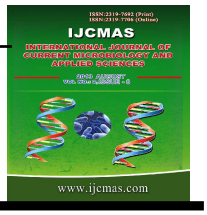
International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 2 Number 8 (2013) pp. 114-123**
http://www.ijcmas.com



Original Research Article

Current status of physico-chemical characteristics and biological factor of W.Ramganga River in Kumaun Himalaya, India

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A B S T R A C T

Western Ramganga is the major river system of kumaun Himalaya, was studied for seven prime physicochemical parameters and two biological factors at five locations for a period of three years (2009–2012) at monthly intervals. The physical factors are water temperature, water current and turbidity of water; whereas the chemical parameters of river comprise pH, dissolved oxygen, total alkalinity and total hardness of water. The biological factors considered were macro-zoo benthos and plankton of the river. River was highly productive as presence of various class and order of benthos, zooplankton and phytoplankton although there were no sign of problems like eutrophication. Biological studies indicate that river water was fit for aquatic organism, such as fishes because of there were plenty of food. Over the years of time, river has been subjected to study and observer very modest human interference (because of very little or no urbanization and since there were no major industries) and water quality was not to be getting deteriorated. physico-chemical parameters levels indicate the moderate quality of water. Thus present study concludes that river water was not polluted; all results are within permissible limit when compared with safe water quality standards.

Keywords

Seasonal changes; Physico-chemical characteristics; River W.Ramganga; biological factor; Water quality.

Introduction

The river ecology is mostly studied for two reasons, firstly for development of aquaculture and secondly for measuring the extent of pollution. The physico-chemical as well as the biological factor of river have vital role in aquaculture and productivity of fishes. The quality of water determines the quality of fish to be produced in it. The physical factors are water temperature, water current and turbidity of water; whereas the chemical parameters of river comprise pH, dissolved oxygen, total alkalinity and total hardness of water. The biological factors considered were macro-zoo benthos and plankton of the river. The seasonal changes in different physico-chemical parameters are responsible for annual variation and growth of biological factors viz. macro-zoo benthos and plankton etc.

Tepe *et al*., (2005) found that the water quality attributes such as water temperature, light penetration, dissolved

oxygen, total alkalinity and total hardness are the representative of the seasonal fluctuation. Ali e*t al*., (2006) showed that the water quality of fresh water ecosystem undergoes complex changes due to all physico-chemical factors and water quality as a sequence disrupting the aquatic life. Hayat *et al.,* (1996) and Jena *et al*., (1998) revealed that temperature and ecological conditions are responsible for the fluctuation of salt contents, which in turn influence the production, and growth of fish.

Materials and Methods

The sampling was carried out in Uttarakhand state in at five different spot they are Chaukhutia, masi, bhikiyasen, salt, ganai (Latitude: 29° 53' 55" N and Longitude: 79° 21' 22" E), annually between September 2009 to August 2012 for three years. About 12 water sample were collected in each months.

The physicochemical factors are water temperature, water current, turbidity of water, pH, dissolved oxygen, total alkalinity and total hardness of water, whereas biological factors were macro-zoo benthos and plankton of the river. Study of physicochemical factors was carried out by using standard methods (APHA, 1998). For the qualitative estimation Safe water quality standards were use (Boyd and Tucker, 1998; Ali *et al.,* 2000). Macro-zoobenthos collected from 1 m^2 area of stream at the depth of 15 cm. The plankton was sampled at each spot by filtering 100 liters of water. Preservation was made on the spot in 4 % formalin. The quantitative analysis of plankton was made with the help of Sedgwick - Rafter counting slide as suggested by Welch (1952).

Result and Discussion

Water temperature

The average water temperature of river was found to be varying from 14.12°C to 21.58°C during January to August respectively. Thus, water of Western Ramganga is coldest in winter and hottest in Monsoon (Table.1).

Water velocity

While calculating the velocity of water, we observed that the rate of water flow is fluctuated from a minimum value of 0.307 m/s in February to a maximum value of 0.899 m/s in August. Thus the water current with a rate of 0.313 m/s in winters to 0.849 m/s in monsoon is useful for fish survive (Table 2).

Turbidity

It has been observed that the water is highly turbid during Manson period (July-August) with a value of 92.9 NTU. This is obvious because water becomes turbid due to the rain fall and flash flood. With an unusual variation water was found extremely less turbid during rest of the seasons with the minimum of 7.9 NTU in winter (Table 3).

pH

pH fluctuation occur only within a narrow range. The pH of river was found to be varying from 7.76 to 8.32 during July to December. Therefore, during monsoon the water is least basic and it seems more basic during winter (Table 4).

