Assessment of Water Quality of Ghaghara River in Chapra District, Bihar and Evaluation of Remedial Techniques for Pollutants

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Abstract

Water pollution is becoming a serious problem in India and has now reached a critical point as about 70% of its surface water resources are contaminated with organic toxic, organic pollutants and inorganic pollutants. The low quality of water is unsafe for both human use and the ecosystem. It is for this reason that I have undertaken the task of assessing water quality in terms of heavy metal and physico-chemical characteristics of the Ghaghara River in Chapra district and some easily accessible remedial techniques for these pollutants. In pre-monsoon and post-monsoon more than 100 water samples were collected from different sites of Ghaghara River between Rivilganj to Tajpur in Chapra district. It lies between 25.782261 North Latitude and 84.626096 East Longitude to 25.876387 North Latitude and 84.493640 East Longitude. pH, turbidity, electrical conductivity, TDS, total hardness, calcium, magnesium, chloride, alkalinity, iron, nitrate, sulphate, fluoride, arsenic and magnesium were analyzed on site and in the laboratory. The pH in the water samples was found to be in the range of 8.24-8.63 and 7.66-8.04 during pre- and post-monsoon respectively. Turbidity, EC, TDS and TH in water samples were found to vary in the range of 0.30-7.40 NTU, 8.40-24.10 NTU; 345-354 µs/cm, 213-228 µs/cm; 224-230 ppm, 139-148 ppm and 164-192 ppm, 76-124 ppm during pre- and post-monsoon respectively. The value obtained almost falls within the permissible limits of BIS. The fluoride content varies in the range of 0.18-0.20 ppm during pre- and post-monsoon season mean values of 0.19 ppm and 0.13-0.17 ppm with mean values of 0.16 ppm. Fluoride of water within the permissible limits of B.I.S.(Bureau of Indian Standards). The iron test was found to be in the range of 0.21 ppm to 0.77 ppm with an average of 0.46 ppm and median of 0.46 ppm in pre-monsoon and 1.06 ppm to 1.94 ppm with an average of 1.45 ppm and median of 1.43 ppm. When river water contains silt, fine organic and inorganic matter, algae and other microorganisms, the water appears hazy. When the sun's rays fall on the muddy water, it disintegrates. As a result, the water appears dirty. Due to the amount of organic matter in the water and other dissolved wastes, the sediment gets deposited in the river, for example the Ghaghara River from Rivilganj to Goldingganj in Saran district is slowly disappearing.This study has been done to assess water pollutants, its impact on aquatic animals and people living along the river banks as well as the purpose of irrigation. The study is needed to evaluate cost-effective bio-absorbents readily available to the general public.

Keywords: Ghaghara River, physico-chemical, turbidity, iron, aquatic animals, cost-effective.

1.0 Introduction:

Water pollution is becoming a serious problem in India and has now reached a critical point as about 70 percent of its surface water resources is contaminated with organic, toxic, organic and inorganic pollutants. In many cases, these sources have been made unsafe for human consumption as well as other activities, such as irrigation and industrial necessity. Almost every river system in India is now largely polluted. As assessed by scientists from the National Environmental Engineering Research Institute (NEERI) Nagpur, about 70% of the water in India is polluted. This proves that due to the decline in water quality, both human life and ecosystem can be affected. It is for this reason that I have undertaken the task of assessing water quality in terms of heavy metal and physico-chemical characteristics of the Ghaghara River in Chapra district and some easily accessible remedial techniques for these pollutants.This study has been undertaken to assess the water pollutants, its effect on aquatic animals and the people living along the river coast as well as irrigation purpose. The need of the study is to evaluate the cost-effective bioadsorbent easily available to common people. Separation of waste material from water before decomposition: Between Kali Mandir of Tajpur to Bengali Baba Ghat of Doriganj in the Ghaghra River there are more than 100 small and big temples and ghats. People take bath and offer prayers at these ghats. The waste material of worship performed at home is filled in polythene and immersed in the river. Polythene and the waste material kept by the people pollute the river water. A simple and cheap way to separate these waste materials and polythene is as follows-At each important bank of river, where people offer prayers and put the worship material in the river, an immersion pool should be made on the banks of the river. According to the number of people and quantity of waste worship material, there should be a pit in which people can put their waste worship material. This pool should have three parts. Organic matter should be deposited in one part, inorganic material in another part and polythene in the third part.

