e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.9, Sep. 2022

PHYSICO – CHEMICAL CHARACTERISTICS OF WATER QUALITY OF DISTRICT SONBHADRA

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ABSTRACT:

The water and environment has become an emotive issue for the people and policy makers. The chief causes for the pollution of water and environment are anthropogenic activities of human beings. Studies of Physico-chemical parameters of water quality based on Physico-chemical paratmeres have been taken from Sonbhadra district, Uttar Pradesh was conducted in pre monsoon season of the year 2022 to evaluate its suitability for domestics purpose. The quality analysis has been made through the pH temperature, hardness, TSS, TDS, DO, BOD, COD, Calcium, Sulphate, Chloride, Fluoride, Magnesium, Iron, Sodium etc. Comparative studies of samples in two sites (Bina and NTPC) were conducted and it was found that the maximum hardness 196.2 ppm in well water at Bina and minimum hardness 137.5 ppm of Tap water at NTPC colony. The total dissolved solids (TDS) of sewage water varies from 397 to 170 mg/l and the maximum TSS were recorded 417mg/l, while the minimum as 256 mg/l due to mine effluents discharged into sewage water. Iron and sulphate also were recorded more than permissible limits. On the basis of cationic and anionic composition of drinking water it can be concluded that the drinking water of Sonbhadra district is Ca, Mg and Na type. In this study were also observed that the people of these areas were affected by different water born diseases like dysentery, diarrhea, jaundice, typhoid and skin diseases.

Introduction

Environmental pollution is a significant issue impacting human health globally. The growth in population, modernization, urbanization, housing congestion, and industrialization has negatively affected the environment, leading to adverse impacts on human health, hygiene, and ecological balance. The misutilization and exploitation of natural resources, infrastructural developments, opencast mining and quarrying, lime and brick-kiln work, and industrialization have degraded the surrounding environment and changed the ecological balance in many districts. To maintain ecological balance and human welfare, a viable attempt is necessary for the rational utilization of resources and improvement of the environment. Imbalances in nature emerge largely due to the adverse relationship

and interaction between natural resources and technology. There are problems of society's current and future demands, the use of natural environments for agricultural and industrial purposes, population settlements, and more. Interdisciplinary research and efforts are necessary to deal with the complexity of the problem, emphasizing the need for effective development to protect the environment. Unfortunately, industrialization brings undesirable effects at the local, national, and global level, with various pollutants contaminating the surrounding natural environment. Water resources have been the most exploited natural system, leading to the contamination of various toxic substances in water bodies, causing a serious problem nowadays. The severity of the water problem in the Sonbhadra district has led to a study being carried out on water pollution caused by various sources and its effect on human health. Sonbhadra is a district located in the southeastern part of Uttar Pradesh in India. The district is home to a diverse range of aquatic ecosystems, including rivers, lakes, and reservoirs, which play a crucial role in supporting the local economy and ecosystem services. However, the water quality of these aquatic ecosystems is under threat due to various anthropogenic activities such as industrialization, mining, and agricultural activities. Water is a precious resource that is essential for the survival of all living organisms. In recent years, the degradation of water quality due to anthropogenic activities has become a major concern, leading to a decline in the availability of safe and clean water for human consumption. The Sonbhadra district, which is known for its mineral wealth, is home to several industries, such as coal mining, thermal power plants, and chemical factories. These activities release pollutants into water bodies, leading to contamination of the water resources in the district. The physico-chemical characterization of water quality is a vital tool for assessing the quality of water and its impact on human health and the environment. The physico-chemical characteristics of water, such as pH, temperature, total dissolved solids, alkalinity, hardness, conductivity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrate, phosphate, and heavy metals, are important indicators of water quality. These parameters can provide valuable information on the source and nature of water pollution and can aid in the development of effective strategies for water quality management and pollution control. The water pollution may be caused by any one or more of the following factors.

1. Atmospheric dissolved gases,
2. Decomposition of animal and vegetable materials,
3. Industrial effluents,
4. Sewage disposal,
5. Weathering of soil and rock materials, and
6. Disposal of radio-active substances.

Huge amount of nutrients, e.g. nitrate and phosphate, sewage, pesticide and fertilizers stimulate the growth of micro-organisms which often increase the biological oxygen demand (BOD) of the water and reduce the amount of dissolved oxygen (DO) available in aquatic life.

