ISSN NO. 2320-5407

Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/4465
DOI URL: http://dx.doi.org/10.21474/IJAR01/4465

RESEARCH ARTICLE

MONTHLY VARIATION OF PHYSICO-CHEMICAL PARAMETERS OF SNOW-FED SHARDA RIVER.

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Manuscript Info

Manuscript History

Received: 12 April 2017
Final Accepted: 14 May 2017
Published: June 2017

Key words:-
Sharda River, physico-chemical, seasonal variations, correlation.

Abstract

This investigation was carried on snow-fed perennial Sharda River between January 2012 and December 2012, during this period various physico-chemical parameters were studied and correlated. Correlation among these parameters showed a profound relationship between them, these parameters were also compared with some reference studies viz. BIS, EPA, WHO.

Introduction:-

As we know that water is one of the most important and precious natural resources for all living organisms including human beings. About 71 percent of the Earth's surface is water-covered, and the oceans hold about 96.5 percent of all Earth's water. Water also exists in the air as water vapor, in rivers and lakes, in icecaps and glaciers, in the ground as soil moisture and in aquifers, No doubt, we are dependent on rivers, lakes, streams for drinking water directly or through groundwater resources. Out of these, rivers are one of the most important sources of drinking water supply system. The Indian river system is made of seven major rivers along with their several tributaries. The majority of the rivers flow into the Bay of Bengal and some of the rivers flow into the Arabian Sea, On the other hand, some parts of India have inland drainage. The Indian River system is classified as Himalayan, peninsular, coastal, and inland-drainage basin rivers. In the present investigation, the Himalayan river system is considered.

The Himalayan rivers are snow-fed and perennial rivers. Due to rapid population and indisposed waste which directly effluents in the riverine ecosystem further deteriorate the water quality. Physico-chemical factors are perfect from the view point of the makeup of the structure of riverine ecosystems which are related to the ecological and geological conditions of the water bodies. Lotic water bodies are fluctuating time to time, therefore, a regular investigation is necessary for accessing the present status of the aquatic ecosystem. Recent water quality monitoring and multidisciplinary research of surface water have been carried around the world by several workers e.g., Joshi et al. 1993; Joshi and Singh, 2001; Shahnawaz et. al, 2009; Sarkar et. al, 2010; Sirajuden et. al, 2013; Pramod et. al, 2014 (a, b) etc. For this purpose, proper monitoring i.e. seasonal investigation is necessary for these aquatic lotic or riverine ecosystems.

The present water quality monitoring was done on Sharda River. The **Sharda River** is also called **Kali Gad** or **Kali Ganga** in Uttarakhand. This river originates from kumaun Himalaya at Kalapani at an altitude of 3600 m (approximate). This place is situated in district Pithoragarh of state Uttarakhand. This river is named Kali River in hilly areas of Uttarakhand, most places of which are in between India and Nepal and is marked as an international border. It is also named as Mahakali River in Nepal. When this river descends in the plains of Uttarakhand and Uttar Pradesh it is known as Sharda River. The river descends from 3,600 meters (11,800 ft) at Kalapani to 200 meters

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(660 ft) as it enters the Terai plains. Tanakpur is the first place where it is actually known as Sharda River. The subject area of present investigation is Thuli Gad in Tanakpur area (29°08′13.72"N, 80°10′56.73"E).

Material and Methods:-

To analyze physico-chemical parameters, water samples were collected fortnightly. Water samples were collected during morning hours. Thuli Gad sampling site **(29°08′13.72"N, 80°10′56.73"E)** was selected, the selection was depended on where the water most frequently used by the communities for drinking and other purposes viz. animal washing, fishing, and other anthropogenic activities in a huge manner. Few parameters viz. temperature, pH, DO, TDS, conductivity, turbidity were performed at the sampling sites while remaining were analysed in the laboratory by following the standard methodology (APHA, 1999; Wetzel, 2001; Khanna and Bhutiani, 2004).

Results and Discussion:-

The prime objective of the study is monthly variation in physico-chemical analysis of riverine water. River water contains suspended and dissolved constituents in varying proportions which has different physical and chemical properties along with biological activities. The interactions between physical and chemical parameters of riverine water play essential role in the composition, distribution, and abundance of aquatic organisms (Saxena et. al, 2011). Water quality may be affected by landslides and pollution in various ways. The result of seasonal variations (Fig 1) in physico-chemical parameters (Average ±S.D.) and their correlation statistics of river water are summarized in **Table 1** and **Table 2**. The data on the concentration of various physico-chemical parameters of water quality were examined and compared with the safe water quality standards of BIS (1994 and 2009), EPA (2011), WHO (2011). All compared physico-chemical data are presented in **table 3.**