1.1 Geographical introduction

Ghaghara River is also known as Karnali River, Saryu River. The Ghaghara is a perennial river that originates in the Tibetan Plateau near Lake Mangareva. It cuts through the Himalayas in Nepal where it is called Karnali and joins the Sharda River at

Brahma ghat in India. Together they form the Ghaghara River, a major left bank tributary of the Ganges by volume. It originates from the Himalayas and flows in the Gangetic plains of North India. It joins the Ganges River between Ballia and Chapra. This river flows through Uttarakhand, Uttar Pradesh and Bihar in India. Major cities like Azamgarh, Bahraich, Sitapur, Gonda, Faizabad, Ayodhya, Tonda, Rajsultanpur, Dorighat, Ballia, Chapra are situated on the banks of this river. The total length of Ghaghara River is 1080 km where as in India it is 970 km.

1.2 Work study area

My study area is about 42 Km starting from Maa Kali Mandir, near Tajpur to Bengali Baba Ghat, Doriganj Saran District. It is located between 25.889545 North Latitude and 84.500205 East Longitude to 25.7457365 North Latitude and 84.7042046 East Longitude. The main places of my study area are Bhabauli, Dumri, Manjhi(west), Manjhi(East), Shri Bhajan Brahmbaba ghat, Kauru Dharu ghat, Simaria ghat, Revelganj cremation ground. On this river there is Jaiprabha Setu (Balia Chapra Bridge) near Shri Bhajan Barham Baba Ghat of Manjhi. There is also a railway bridge to the west beside it. The Ghaghara River from Tajpur to Revelganj in Saran district has water throughout the year, but from Revelganj to Doriganj, water remains during the floods. Chapra is a big city situated on the north side of Ghaghara River. The Ghaghara River from Revilganj to Doriganj has ceased to exist due to sediment deposition in the river and solid waste by the city of Chapra.

2.0 Material and methods

Collected water samples from different sites of Ghaghara river water in Chapra district of Bihar and analyzed for physico-chemical characteristics like pH, TDS, conductivity, phosphate, nitrates, BOD, COD, etc. and heavy metal pollutants like Samples of arsenic, iron lead, etc., in the middle of the river and below the surface, took more than 100 samples in different seasons. The pH, TDS, DO and conductivity was analyzed by water analysis kit available in the department. BOD was analyzed by the BOD incubator. COD, nitrates, and phosphate parameters were assessed in the Department of Chemistry's laboratory by chemical methods prescribed at APHA. Arsenic, iron and other heavy metal contaminants were detected by UV-visible spectrophotometer in the Department of Chemistry by the standard method prescribed at APHA. Arsenic was also analyzed with the help of on-spot kits available in the market. Statistical analysis was also done with international standard.

It aims to focus on evaluation of some new technologies for the removal of heavy metal pollutants from water by chemical or bioremediation process that would be cost-effective and readily available to the public. For this purpose, various adsorbents such as ash, sand, charcoal husk etc., and the bark and leaves of plants are used to investigate their role in the adsorption of arsenic, iron, etc. and develop simple methods.

3.0 Result & Discussion

Table No. – 01: Descriptive statistical analysis of water quality parameter of River water during Pre- and Post-monsoon

Parameters	Pre-monsoon				Post-monsoon			
	Min	Max	Average	Median	Min	Max	Average	Median
pH	8.24	8.63	8.39	8.36	7.66	8.04	7.88	7.89
Turbidity	0.30	7.40	2.69	2.60	8.40	24.10	14.87	13.80
TDS (ppm)	224.0	230.0	227.09	227.0	139.0	148.0	142.29	141.0
EC (µS/cm)	345.0	354.0	349.56	349.0	213.0	228.0	219.18	217.0
Total Hardness (ppm)	164.0	192.0	179.11	180.0	76.0	124.0	90.58	88.0
Ca Hardness (ppm)	30.46	38.47	34.02	33.66	17.63	28.86	23.15	22.44
Mg Hardness (ppm)	17.49	26.24	22.51	22.35	1.90	12.69	8.11	7.77
Total Alkalinity (ppm)	148.0	192.0	180.42	184.0	108.0	128.0	117.07	116.0
F^- (ppm)	0.18	0.20	0.05	0.04	0.13	0.17	0.16	0.16

