Assessment and Monitoring of Water Quality of Manushmara River Basin in Sitamarhi District, North Bihar, India

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Abstract

The present investigation was carried out to study the physico-chemical characteristics of Manushmara river basin in different seasons (pre-monsoon, post monsoon, winter) during 2014-15 and 2015-16 . River water samples were collected from thirteen selected locations namely Bahera Tola ,Garhwa Bishunpur, Hanuman nagar, Riga(up side), Riga (DN Side), Shahbazpur, Mohanpur, Prashuramprur , Dhankaul, Belsand, Basaul bridge, chandauli &Basantpur, and brought to laboratory for studying physico-chemical parameters like colour, temperature, PH, turbidity, electrical conductivity(EC), TSS, TDS, TS ,DO ,BOD, COD, Chloride, sodium, total hardness(TH), Carbonate , Bicarbonate and heavy metal contaminants. By comparing the results with the permissible limits of BIS and WHO, high seasonal variations were obtained. The results reflect that in pre –Monsoon period the river becomes highly polluted from Dhankaul (S_9) To Chandauli (S_{13}) and don't satisfy the requirement for the use of various purposes like domestic, agricultural, industrial etc. No fishing activity is seen in these areas and river becomes the reservoir of aquatic weeds. In the rainy season whenever river overflows a large area of paddy crops are being submerged, wilted through Plasmolysis & destroyed by this polluted water. People in the adjoining area are affected by several diseases like Asthma, skin disorders, gastroenteritis, Typhoid…etc.

Keywords -*Physico-chemical characteristics, contaminants, permissible limit, plasmolysis, wilt, aquatic weeds.*

I. INTRODUCTION

Water is one of the most common and the most precious resources on earth without which there would be no life on the planet. However, the distribution of water resources on this planet is uneven and only 30% of global water is found in the continents & the rest is present in oceans.Even in this 30% of water found on the land, about three fourth is locked in icebergs and glaciers. So the sources of water available to the living beings are less than one percent in lakes, streams and ground. Most of the developing countries depend on surface water bodies as source of drinking water. Ground water is the subsurface water that occurs beneath the water table in soil and geologic formation that are fully saturated[1]. It is an increasingly important resource all over the world and supports drinking water supply in both urban and rural areas, livestock needs, irrigation, industrial and many commercial activities,[2] but now-a-days fresh ground water ecosystems are being polluted at faster rate by leaching of various pollutants from surface water bodies, so preservation of water bodies free from pollution is essential requirement for any country .

Industrialisation ,Urbanisation and modern agricultural practices have influeneed the water sources qualitatively and quantitatively. Humans produce bodily wastes that enter into river and pollute water. Industries discharge variety of pollutants in the waste water including heavy metals, organic toxins, oil nutrients & solids. Many of the substances are toxic or even carcinogenic. Pathogens can obviously produce water diseases in either human or animal hosts. These wastes also increase the concentration of suspended solids, bacteria & viruses growth leading to potential health impacts. Increases in nutrient load may lead to eutrophication, organic wastes increase the oxygen demand in water leading to oxygen reduction in water with potentially severe impacts on whole ecosystems. so analyses of the water quality and water chemistry of water bodies (rivers. Lakes, ponds, streams … etc)is needed as an index of health and well being of the society.

The area under present study is the basin of Manushmara river which originates from Nepal and enters in India at 26.78N latitude and 85.41E longitude , 42m above sea level.It passes (approx 150km)mainly through district Sitamarhi in North Bihar and drains into Bagmati river near Chandauli (Sitamarhi district, map enclosed, fig.1)