The Sonbhadra district is a region that requires immediate attention in terms of water quality management. The existing water supply systems are inadequate and often contaminated, leading to waterborne diseases, especially in rural areas. Therefore, it is essential to monitor the water quality in the district and take necessary measures to prevent contamination and promote safe and clean water supply. This research paper aims to contribute to this effort by providing a comprehensive assessment of the physico-chemical characteristics of water quality in the Sonbhadra district.

The research will be conducted by collecting water samples from various sources in the district, including rivers, lakes, groundwater, and wells. The physico-chemical parameters of water quality will be analyzed in the laboratory using standard methods. The data obtained will be analyzed using statistical tools to identify the patterns and trends in water quality parameters and to assess the impact of pollution on human health and the environment.

In conclusion, the physico-chemical characterization of water quality is a critical tool for assessing the quality of water and identifying the sources and nature of water pollution. The results of this research will provide valuable information for policymakers, stakeholders, and water resource managers to develop effective strategies for water quality management and pollution control in the Sonbhadra district. It will also contribute to the broader goal of ensuring access to safe and clean water for all.

The discharge of sewage wastes into water bodies can cause several health problems due to the presence of pathogenic bacteria and viruses. However, water is essential for human survival and is used in various forms such as domestic, agriculture, and industrial purposes. The limited reserve of fresh water is being deteriorated due to human activities like industrialization, urbanization, and mining, which discharge effluents containing toxic and non-toxic pollutants, adversely affecting the aquatic ecosystem. Only 12% of the total population in India has access to safe drinking water, while the rest depend on polluted water sources. The natural quality of water is being degraded due to man's activities, and the proportion of water use in India is estimated as agriculture 96%, domestic 3%, and industrial 1%. The average daily consumption of water varies from 50 litres/capita/day in small towns to 450 litres/capita/day in large industrial cities.

The major sources of water pollution in Sonbhadra district is effluents discharged from coal mining areas of Bina and Khadia, Thermal power plants such as Obra, NTPC, Anpara, Renusagar, Bijpur; Industries Hindalco, Kanoria Chemicals and Carbon Hi-tech at Renukoot which pollute the water of

river Rihand and G.B. Pant Sagar reservoir. The mining and industrial activities pollute the water bodies as follows (*Mahajan et.al., 1994*).

(a) Discharge of effluents (acidic and basic rich metal pollutants) into streams or directly into water bodies.

(b) Transportation of coal dust particles through effluent into stream or water bodies,

(c) The discharge of pollutants into water bodies during rainy season by run off and surface water.

In Sonbhadra district, the water is highly polluted due to mixing of coal dust, effluents discharge from Hindalco, NTPC and other thermal power plants at Obra, Anpara, Renusagar and Bijpur. Study has been carried out to assess the water quality and its impact on human health in the vicinity of Hindalco, Kanoria Chemicals at Renukoot, NTPC at Shaktinagar and Bina and Khadia coal mining area. The major sources of water pollution in opencast coal mining areas are coal dust in the form of suspended particles, oil and grease discharged from workshop, soil, sand stone and trace elements from overburden dumps, polluted water from Coal Handling Plant (CHP) etc. The polluted water discharged from mines in the form of mine effluents, flows through drain and falls into the Bijul River and streams and finally fall into the Rihand reservoir and pollute it.

MATERIALS AND METHODS:

WATER SAMPLING METHODOLOGY

The water samples have been taken from taps, handpumps, wells, natural streams and nallas, mine sump water, workshop effluent, coal handling plants effluent, silting ponds, etc. The standard sampling techniques have been used. Attention has been given to collect water samples in prescribed sampling bottles. The selection of site, time and method of sample collection, transportation and storage of collected samples have been made so that accuracy may be very carefully maintained during analysis. For the selection of sampling sites, emphasis has been given to the choice of location, depth and cross-section point in case of domestic waste water and streams, where sewage is mixed into the effluent. The location of water sampling sites are Bina coal mines and residential colonies of NTPC for the analysis of drinking water, domestic waste water, rivers/ streams and effluents of mine water quality. The sources of water and sampling sites have been given in Table 1.