Cl^- (ppm)	11.99	15.99	13.21	12.99	7.99	17.99	12.01	11.99
NO_3^- (ppm)	0.02	0.20	0.05	0.04	1.65	3.65	2.57	2.45
SO_4^{2-} (ppm)	17.20	20.10	18.47	18.20	21.20	41.30	28.33	27.40
Iron (ppm)	0.21	0.77	0.46	0.46	1.06	1.94	1.45	1.43

3.1 Statistical Analysis

Table No. – 02: Statistical analysis of turbidity between Pre-Monsoon and Post-Monsoon

Statistics

		Pre-Turbidity	Post-Turbidity
N	Valid	45	45
	Missing	0	0
Mean		2.6889	14.8667
Std. Error of Mean		0.33208	0.73003
Median		2.6000	13.8000
Mode		0.30[a]	10.80
Std. Deviation		2.22764	4.89722
Variance		4.962	23.983
Range		7.10	15.70
Minimum		0.30	8.40
Maximum		7.40	24.10

a. Multiple modes exist. The smallest value is shown

Table No. – 03: Correlation between turbidity of Pre-Monsoon and Post-Monsoon

Correlations

		Pre-Turbidity	Post-Turbidity
Pre-Turbidity	Pearson Correlation	1	0.254*
	Sig. (1-tailed)		0.046
	N	45	45
Post-Turbidity	Pearson Correlation	0.254*	1
	Sig. (1-tailed)	0.046	
	N	45	45

*. Correlation is significant at the 0.05 level (1-tailed).

Table No. – 04: Descriptive Statistical analysis between turbidity of Pre-Monsoon and Post-Monsoon

Descriptive Statistics

	Mean	Std. Deviation	N
Pre-Turbidity	2.6889	2.22764	45
Post-Turbidity	14.8667	4.89722	45