Table.1 Average monthly and seasonal variation in water temperature (°C) of river

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Spot 1	20.4	19.7	17.9	14.5	12.7	13.2	15.9	16.5	17.8	20.4	21.6	21.9
Spot 2	19.5	18.6	17.7	16.4	15.6	16.8	18.3	18.3	19.6	20.6	20.4	20.8
Spot 3	20.6	18.8	16.9	13.4	11.6	12.3	16.6	18.1	19.8	19.5	20.8	22.4
Spot 4	19.6	18.6	17.6	16.8	15.3	17.5	18.7	19.5	20.6	20.8	21.5	21.3
Spot 5	19.5	18.8	17.3	16.7	15.4	17.7	18.8	19.2	20.9	20.1	20.4	21.5
Average	19.92	18.9	17.48	15.56	14.12	15.5	17.66	18.32	19.74	20.28	20.94	21.58
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	18.77			15.06			17.99		20.01		21.26	

Table.2 Average monthly and seasonal variation in water current velocity (m/s) of river

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Spot 1	0.615	0.433	0.269	0.281	0.274	0.289	0.364	0.393	0.416	0.576	0.663	0.849
Spot 2	0.813	0.522	0.391	0.324	0.314	0.304	0.337	0.393	0.428	0.438	0.864	0.957
Spot 3	0.651	0.434	0.354	0.265	0.261	0.271	0.366	0.398	0.421	0.421	0.633	0.765
Spot 4	0.811	0.614	0.483	0.388	0.391	0.337	0.351	0.598	0.924	0.924	0.963	0.972
Spot 5	0.813	0.619	0.433	0.335	0.325	0.334	0.349	0.598	0.944	0.923	0.877	0.951
Average	0.741	0.524	0.386	0.319	0.313	0.307	0.353	0.476	0.627	0.656	0.800	0.899
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	0.55			0.313			0.415		0.642		0.849	

Table.3 Average monthly and seasonal variation in turbidity (NTU) of river

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Spot 1	51	31	11	08	10	09	11	17	10	12	95	86
Spot 2	64	41	18	07	10	06	05	11	09	17	91	96
Spot 3	59	39	14	05	07	05	08	09	11	22	88	99
Spot 4	61	31	12	11	08	07	09	06	13	21	89	94
Spot 5	57	27	10	09	08	09	07	05	09	19	94	97
Average	58.4	33.8	13	8.0	8.6	7.2	8.0	9.6	10.4	18.2	91.4	94.4
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	35.1			7.9			8.8		14.3		92.9	

Table.4 Average monthly and seasonal variation in pH of river

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Spot 1	8.3	8.2	8.6	8.2	8.1	8.2	8.3	8.2	8.1	8.2	7.9	7.9
Spot 2	7.3	7.4	7.7	8.1	8.3	7.4	8.3	8.2	8.7	8.6	7.6	7.6
Spot 3	8.2	8.3	8.1	8.7	8.4	8.1	8.6	8.2	7.9	7.9	7.2	7.8
Spot 4	7.9	7.8	8.3	8.5	8.2	8.2	8.1	8.2	8.3	8.5	8.1	8.1
Spot 5	7.6	7.8	8.0	8.1	8.2	8.0	8.1	8.2	8.3	8.3	8.0	8.1
Average	7.86	7.9	8.14	8.32	8.24	7.98	8.28	8.2	8.26	8.3	7.76	7.9
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	7.967			8.18			8.24		8.28		7.83	

Dissolved Oxygen

In December, the oxygen content dissolved in water was found to be highest with the value of 10.72 mg/l. The river has less DO content in July with the value of 7.6 mg/l. Thus the fish can endure water having the dissolved oxygen content from 7.93 mg/l (during monsoon) to 10.57 mg/l (during winter). (Table 5).

Total Alkalinity

In our observation it has been observed that the river water was alkaline and the magnitude was varying from 59.34 mg/l to 100.46 mg/l from August to February. Thus, the water of Ramganga is most alkaline during winter and then with a regular decrement is least alkaline during monsoon(Table 6).

Total Hardness

The degree of hardness calculated in the river water was lowest in July (78.52 mg/l) and highest in February (109.26 mg/l). The study summarized that the water in winter is highly hard, while least hard during monsoon. (Table 7).

Macro-zoo benthic Density

The number of Ephemeroptera (211 Units/m^2 in December while 12 Units/m^2 in July), Trichopteran (210 Units/m^2 in December while 8 Units/m^2 in July), Dipteran (13 Units/m^2 in July while 145 Units/m^2 in February), Plecopteran nymphs (51 Units/m^2 in January while 1 Unit/m^2 in August), Coleopteran larvae (99 Units/m^2 in December while 9 Units/m^2 in July). Odonata larvae (130 Units/m^2 in December while 7 Units/m^2 in June). The average total macro-zoobenthos observed (812 Units/m^2 in December while 56 Units/m^2 in July) and (in winter season 646.33 Units/m^2 while during Monsoon 114 Units/m^2). (Table 8).

