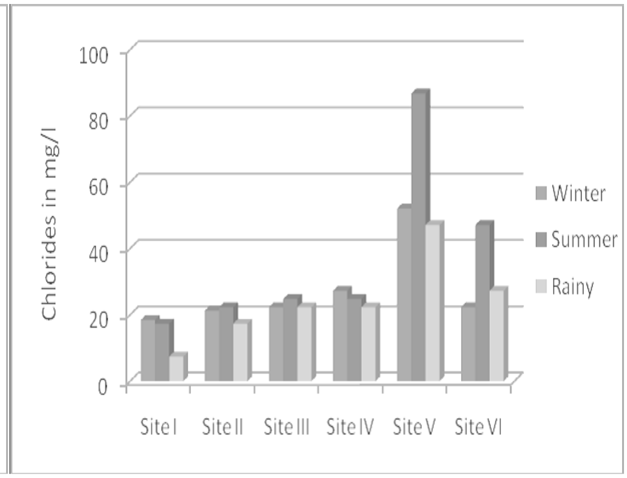
Graph. ix : Seasonal variations in Magnesium Hardness



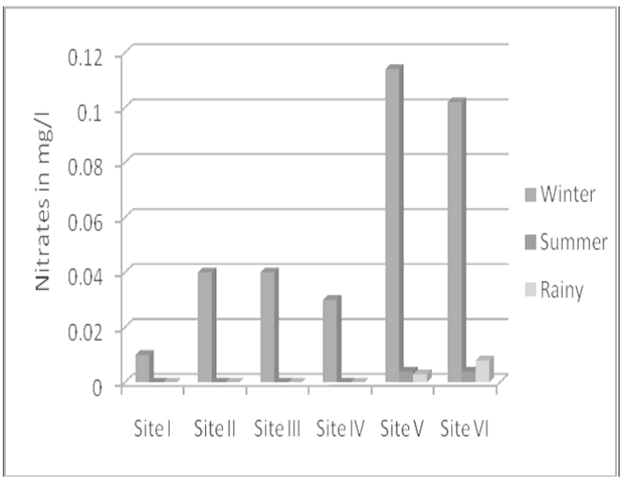
Graph. x : Seasonal variations in Sodium



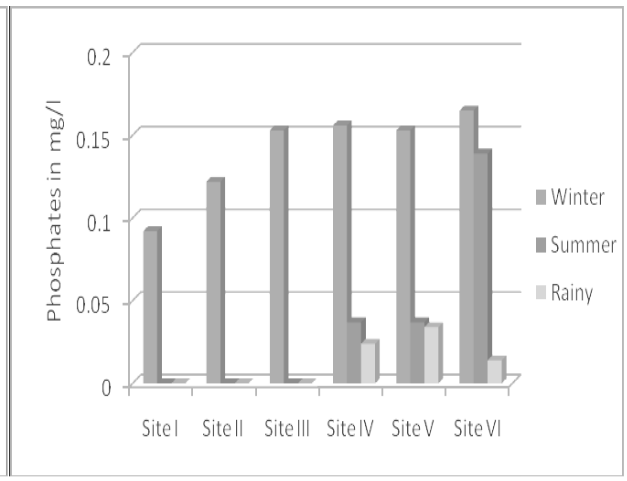
Graph. xi : Seasonal variations in Potassium



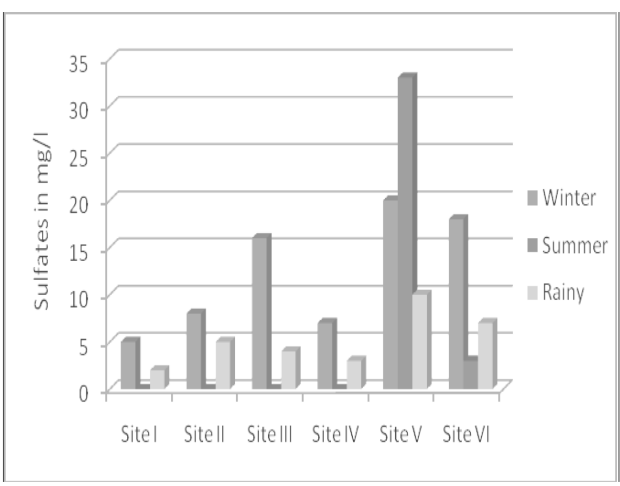
Graph. xii : Seasonal variations in Chlorides