The ambient temperature of the studied area marked the highest value during June 35.9±0.14 ^{0}C and the minimum value in the month of December 17.45±1.76 ^{0}C. The water temperature showed its maximum values in the month of June 28.65±0.21 ^{0}C and minimum 13.75±0.07 ^{0}C in the month of January. River water velocity fluctuated between 0.55 (Feb) and 1.61 (July) m/s throughout the study period. Water turbidity of the river was considerably higher during summer and lower during winter months but worsen during monsoon months. From the results obtained, it is noticed that river water turbidity fluctuated minimum in the month of January 26.5±2.12 JTU to maximum 96.5±2.12 JTU in the month of July. Seasonal variations in the values of TDS concentration were recorded, during monsoon months TDS was noticed maximum 172.5±3.53 mg/l (August) and the minimum in winters 106±5.65 mg/l (Jan). Similar to the TDS concentration values of total solids also fluctuated, highest and lowest concentration was noticed in the months of August (237.5±3.53 mg/l) and January (133.5±4.94 mg/l). High level of conductivity and cations are the products of decomposition and mineralization of organic matters and its value also effects of landslides in the riverine water (Sirajudeen et.al, 2013; Goyal et. al, 2013). In the present investigation, maximum conductivity was recorded during August 362±8.48 µs/cm and minimum during January 222±11.3 µs/cm. The pH value, high during winter and lower during summer and monsoon season may be due to photosynthetic activity. pH of river water lies between 7.45 to 8.75, potability standards reveals that usually the pH of natural water varies between 7.2 and 7.6 and enhanced value of pH can result from the calcium and magnesium dissolution existing which indicates slightly alkaline nature of water.

The oxygen present in water can be dissolved from the air or produced by the photosynthetic activity of phytoplankton and submerged plants. In the present study, maximum dissolved oxygen (DO) was recorded during winter, moderate during monsoon and lower during summer months, similar values obtained by (Khinchi et. al, 2011). The concentration of DO showed a variation of 7.4±0.14 mg/l (May) to 10.35±0.91 mg/l (Jan). Valued of free CO_2 ranged from 2.6±0.14 mg/l (Dec) in winter to 4.85±0.21 mg/l in June. Relatively higher values of free CO_2 were observed during August. Due to high summer temperature, the respiratory activities of aquatic organisms accelerated with the process of decay of organic matter, resulting in the addition of large quantities of CO_2 in the water.

The highest concentration of alkalinity was recorded in 102±2.82 mg/l (August) and minimum 66±2.82 mg/l (Sep). Throughout the study period, total hardness varied from 80±1.41 mg/l (Sep) to 107.5±2.12 mg/l (Jan). The highest concentration of chloride was recorded 13.09±0.01 mg/l in August and minimum 3.47±0.04 in March. From the results obtained, it is noticed that the chloride concentration in water was modest, the source of chloride in riverine water may be by the mineral weathering of rocks as well as due to anthropogenic activities. The permissible limit of

chloride in water is 250 mg/l. So the chloride content is under the desirable and permissible limit, hence water is most frequently used for drinking.

Fig 1:- Monthly variation among parameters.