Plankton Diversity

The total phytoplanktons were Chlorophyceae, Bacillariophyceae and Cyanophyceae (2925 Units/l in January while 400 Units/l in August). The total zooplanktons were Crustaceans and Rotifers (25 Units/l in August and 400 Units/l in January). The total plankton density vary (3110 Units/l in January to 425 Units/ l in August). (Table 9)

In the present study, the water temperature of the river was observed to be moderate throughout the year. This moderate water temperature is due to its spring-fed nature of origin. It is also supported by Odum (1971) that photoperiod was shorter in winter than summer which is directly related to temperature and hence water temperature is highest in June. The velocity of water current was observed to be fluctuated from a minimum of 0.307 m/s (February) to a maximum of 0.899 m/s (August). It is also obvious from our study that the average rate of water is highest in monsoon whereas lowest in winter. Thus it has been conclude that the velocity of water current is very low in comparison to other hill streams probably due to lower gradient of water flow.

In present study water was highly turbid during Monsoon (July-August) while very low during rest of the seasons with the minimum of 7.9 NTU in winter. These observations are also supported by Jhingran (1965) who reported that turbidity generally increased to a maximum value in Monsoon due to the suspended solids in the flooded water whereas, during the post Monsoon months the turbidity values were low but increased again during the summer months with the

Table.5 Average monthly and seasonal variation in dissolve oxygen (mg/l) of river

Month	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Spot 1	8.5	9.3	9.8	10.5	10.3	9.8	8.9	8.4	8.6	7.8	7.2	8.1
Spot 2	8.6	9.3	10.1	10.4	10.8	11.3	8.9	7.8	7.2	7.4	7.4	7.1
Spot 3	8.7	9.4	9.2	10.9	10.1	9.8	8.9	9.5	8.3	7.9	8.2	8.7
Spot 4	9.3	9.9	10.5	11.1	10.9	10.4	9.3	8.7	7.4	7.4	8.2	8.3
Spot 5	9.5	9.8	10.5	10.7	11.2	10.4	9.3	8.6	7.9	7.5	7.9	8.2
Average	8.92	9.54	10.02	10.72	10.66	10.34	9.06	8.6	7.88	7.6	7.78	8.08
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	9.493			10.57			8.83		8.24		7.93	

Table.6 Average monthly and seasonal variation in total alkalinity (mg/l) of river

Month	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Spot 1	64.4	73.5	85.9	89.9	92.4	91.9	80.1	76.2	71.0	64.2	62.4	60.8
Spot 2	62.5	79.8	89.1	99.2	101.2	96.2	87.1	80.8	74.1	63	61.7	61.8
Spot 3	67.8	77.6	81.1	101.5	99.2	99.6	83.4	78.5	74.7	62.7	65.4	59.9
Spot 4	70.4	91.1	95.3	98.2	99.8	103.3	97.1	79.7	70.2	71.1	60.1	57.6
Spot 5	71.1	87.1	91.3	91.9	108.2	111.3	97.1	81.7	73.2	73.1	62.8	56.6
Average	67.24	81.82	88.54	96.14	100.16	100.46	88.96	79.38	72.64	66.82	62.48	59.34
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	79.2			98.92			84.17		69.73		60.91	

Table.7 Average monthly and seasonal variation in total hardness (mg/l) of river

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Spot 1	77.2	82.5	90.6	92.3	97.5	101.2	93.7	91.2	89.1	75.4	77.5	78.2
Spot 2	78.2	82.1	89.2	96.7	101.2	109.3	98.8	85.9	78.2	77.1	75.9	74.9
Spot 3	84.9	89.6	98.4	99.6	103.1	104.3	98.5	99.8	92	90	84.4	81.7
Spot 4	88.2	91.5	101.4	106.1	109.2	112.4	96.5	94.7	87.5	85.1	74.9	82.4
Spot 5	86.9	87.5	98.2	106.3	108.5	119.1	107.4	96.2	86.3	84.6	79.9	84.3
Average	83.08	86.64	95.56	100.2	103.9	109.26	98.98	93.56	86.62	82.44	78.52	80.3
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	88.42			104.45			96.27		84.53		79.41	