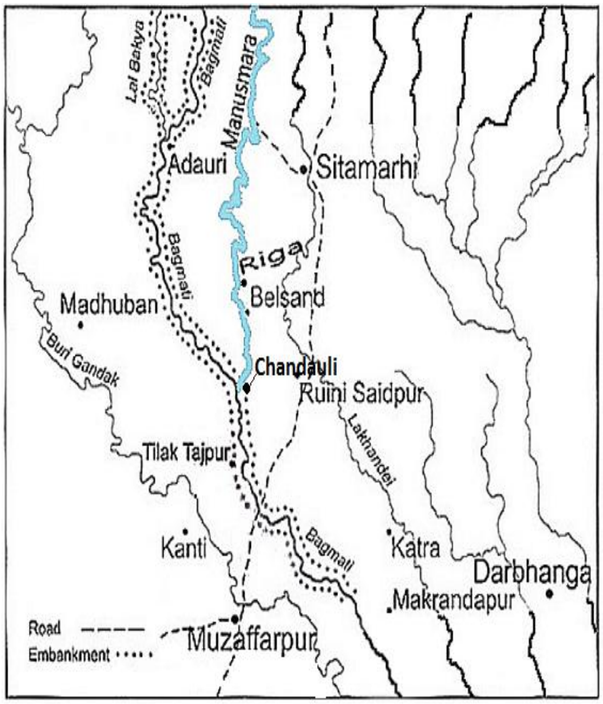

Fig.1

Effluents of Riga sugar cane industry & distilleries drains into this river at 26.62N latitude and 85.41E longitude , 33m above sea level. The flow rate of river water gradually decreases , so effluents & nutrients get deposited giving rise to it a bad taste ,dark colour,offensive odour, high turbidity, frothing and unchecked growth of aquatic weeds . A huge area of agricultural land is being submerged by this polluted water, whenever river overflows in rainy season , causing destruction of paddy crops. People residing in the concerned area affected by several skin diseases, allergy, breathing trouble , Asthma etc. So present study refers to the analysis of physico-chemical characteristics of water of this river basin to determine its suitability for consumption in various fields & to preserve it for future generation

II. MATERIALS & EXPERIMENTAL METHODS

A. Sampling & Preservation

Water samples from following 13 different sites were collected in pre-monsoon, post-monsoon & winter seasons in 2014-2015 from the surface water of the river in pre-cleaned polythene bottle. All the samples were brought to the laboratory and stored at 4^oC temperature in refrigerator till the analysis was complete.

Table 1:- Sampling points with their GPS location in Manushmara river.

Sl. No.	Location of sampling points & their Description	GPS location
1	Bahera Tola (S_1) (Entrance of the river into India from Nepal)	26.78 N Latitude & 85.41 E longitude
2	Garhwa Bishanpur (S_2)	26.71 N Latitude & 85.41 E longitude
3	Hanuman Nagar (S_3)	26.68 N Latitude & 85.41 longitude
4	Riga (up side) (S_4)	26.63 N Latitude & 85.42 E longitude
5	Riga (DN side) (S_5) (Distilleries drains into the river)	26.62 N latitude & 85.41 E longitude
6	Shahbazpur (S_6)	26.56 N Latitude & 85.40 E longitude
7	Mohanpur (S_7)	26.54 N Latitude & 85.41 E longitude
8	Prashurampur (S_8)	26.52 N Latitude & 85.39 E longitude
9	Dhankaul (S_9)	26.50 N Latitude & 85.38 E longitude
10	Belsand (S_{10})	26.44 N Latitude & 85.40 E longitude
11	Basaul bridge (S_{11})	26.44 N Latitude & 85.39 E longitude
12	Basantpur (S_{12})	26.38 N Latitude & 85.50 E longitude
13	Chandauli (S_{13}) (river drains into Bagmati river)	26.43 N Latitude & 85.40 E longitude

III. PHYSICO-CHEMICAL ANALYSIS

The collected samples were analysed for physico-chemical water quality parameters like colour , odour , temperature, PH, electrical conductivity (EC), Total Suspended Solids (TSS), Total dissolved soilds (TDS), Total Solid (TS), Total hardness (TH), Turbidity, Dissolved Oxygen (DO), Biological oxygen demand (BOD), Chemical Oxygen demand (COD), Chloride (Cl^-), Sodium (Na^+), Carbonate (CO_3^{2-}), & Bicarbonate (HCO_3^-). Temperature, PH and DO were measured at the sample collection site. The concentration of dissolved oxygen (DO) present in collected samples were estimated by winkler method. The determination of COD was carried out according to Ademoroti. The chloride was estimated by silver nitrate titration method. All the physico-chemical parameters were analysed following standard method as per APHA (2005). The reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions.

