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Seasonal Variations in the Water Quality Parameters from Manawar Tawi River in Rajouri District of J&K, India

KEYWORDS: Seasonal variations, physicochemical parameters, Manawar Tawi River

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ABSTRACT *The present study was carried out to assess the water quality of Manawar Tawi river of Rajouri during May 2013 to April 2014 in four different seasons viz. Summer (March to June), Monsoon (July- August), Post Monsoon(September to October) and Winter (November to February). Two stations were identified on the basis of anthropogenic load viz. Station I & Station II. Water samples were analyzed for physicochemical parameters including: Air temperature, Water temperature, Transparency, pH, DO, FCO2, BOD, Carbonates, Bicarbonates, Total dissolved solids(TDS),Total suspended solids(TSS),Conductivity, Calcium, Magnesium, Nitrates, Chloride, Sulphates and Phosphate from two different stations. The results revealed seasonal variations in the Physico-chemical parameters at Station I & Station II and further investigations showed that water was clear with high values of pH and DO and low values of FCO2, TDS, TSS and BOD at Station 1 while at Station II high values of BOD, nitrates, chlorides, free CO2, TDS but low value of DO & pH indicated pollution load. The comparative study showed that the water quality of the Manawar Tawi was degraded due to the presence of significant amount of pollutants discharged from Rajouri city at Station II so water is not potable at this site. To maintain the healthy ecosystem of the river there is a need for proper management and monitoring of water quality of the river.*

Introduction

Water is the elixir of life and whole life of aquatic ecosystem is directly or indirectly dependent on it. It is one of the most vital natural resources and almost all the major human civilization is centered on river basins. But in the present era, due to increased human activities such as industrialization, use of fertilizers in agriculture and urbanization has lead to generation of copious volume of waste effluents which have degraded the water quality of river ecosystem. These wide array of pollutants discharged into aquatic environment may have physico-chemical, biological, toxic and pathogenic effects (Goel, 2000).

The quality of water may be described according to their physico-chemical and micro biological characteristics. So, the life of aquatic ecosystem depends on the water quality directly or indirectly (Contreras *et al.,* 2009).The availability of good quality water is an indispensable feature for preventing disease and improving quality of life. A well-known method of expressing water quality that offers a simple, stable and reproducible unit of measure is the water index which responds to changes in the principal characteristics of water (Brown *et al.*, 1970).It is regarded as one of the most effective way to communicate water quality (Sinha, 1989; Pradhan *et al.*, 2001).

Variations in the water quality and biological parameters of lotic ecosystems are widely studied in the case of several world rivers. Sileika *et al.*, 2006 reported variations in the trace elements in the Nemunas river of Russia. Schaefer and Alber, 2007 examined nitrogen and phosphorus in the Altamaha river of Georgia. Meghla *et al.,* 2013 studied seasonal changes in the Turag river of Dhaka. In India, earlier work on physico-chemical parameters of rivers had been reported by Joshi and Bisht(1993), Chopra & Patrick (1994), Prasanakumari *et al.,*(2003), Kumar *et al.,*(2004), Gandotra *et al.,*(2008), M.R. Singh(2010), Muniyan & Ambedkar(2011),BS Chauhan *et al.,* (2013), Ahmed & Hussain (2014),

In the present study, the water quality parameters were investigated from the Manawar Tawi river and compared with relevant standard levels to know the present status of the river. The water quality parameters were also compared among four seasons of the year to understand the temporal variations and their impacts.

