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RESEARCH ARTICLE

WATER QUALITY ASSESSMENT OF THE RIVER BIRMA: A TRIBUTARIES OF YAMUNA RIVER HAMIRPUR DISTRICT (U.P.) INDIA

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ABSTRACT

In Indian context, rapid urbanization and industrialization, intensive agriculture, and growing demands for energy during the last few decades has affected the physicochemical parameters and biological attributes of the ground and surface water. Hamirpur district comes under semi arid region, so the surface water is main source of water in this region. The variations in selected physico-chemical factors were investigated for one year to determine the water quality of Birma River, Hamirpur district, Uttar Pradesh, for drinking, irrigation and fish production. Five stations were chosen on the river to reflect the effect of human activities, lacustrine and lotic habitats. Temperature, pH, conductivity, total dissolved solids, dissolved oxygen, nitrate, phosphate, chemical oxygen demand, total alkalinity, total hardness, sulphate, were analyzed monthly between July 2011 and June 2012 using standard methods and procedures APHA-2005. After compare from water quality standard we find that Birma River is unpolluted up stream while as downstream it is polluted and may not be used for domestic purpose without treatment but may used for irrigation. Themain source of pollution is the sewage disposal and agricultural runoff from the catchments areas and need to be proper treatment before uses.

INTRODUCTION

Water is the most vital resource for life. Approximately 97.2% water lies in oceans as salt water. While 2.15% in frozen ice from and the remaining 0.65% remain as fresh either on surface or ground water. Available fresh water resources are very limited. The demand for fresh water has increased day by day and will increase with the rapid growth of population, agriculture and industry. As a result the fresh water reserve depletes day by day too. The requirement of clean water per person is about 2.7 lit per day, thus the global requirement is about 5 billion cu. m. only for drinking purpose. Agriculture is also one of the major consumers of fresh water resources (Zaidi *et al.,* 2011). India is a country having various land forms and rivers. There are 14 major rivers in India. Water, the universal solvent because of high dielectric constant has the property of dissolving most of the substances but the access of these substances leads to water pollution (Gautam, 1990). The water bodies get polluted due to the discharge of effluents from the industries, domestic activities, and soil pollution from the nearby dumping sites and agricultural drainage. These factors results in the deterioration of water quality of the various water bodies. The impact of the industrial effluents and domestic sewage on river Ganga at Allahabad and reported that all the pollution parameters are beyond the permissible limits and unfit for human consumption (Singh and Rai, 2003). The pollution potential of river Pandu contaminated heavily by the discharge of various industries (Tiwari, 2004). Untreated sewage discharge not only damage for aquatic life but also hazardous to human health used for drinking purpose in the downstream areas of the river (Morisava, 1985). Most of the cities and towns have developed along the banks of rivers because of the multipurpose-use of river water. But unfortunately some rivers are being polluted by indiscriminate disposal of sewage and industrial wastes.

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The surface water quality is affected by both the anthropogenic activities and natural processes (Carpenter *et al.,* 1998; Mokaya *et al.,* 2004; Melina *et al.,* 2005; Singh *et al.,* 2005a). Natural processes influencing water quality include precipitation rate, weathering processes, and sediment transport whereas anthropogenic activities include urban development and expansion, industrial and agricultural practices. These activities often results in the degradation of water quality, physical habitat and biological integrity of lotic system (Yayýntas *et al.,* 2007). Increasing exploitation of water resources in catchment is responsible for much of pollution load (Güler *et al.,* 2002; Singh *et al.,* 2005a; Pandey, 2006). Spatial and temporal variability in water chemistry in rivers and streams is directly related to different factors. Rivers and streams are highly heterogeneous at different spatial scales. The spatial heterogeneity within the stream is due to local environmental conditions (e.g., light, temperature, discharge, and water velocity) that change through time and differences in local channel form (Chakrapani 2005) whereas degree of temporal variability of surface water chemistry varied as a function of stream/river type and depended on the chemical parameter of interest. Seasonal variations in precipitation, surface runoff, interflow, ground water flow, and pumped in and outflow have a strong effect on river/streams discharge and subsequently on the concentration of pollutants in surface water (*Singh et al., 2005a*). This is true particularly with reference to most of the developing countries, in particular South Asian countries such as Nepal, India, Pakistan and Bangladesh (Karn and Harada 2001), where pollution of rivers and their tributaries is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities. About 90 to 95% of all domestic sewage and 75% of all industrial effluent usually from urban areas are discharged into surface waters without any treatment (Hinrichsen *et al.,* 1997; Pandey 2006). Chemical contamination of the environment is a pervasive insidious side effect of human population growth and technological development. With this background present proposed study has been undertaken for examine the water quality of river Birma, Hamirpur district, U.P.