Some of the samples were analysed for heavy metal determination using Atomic absorption spectrophotometer from outside laboratory.

The average results of the physico-chemical parameters are presented in table 2,3 & 4.

Table:-2 (Average values of physico-chemical Parameters of water samples)

Parameters	Period of sampling	Sampling Points													BIS Standards IS: 2490-1974,1981
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	
Temp(^{o}c)	**Pre-monsoon**	**31.5**	**32**	**32**	**33.3**	**34**	**34**	**33**	**33.3**	**33.5**	**33.6**	**33.4**	**33.5**	**33.3**	**Should not exceed 40^{o}c**
	Post-monsoon	**24.6**	**24.5**	**24.8**	**25.2**	**26.3**	**26.1**	**26**	**26**	**26**	**26**	**26**	**25.6**	**25.8**	
	Winter	**20**	**20.2**	**20.2**	**20.5**	**21.8**	**20.2**	**20.3**	**20.5**	**20.8**	**20.8**	**21**	**20.8**	**21**	
PH	**Pre-monsoon**	7.8	7.9	8.0	8.2	6.0	8.0	8.0	8.2	8.4	8.6	8.6	8.7	8.5	5.5 to 9.0
	Post-monsoon	7.6	7.6	7.8	8.3	8.0	8.1	8.1	8.1	8.0	8.0	8.1	8.1	8.0	
	Winter	7.5	7.6	7.6	8.0	5.9	7.8	7.8	8.0	8.2	8.3	8.2	8.3	8.2	
EC	**Pre-monsoon**	330	345	399	425	465	505	553	608	652	690	760	810	800	300*
	Post-monsoon	280	280	285	306	315	315	326	325	350	352	350	352	350	
	Winter	260	270	290	320	355	400	465	485	510	548	615	652	650	
TSS	**Pre-monsoon**	475	539	585	605	2113	2503	2610	2903	3285	3498	3465	3176	3017	100
	Post-monsoon	421	490	523	592	892	880	898	935	963	1007	1013	1026	998	
	Winter	403	417	439	452	915	935	943	992	996	1038	1036	1063	990	
TDS	**Pre-monsoon**	210	212	220	232	345	402	495	577	685	705	732	729	689	2100
	Post-monsoon	178	182	188	198	210	219	218	220	219	223	231	210	206	
	Winter	190	190	197	209	226	280	272	265	271	293	302	282	271	
TS	**Pre-monsoon**	685	751	805	837	2458	2905	3105	3480	3970	4203	4197	3905	3706	2100
	Post-monsoon	599	672	711	790	1102	1099	1116	1155	1182	1230	1244	1236	1204	
	Winter	593	607	636	661	1141	1215	1215	1257	1267	1331	1338	1345	1261	
TH	**Pre-monsoon**	105	106	112	118	173	201	240	289	320	350	356	352	350	1000
	Post-monsoon	89	92	96	99	108	109	109	115	116	119	123	125	122	
	Winter	95	97	100	110	112	140	138	141	145	149	152	153	150	
Turbidity	**Pre-monsoon**	0.61	0.85	0.86	1.78	6.5	5.9	7.3	13.6	20.8	37	39.5	30.3	26.8	Less than 5*
	Post-monsoon	0.54	0.73	0.78	1.21	5.1	5.0	6.2	6.5	6.0	6.3	6.9	6.1	5.8	
	Winter	0.49	0.57	0.60	0.96	5.4	5.3	5.8	9.7	15.4	18.2	19.1	18.7	16.3	
DO	**Pre-monsoon**	6.5	6.5	6.4	6.0	5.2	4.8	4.6	3.4	2.9	2.8	2.6	3.2	4.3	4-6
	Post-monsoon	6.8	6.8	6.6	6.4	5.6	5.6	5.2	5.0	4.7	4.8	4.7	5.0	5.2	
	Winter	7.2	7.1	7.0	6.8	5.9	5.8	5.5	5.5	5.1	5.3	5.1	5.2	5.4	
	Pre-monsoon	1.45	1.51	1.58	1.62	98	105	112.5	117	155	162.7	188.6	150	142	