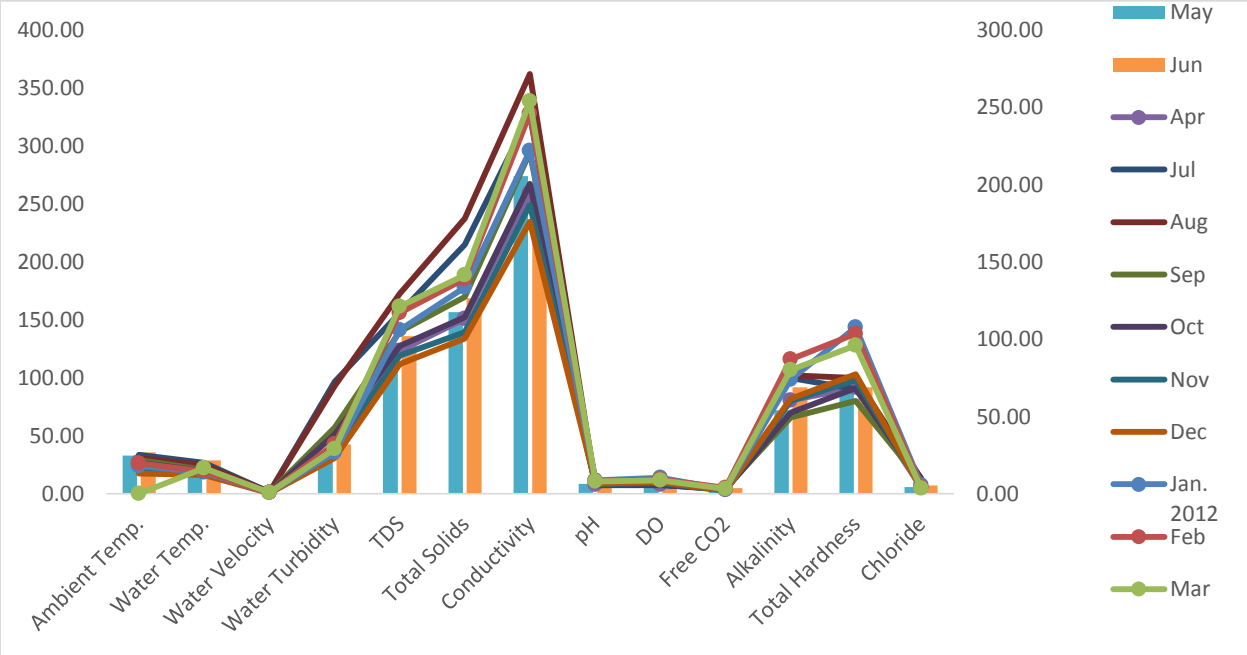

Table 1:- Seasonal variation of physico-chemical parameters of Shrada River (January 2012 to December 2012)

Month	Ambient Temp. (^{0}C)	Water Temp. (^{0}C)	Water Velocity (m/s)	Water Turbidity (JTU)	TDS (mg/l)	Total Solids (mg/l)	Conductivity (µs/cm)	pH	DO (mg/l)	Free CO_2 (mg/l)	Alkalinity (mg/l)	Total Hardness (mg/l)	Chloride (mg/l)
Jan. 2012	17.95±0.49	13.75±0.07	0.60±0.005	26.5±2.12	106±5.65	133.5±4.94	222±11.3	8.7±0.14	10.35±0.91	2.9±0.14	74±2.82	107.5±2.12	5.42±0.26
Feb	19.6±0.56	14.35±0.49	0.55±0.006	32±2.82	117±2.82	139±1.41	246±5.65	8.45±0.07	9.45±0.77	3.8±0.42	87±0.70	103.5±2.12	4.229±0.02
Mar	24.2±0.56	16.75±0.63	0.654±0.01	29±1.41	121±1.41	141.5±9.19	254±2.82	7.85±0.07	8.7±1.13	3.1±1.55	80±1.41	96±1.41	3.47±0.04
Apr	27.2±0.28	18.95±0.35	0.8±0.007	36.5±2.12	123.5±0.70	151±1.41	259.5±3.53	8±0.14	7.95±0.21	3.2±1.21	80.5±2.12	91.5±0.70	5.19±0.03
May	32.95±1.90	26.85±0.63	0.84±0.04	33.5±2.12	130±2.82	156.5±4.94	274±5.65	8.75±0.07	7.4±0.14	3.9±0.14	72±1.41	87.5±2.12	5.71±0.04
Jun	35.9±0.14	28.65±0.21	0.812±0.01	42.5±3.53	136±2.82	168.5±2.12	285.5±7.77	8.4±0.14	8.1±0.14	4.85±0.21	92±2.89	92±2.41	7.17±0.07
Jul	33.55±0.91	26.55±0.49	1.61±0.04	96.5±2.12	156±8.48	215±21.21	327±18.38	7.5±0.28	7.55±0.49	4.25±0.07	100±3.23	90±3.42	12.75±0.04
Aug	30.78±	25.05	1.59±0	93±4.2	172.	237.5	362±	7.45	8.05	4.65	102	100±4.	13.0

	1.06	±0.49	.22	4	5±3.53	±3.53	8.48	±0.21	±0.63	±1.06	±2.82	82	9±0.01
Sep	28.95±0.91	20.95±1.76	0.98±0.002	57±4.24	140±11.31	170±14.14	294.5±24.7	7.8±0.14	8.55±0.91	4.7±0.14	66±2.82	80±1.41	10.67±0.63
Oct	26.5±0.28	19.6±0.28	0.937±0.01	51±1.41	127.5±2.12	152.5±0.70	267.5±3.53	8±0.70	8±0.14	3.5±0.42	70±2.12	91±2.82	9.325±0.77
Nov	22.25±2.89	18.05±0.21	0.82±0.003	39±1.41	119±1.41	139.5±0.70	249.5±3.53	8.15±0.07	9.2±0.98	2.9±0.14	80±2.12	98±1.41	6.67±0.76
Dec	17.45±1.76	16.15±0.91	0.674±0.03	31±4.24	112±5.65	134±4.24	234.5±13.4	8.75±0.21	10.2±0.28	2.6±0.14	82±2.37	103±1.41	4.53±0.82

Table 2:- Matrix of correlation between physico-chemical parameters.