Material and Methods

Study area

The study was conducted for a period of one year from May 2013 to April 2014 at the Manawar Tawi River in Rajouri, J&K. The river is an important right bank tributary of Chenab River. The river originates from mountains of Pir Panjal range in Thana Mandi area of Rajouri district. It flows through Chingus, Nowshera and then enters Pakistan's Punjab at Manawar to join Chenab River. It is most important river that drains the major portion of Rajouri city and is also the sole source of drinking water to the inhabitants. Numerous human activities such as sand mining, dredging, bathing, disposal of solid wastes and sewage from human colonies are the potential sources of river pollution. So for the present investigation, two sampling sites viz. Station 1(S_1) and Station 2 (S_2) have been set up along the longitudinal profile of Manawar Tawi River. Station 1 (S_1) is situated about 6.5 km upstream from Jhulla bridge near Government Degree college (G.D.C) Kheora where least human activity is present and water is almost pristine. While Station 2 (S_2) is situated beside main bazaar & new bus stand area where there has been a lot of human activity due to the discharge of domestic sewage and disposal of solid wastes from the locality.

The water samples were collected from both the stations established on Manawar Tawi River from May 2013 to April 2014 for four seasons viz. Summer(March to June), Monsoon (July to August),Post Monsoon (September to October) and Winter (November to February). Utmost care was taken to avoid spilling of water and air bubbling at the time of sample collection. Some of the physico-chemical

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parameters including air temperature, water temperature, transparency, pH, Dissolved oxygen (DO), free carbon dioxide (FCO_2), chloride, calcium and magnesium were determined on spot. While other parameters including Conductivity, Total dissolved solids (TSS), Total suspended solids (TSS), Nitrates, Sulphates, Phosphates, Biological oxygen demand, were analyzed in the laboratory within five to six hours of collection. The physico-chemical parameters of water were analyzed according to standard methodology (APHA, 2005) and their results were analyzed and compared with various drinking water standards (WHO and ICMR).

Statistical analysis
The collected data were analyzed by using MS EXCEL 2007, where the mean, standard deviation were calculated while Pearson correlation coefficient among physico-chemical properties of water was computed using SPSS 18.0.

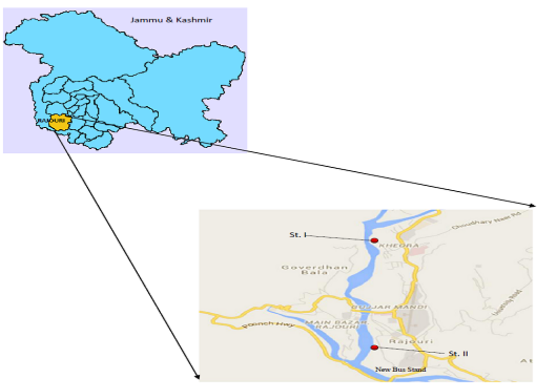

Figure 1: Locations of study sites within Manawar Tawi

Results & Discussion
The results of physicochemical parameters observed during different seasons at Station I and II of Manawar Tawi River are given in table1& table2 respectively. The estimated values of all the physico-chemical parameters of water were found within the permissible limit at station I when compared to station II.

The minimum and maximum air temperature of station I ranges from 23.5-39.8.While that of Station II ranges from 24.2^{0}C to 40.3^{0}C. Similarly the minimum and maximum water temperature of Station I ranges from 15.0^{0}C to 28.2 ^{0}C. While that of Station II ranges from 15.3^{0}C to 28.4^{0}C .The highest air temperature was noticed during the summer season which may be attributed to the increased photoperiod and longer day length and lowest was during the winter season which may be due to shorter photoperiod and shorter day length. Further water temperature was observed to follow air temperature thereby indicating that the samples collected from shallow zone have direct relevance with air temperature as also demonstrated by Welch (1952) that shallow water reacts quickly with changes in atmospheric temperature.

Transparency has direct bearing on the light penetration of water and depends upon suspended matter and dissolved coloured substances. During the present study period, the transparency value recorded ranges from 91.4 to 181.7 cm at Station I while that of Station II ranges from 76 to 119.7 cm. The higher values recorded during summer and winter season were due to settled silt, clay and less suspended matter, whereas lower values were found in monsoon season due to mud and silt in river brought by rain water. Similar results were observed by Lendhe and Yeragi (2004) in Tansa River, Thane during monsoon season.

pH of water is an important indication of its quality and provides information about various geochemical equilibrium. During the present study period, pH of water remains alkaline throughout the year at station I & ranged between 8.1-8.9.While at station II pH value ranged from 6.2-7.1 which was slightly acidic because of anthropogenic load from nearby localities. Krishnaram *et al.,* (2007) documented that pH range of 6.7 to 8.4 is considered to be safe for aquatic life to maintain productivity and pH below 4.0 and above 9.6 found hazardous to life.