MATERIALS AND METHODS

Sampling Sites: In the study area, Five stations were chosen on the river to reflect the effect of human activities, lacustrine and lotic habitats show in Fig-1.

Station A (JAITPUR): - It is a littoral site that represent South-West corner the dam adjoining area of this stations is main catchment area of Birma River. It is a shallow and marginal area of the dam whoever no directs interference of man was recorded.

Station B (PANVARI):- It is the western site of the dam which is continued with the submergence area of forest. It is noted to be an undisturbed area of present water body as no domination human activities were recorded from this region. However wandering and grazing activities of domestic animals were recorded on the adjoining area of forest land. The site B is also characterized by having rocky bottom and patches of pits on it. The depth of water was documented to be fluctuated from 1.5m to 3.5m.

Station E (AKONA):- The littoral station E represent a northern area of the lake it is the area from where water of Birma River enters in the dam. Therefore, it is a permanent submerge area with a depth range of 2.0 m t0 4.2 m. The wandering and grazing activities animals and birds were also recorded from adjoining land area.

Limnetic Station

Station C (MUSKURA):- It is the Eastern and Limnetic site that was marked near the main Dam. It is deep water was recorded to be of 7.0m.The regular activities of taking bath and washing clothes were noted from this site.

Station D (JALALPUR):- It is the deepest and Limnetic and which represent the Northern-South corner of the lake. The main canal of the dam also commence from this region. The water area of the dam on station D is also restricted by the main Dam. It also has a regulatory device of Sluice Gate. The human activities of taking bath and washing clothes are also noted from this region. The depth water was recorded to be fluctuated from 4.0m to 7.2m during the period of present investigation.

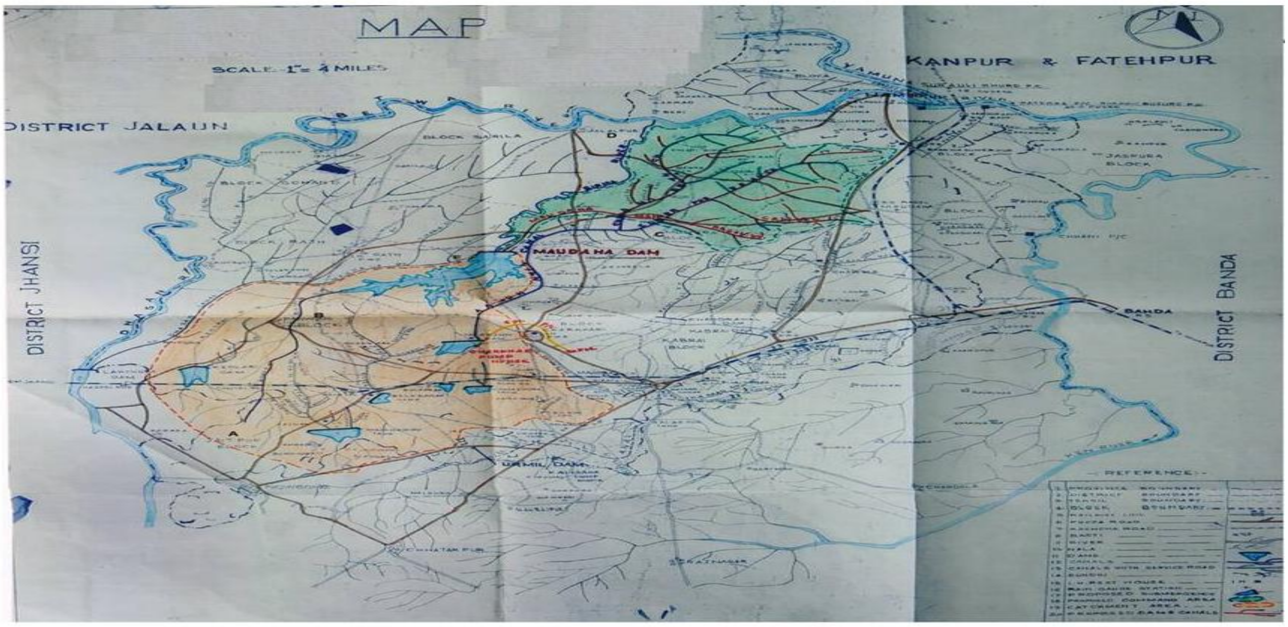

Fig. 1. Shows the sampling sites viz; 1- Station A (JAITPUR), 2- Station B (PANVARI),3- Station E (AKONA), 4- Station C (MUSKURA), 5- Station D (JALALPUR)