BOD	**Post-monsoon**	1.16	1.19	1.2	1.25	67	70	75	79	85	91	98	103	98	30
	Winter	1.31	1.35	1.47	1.57	94	101	108	105	122	150	159	141	135	
COD	**Pre-monsoon**	3.7	3.9	4.4	4.9	199	222	247	309	425	487	509	400	390	250
	Post-monsoon	3.0	3.1	3.8	4.2	185	190	198	205	215	221	240	258	250	
	Winter	3.0	3.2	3.8	4.5	192	212	238	258	348	399	411	383	365	
Cl^-	**Pre-monsoon**	70	72	70	78	89	100	107	121	128	133	130	105	109	1000
	Post-monsoon	65	68	68	70	79	93	98	107	110	113	109	101	102	
	Winter	68	67	67	72	82	90	99	109	115	114	108	104	104	
Na^+	**Pre-monsoon**	80	85	97	105	138	146	150	156	158	160	160	155	158	200*
	Post-monsoon	72	74	78	85	92	103	115	121	121	119	122	118	118	
	Winter	77	78	84	92	100	108	119	126	130	128	129	120	120	
HCO_3^-	**Pre-monsoon**	85	85	87	90	102	178	190	205	235	239	242	242	240	500*
	Post-monsoon	78	80	83	85	92	99	100	107	112	125	115	117	116	
	Winter	76	79	80	82	98	120	128	135	138	140	142	145	144	
CO_3^{2-}	**Pre-monsoon**	**35**	37	37	36	45	72	85	112	117	120	122	120	120	-
	Post-monsoon	27	27	26	26	39	47	50	55	65	69	72	75	78	
	Winter	28	28	30	31	42	60	64	65	70	75	80	82	85	

*All parameters are in mg/l, except PH, EC & Turbidity , EC in µs/cm; Turbidity in NTU, *Limits prescribed by WHO- 1993*

Table-3 Colour and Odour

Parameters	**Period of sampling**	**Sampling Points**		**BIS Standards** IS:2490 - 1974,1981
		S_1-S_4	**S_5-S_{13}**	
Colour	***Pre-monsoon***	***Colourless***	*Muddy Yellowish*	***Colourless***
	Post-monsoon	***Colourless***	*Muddy-Faint Yellowish*	
	Winter	***Colourless***	*Muddy Light Yellowish*	
Odour	***Pre-monsoon***	*Odourless*	*Decaying Organic*	***Odourless***
	Post-monsoon	*Odourless*	*Faint foul*	
	Winter	*Odourless*	*Decaying Light Organic*	

Table – 4
Analysis for Heavy Metals in ppm

Period of Sampling	**Parameter**	**Sampling Points**			**BIS Standards (IS: 2409-1981)**
		S_9	**S_{10}**	**S_{11}**	
Pre-monsoon	Cd	0.116	0.416	0.385	2.0
Pre-monsoon	Pb	Tr	1.373	0.98	0.1
Pre-monsoon	Ni	Tr	Tr	Tr	3.0
Pre-monsoon	**Cr^{6+}**	Tr	0.041	0.049	0.1
Pre-monsoon	Zn	0.09	0.095	0.063	5.0
Pre-monsoon	Cu	0.038	0.039	0.016	3.0
Pre-monsoon	Fe	1.3	1.38	1.09	-
Pre-monsoon	Mn	0.141	0.148	0.124	-