Table.8 Average monthly and seasonal variations in Macro-zoo benthic density (Units/m^2)

macrobenthic groups (Units/m^2)	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Ephemeroptera	64	110	144	211	155	149	73	52	24	21	12	35
Trichoptera	64	110	144	210	150	140	77	35	21	10	8	35
Diptera	62	88	139	142	110	145	116	63	43	34	13	29
Plecoptera	14	3	14	20	51	48	39	43	40	21	2	1
Coleoptera	22	94	88	99	39	46	61	22	38	11	9	22
Odonata	52	92	110	130	52	42	76	39	29	7	12	50
Total Macro-zoobenthos (Units/m^2)	278	497	639	812	557	570	442	254	195	104	56	172
Season	Autumn			Winter			Spring		Summer		Monsoon	
Range	471.33			646.33			348		151		114	

Table.9 Average monthly and seasonal variations of Plankton density (Units/l)

Plankton Group (Units/l)	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Chlorophyceae	230	475	650	500	600	375	725	325	510	135	275	Nil
Cyanophyceae	125	75	150	200	250	225	175	Nil	200	125	125	Nil
Total Phytoplankton	1080	2850	2629	2550	2925	2175	1725	1550	1420	950	802	400
Crustaceans	75	100	225	155	125	175	100	50	175	25	75	25
Rotifers	25	25	175	100	60	Nil	100	200	220	75	Nil	Nil
Total Zooplankton	100	125	400	215	185	175	200	250	395	100	75	25
Total plankton (Units/1)	1180	2975	3029	2805	3110	2350	1925	1800	1815	1050	877	425
Season	Autumn			Winter			Spring		Summer		Monsoon	

increase in tidal management and intensity. Upadhyay (1997) calculated the turbidity variation from 2 to 162 NTU.

pH is gradually increased from a minimum of 7.83 during Monsoon to a maximum of 8.28 during summer. Similar variations in pH of the river Khoh were recorded by Kumar et. al. (2006) in Garhwal Himalayas. They concluded that winter maxima for pH might be due to algal growth and minima in Monson might be due to influx of organic and inorganic ions in to the river caused by flash flood. Chacko and Srinivasan (1955) explained the hydro-biological feature of river Godavari having the pH range from 7.2 to 8.3. In our study DO highest during winter whereas lowest during, Ali (1999) reported that the dissolved oxygen variation shows inverse relationship with water temperature variation. Bhatt et. al. (1984) also reported high DO and low free CO_2 concentrations in winter for such hillstreams.

We study, the water of W. Ramganga was found to be most alkaline during winter and least during Monsoon. The similar study has been done by Vass *et al*., (1977) and observed that the alkalinity of Jhelum River is varies from 22 to 94 mg/l. Swingle (1967) calculated the alkalinity from 10 to 50 ppm. Total hardness show minimum during Monsoon to a maximum during winter. Our study is also supported by Ajmat *et al*., (1985), observed that the hardness of river Kali-nandi is highest during summer. Shukh (1996) estimated the hardness ranges from 90.6 to 160 mg/l in Betwa Koare dam.

Density of total Macro-zoobenthos and total plankton populations were plenty in winter while rarely during Monsoon. Detritus standing stock is the main reason for high density of benthos in winter and substratum stability too. Moderate temperature and low gradient of velocity favors the growth of biotic communities. Similar study was carried out by Rautela *et al*., (2006) who reported that the macro-zoo benthos had a maximum population during winter (325 Units/m^2) and the minimum (15 Units/m^2) during monsoon season. Sharma *et al*., (1990) also

observed that the average density of 677 Units/m^2 of macro-zoobenthos in the river Bhilangana. Similar observations are seen by Moitra and Bhattacharya (1965) that the moderate temperature favors the growth of plankton. Present study also show the maximum population of Bacillariophyceae in comparison to Chlorophyceae from western Ramganga. Our observation was resembled by the finding of Chakrabarty *et al*., (1959) in river Jamuna, Nautiyal (1982) in the river Alakanda, Khanna *et al*., (1992) in river Ganga.

Briefly, present study concluded that physicochemical parameters levels indicate the moderate quality of water, river water of the study area was not polluted in respect to physicochemical assessment. But biological studies indicate that river water was fit for aquatic organism, such as fishes because of there were plenty of food in the form of benthos, zooplankton and phytoplankton.

River Western Ramganga water was habitable for fishes and fit for development of aquaculture. There were no sign of problems like eutrophication. It is also concluded that the higher growth of macro-zoobenthos and planktons in the river is favoured by low water temperature, low current velocity, moderate turbidity with high DO, high alkalinity and high hardness during winters season.

Acknowledgement

The author acknowledges the LSRB-DRDO (R&D) New Delhi organization for financial assist and FRDL for Laboratory as well technical support.

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