Analytical design

Samples were collected at the monthly variation from July 2011 to June 2012. For sampling, Plastics bottles were used. Sampling was carried out directly without adding any preservatives in clean bottles to avoid any contamination and brought to the laboratory. Collected water samples were brought to the laboratory and stored in cold room at 1-4 ^{0}C temperature in order to avoid any major chemical alteration for various physico-chemical analysis (APHA-2005).

RESULTS AND DISCUSSION

The average recorded value of physico-chemical properties of Birma River, Hamirpur District, (U.P.) India has been presented in Table – 1:

Temperature

With the rise in atmospheric temperature a corresponding change in the water temperature was also recorded the change in air temperature naturally affects the water temperature and causes thermal variation in water. The lowest water temperatures were documented in December and January, while the high temperature was noted in June. The mean values representing seasonal variation ranged from 19.32 °C to 24.1 °C in summer from 15.22°C to 23.47 °C in winter and between 22.72°C and 26.78°C in monsoon like air temperature. The data recorded from water temperature also exhibit a regular increasing trend from January onwards with the maximum in summer months.

Table 1. Physico-chemical water property of Birma river Hamirpur district (U.P.) India

S.No.	Para.	Month		Monsoon				Winter				Summer	
		Sites	July	Aug	Sep	Oct	Nov.	Dec	Jan	Feb	March	April	May	June
1	Tem	*A*	28	25	23.1	24	22.05	23	15	18	26	24	26	25
		B	23.1	24	23	22.05	22.8	23.1	15.8	18.8	19.8	23.8	26.07	24
	°C	*E*	27.1	25	23	23	23.06	23.8	16.1	18.08	19	24.1	27	24.1
		C	25.8	25.1	24.05	22.1	24	21	14.05	17.8	19	23	25.05	24
		D	26	26.08	24	22	24.8	21.1	14.09	17.05	18.8	23.8	25.06	25.8
2	pH	*A*	7.04	6.9	7.25	7.4	7	6.7	6.8	6.6	6.2	6.4	6.8	7
		B	7.5	7.7	7.3	7.7	7.1	7.1	6.7	7.2	7.3	6.5	6.9	6.8
		E	7.35	7	6.9	7.4	7.25	7	7.2	6.9	6.8	6.8	7.2	7.1
		C	6.9	7.9	7.25	7.6	7.35	7.6	7.2	6.8	7.9	7.1	7.4	7.2
		D	7.1	7.2	7.4	7.1	7.35	6.7	7.3	7	7.25	7.3	7.6	7.35
3	CO2	*A*	5.9	5.1	6	8	7.7	5.4	6	8	6.1	7	6.5	5
	Mg/l	*B*	5.3	6.4	5.9	7.9	5.2	5.7	5	5.4	6.4	8.1	6	4.2
		E	5.1	4.1	4.2	5.2	5	4.35	4.5	7.4	7	7.95	6.7	5.4
		C	6	8	8.05	7.8	7.1	5.4	6.2	8	6.1	7.7	5.6	6.1
		D	5	6	6.4	6.2	5	5.2	7	6.6	6.6	8.5	5.8	5.7
4	Al	*A*	86	88	84	110	140	200	285	300	315	260	70	78
	Mg/l	*B*	71	79	95	120	180	225	227	270	328	285	50	60
		E	81	71	92	123	182	240	280	292	340	270	65	80
		C	88	81	94	150	170	230	282	294	320	276	71	80
		D	82	76	94	120	170	230	290	302	338	270	60	79
5	TH	*A*	190	165	180	220	205	195	198	188	192	210	245	170
	Mg/l	*B*	198	230	205	250	215	222	204	170	185	190	200	180
		E	290	200	230	210	205	210	205	225	230	200	220	240
		C	202	250	225	240	223	214	210	212	240	205	218	210
		D	210	270	240	258	230	221	200	220	272	235	240	204
6	DO	*A*	6.1	6	7	7.3	8	9.2	14.1	16	13	6.8	5.3	5.8
	Mg/l	*B*	5	6.2	5.8	5.2	8.1	8.8	14	15.3	12.1	6.3	4.1	5.3
		E	5.9	7.4	6.8	7.8	8.1	9	14	16	14	7.4	6.1	6.4
		C	6.9	5.9	6.4	5.8	7.4	9.5	14.2	16.8	13.1	6.65	4.2	6.6
		D	6.3	7.4	6.9	6.9	6.3	8.1	14	15	14.3	7	5.8	6
7	N	*A*	7	5.3	5.1	6.5	6.2	7.6	10.9	13.3	11.1	10.6	8.5	7.1
	Mg/l	*B*	7.1	5.6	5.8	6.1	6.3	7.3	11.9	14.3	12.1	11.6	8.3	7.3
		E	6.5	5.2	5.4	5.9	6	7.1	11.5	14.1	10.8	10.2	8.7	6.9
		C	7.8	5	5.5	6.6	6.7	7	11.2	13	11.5	11.2	8.6	7.5
		D	7.8	5	5.5	6.6	6.7	7	11.2	13	11.5	11.2	8.6	7.5
8	P	*A*	35.2	44.6	43.5	55.3	64.2	73.1	80.6	82.1	70.9	60.3	56.2	42.5
	Mg/l	*B*	37.1	45.6	45.8	56.1	66.3	77.3	81.9	84.3	72.1	61.6	58.3	47.3
		E	34	47.2	48.9	53.5	61.2	75.2	78.4	74.2	71.6	58.3	55.2	42.1
		C	35.5	47.9	48.3	53.2	62.1	71.2	80.4	87.1	78	53.2	51.1	43.7
		D	32.6	48.7	46.2	52	65.4	79.7	76.9	81.2	68.1	65.3	53.2	44.1
9	TS	*A*	365	408	416	371	330	326	302	315	347	356	358	362
	Mg/l	*B*	385	389	401	408	336	320	312	325	358	370	373	378
		E	395	415	428	430	397	342	315	305	332	347	358	380
		C	382	391	410	425	353	348	332	315	324	341	355	362
		D	395	400	410	425	398	378	354	321	349	362	371	379