Dissolved Oxygen(DO) is one of the important parameters in water quality assessment. Its presence is essential to maintain variety of forms of life in the water and the effect of waste discharge in a water body are largely determined by the oxygen balance of the system. It is a critical water quality parameter for characterizing the health of an aquatic ecosystem and reflects the physical, chemical and biological processes prevailing in water (Dirican *et al.,* 2009).In the present study the value of DO ranges from 8.8 to10.7 mg l^{-1}at station I and for station II it ranges from 3.9 to5.4 mg l^{-1}. DO showed highest records during winters and lowest during summers. Higher values of DO can be attributed to low temperature which has higher oxygen retention capacity, this further increased solubility of gases in water at low temperature. While rise in temperature lowers the oxygen retention capacity of water and thereby results in low value of DO during summer. Further, it increases the rate of decomposition of organic matter involving the rapid utilization of oxygen. The results are in agreement with Jameel (1998).

The amount of Free CO_2 of water depends upon the water temperature, rate of respiration, decomposition of organic matter and geographical features of the terrain surrounding the water body. An inverse relationship between DO and FCO_2 was recorded at both station I &II. The FCO_2 value ranges from 3.2 to 5.3 mg l^{-1} at Station I and from15.49 to 21.20 mg l^{-1} at Station II. High values of FCO_2 were found in summer season which may be due to the decomposition of organic matter, utilizing dissolved oxygen and liberating carbon dioxide.

Carbonates were found to be absent at both the stations. While Bicarbonates were recorded in higher concentrations at station II and low at station I. The value of bicarbonates at station I ranged from 86.10 to 157.0 mg l^{-1} while at Station II ranged from 127.2 to 146.3 mg l^{-1}. High values of bicarbonates were found in monsoon and summer season due to decomposition and oxidation of anthropogenic pollutants and to some extent weathering of underlying rocks by river.

Cation of calcium and magnesium contribute to the hardness of water (Shrivastava and Patil,2002).In the present study, high values of calcium (56.22±8.30 mg l^{-1}) at station II is due to discharge of domestic sewage from nearby localities, washing, dumping of waste material from adjoining slaughtered houses. While value of calcium recorded at station 1 was low (36.86±11.40 mg l^{-1}).The mean value of Magnesium at station I & II was found to be 21.38±4.47 mg l^{-1} and 42.85±10.16 mg l^{-1} respectively. High value of magnesium was recorded at Station II which is probably due to regular addition of large quantities of sew-

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age and detergent into river from the nearby residential localities. Similar observation was made by Kaur *et al.*,(1996).

Nitrates are formed in water due to oxidation of ammonia by bacterial action and their presence indicates that nitrogenous organic matter is under nitrification. The observed range of nitrate for station I was 0.80-2.43 mg l^{-1} while for station II the observed range was 13.67-17.97 mg l^{-1}. The high values of nitrate at station II was due to excessive use of fertilizers in agriculture, domestic effluents, and sewage disposal.

Chloride content of the river varied from13.30-23.30 mg l^{-1} at station I while it varied from 26.95- 55.77 mg l^{-1}.Low value of chloride during summer and monsoon seasons at both the stations was due to dilution effect caused by direct rainfall and inundation of river water from catchment area.

Biochemical Oxygen Demand (BOD) is an index of organic pollution to measure the amount of DO required by microbial community in decomposing the organic matter present in a water sample by aerobic biochemical action. In the present study an inverse relationship between DO and BOD was recorded at the both stations I &II. Higher value (14.33±3.31 mg l^{-1}) at station II can be attributed to effluents from surrounding small industries.