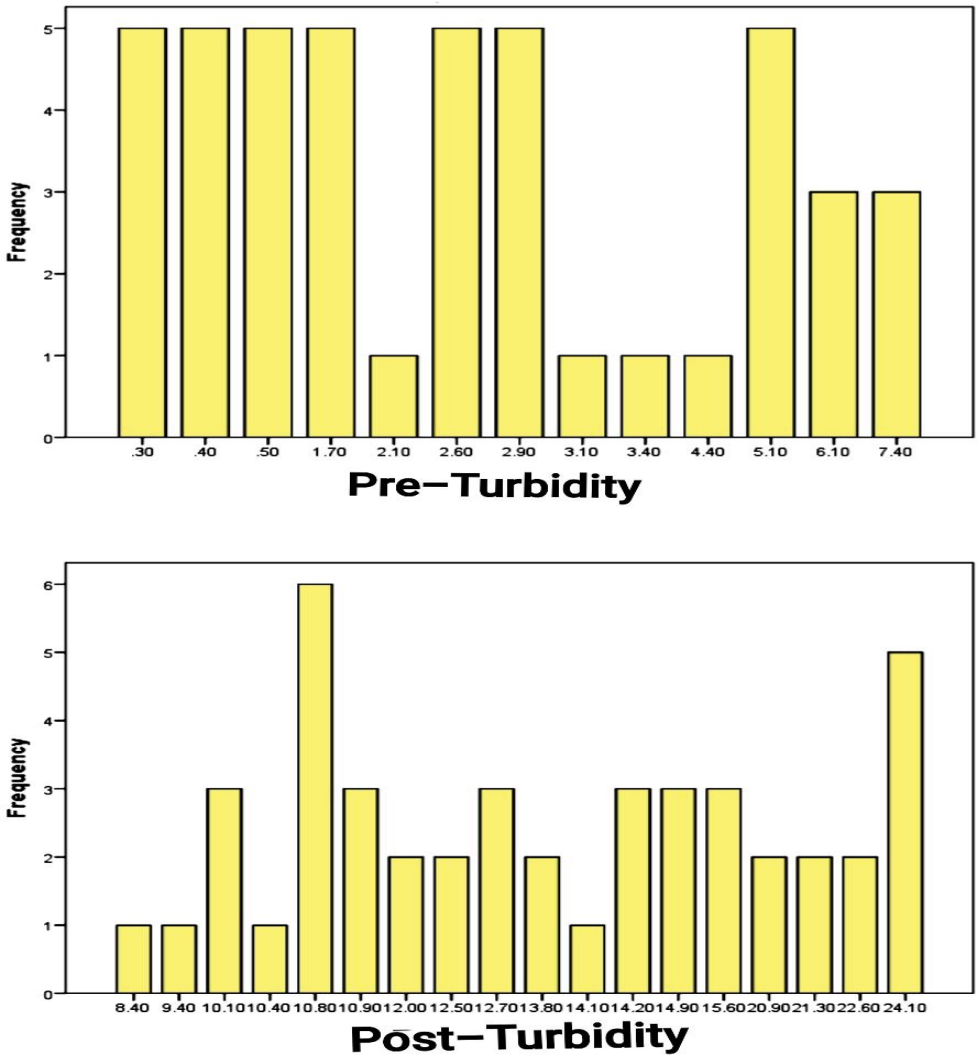

Figure No.-01: Bar Chart of Turbidity of Pre-Monsoon and Post-Monsoon

Table No. – 05: Statistical analysis of Iron between Pre-Monsoon and Post-Monsoon

Statistics

		Pre-Fe	Post-Fe
N	Valid	45	45
	Missing	0	0
Mean		0.4647	1.4524
Std. Error of Mean		0.02749	0.03966
Median		0.4600	1.4300
Mode		0.50	1.70
Std. Deviation		0.18441	0.26602
Variance		0.034	0.071
Range		0.56	0.88
Minimum		0.21	1.06
Maximum		0.77	1.94

Table No. – 06: Correlation between Iron of Pre-Monsoon and Post-Monsoon

Correlations

		Pre-Fe	Post-Fe
Pre-Fe	Pearson Correlation	1	0.077
	Sig. (1-tailed)		0.308
	N	45	45
Post-Fe	Pearson Correlation	0.077	1
	Sig. (1-tailed)	0.308	
	N	45	45

Table No. – 07: Descriptive Statistical analysis between iron of Pre-Monsoon and Post-Monsoon