……….Continue

10	TDS	*A*	318	320	325	315	298	285	280	278	288	298	302	308
	Mg/l	*B*	305	315	332	320	284	271	270	269	288	290	300	302
		E	321	337	346	340	325	294	291	288	278	285	291	305
		C	298	291	306	310	286	281	275	270	285	290	294	295
		D	325	329	335	341	331	325	315	309	314	318	320	325
11	TSS	*A*	47	88	91	56	32	41	22	37	59	58	56	54
	Mg/l	*B*	80	74	69	88	52	49	42	56	70	80	73	76
		E	74	78	82	90	72	48	24	17	54	62	67	75
		C	84	100	104	115	67	67	57	45	39	51	61	67
		D	70	71	75	84	67	53	39	12	35	44	51	54
12	BOD	*A*	2.8	2.6	2.9	3.1	3.5	4	4.2	4.1	4	2.9	2.8	2.7
	Mg/l	*B*	2.1	3.01	2.8	2.6	3.2	3.5	4	4.12	3.8	3.7	2.1	2.4
		E	2.7	2.9	3.2	3.3	3.9	3.2	3.6	3.9	4.1	3.4	2.9	2.1
		C	1.8	2	1.9	2.3	2.5	3.1	4.6	3.2	2.9	2.1	2.9	2
		D	2.7	2.3	2.8	3.1	2.9	3.1	4	3.2	3.2	2.7	2.2	2
13	COD	*A*	44	47	46	49	38	35	37	35	39	40	42	41
	Mg/l	*B*	48	47	51	53	47	42	38	35	41	42	44	46
		E	50	52	55	57	48	45	41	35	38	37	42	44
		C	50	55	57	59	40	38	33	31	42	44	47	49
		D	38	40	42	45	35	33	32	30	37	39	40	41
14	EC	*A*	508.8	512	520	504	476.8	456	448	444.8	460.8	476.8	483.2	492.8
	Mg/l	*B*	488	504	531.2	512	454.4	433.6	432	430.4	460.8	464	480	483.2
		E	513.6	539.2	553.6	544	520	470.4	465.6	460.8	444.8	456	465.6	488
		C	476.8	465.6	489.6	496	457.6	449.6	440	432	456	464	470.4	472
		D	520	526.4	536	545.6	529.6	520	504	494.4	502.4	508.8	512	520

Hydrogen Ion Conc^n (pH)

The pH of natural water is nearly seven. However, in present study it remained over 7 (i.e. alkaline) because of the presence of sufficient quantities of carbonates. The increase in pH during day is largely because of photosynthetic activity. The mean values representing seasonal variation ranged from 7.1 pH to 6.8 pH in summer from 7.2 pH to 6.9 pH in winter and 7.4 pH to 7.1 pH in monsoon. Maximum pH (7.4) value was recorded during September and minimum pH (6.8) was recorded during March.