The value of sulphate at station I ranges from2.12 to2.88 mg l^{-1} and17.24 to21.30 mg l^{-1} at station II. In the present investigation, the Sulphate values were maximum during monsoon season and minimum during winter season. Maximum Sulphate concentration during monsoon may be due to the dilution and utilization of Sulphate by aquatic plants. However, the low Sulphate concentration noted during winter may be due to biodegradation and low water level. Similarly, results have been reported Shanthi *et al.*,(2006), Telkhadeet *et al.,* (2008), and Reddy *et al.*,(2009) observe high value in monsoon season.

Phosphate is considered to be a significant nutrient responsible for eutrophication of the water body. In the present study, the amount of phosphate recorded ranges between 0.12 to 0.32 mg l^{-1} at Station I and between 3.24 to5.72 mg l^{-1} at Station II. The minimum amount was recorded during winter season and maximum mount during summer season. High values during summer may be due to influx of sewage effluents, detergents, human waste and decomposed organic matter.

Electrical conductivity is a measure of capacity of a solution to conduct electrical current through it and depends on the concentration of ions. The conductivity serves as a good and rapid measure of the total dissolved solids in water. Higher the value of dissolved solids, greater is the amount of ions in water. The values of Electrical conductivity range between 112.4-138.15 μS.cm^{-1}for station I and between 308.6-425.15 μS.cm^{-1} for station II.

Water with high total dissolved solids (TDS) indicated more ionic concentration which is of inferior palatability and can induce unfavorable physicochemical reactions.High content of dissolved solids elevate density of water, influence osmoregulation, reduce gas solubility and utility of water for drinking, irrigation and industries as reported by Edmondson (1959). In the present study slightly high values of TDS were reported at Station II (428.18±31.31 mgl^{-1}. In the present study the total suspended solids ranged between 91.6-111.7 mgl^{-1} at station I and between 95.30-112.3 mgl^{-1} at station II.). High levels of Suspended solids were observed due to pouring of sewage in the River Manawar tawi at Station II.

Table1: Physico-chemical parameters observed from May2013 to April 2014(Station I)

S.no	Parameters	Units	Seasons				Range	Mean ± S.D
			Summer	Monsoon	Post Monsoon	Winter		
1.	Air temp	^{0}C	39.8	34.4	37.0	23.5	23.5-39.8	33.67± 7.13
2.	Water temp	^{0}C	28.2	23.0	25.7	15.0	15.0-28.2	22.97± 5.72
3.	Transparency	cm	172.2	91.4	148.5	181.7	91.4-181.7	148.45± 40.51
4.	pH	-	8.4	8.3	8.1	8.9	8.1-8.9	8.42 ± 0.34
5.	DO	mg l^{-1}	8.9	9.3	8.8	10.7	8.8-10.7	9.42 ±0.87
6.	FCO_2	mg l^{-1}	5.3	3.7	3.2	3.45	3.2-5.3	3.91 ± 0.94
7.	Conductivity	μS.cm^{-1}	112.4	135.0	138.15	115.25	112.4-138.15	125.2 ± 13.24
8.	Carbonates	mg l^{-1}	-	-	-	-	-	-
9.	Bicarbonates	mg l^{-1}	107.4	157.0	102.8	86.10	86.10 -157.0	113.32 ± 30.52
10.	Magnesium	mg l^{-1}	15.55	23.10	26.15	20.73	15.55-26.15	21.38± 4.47
11.	Calcium	mg l^{-1}	28.95	47.0	46.30	25.2	25.2-47.0	36.86 ± 11.40
12.	Chloride	mg l^{-1}	15.8	19.45	23.30	13.30	13.30-23.30	17.96± 4.36
13.	Phosphates	mg l^{-1}	0.32	0.25	0.12	0.16	0.12-0.32	0.21 ± 0.08
14.	Sulphates	mg l^{-1}	2.65	2.88	2.75	2.12	2.12-2.88	2.6 ± 0.33
15.	Nitrates	mg l^{-1}	2.28	0.80	1.65	2.43	0.80-2.43	1.79 ± 0.74
16.	BOD	mg l^{-1}	3.44	4.75	4.24	4.87	3.44-4.87	4.32 ± 0.65
17.	TDS	mg l^{-1}	130.6	201.75	138.25	109.40	109.40-201.75	145±39.75
18.	TSS	mg l^{-1}	92.8	111.7	105.3	91.6	91.6-111.7	75.35 ±42.88