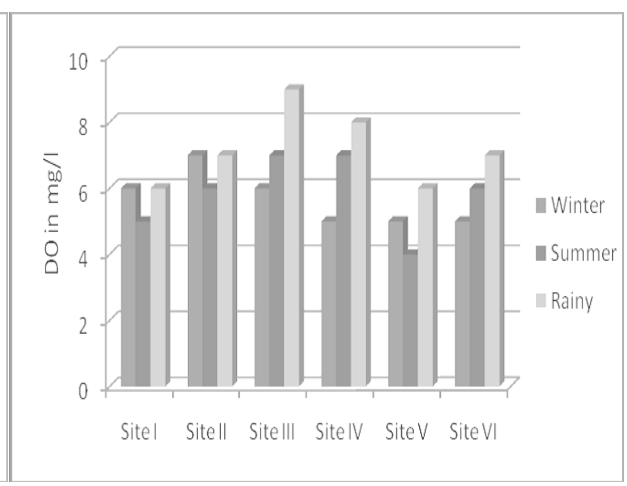
Graph. xiii : Seasonal variations in Nitrates



Graph. xiv : Seasonal variations in Phosphates



Graph. xv : Seasonal variations in Sulfates



Graph. xvi : Seasonal variations in DO

Table 1 : Physico- chemical parameters of six sites of Hiranyakeshi River during Winter Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	21	21	27	24	26	26	24.16667	2.409472
Water Temperature	19	19	21	21	21	22	20.5	1.118034
E. C.	0.03	0.12	0.15	0.33	0.52	0.22	0.228333	0.159522
pH	4.91	6.24	6.72	7.67	7.8	6.94	6.713333	0.96812
Free CO_2	4.4	8.8	30.8	17.6	8.8	6.6	12.83333	9.018808
Total Alkalinity	26	20	20	32	36	22	26	6.110101
Total Hardness	16	20	30	136	188	66	76	64.67354
Ca- Hardness	4.8	5.6	8.02	40.1	52.9	17.6	21.50333	18.53169
Mg- Hardness	2.72	3.5	5.3	23.3	23.1	11.7	11.60333	8.691992
Sodium	9	10	16	50	90	36	35.16667	28.61478
Potassium	1	1	3	4	10	7	4.333333	3.248931
Chlorides	1846	21.3	22.32	27.28	52.08	22.32	331.8833	677.2178
Nitrates	0.001	0.004	0.04	0.03	0.114	0.102	0.0485	0.044354
Phosphates	0.092	0.122	0.153	0.156	0.153	0.165	0.140167	0.025321
Sulfates	5	8	16	7	20	18	12.33333	5.849976
DO	6	7	6	5	5	5	5.666667	0.745356

Table 2 : Physico- chemical parameters of six sites of Hiranyakeshi River during Summer Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	22	24	29	31	33	33	28.66667	4.268749
Water Temperature	19	26	26	26	26	27	25	2.708013
E. C.	0.07	0.08	0.09	0.12	0.58	0.2	0.19	0.179629
pH	5.25	6.06	6.34	7.09	7.51	7.29	6.59	0.787972
Free CO_2	4.4	7.92	28.6	13.8	11	7.48	12.2	7.899333
Total Alkalinity	14	24	22	26	45	76	34.5	20.7826
Total Hardness	22	36	36	68	192	25	63.16667	59.51027
Ca- Hardness	6.4	10.4	10.4	19.2	64.1	20.8	21.88333	19.55372
Mg- Hardness	3.8	6.2	6.2	11.8	31	1.02	10.00333	9.93479
Sodium	0	2	2	6	58	12	13.33333	20.35245
Potassium	0	0	0	0	1	0	0.166667	0.372678
Chlorides	17.36	22.32	24.8	24.8	86.8	47.12	37.2	24.08709
Nitrates	0	0	0	0	0.004	0.004	0.001333	0.001886
Phosphates	0	0	0	0.037	0.037	0.139	0.0355	0.049155
Sulfates	0	0	0	0	33	3	6	12.12436
DO	5	6	7	7	4	6	5.833333	1.067187