Free CO_2 (mg/l)

Mathew (1978), observed an inverse relationship between CO_2 and DO in Govind Sagar lake. free CO_2 may be depends upon alkalinity and hardness of water body. The value of CO_2 was high in February. This could be related to the high rate of decomposition in the warmer months. The mean values representing seasonal variation ranged from 6.4 to 5.2 mg/l in summer from7.8 to 6.0 mg/l in winter and 6.3 to 5.4 mg/l in monsoon. Maximum free CO2 (7.8 mg/l) value was recorded during March and minimum free CO_2 (5.2 mg/l) was recorded during November.

Total Alkalinity (mg/l)

Alkalinity plays an important role in buffering capacity of water according Hutchinson, (1967) classification where upstream sites fall under soft medium water type and downstream site fall under hard water increased catchment influences on the stream water. The natural water most of the alkalinity is due to CO_2. The free CO_2 react with water partly to form carbonic acid (H_2CO_3) which futher gets dissociated in to hydrogen (H^+) and bicarbonate (HCO_3) ions. The HCO_3 ions thus formed get further dissociated into H^+ and (CO_3) ions.

The mean values representing seasonal variation ranged from 328 to 63 mg/l in summerfrom291 to 168 mg/l in winter and 124.6 to 81.6 mg/l in monsoon. Maximum Alkalinity (328 mg/l) value was recorded during February and minimum Alkalinity (63 mg/l) was recorded during April.

Total Hardness (mg/l)

Hardness is the property of water which presents the soap and increase the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salt or both. Calcium and magnesium, the two most dominant cations play a major role in determining the hardness of the water. Hardness may be due to the presence of Ca++ and Mg++ salt from detergents and soaps used for laundering on the bank of the water body precipitated as calcium carbonate. During the study maximum (223.8 mg/l) total hardness was recorded during February month and minimum (200 mg/l) was recorded in November month. The mean values representing seasonal variation ranged from 223 to 200 mg/l in summer from 215 to 203 mg/l in winter and 235 to 218 mg/l in monsoon.

Dissolved Oxygen (mg/l)

Dissolved oxygen is of great important in all aquatic ecosystems as it regulates most of metabolic processes of organism and also the community architecture as a whole (Hutchninson 1967). The main sources of dissolved oxygen in water are diffusion of oxygen from air and photosynthetic activity taking place in water. Dissolved oxygen is of great important in all aquatic ecosystems as it regulates most of metabolic processes of organism and also the community architecture as a whole. The main sources of dissolved oxygen in water are diffusion of oxygen from air and photosynthetic activity taking place in water. The diffusion of oxygen from air mainly dependent on temperature, salinity, total dissolved salt and water movements etc. (Kumar *et al*., 2010). In the present study, the Dissolved Oxygen ranged from 13.3 mg/l to 6.02 mg/l during summer from 15.8 to 7.5 in winter and 6.6 to 6.04 mg/l recorded in monsoon.

Nitrate

In water the most important source of nitrate- nitrogen is biological of nitrogen organic matter both autochthonous and allochthonous origin. Domestic sewage and agriculture runoff have been regarded as the main source of allocthonous organic matter. Metabolic wastes of aquatic community and dead organism add the autochthonous nitrogenous organic matter. There are nitrifying bacteria which are known to play significant role in oxidation of such organic matter. The mean values representing seasonal variation ranged from 7.08 to 11.9 mg/l in summer from 5.38 to 12.16 mg/l in winter and between and 4.2 to 6.3 mg/l in monsoon.

Phosphate

The high value of Phosphate due to rain, surface water runoff, agriculture runoff, washer man activity could have also contributed to the inorganic phosphate content. The mean values representing seasonal variation ranged from 72 to 43.9 mg/l in summer from 81.7 to 63.8 mg/l in winter and 54.24 to 34.8 mg/l in monsoon. Maximum Phosphate (79.6 mg/l) value was recorded during December and minimum (43.9 mg/l) was recorded during May.