IV. RESULTS & DISCUSSION

A. Colour, odour and Temperature

The colour is an important parameter in the assessment of water quality as it affects the transparency of water & quality of sunlight that penetrates to a given depth inhibiting plant and animal metabolism. Odour pollution of water is caused by both the chemical agents (like H_2S, free Cl_2, NH_3, phenols, alcohols, esters, hydrocarbons etc.) and biological agents (like algae, fungi, micro-organism etc). So river water should be colourless and odourless and having temperature 20-30^{o}c for sustaining aquatic life.

In the present investigation, the water samples from S_5 to S_{13} are muddy yellowish having smell, showing high organic load. However, temperature complies with standard except at S_5 where effluents drain into the river.

B. PH

Sewage waste and industrial effluents generally contains acids, alkalis, toxic metals, and other poisonous substances which collectively, or individually alters physico-chemical characteristics of medium. So the measurement of PH of water is considered as one of the tools in controlling and treatment of sewage waste and industrial effluents.

In the presence of very large quantities of organic matter, PH is normally low due to release of CO_2. In the present investigation PH of all the sampling sites except S_5 was found to be more '7' ranging from 7.5-8.9, showing alkaline nature of water. Due to discharge of effluents at S_5, the PH is in the vicinity of '6', which shows acidic nature of water sample, dangerous to aquatic life. In a pre-monsoon season the PH of all the water samples were found to be high that might be due high temperature that reduces the solubility of CO_2.

C. Electrical Conductivity

Conductivity is the measure of capacity of a substance or solution to conduct electric current. The value of EC for all the investigated samples are higher than the prescribed limit implying the presence of high level of ionic species. However the measured values were found maximum in pre-monsoon ranging from 330 to 960 μs/cm and minimum in post-monsoon ranging (280-352 μs/cm) periods.

D. Total Dissolved Solids (TDS). Total Suspended Solids (TSS) & Total Solids (TS)

The amount of total solids consist of suspended (TSS) and filterable partials (TDS). The dissolved solids normally confer a degree of hardness. It comprises inorganic salts (mainly bicarbonates, carbonates, chloride, phosphates & nitrates of Ca, Mg, Na, K, Mn etc), soluble organic matters & other particles in molecular, ionized or colloidal (micro-granular) from. TDS are differentiated from TSS in the latter can't pass through a sieve of two micrometers & yet indefinitely suspended in solution. High TDS causes scaling in containing vessels & boilers. In the present investigated samples its values are found high in pre-monsoon season (ranging from 210-765 ppm) while low in post-monsoon & winter due to increase in dilution, but within the permissible limit of BIS (2100 ppm).

Total Suspended Solids include the nun-filterable residue of inorganic, organic substances, silt & other particles. They prevent the growth of aquatic plants by blocking the sunlight and interfering with natural aeration. They are dangerous to aquatic animals also, as they utilize the dissolved oxygen and produce noxious gases & odour. Larger suspended particles act as suitable sites & promote bacterial growth. All the investigated samples are found to have higher TSS (in all the seasons) than the prescribed BIS limit (100 ppm). However the measured values are much higher in pre-monsoon (ranging from 475-3498 ppm) than post-monsoon (421-1026 ppm) & winter season (403-1038 ppm).

Higher the TDS & TSS, higher is the value of total solids which reduces the water clarity, increases the water temperature, decreases the oxygen level due to less photosynthesis and solids can bind to toxic compounds and heavy metals.

The investigated samples from S_5 to S_{13} have TS values are above the standard BIS limit (2100 ppm) due to presence of both organic and inorganic compounds. The values are found high in pre-monsoon (summer) and winter and lower in post-monsoon due to increase in dilution.