Table 1: Sources of Water and Sampling Sites.

Area	Sources of Water	Sampling Sites
1. Bina	A. Drinking Water	
	(i) Tap Water	Bina colony near shopping centre

		(ii)	Handpump Water	Rehta rehabilitation Complex
		(iii)	Well Water	NCL Colony
		B.	Domestic Waste Water	Discharge into Bijul river
		C.	Mine Water and effluent	Mine water near Erection yard
				Near dumpsite
				Mine water effluent near workshop.
2.	NTPC Shaktinagar	A.	Drinking Water	
		(i)	Tap Water	NTPC Colony
		(ii)	Handpump Water	NTPC colony near shopping centre.
		(iii)	Well Water	Kota (village)
		B.	Domestic Waste Water	Effluent discharge into nallah near by colony

Before collecting water samples, all the plastic containers and BOD bottles were cleaned with detergent and finally with distilled water. All the samples of water (drinking water-tap, handpump, well, domestic waste water, mine water and river/stream water etc.) were collected in two litre plastic containers and 300 ml BOD bottles. The time of sample collection at different sites from the area of mines and colonies ranged in between 9.00 a.m. to 12.00 p.m.during January-February, March-April and May-June, 2022. Only one sample from each site has been taken due to long distance from the laboratory and limited time, resources and lack of other facilities. The samples were transported in the ice-box container to the laboratory and stored at 8-15 ^{0}C temperature. The analysis of samples has been undertaken in the laboratory using standard methods.

RESULTS AND DISCUSSION:

The water samples were analyzed for pH temperature, hardness, TSS, TDS, DO, BOD, COD, Calcium, Sulphate, Chloride, Fluoride, Magnesium, Iron, Sodium etc. date given in table 3. Normally pure water should be clear, colourless, odourless, well-acrated, cool, soft and free from toxic pollutants, suspended matter, etc. But water is rarely found in pure condition. With the rapid growth of urbanisation and mining activities potable water has also been contaminated (*Killey, 1988*). In the area of Sonbhadra, the process of unplanned development along with fast industrialization and mining activities has created problem of pollution to its limited sources of drinking water. To know the quality

of drinking water physico-chemical characteristics have been examined of handpump, tap water, well water of the two mines, and residential areas. For this purposes, the various parameters e.g., pH. temperature, hardness, TSS, TDS, DO, BOD, COD, Calcium, Sulphate, Chloride, Fluoride, Magnesium, Iron, Sodium etc. summarized (Table 2, Fig. 1.1 & 1.2).

Table 2: Physico – Chemical Characteristics of Drinking Water Quality (Bina coal mining and NTPC Shaktinagar)

Parameters	Bina			NTPC			Limits IS:10500
	Tap Water	Handpump Water	Well Water	Tap Water	Handpump Water	Well Water	
Temperature (^{0}C)	25.2	22.5	23.1	26.5	22.8	25.	t+5
pH	7.3	7.4	7.5	7.3	7.5	7.6	6.5-8.5
TSS (mg/l)	30	56	42	30	39	44	-
TDS (mg/l)	292	426	279	343	418	492	500
DO (mg/l)	6.6	6.2	5.8	6.6	5.2	4.4	4.0
BOD (mg/l)	< 5.0	< 5.0	11	< 5.0	< 5.0	11	3.0
COD (mg/l)	14	40	35	18	26	36	-
Hardness ($CaCO_3$)ppm	141.8	162.5	196.2	137.5	147.5	186.8	-
Calcium(Ca^{++})(mg/l)	16.8	17.4	18.9	16.9	18.7	21.7	75.0
Sulphate (SO_4^{--}) (mg/l)	48.2	72.2	48.8	49.8	92.2	55.4	150.0
Chloride (Cl^-) (mg/l)	38.0	45.0	48.2	38.6	36.5	47.5	250.0
Fluoride (F^-) (mg/l)	0.16	0.19	0.27	0.12	0.36	0.39	0.6-1.2
Magnesium(Mg^{++}) (mg/l)	20.8	38.2	42.0	19.5	22.5	28.7	-
Iron (Fe) (mg/l)	0.09	0.25	0.28	0.11	0.18	0.26	0.3
Sodium(Na^+) (mg/l)	14.41	43.5	24.1	17.25	31.2	36.7	30

Source : Personal Investigation and Analysis, March-April 2008.
IS : 10500 : Tolerance Limits for Drinking Water.