Descriptive Statistics

	Mean	Std. Deviation	N
Pre-Fe	0.4647	0.18441	45
Post-Fe	1.4524	0.26602	45

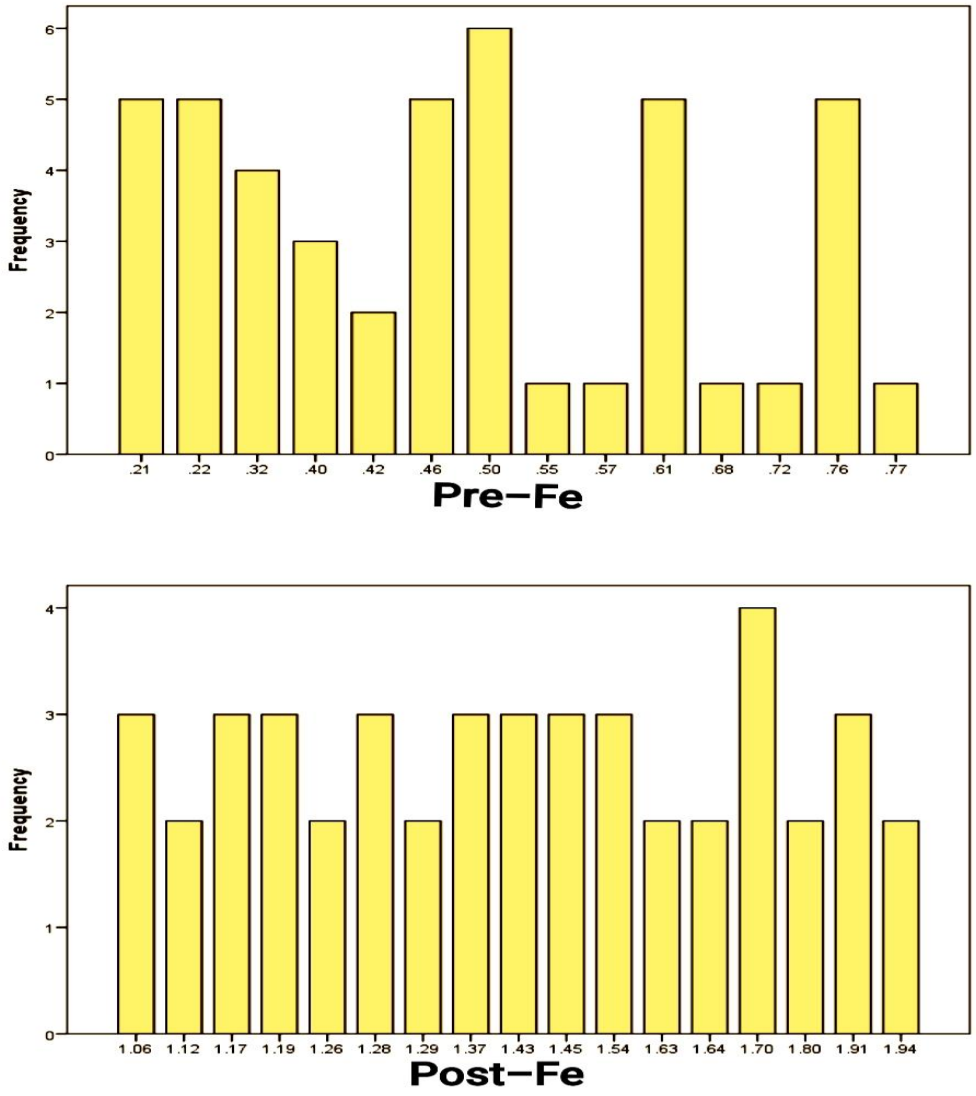

Figure No.-02: Bar Chart Iron of Pre-Monsoon and Post-Monsoon

Table No. - 08.

3.2 Correlation Matrix of all Parameters (Pre-monsoon)

pH	*Turb.*	*EC*	*TDS*	*TH*	*Ca*	*Mg*	*Cl*	*Alka.*	*Fe*	*NO3*	*SO*
1											
-0.0508	1										
0.45218	0.263506	1									
0.580285	0.23792	0.941927	1								
-0.18451	0.061037	0.227718	0.052986	1							
0.236673	-0.04988	-0.44374	-0.3428	-0.17259	1						
-0.24744	0.018421	0.417796	0.220762	0.842824	-0.52487	1					
0.310356	-0.23628	-0.09177	0.070059	-0.6563	0.032286	-0.55913	1				
-0.15309	-0.50698	-0.10127	-0.11578	-0.31137	-0.31128	-0.12719	0.287006	1			
-0.90209	0.057777	-0.15751	-0.3126	0.313332	-0.28351	0.37816	-0.32138	0.156202	1		
-0.19005	-0.13787	-0.00613	0.000827	-0.08179	-0.39761	0.088372	0.512513	0.268637	0.225034	1	
-0.3247	0.018505	-0.02372	-0.04765	-0.09886	-0.55446	0.136028	0.223782	0.444635	0.327728	0.547017	1
-0.29783	-0.0146	-0.56108	-0.59741	0.028637	0.443937	-0.24442	-0.20406	0.146794	0.193509	-0.22015	-0.