E. Turbidity

Turbidity in water mainly arises from colloidal matter, fine suspended particles, planktons, micro-organism & soil erosion. It is an expression of optical property of water which causes light to be scattered and absorbed rather than the transmitted. It decreases the penetration of sunlight in water, so seriously affects the normal life of aquatic plants (by reducing photosynthesis) & animals also. Turbid water becomes unsuitable for industrial purposes & also for domestic use because Fe, Mn, Ni, Co, Pb, Sb, Bi etc present in it may cause stains on cloths, sinks and bath etc.

The turbidity of the present investigated water samples vary from 0.53-39.5 NTU. For the samples S_5

to S_{13} the values are higher than the values prescribed by WHO (less than 5 NTU).

F. Total Hardness

The total hardness is mainly due to concentration of calcium and magnesium ions expressed in calcium carbonate. During summer, due to higher decomposition rate, the CO_2 is liberated, which prevents the dissociation of bicarbonates into carbonates, thus enhancing the total hardness of water. But the Fe^{2+} & Zn^{2+} also show some relation with hardness. The soap consuming power of hard water is lowered by these heavy metals & alkaline earth metals. The hard water is not suitable for domestic use in washing, cleaning & laundering.

In the present study the values of hardness (ranging from 89-356 ppm) of water samples are within the permissible limit of BIS (viz 1000 mg/l).

G. Dissolved Oxygen (DO)

Dissolved Oxygen is one of the most important parameter in the assessment of water quality since it reflects the physical and biological process prevailing in water. Low concentration of O_2 in water kills the aquatic life. The dissolved Oxygen decreases with increases in temperature and also by heavy contamination of organic matter. The decaying organic matter present in the effluent consumes more oxygen and reduce the DO content (Hynes, 1971). So the analysis of D.O. plays a key role in water pollution control activities and waste-treatment process control.

In the present study the concentration of D.O. in S_8 to S_{12} water samples in pre-monsoon season were found from 3.4 to 3.2 ppm, which were lower than the BIS recommended limit from 4 to 6 ppm, indicating high organic load. The situation was alarming from Dhankual (S_9) to Belsund (S_{11}) where the concentration of D.O were found below 3.0 ppm. In post-monsoon & winter season the concentration of D.O were found slightly increased in these sites due to addition of water & mixing of O_2 with water. In winter the O_2 holding capacity of water increases due to low water temperature. This is also supported by fact that no fishing activities was seen from Riga to Belsund while before Riga it is found regularly.

H. Biological Oxygen Demand

BOD represent the quality of O_2 required by bacteria and other micro-organism during the bio-chemical degradation and transformation of organic matter present in water bodies under aerobic conditions. The demand of O_2 in water is proportional to the amount of organic matter in it. So BOD is an important parameter, which shows the level of organic pollution in water body. Whenever, there is low DO content in water, normally high BOD is observed. Depending upon BOD load, retention time of waste in a treatment plant is determined/fixed. So, measurement of BOD is also useful in design and management of water treatment plants.

In the present investigation BOD of water samples S_5 to S_{13} were found much higher (ranging from 98 to 188 ppm) in pre-monsoon seasons in comparison to post-monsoon (ranging 67 to 98 ppm) and winter season (ranging 94 to 135 ppm). In all the seasons these values are higher than the recommended BIS standards showing high organic load. In summer the values are quite high due to high pollution load & reduced water flow (Khatavkar and Trivedy, 1988) while lower value in post-monsoon & winter is due to dilution of water & low microbial population (zutshi & vass 1982).