Temperature is an important parameter for the determination of water quality. The lowest value of 22.5^{0}C was recorded for handpump water, while maximum 25.5^{0}C for tap water at shopping centre of Bina and Shaktinagar NTPC colony. Table 3 clearly reveals that the temperature of well water, tap water and handpump water of Bina and NTPC Shaktinagar colony and rural settlements nearby the coal mines. The temperature of handpump and well water is found to be comparatively lower than that of tap water. The pH value of handpump water ranges from 7.4 at Bina colony to 7.6 at Shaktinagar. In case of well water, pH value varies from 7.6 at rural settlement near Bina to 7.5 at NTPC Shaktinagar. The maximum pH value was recorded for well water at Bina and Handpump water at Shaktinagar 7.6 while minimum level is 7.2. The materials remained in water filtration of suspended solids analysis is considered to be dissolved solids. The concentration of dissolved solids (TDS) in drinking water of the study area varies from 279 mg/l in well water at Bina to 492 mg/l at Shaktinagar.

The amount of total suspended solids (TSS) in drinking water. It is recorded as maximum 56 mg/l at Shaktinagar handpump water, while minimum 30 mg/l for tap water at Bina colony. The concentration of suspended solids was observed below permissible limit.

Dissolved oxygen is the most important parameter to assess the purity of water. In the study of drinking water characteristics, the maximum concentration of DO was found as 6.6 mg/l for tap water at Bina colony, while minimum 4.4 mg/l for well water at Shaktinagar.

The amount of oxygen required for the biochemical degradation and oxidation of organic matters by biological process under standard conditions, Indian standard of BOD for drinking water is recommended as 3.0 mg/l. BOD of drinking water varies from < 5.0 mg/l to 10 mg/l (Table 3). It is obvious from the table that the maximum amount of BOD has been recorded 11 mg/l for well water at NTPC Shaktinagar while minimum <5.0 mg/l for taps and handpumps at both Bina.

The concentration of COD in drinking water varies from 18 mg/l to 40 mg/l. Table 3 reveals that the concentration of COD was maximum 40 mg/l at Bina while minimum 18 mg/l at NTPC Shaktinagar tap water.

It is found due to the natural accumulation of salts from contact with soil and geological formulation or it may enter from direct pollution by Industrial and mining effluents (*Manivaskam, 1984*). The permissible limit of total hardness of drinking water is 300 ppm. Table 3 reveals that the total hardness of tap water varies from 137.5 ppm at NTPC Shaktinagar to 196.8 ppm at Bina. The hardness of tap water is found below the permissible limits. The concentration of hardness in handpump and well water of the study area is found below the permissible limits. The Calcium (as Ca^{++}) in water is mainly due to its passage through or over deposits of limestone, dolomite and gypsum. The maximum 21.7 mg/l concentration for well water was recorded at NTPC Shaktinagar, while minimum 16.8 mg/l for tap water at Bina. The concentration of calcium in drinking water (tap. handpump and well water) was observed below the permissible limit (75mg/l). However, Sulphate occurs naturally in water as a result of leachings from gypsum and other minerals. Concentration of sulphate in potable water is usually increased during classification by alum. In handpump water the maximum concentration of sulphate was observed at NTPC Shaktinagar 92.2 mg/l whereas minimum 48.2 mg/l in tap water at Bina. Further, it varies from 48.2 mg/l at Bina to 49.8 mg/l at NTPC Shaktinagar in tap water. The highest concentration of sulphate in well water was recorded at NTPC Shaktinagar 55.4 mg/l while minimum 48.8 mg/l at Bina. Table 3 reveals that the concentration of sulphate in drinking water which is under the permissible limits (150 mg/l). Moreover, the concentration of chlorides in drinking water varies according to sources of concentration as well as surface and ground water. Higher concentration of chloride as 48.2 mg/l is found in well water at Binar, while minimum 36.5 mg/l in Handpump water at NTPC Shaktinagar (Table 3) reflects that the concentration of chlorides in samples of well water is comparatively higher than the handpump and tap water in almost all the samples of the study area. The maximum permissible limit for chloride in drinking water is recommended as 250 mg/l. None of the samples of the drinking water of the study area exceeds this limit. The Fluoride occurs in almost all natural sources of water. The high concentration of fluoride is not a common constituent of surface water, but it may be found in harmful concentration in ground water sources. The concentration of fluoride in handpump water ranges from 0.19 mg/l at Bina to 0.36 mg/l at NTPC Shaktinagar.