Total solid (TS)

Total solids are a measure of the suspended and dissolved solids in water. Total solids are those that can be retained on a water filter and are capable of settling out of the water column into the stream bottom when stream velocities are low. They include silt, clay, plankton, organic wastes, and inorganic precipitates such as those from acid mine drainage. Dissolved solids are those that pass through a water filter. They include some organic materials, as well as salts, inorganic nutrients, and toxins. The mean values representing seasonal variation ranged from 372 to 342 mg/l in summer from 362 to 316 mg/l in winter and 411.8 to 384.0 mg/l in monsoon. Maximum Total Solid (411 mg/l) value was recorded during September and minimum (316 mg/l) was recorded during January.

Total dissolved Solid (TDS)

In natural water dissolved solids are consists of inorganic salts, small amount of organic matter and dissolved materials. Dissolved solids are mainly due to carbonates, chlorides, sulphates, nitrates, phosphates, Ca, Mg, Na, K, Fe, Mn, etc. The mean values representing seasonal variation ranged from 307 to 290 mg/l in summer from 304 to 282 mg/l in winter and 313 to 328.80 mg/l in monsoon. Maximum Total Solid (328 mg/l) value was recorded during August and minimum (282 mg/l) was recorded during January.

Total Suspended Solid (TSS)

The suspended solids determination is particularly useful in the analysis of sewage and other waste waters and also indicates significant relationship as BOD determination. It is used to evaluate the strength of domestic waste waters and efficiency of treatment units. Suspended solids containing much organic matter may cause putrefaction i.e., decomposition and consequently the water body may be devoid of dissolved oxygen. The mean values representing seasonal variation ranged from 51 to 65 mg/l in summer from 33 to 58 mg/l in winter and 86 to 71 mg/l in monsoon. Maximum Total Solid (86 mg/l) value was recorded during September and minimum (33 mg/l) was recorded during January.

Biochemical Oxygen Demand (BOD)

BOD determines the amount of oxygen required for biological oxidation of organic matter with the help of microbial activities. The highest value of BOD was recorded (20 mg/l) in river Purna in Maharashtra due to highly pollution load by organic enrichment, decay of plant and animal matter in the river .The mean values representing seasonal variation ranged from 3.6 to 2.2 mg/l in summer from 4.0 to 3.2 mg/l in winter and 2.8 to 2.4 mg/l in monsoon. Maximum BOD (4.08 mg/l) value was recorded during December and minimum (2.2 mg/l) was recorded during May

Chemical Oxygen Demand

COD test is quite useful in finding out the pollution strength of industrial waste and sewage. Chemical oxygen demand as is the amount of oxygen required for a sample to oxidize at its organic and inorganic matter. The mean values representing seasonal variation ranged from 39 to 44.2 mg/l in summer from 41.6 to 33.2 mg/l in winter and 52 to 46 mg/l in monsoon. Maximum Total Solid (51.4 mg/l) value was recorded during September and minimum (35 mg/l) was recorded during January.

Conductivity (EC)

The conductivity mainly depends on ionic concentration or dissolved inorganic substance. Electrical conductivity (EC) also can be used to give a rough estimate of the total amount of dissolved solid (TDS) in water. Typically, the TDS value in mg/l is about half of the EC (µs/cm). The mean values representing seasonal variation ranged from 491 to 464 µs/cm in *summer* from 487 to 452 µs/cm in winter and 526 to 501 µs/cm in monsoon. Maximum Total Solid (526 µs/cm) value was recorded during August and minimum (452 µs/cm) was recorded during January.

Conclusion

According to a United Nations assessment of freshwater resources one third of the world's population lives in countries experiencing moderate to high water stress. Many countries in arid and semi-arid regions of the world are already close to or below the threshold for water scarcity. The present study area comes under semi arid region with low precipitation (900 mm/yr) and higher evaporation (1800 mm/yr). Therefore ground water is in small quantity and ground water table goes down during summer month (mid April to June). Surface water is Main source of water in Hamirpuri. e. Birma River. After treatment, the surface water is supplied to various areas through pipelines for municipal uses. So, surface water is a very much valuable resource for this region. Both the quality and quantity of this resource should be maintained for betterment of the local people. Before management of the surface water bodies the physico-chemical characteristics of the water quality was analyzed for physico-chemical characteristics (Temperature, pH, EC, Nitrate, DO, Turbidity, TS, TDS, TSS, Fluoride, Total Hardness and BOD organism are also recorded in soil on a monthly basis over a period of 2011-2012. After compare from water quality standard we find that Birmariver is unpolluted up stream while as downstream it is polluted and may not be used for domestic purpose without treatment but may used for irrigation. The main source of pollution is the sewage disposal and agricultural runoff from the catchments areas and need to be proper treatment before uses.

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