I. **Chemical Oxygen Demand (COD)**

COD is the amount of O_2 required by the organic substances in water body to be oxidized by a strong chemical oxidant. Hence it is used as an important parameter, which shows the organic load of industrial & domestic waste in the water body. However in the process O_2 is also consumed in oxidizing some inorganic substances like sulphides, reduced metal ions, thiosulphates etc and some organic material like benzene, pyridine, & few other cyclic organic compounds are not oxidized. Yet, COD test measures oxygen requirement for the removal of chemically oxidizable organic matter present in the water body. Therefore like BDO it is also useful in design and management of water treatment plants.

In the present study COD of water samples from S_8 to S_{13}, were found higher than the recommended BIS Standard (250 ppm) showing high organic load in water body. COD values were found higher in pre-monsoon (ranging from 309 to 508 ppm) and winter (285-411 ppm) seasons due to high pollution load & reduced water flow. The values are lower (205-258 ppm) in post-monsoon season due to dilution of water.

J. Chloride

The major contribution of chloride to water pollution is domestic sewage, industrial effluent and human wastes, High chloride content in water bodies harms metallic pipes and structures as well as agricultural crops.

In the present investigation chloride concentration was maximum in pre-monsoon season & found in the range 70-133 ppm, which was within the prescribed limit of BIS Standard & WHO. Due to increase in dilution its value was lower in post-monsoon and winter season.

K. Sodium

The major source of sodium in water body is the weathering of various rocks, industrial wastes & domestic sewage. The sodium ion concentration in the present study varied seasonally and found maximum in pre-monsoon period due high pollution load & reduced water flow, which was 80 to 160 ppm. In post-monsoon & winter period, the values were found lower. However all these values were within the permissible limit of BIS.

L. Carbonates & Bicarbonates

Excess of inorganic pollutants like carbonates, bicarbonates of calcium & magnesium make the water hard & unsuitable for boilers.

In the present investigation bicarbonate & carbonate concentration was maximum in pre-monsoon season while minimum in winter. However the value was found increasing from S_4 to S_{12} due to accumulation of effluents in pre-monsoon & winter season both, but the value was within the prescribed limit of WHO (500 ppm).

M. Heavy Metals

Beyond the tolerance limits, some of the heavy metals like Pb,Hg, As, Fe, Co, Ni, Cr, Zn, Mn, Cu, Cd etc have been identified as deleterious to aquatic ecosystem and human health. These elements are added in aquatic system from industrial process, domestic sewage discharge, street dust, land run off and fossil fuel burning. However the degree of toxicity depends upon the form in which they are present. For instance organo-mercury & organo-lead are much more poisonous than their inorganic forms. Similarly hexavalent chromium and iron are more toxic than its trivalent form. In the environment, microbial oxidation and reduction of metals contribute to the problem of toxicity by metals.

In the present study some of the water samples were analyzed for heavy metal contamination using AAS and the results are presented in table 03. All the heavy metals analyzed were found within the permissible limits of BIS Standard, except 'Pb' at S_{10} & S_{11}, probably due to human activities.

CONCLUSION

On the basis of analysis report it seems that the pollution of river water starts from effluent discharging point, Riga (S_5) and it increases onwards. From Dhankaul (S_9) to Belsund (S_{10}) & Basaul bridge (S_{11}), all the physico-chemical parameter like TSS, TS, EC, BOD, COD, turbidity are found to be very high than the permissible limits prescribed by the Bureau of Indian Standards : 2490-1974, 1981 and by WHO-1993. In the pre-monsoon season, the DO is found to be in the vicinity of 3.0 ppm in these sites which is quite dangerous to aquatic life. All these findings indicate high organic load & the river is found to be highly polluted in these areas. Effluents of distillery discharge get accumulated in these areas due to reduced flow rate of water causing it polluted. Aquatic life is in danger, no fishing activity is visualized, river becomes the reservoir of aquatic weeds & water is unsafe for human use. Whenever river water overflows in rainy seasons, a huge area of paddy crops are being submersed, wilted through plasmolysis and destroyed. People in the adjoining areas are found affected by several diseases like Asthma, Tuberculosis, Skin disorders, Gastroenteritis, typhoid etc. Thus, some additional measures are needed by the sugar industry for environmental protection. This may be use of bio-tower which gives zero waste rather than conventional methods of effluent treatment.