Table2: Physico-chemical parameters observed from May2013 to April 2014(Station II)

S.no	Parameters	Units	Seasons				Range	Mean ± S.D
			Summer	Monsoon	Post Monsoon	Winter		
1.	Air temp	^{0}C	40.3	34.0	37.3	24.2	24.2-40.3	33.95± 6.99
2.	Water temp	^{0}C	28.4	23.7	25.9	15.3	15.3-28.4	23.32 ± 5.68
3.	Transparency	cm	108.4	76.7	108.3	119.7	76.7-119.7	103.28 ± 18.51
4.	pH	-	6.8	6.7	6.2	7.1	6.2-7.1	6.7 ±0.37
5.	DO	mg l^{-1}	4.7	4.8	3.9	5.4	3.9-5.4	4.72 ±0.61
6.	FCO_2	mg l^{-1}	21.2	15.5	7.5	15.4	15.49-21.20	17.43 ±2.67
7.	Conductivity	μS.cm^{-1}	317.6	308.6	425.15	401.10	308.6-425.15	363.11± 58.69
8.	Carbonates	mg l^{-1}	-	-	-	-	-	-
9.	Bicarbonates	mg l^{-1}	137.4	146.3	133.3	127.2	127.2-146.3	136.06 ± 8.01
10.	Magnesium	mg l^{-1}	33.3	50.5	52.7	34.9	33.3-52.7	42.85 ± 10.16
11.	Calcium	mg l^{-1}	50.5	60.7	65.6	48.10	48.10-65.6	56.22 ±8.30
12.	Chloride	mg l^{-1}	26.95	31.0	55.77	27.92	26.95-55.77	35.41 ±13.68
13.	Phosphates	mg l^{-1}	5.72	4.19	4.15	3.24	3.24-5.72	4.32 ± 1.02

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14.	Sulphates	mg l^{-1}	17.38	21.30	21.10	17.24	17.24-21.30	19.25 ± 2.24
15.	Nitrates	mg l^{-1}	14.68	14.38	13.67	17.97	13.67-17.97	15.18± 1.91
16.	BOD	mg l^{-1}	10.3	16.2	17.75	13.10	10.3-17.75	14.33± 3.31
17.	TDS	mg l^{-1}	387.52	422.55	460.95	441.72	387.52-460.95	428.18 ± 31.31
18.	TSS	mg l^{-1}	104.5	112.3	98.60	95.30	95.30-112.3	102.67 ± 7.46

Significant correlation among various physico-chemical parameters at Station1 revealed that there is a positive correlation between pH and transparency, DO and pH, DO and Transparency, FCO_2 and air & water temperature and between BOD and pH while there is negative correlation between pH and water temperature; DO and water temperature; FCO_2 and Transparency; BOD and Transparency & Electrical conductivity and DO. Similarly, at Station II positive correlation is found between pH and Transparency; DO and pH; BOD and DO; TDS and FCO_2; TDS and BOD respectively while negative correlation is found between DO and Transparency;FCO_2 and pH ;FCO_2 and DO;BOD and DO; pH and Transparency;;and between TDS and DO respectively.