Table 3 : Physico- chemical parameters of six sites of Hiranyakeshi River during Rainy Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	20	20	20	21	22	22	20.83333	0.897527
Water Temperature	21	20	21	22	23	23	21.66667	1.105542
E. C.	0.12	0.14	0.14	0.17	0.27	0.2	0.173333	0.050222
pH	5.11	5.88	6.18	6.46	6.76	6.67	6.176667	0.561209
Free CO_2	4.4	8.8	17.6	11	8.8	4.4	9.166667	4.475737
Total Alkalinity	4	14	16	20	26	20	16.66667	6.798693
Total Hardness	16	20	26	60	80	74	46	26.17887
Ca- Hardness	2.4	4.8	7.2	12.03	20.8	18.4	10.93833	6.815156
Mg- Hardness	3.3	3.6	4.5	11.6	14.3	13.5	8.466667	4.748567
Sodium	2	1	2	4	12	7	4.666667	3.815174
Potassium	0.1	0	0	0	1	0	0.183333	0.367045
Chlorides	7.44	17.36	22.32	22.32	47.12	27.28	23.97333	12.03645
Nitrates	0	0	0	0	0.003	0.008	0.001833	0.002967
Phosphates	0	0	0	0.024	0.034	0.014	0.012	0.013317
Sulfates	2	5	4	3	10	7	5.166667	2.67187
DO	6	7	9	8	6	7	7.166667	1.067187

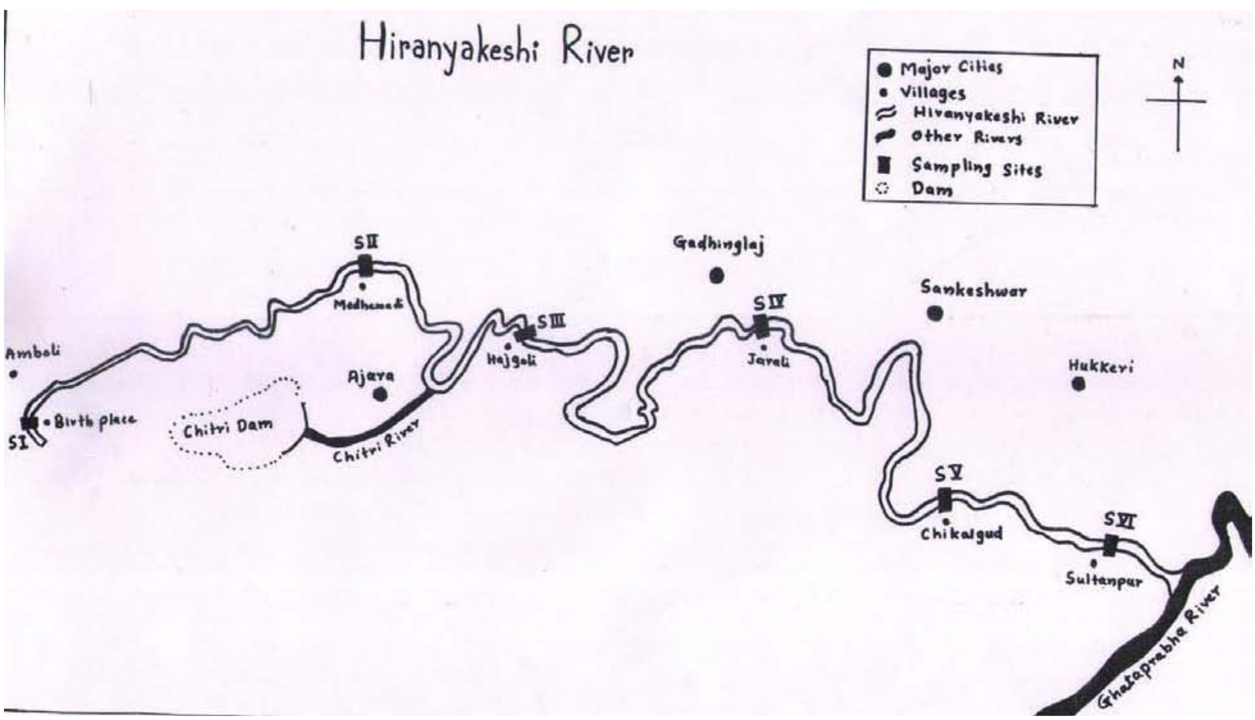


Figure I : Map of Hiranyakeshi River showing sampling sites