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REFERENCES

[1] M.R Mahananda, B.P Mohanty.,N.R Bahera, "physico-chemical analysis of surface and Groundwater of Bargarh district, Orissa, India", IJRRAS vol 2(3). March 2010.

[2] S.S Parihar, A Kumar, R.N Gupta, M.Pathak, A.Shrivastava,A.C Pandey , "physico-chemical analysis of under-ground water in and around Gwalior city, M.P, India", Research journal of recent sciences,vol I(6); PP62-65, 2012

[3] P.G ‘‘ Parivesh Ground water’’ Ed. Dilip Biswas P.3, July 2003

[4] T.N Tiwari. & M. Mishra ‘‘ Pollution in the river Ganga at Varanashi’’ life science advance vol 5, , PP 130-137. 1986

[5] P.M Reddy and V. Venkateswar ‘‘Assessment of water quality in the river Tungabhadra near Kurnol’’, A.P..J Environ. Biol. 8, PP 109-119, 1987

[6] R.Ragunath,T.R. Sreedhar Murthy, and B.R.Raghwan, "Spatial distribution of PH, EC and total dissolved solids of Nethravathi river basin, Karnataka state, India", Pollution Research vol 20 (3),pp 413-418.2001

[7] V.Simeonova, J.A Stratisb, C.Samarac, G.Zuchariadish, D.Voutsac, A.Anthemidis, M.Sofonioub, Th.Kouimtzisc, ," Assessment of surface water quality in northern Greece", water research vol 37, pp 4119-4124, 2003.

[8] DR.Khanna, R.Bhutiani, B.Tyagi, PK.Tyghi & M.Ruhela, "Determination of water quality index for the evaluation of surface water quality for drinking purpose", International journal of science and engineering vol 1(1) pp 09-14, 2013

[9] S.k Sinha "Physico-chemical characteristics of effulent discharged from Lohat Sugar factory in Bihar", Environment and Ecology, vol 11(2) pp 256-268 1993

[10] Dr. Khanna, R. Bhutani, V. Tyagi & F. Ahmed "Impact of sugar mill effluent on physico-chemical properties of Malin river in Nazibabad district" Indian journal of scientific research, special edition pp 5-10, 2014

[11] E.O. Lawson, "physico-chemical Parameters and heavy metal contents of water from the Mangrove swamps of Lagos Lagoon, Lagos, Nigeria", Advances in Biological research , vol 5 (1) pp 08-21, 2011
[12] Wei, Yuan-an and Xu, Yuan-Jin, "Eco friendly management of sugar industry effluent in Guangxi, China", Sugar Tech, vol 6 pp 285-290 ,2004
[13] J. Uppal, "water utilization and effluent treatment in the Indian alcohol industry an overview", India-E.U. workshop on promoting efficient water use in agro based industries , New Delhi, India. 15-16, Jan 2004,
[14] A.K Baruah, R.N. Sharma, G.C. Borah, "impact of sugar mill and distillery effluent on water quality of the river Galabil, Assam", Indian journal of environment and health, vol 35, PP:288-293. 1993
[15] D.B Sapkal and B.B Gunjal. "Achieving zero waste water requirements and zero discharge in sugar industry", Proceedings. 2004
[16] APHA/AWWA-WPCF "Standard methods for the examination of water and waste water", 19th Edn, American Public Health Association, AWWA & WPCF, Washington D.C (USA). 1995
[17] BIS, Indian Standard specification for industrial effluents discharged into inland surface water IS: 2490 (Part I & II) 1974,1981
[18] Gay and Proop ''Aspects of river pollution , Butterworth scientific publication", London. 1993
[19] A.K Dey, "environmental chemistry" 4th Edn, New Age International Publishers, New Delhi-2002