Table No. – 09.

	pH	*Turb.*	*EC*	*TDS*	*TH*	*Ca*	*Mg*	*Cl*	*Alka.*	*Fe*	*NO3*	*SO4*	*F*
pH	1												
Turb.	0.543231	1											
EC	-0.66464	-0.54897	1										
TDS	-0.55887	-0.50461	0.962488	1									
TH	-0.12869	-0.20579	-0.06448	-0.08202	1								
Ca	0.141463	0.534648	-0.44173	-0.47396	0.072336	1							
Mg	-0.12471	-0.45033	0.11386	0.12384	0.818879	-0.42534	1						
Cl	0.330134	-0.07774	-0.28342	-0.27407	0.368666	-0.06298	0.390299	1					
Alka.	-0.37308	-0.01573	0.181625	0.124772	0.385621	0.358494	0.185838	0.076081	1				
Fe	-0.03182	0.068399	0.056884	0.118445	-0.10067	0.14244	-0.16992	-0.14974	0.202771	1			
NO	0.6709	0.6979	-	-	-	0.4580	-	-	-	0.1364	1		

3	79	83	0.59479	0.52201	0.44625	29	0.59887	0.04935	0.30095	14			
SO4	0.649004	0.58271	-0.51505	-0.45844	0.04724	0.484582	-0.17505	0.28012	-0.04503	0.129277	0.716474	1	
F	0.132609	0.004343	-0.18393	-0.22406	0.255088	-0.01377	0.250612	-0.0145	-0.13554	-0.25192	-0.15321	-0.0189	1

3.3 Correlation Matrix of all Parameters (Post-monsoon)

3.4 Data Analysis & Discussion

On the spot and laboratory testing of water samples from different places between Riviganj and Tajpur of Ghaghara River in Chapra district, many data were obtained.The pH in the water samples was founded to vary in the range of 8.24-8.63 and 7.66-8.04 with average of 8.39 and 7.88 median of 8.36 and 7.89 during pre- and post-monsoon respectively. This figure is within the limits of BIS and WHO.Turbidity of the water samples during pre-monsoon was founded to vary in the range of 0.30 NTU to 7.40 NTU with an average of 2.69 NTU and median of 2.60 NTU. In post-monsoon turbidity was founded to vary in the range of 8.40 ppm to 24.10 ppm with an average of 14.87 ppm and median of 13.80 ppm. The Total Dissolved Solids (TDS) of the water samples at different locations was founded to be in the range of 224 ppm to 230 ppm with an average of 227.09 and median of 227.0 ppm during pre-monsoon and the range of 139.0 ppm to 148.0 ppm with average of 142.29 ppm and median of 141.0 ppm in post-monsoon. The electrical conductance (EC) was found to vary in the range of 345.0 µS/cm to 354.0 µS/cm, with an average of 349.56 µS/cm and median value of 349.0 during pre-monsoon and between 213.01 µS/cm to 228.0. µS/cm with an average of 219.18 µS/cm and median of217.0 µS/cm in post-monsoon. The total hardness of water samples found to vary in the range of 164.0 ppm to 192.0 ppm with an average of 179.11 ppm and median value of 180.0 ppm in pre-monsoon and the range of 76.0 ppm to 124.0 ppm with average value of 90.58 ppm and median of 88.0 ppm in post-monsoon. Water samples from different locations were examined and it was found that the calcium content in water in pre-monsoon ranged from 30.46 ppm to 38.47 ppm with mean value of 34.02 ppm and median 33.66 ppm. In post-monsoon calcium content was foundvary on 17.63 ppm to 28.86 ppm, with the mean value of 22.15 ppm and a median of 22.44 ppm.When the magnesium of water samples was examined, it was founded that to vary in between 17.49 ppm and 26.24 ppm with an average of 22.51 ppm and median 22.35 ppm in pre-monsoon. In post-monsoon found varying in 1.90 ppm to 12.69 ppm with an average of 8.11ppm and median of 7.77 ppm. Chloride was founded varying in the range of 11.99 ppm to 15.99 ppm with an average of 13.21 ppm and median of 12.99 ppm in pre-monsoon whereas its range 7.99 ppm to 17.99 with an average of 12.01 ppm and median of 11.99 ppm in post-monsoon. The total alkalinity in water samples was founded to vary in the range of 148 ppm to 192 ppm with an average of 180.42 ppm and the median value of 184 ppm during pre-monsoon between and 108 ppm to 128 ppm with an average of 117.07 ppm and median value of 116 ppm in post-monsoon. Alkalinity value within the permissible limit of BIS. The iron of water samples was founded to vary in the range of 0.21 ppm to 0.77 ppm with an average of 0.46 ppm and the median value of 0.46 ppm in pre-monsoon and the range of 1.06 ppm to 1.94 ppm with an average of 1.45 ppm and the median value of 1.43 ppm in post-monsoon. Water of iron within the permissible limits of BIS. Nitrate ion concentration varies in the range of 0.02 ppm to 0.20 with the average value of 0.05 ppm and median value of 0.04 ppm in pre-monsoon and ranged from 1.65 ppm to 3.65 ppm with the average of 2.57 ppm and the median value of 2.45 ppm in post-monsoon. Sulphate ion of water samples was founded to vary in range of 17.20 ppm to 20.10 ppm with the average value of 18.47 ppm and the median value of 18.20 ppm in pre-monsoon and range of 21.20 ppm to 41.30 ppm with the average value of 28.33 and median value of 27.40 ppm in post-monsoon.