	Ambient Temp.	**Water Temp.**	**Water Velocity**	**Water Turbidity**	**TDS**	**Total Solids**	**Conductivity**	**pH**	**DO**	**Free CO_2**	**Alkalinity**	**Total Hardness**	**Chloride**
Ambient Temp.	1												
Water Temp.	0.957*	1											
Water Velocity	0.616*	0.648*	1										
Water Turbidity	0.567	0.586*	0.982*	1									
TDS	0.742*	0.746*	0.929*	0.924*	1								
Total Solids	0.677*	0.699*	0.955*	0.951*	0.981*	1							
Conductivity	0.746*	0.749*	0.926*	0.921*	0.999*	0.979*	1						
pH	-0.435	-0.310	-0.763*	-0.791*	-0.754*	-0.729*	-0.752*	1					
DO	-0.901*	-0.809*	-0.591*	-0.526	-0.674*	-0.594*	-0.680*	0.516	1				
Free CO_2	0.800*	0.758*	0.573	0.619*	0.782*	0.722*	0.786*	-0.440	-0.608*	1			
Alkalinity	0.317	0.404	0.595*	0.618*	0.601*	0.676*	0.596*	-0.413	-0.204	0.360	1		
Total Hardness	-0.711*	-0.589*	-0.313	-0.285	-0.399	-0.273	-0.406	0.373	0.738*	-0.541	0.289	1	

Chloride	0.579*	0.590*	0.924*	0.944*	0.876*	0.881*	0.873*	-0.724*	-0.503	0.668*	0.389	-0.402	1

*Correlation is significant at 0.05 level (2-tailed test of significance is used)

Table 3:- Annual mean values of different parameters of Sharda River water and desirable, permissible limit of Bureau of Indian Standard (BIS 1994 and 2009), WHO (2011) and EPA (2011) for drinking water and fish culture.

S. No.	Parameters	Tolerance limit for fish culture as per BIS (1994)	Maximum permissible limit of BIS (2009) for drinking water	Maximum permissible limit of WHO (2011) for drinking water	Maximum permissible limit of EPA (2011) for drinking water	Annual Mean and Range values
1	Ambient temp. (^oC)	-	-	-	-	**26.44** (17.45 to 35.9)
2	Water temp. (^oC)	2 to 35	-	-	-	**20.47** (13.75 to 28.6)
3	Turbidity (NTU)**	10	5	5	5	**47.29 JTU** (26.5 to 96.5)
4	Conductivity (µS/cm)	-	-	-	-	**273** (222 to 362)
5	TDS (mg/l)	-	500	600	500	**130** (106 to 172.5)
6	Total solids (mg/l)	-	-	-	-	**161.5** (133.5 to 237.5)
7	pH	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	**8.15 (**7.4 to 8.75)
8	DO (mg/l)	4	-	-	-	**8.625** (7.4 to 10.35)
9	Free CO_2 (mg/l)	12	-	-	-	**3.69** (2.6 to 4.85)
10	Alkalinity (mg/l)	100-300	200	-	-	**82.12** (66 to 102)
11	Hardness (mg/l)	-	200	-	-	**95** (80 to 107.5)
12	Chloride (mg/l)	-	250	250	250	**7.35** (3.47 to 13.09)
13	Water velocity (m/s)	-	-	-	-	**0.905** (0.55 o 1.61)

** 1 JTU ≈ 1NTU

Relationship between hydrological attributes:-

The statistical correlation data between the hydrological attributes is presented in **Table 2.** Turbidity is positively correlated with river water velocity, dissolved solids. Conductivity showed an inverse relationship with TDS and Total solids, whereas the direct relationship with river water turbidity. DO concentration show a strong inverse relationship with ambient and water temperature, but positive relationship with pH. Free CO_2 was positively correlated with water temperature and negatively with pH and dissolved oxygen concentration. TDS was positively correlated with ambient, water temperature, conductivity and free CO_2 and an inverse relationship with DO and pH. Chloride concentration showed a positive correlation with river water turbidity and dissolved solids and negative relationship with pH. Alkalinity was positively correlated with total solids, but showed an inverse relationship with pH and DO. TDS were highly positively correlated with water temperature, water velocity, and conductivity

Conclusion:-

Overall, on the basis of fair examination of various observations on physico-chemical characteristics and their comparison with reference standards (table 3), it can be concluded that the water quality of the Sharda River at Tanakpur region is fair good. The trophic state of the water body is supportive for fishery production in concordance with pollution level in the river. The water of the study area was not polluted with respect to physico-chemical assessment. Therefore, this water can be said potable after proper treatment.

Acknowledgement:-

Sincerely thankful to the Head department of Zoology, R.H. Govt. P.G. College, Kashipur, Uttarakhand and Prof. P. K. Gupta, DSB campus Kumaun University Nainital for laboratory facilities.

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