However, in case of tap water it is maximum 0.16 mg/l at Bina colony and minimum 0.12 mg/l at NTPC Shaktinagar colony (Table 3). The concentration of fluoride in drinking water is under permissible limits in all the water samples. The excessive quantities of fluoride in drinking water may cause endemic cumlative fluorosis and skeletal damage in both children and adults of these mining areas.

The concentration of magnesium in well water was maximum 42.0 mg/l at Bina while minimum 28.7 mg/l at NTPC Shaktinagar. Table 2 depicts that highest concentration of Mg in well and handpump water is reported in Bina area. In Bina the concentration of Magnesium is higher than the permissible limits (30 mg/l). It is because of geological structure and sub-surface leaching process of toxic chemicals from mine effluents. Its higher concentration may affect the taste and contributes to hardness of water as well as it causes gastro-intestinal in the presence of sulphate.

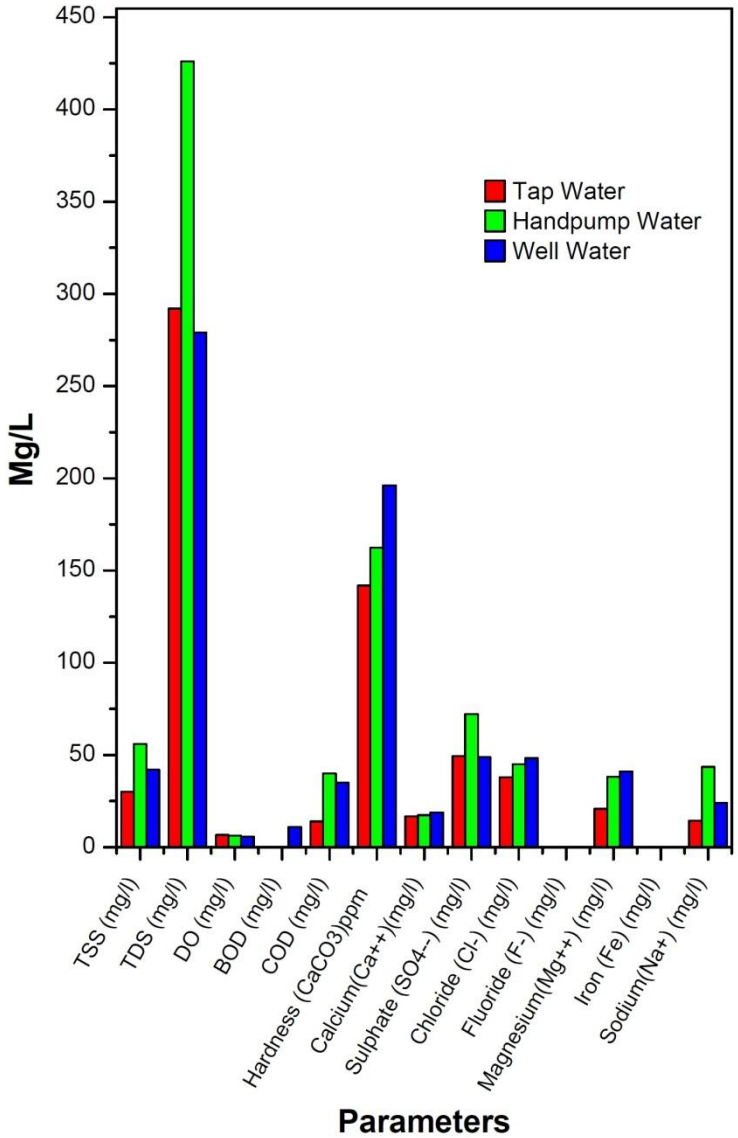

Fig. 1.1. Physico-Chemical Characteristics of drinking water quality at Bina Coal mining.