3.5 Effect of Turbidity

When river water contains silt, fine organic and inorganic material, algae and other microorganisms, the water appears hazy. Water mellowness is visible due to the fine particles suspended in the water. When the sun's rays fall on the turbidity water, it disintegrates. As a result, the water appears turbid.

Due to this turbidity of water, it has some side effect.

1. The cost of drinking water treatment increases.
2. It has an adverse effect on the existing fish and other aquatic organisms in the river.
3. The beauty of the river gets reduced as a result of which tourists come less.
4. Water used in agricultural work also damages the crop.
5. Due to the amount of organic matter in the water and other dissolved waste materials, sediment gets deposited in the river, for example, the Ghaghara River from Rivilganj to Goldinganj is gradually disappearing.

3.6 Effect of Iron

Iron is the most abundant element on earth. According to the Indian standard, the iron content in drinking water should be less than 0.3 ppm, but in post-monsoon, the average value of iron in Ghaghara River is 1.45 ppm, which is a matter of concern. The presence of iron in the water of Ghaghara River in post monsoon proves that there is an excess of iron in the water source of the river. In the hilly areas, there are a lot of iron deposits between the stones, due to rain and water currents, the iron becomes soft and dissolves in the water, the river brings the dissolved iron with it. During rains, iron mixed water gets mixed in the fields and human useful water source. That water is supplied to the city by the municipality.

Iron exists in water in two forms –

(i) In the form of soluble iron and
(ii) In the form of insoluble iron

Water containing iron present in small amounts is not harmful to health, but if its quantity is high, it becomes a cause of trouble. The condition of absorbing excess amount of iron by the body is called hemochromatosis. Due to the high amount of iron in the body, there is more pressure on the cells of the body, as a result of which the following problems occur.

- Liver enlarges and pain starts.
- Man feels tired and lethargic.
- Stomach always hurts.
- The heartbeat becomes irregular.
- There is pain in the joints.
- There is weakness in the muscles.
- Memory power starts getting weak.

3.7 Remediation of Pollutant

Microorganisms are present in the water of Ghaghara River which can pose a threat to the health of the people of Chapra district. The Department of Health recommends that these waters will be professionally tested and treated before being used for drinking, bathing, swimming and paddling bridges, food preparation or cooking. The use of ultraviolet UV treatment systems is of paramount importance for the removal of disease-causing microbiological contaminants. Light disinfection is used to remove most forms of microbiological contamination from water. UV light is part of natural sunlight. It cannot be seen with the naked eye because the UV light is between the visible light and the X-ray. When UV light enters the microorganisms, its energy is to damage the cellular function of the microorganism, resulting in it unable to grow. UV light is generally effective against all viruses, bacteria and protozoa. However, some microorganisms, such as Cryptosporidium and Giardia, have protective or thick cell walls that are not able to penetrate some low-powered UV light systems. UV light acts to kill microorganisms. UV light will only travel in a straight line so any shadows or obstacles will reduce its efficiency. Water that is not filtered may contain iron, manganese and other particles that can either absorb or scatter UV light thereby reducing the effectiveness of the disinfection system. Microorganisms that are able to be protected by dirt, debris or shadows created by other microorganisms may be able to survive the treatment.It is important to filter the water prior to treatment with UV light to ensure that all suspended particles are removed. Suspended particulates and microorganisms present in water cannot be filter by UV light.Purification of water by ultraviolet ray is 100% chemical free water treatment method. It physically purifies the water. It is the DNA of disease-causing microorganisms. Permanently destroys and inactivates, due to which the power of microorganisms becomes weak and they are not able to cause disease. Hence the risk of infection is reduced. UV disinfection method is one of the cheapest, safe and effective water treatment methods. Being a natural purification process, the taste, colour, odour and pH level of the water does not change. It reduces wastage of water hence UV water disinfection method is FDA approved method. UV light requires electric current to operate. If the power fails or drops below the correct operating level the UV light intensity will fail or drop and as a result the system will not be able to safely disinfect the water. The Department of Health recommends that UV light systems be attached to water pumps so that untreated water cannot be supplied in the event of a power failure.