Table3: Correlation coefficient among different physico-chemical parameters at Station I of Manawar Tawi River

Parameters	AT	WT	TRA	pH	D.O	FCo_2	Co_3^{2-}	HCo_3^-	Ca^{2+}	Mg^{2+}	Cl^-	BOD	Po_4^{3-}	So_4^{2-}	No_3^-	TDS	EC	TSS
AT	1																	
WT	.998**	1																
TRA	-.773	-.808	1															
pH	-.920	-.911	.539	1														
D.O	-.863	-.832	.347	.935	1													
FCo_2	.527	.553	-.865	-.162	-.083	1												
Co_3^{2-}	a	a	a	a	a	a	a											
HCo_3^-	.418	.469	-.899	-.134	.098	.883	a	1										
Ca^{2+}	.845	.875	-.832	-.831	-.596	.445	a	.601	1									
Mg^{2+}	.300	.351	-.474	-.422	-.082	.041	a	.457	.758	1								
Cl^-	.779	.793	-.549	-.916	-.726	.071	a	.239	.917	.745	1							
BOD	-.278	-.213	-.344	.385	.678	.317	a	.677	.187	.588	-.053	1						
Po_4^{3-}	-.327	-.318	.438	-.046	.083	-.826	a	-.481	.018	.526	.318	.105	1					
So_4^{2-}	.948	.938	-.575	-.995**	-.948	.232	a	.167	.820	.360	.881	-.409	-.049	1				
No_3^-	-.800	-.836	.992**	.609	.395	-.794	a	-.868	-.894	-.567	-.645	-.341	.374	-.634	1			
TDS	.398	.459	-.827	-.261	.063	.616	a	.904	.754	.783	.497	.769	-.068	.253	-.849	1		
EC	.688	.727	-.741	-.727	-.438	.311	a	.576	.968*	.898	.910	.347	.219	.696	-.820	.811	1	
TSS	.810	.848	-.940	-.701	-.455	.643	a	.783	.967*	.707	.785	.331	-.170	.706	-.976*	.857	.924	1

** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2- tailed) a- cannot be computed because at least one of the variable is constant. AT=air temperature, WT = water temperature, TRA= transparency, D.O = dissolved oxygen, FCO_2= free carbon dioxide, Co_3^{2-}= carbonate, HCo_3^-= bicarbonate, Ca^{2+}= calcium, Mg^{2+}= magnesium, Cl^- = chloride, BOD=biological oxygen demand, Po_4^{3-} = phosphate, So_4^{2-} = sulphate, No_3^- = nitrate, TDS = total dissolved solids, EC =electrical conductivity and TSS = total suspended solids.

Table4: Correlation coefficient among different physico-chemical parameters at Station II of Manawar Tawi River

Parameters	AT	WT	TRA	pH	D.O	FCo_2	Co_3^{2-}	HCo_3^-	Ca^{2+}	Mg^{2+}	Cl^-	BOD	Po_4^{3-}	So_4^{2-}	No_3^-	TDS	EC	TSS
AT	1																	
WT	.986*	1																
TRA	-.882	-.797	1															
pH	-.621	-.699	.219	1														
D.O	-.570	-.667	-.410	.991**	1													
FCo_2	.846	.748	-.950*	-.332	-.224	1												
Co_3^{2-}	a	a	a	a	a	a	a											
HCo_3^-	.971*	.919	-.955*	-.499	-.421	.948	a	1										
Ca^{2+}	.765	.776	-.508	-.913	-.851	.661	a	.731	1									
Mg^{2+}	.745	.718	-.590	-.794	-.705	.770	a	.769	.971*	1								
Cl^-	.304	.373	.071	-.913	-.895	.139	a	.217	.823	.736	1							
BOD	.513	.472	-.398	-.700	-.601	.648	a	.572	.891	.953*	.770	1						
Po_4^{3-}	.205	.223	.039	-.759	-.703	.238	a	.201	.785	.780	.936	.891	1					
So_4^{2-}	.785	.754	-.639	-.782	-.692	.804	a	.809	.968*	.998**	.700	.934	.738	1				
No_3^-	-.617	-.678	.246	.991**	.966*	-.392	a	-.521	-.948	-.855	-.935	-.787	-.824	-.840	1			
TDS	-.102	-.128	.190	-.428	-.356	.124	a	-.031	.519	.587	.727	.799	.913	.536	-.524	1		
EC	-.480	-.438	.661	-.309	-.305	-.401	a	-.488	.198	.183	.666	.423	.755	.118	-.359	.853	1	
TSS	.830	.772	-.937	-.087	-.043	.782	a	.856	.293	.328	-.280	.078	-.333	.389	-.073	-.516	-.868	1