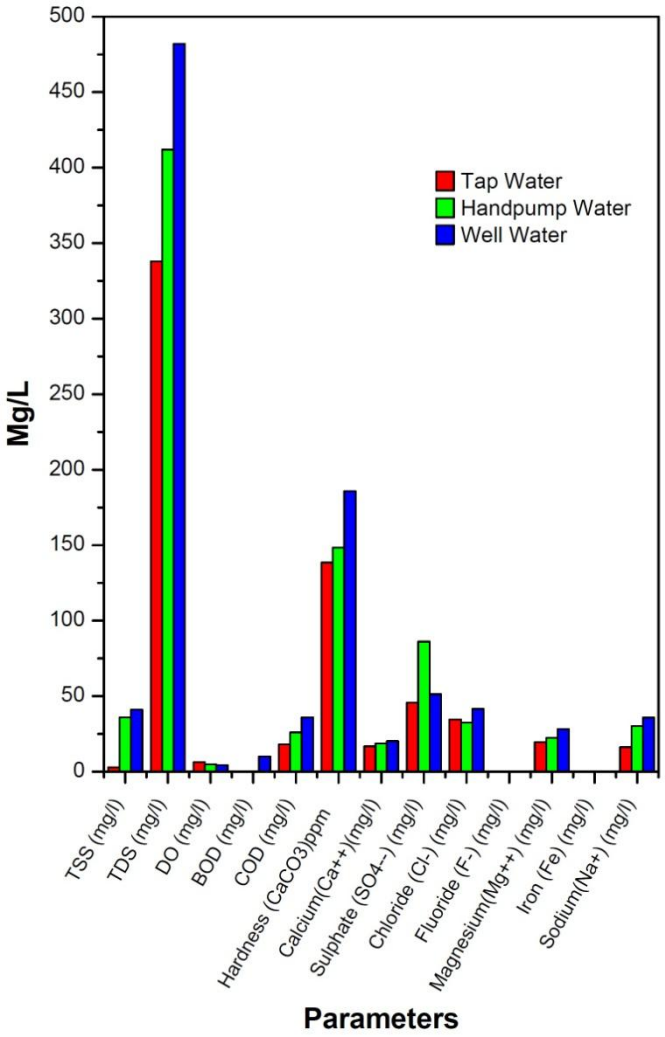

Fig. 1.2. Physico-Chemical Characteristics of drinking water quality at NTPC Shaktinagar.

PHYSICO-CHEMICAL CHARACTERISTICS OF DOMESTIC WASTE WATER QUALITY :

Disposal of waste water from domestic sources through sewage pipe lines is big problems in colonies of coal mines. Such improper disposal of domestic waste water in rivers / nallas have created pollution of rivers / streams water and has become a health hazard to human, animal and other aquatic life (*Dhar et.al., 1993*). In sewage water, the human excreta is one of the component of domestic sewage, with the waste of washing, household cleaning and food preparation added to the dissolved and suspended organic and inorganic material and these alone contribute to high level of pollution. All residential colonies of the Sonbhadra facing problems of waste water disposal system. To assess the above facts it is essential to analyse the Physico-chemical characteristics of domestic waste water (Table 3, Fig. 2.1, 2.2). In sewage water, the maximum temperature 32.0^{0}C was recorded near treatment plant mixing point of domestic sewage into stream in Bina, while minimum 28.8^{0}C at NTPC 100m away from mixing point into natural stream. Fig 2.1 & 2.2 shows the comparative trend of temperature variation in sewage water at sampling sites in the study area.

The pH value of sewer water ranges from 7.6 at treatment plant to 8.3 at NTPC. It may be attributed to a variety of factors including increase in the use of detergent particularly strong alkali soda and alkaline earth metals and discharge form sewage system.