4.0 Conclusion:

The water quality of Ghaghara River under Chapra district has been found suitable but some important parameters like turbidity and iron were found to be more than the permissible limits of BIS and WHO. The mean value of turbidity during pre-monsoon was found to be 2.69 NTU, but the post-monsoon average value was 14.87 NTU which was found to be more than the permissible limit (1.0-5.0 NTU) of BIS and WHO. Also the average level of TDS in pre-monsoon is 227.09 ppm and post-monsoon is 142.29 ppm, which proves that the solids dissolved in water are not natural but man-made. Therefore water management is essential. Other parameters tested during pre- and post-monsoon, such as calcium, magnesium, total hardness, alkalinity, fluoride ions, chloride ions, nitrate ions and sulphate ions were within the safe standard limits of BIS, WHO and USEPA but iron content was found to be high. As BIS and WHO iron content in water should be less than 1 ppm. In pre-monsoon iron content in water was found to be maximum 0.77 ppm which is within permissible limit but during post-monsoon the maximum iron level to be 1.94 ppm which is more than the permissible limit. Hence there is a need to manage iron in river water.

Pollutants can be removed economically.

Measure to prevent river from getting polluted.

- Prohibition on dumping garbage in river and drains.
- Prohibition on the flow of dead animals into the river.
- Establishment of electric crematoriums on the banks of the Ghaghara instead of burning dead bodies with wood.
- Effective removal of silt deposited in rivers (when the amount of water flow is limited) and regularizing the flow area.
- Use of improved construction methods in the area affected by rivers.
- Proper management of waste after construction so that this waste does not affect the rivers.
- Construction area waste can be controlled by using pre-made concrete blocks etc. Promote the use of such methods.
- To create a balance of aquatic organisms naturally in the rivers so that the natural balance can be maintained according to the ecology. There is a need to create biological and ecological balance.
- Removal of obstructions in the natural flow of rivers due to construction activities in the area.

- Proper planting and propagation of suitable trees and vegetation of that site in the water flow area coming towards rivers during rainy days so that soil erosion is minimized. The erosion of the land brings with it a lot of soil flow and chokes the rivers in a way blocks the flow. Along with soil conservation, water conservation is also inherent by preventing land erosion, so such an effort will also solve the disaster caused by floods.
- Natural trees and vegetation found locally appropriate in the area of river flow will have to be spread and protected.
- It should be the duty of all of us to create education and social consciousness about river and water conservation.
- Eucalyptus trees, which consume a lot of groundwater, should not be planted in such areas, where there is a danger of depleting groundwater level.
- To take effective action on the units mainly non-compliance of pollution standards, expeditiously.
- In order to balance the water flow of rivers through canals, study and work on it by making long-term project, this work should be done on a small scale first.
- Small dams should be developed along with big dams. With the development of small and micro water projects, electricity will be available even at remote places and the compulsion of the local people to take fuel wood from the forest will be removed, due to this the forests will be protected and due to the ecological balance, rainfall will be regular and water conservation. This will be far-reaching effort, which will prove to be a worthwhile step.

5.0. References

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