** Correlation is significant at the 0.01 level (2- tailed) * Correlation is significant at the 0.05 level (2-tailed) a- cannot be computed because at least one of the variable is constant. AT=air temperature, WT = water temperature, TRA= transparency, D.O = dissolved oxygen, FCO_2= free carbon dioxide, Co_3^{2-}= carbonate, HCo_3^-= bicarbonate, Ca^{2+}= calcium, Mg^{2+}= magnesium, Cl^- = chloride, BOD=biological oxygen demand, Po_4^{3-} = phosphate, So_4^{2-} = sulphate, No_3^-= nitrate, TDS =total dissolved solids, EC =electrical conductivity and TSS = total suspended solids.

Table5: Summary analyzed parameters and guideline values as per WHO & ICMR standard

S.no	Parameters	Units	Variation of Range		WHO Limits	Desirable Limits of ICMR
			Station1 (S_1)	Station 2 (S_2)		
1.	Air temp	^0C	23.5-39.8	24.2-40.3	-	-
2.	Water temp	^0C	15.0-28.2	15.3-28.4	-	-
3.	Transparency	cm	91.4-181.7	76.7-119.7	-	-
4.	pH	-	8.1-8.9	6.2-7.1	6.5-8.5	7.0-8.5
5.	DO	mg l^{-1}	8.8-10.7	3.9-5.4	4.0	5.0
6.	FCO_2	mg l^{-1}	3.2-5.3	15.49-21.20	-	-
7.	Conductivity	$\mu S.cm^{-1}$	112.4-138.15	308.6-425.15	750	300
8.	Carbonates	mg l^{-1}	-	-	-	-
9.	Bicarbonates	mg l^{-1}	86.10 -157.0	127.2-146.3	-	-
10.	Magnesium	mg l^{-1}	15.55-26.15	33.3-52.7	30-150	30
11.	Calcium	mg l^{-1}	25.2-47.0	48.10-65.6	100	75
12.	Chloride	mg l^{-1}	13.30-23.30	26.95-55.77	250-600	200
13.	Phosphates	mg l^{-1}	0.12-0.32	3.24-5.72	> 0.5	-
14.	Sulphates	mg l^{-1}	2.12-2.88	17.24-21.30	200-400	200
15.	Nitrates	mg l^{-1}	0.80-2.43	13.67-17.97	10-45	20
16.	BOD	mg l^{-1}	3.44-4.87	10.3-17.75	6.0	5.0
17.	TDS	mg l^{-1}	109.40-201.75	387.52-460.95	600	500
18.	TSS	mg l^{-1}	91.6-111.7	95.30-112.3	600	500

In the present investigation on Manawar Tawi River, all the physico- chemical parameters were recorded to be within permissible limits at both Stations I & II as per WHO Standards and ICMR guidelines. However comparison of

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water quality revealed that some of the water quality parameters viz. low pH, low DO, high FCO_2, high conductivity, high BOD, high TDS, high bicarbonates, high TSS at station II reveal that this site has anthropogenic stress on the river. Although, this water body is productive & suitable for fish culture, irrigation & drinking purpose but if necessary steps were not taken well in time, it could turn into a Dead River. So, to protect this water ecosystem there should proper management and regulation of domestic wastes and other anthropogenic activities so that pristine ecology of this river can be restored.

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