Table 3: Physico-Chemical Characteristics of Domestic Waste Water Quality

Parameters	Bina		NTPC		Limits IS:2490
	Handpump	Tap water	Handpump	Tap water	
Temperature	30.5	32.0	28.5	30.8	t+5
pH	8.4	8.1	8.4	7.8	5.5-9.0
TSS (mg/l)	335	256	417	367	2100
TDS (mg/l)	397.0	250.5	211.0	170.0	100
DO (mg/l)	5.8	7.4	6.8	7.6	-
BOD (mg/l)	85.0	47.0	99.0	63.0	30
COD (mg/l)	278.0	212	218.5	196.5	250
Chloride(mg/l)	73.2	60.0	68.0	46.0	1000
Fluoride (mg/l)	0.53	0.34	0.44	0.39	2
Potassium (mg/l)	4.80	3.65	4.42	3.68	-
Sodium (mg/l)	64	47	81	48	-
Phosphate (mg/l)	0.22	0.15	0.27	0.24	-
Bicarbonate (mg/l)	138.5	113.8	152.0	121.3	-
Iron (mg/l)	0.12	0.07	0.08	0.06	0.3
Sulphate (mg/l)	164	114.5	147.6	99.5	1000
Calcium (mg/l)	79.5	75.8	80.0	66.2	-

The concentration of dissolved solids in sewage water of the colony varies from 170.0 mg/l near Bina treatment plant to 397.0 mg/l near Amjhar nala of sampling sites of the study area. Fig. 2a & 2b shows the comparative study of dissolved solids at sample sites. Table 3 shows the quantity and quality of suspended solids in sewage water. It is recorded as maximum 417 mg./l at NTPC while minimum 256 mg/l at Bina. The higher concentration of TSS is caused by the same mine effluent discharged into the surface water.

Dissolved Oxygen (DO) is the most important parameter to assess the purity of water. The maximum DO is recorded 7.6 mg/l at NTPC whereas minimum 5.8mg/l at Bina Fig. 2a &2b shows the spatial variation of DO at selected sampling sites of these two mining areas.

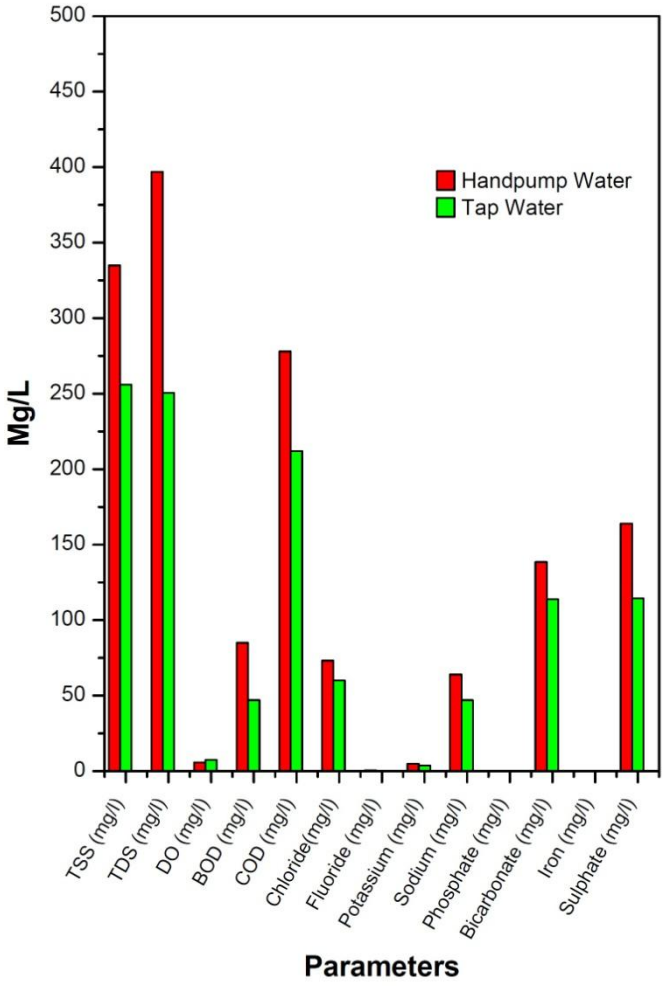

Fig. 2.1. Physico-Chemical Characteristics of domestic waste water quality at Bina.

BOD of sewage water varies from 47 mg/l to 99 mg/l (Table 4). It is obvious from Fig. 2a &2b that the maximum amount of BOD has been recorded 99 mg/l at NTPC. The minimum BOD value was recorded in sewer water of Bina. The analysis reveals that BOD of all the samples is higher than permissible limits.

The concentration of COD in sewage water varies from 196.5 mg/l to 278 mg/l Fig. 2a &2b shows that the maximum concentration of COD was (278 mg/l) at Bina, while minimum 196.5 mg/l at NTPC. The analysis reveals that the sewage water of Bina is more polluted than that of other sites. The concentration of chlorides in sewage water varies from 46.0 mg/l to 73.2 mg/l. It is clearly evident from Table 4 that the maximum chloride was detected 73.2 mg/l At Bina while minimum 46.0 mg/l at NTPC. Fig. 2a &2b shows that the concentration of chlorides is found below permissible limits at all the sampling sites.

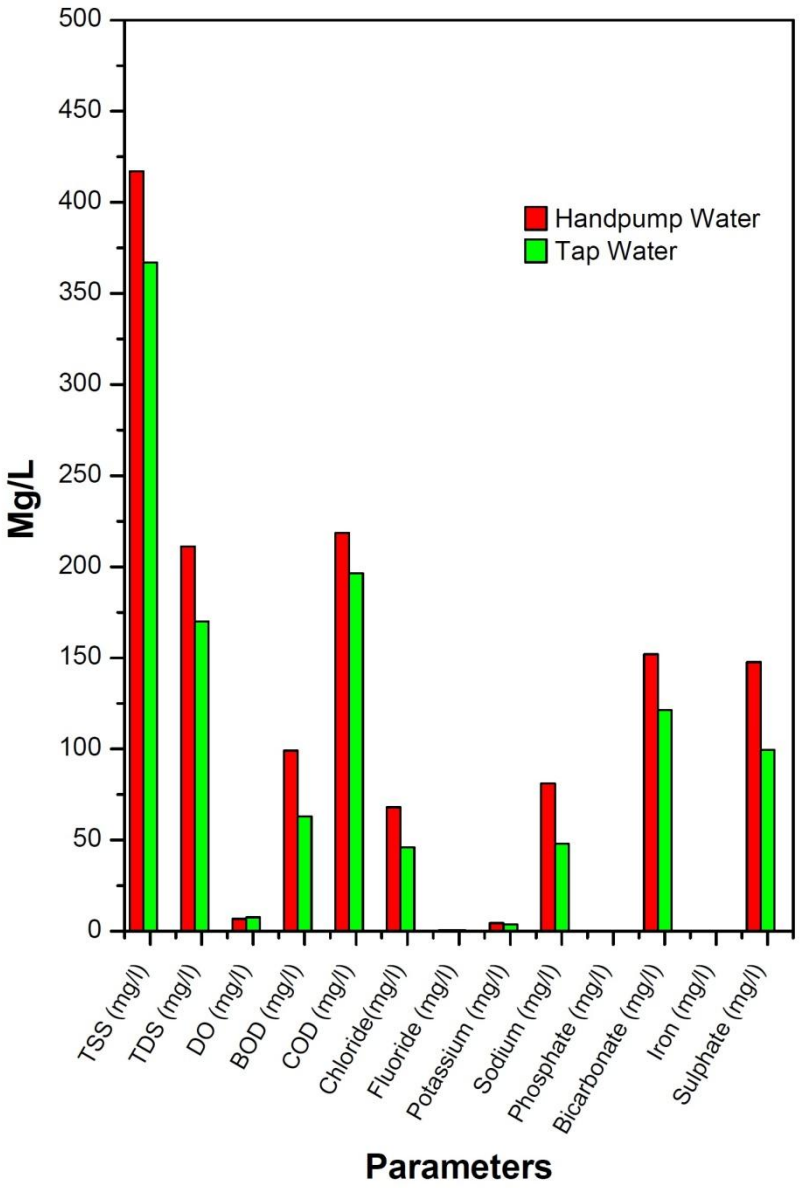

Fig. 2.2. Physico-Chemical Characteristics of drinking water quality at at NTPC Shaktinagar.

Fluoride concentration of sewage water varies from 0.34 mg/l to 0.53 mg/l. Table 5.4 shows the clear picture of fluoride concentration in all sampling sites (Fig. 5.2a,b). The maximum concentration of sodium was recorded in sewage water 81.0 mg/l at NTPC, while minium 47.0 mg/l at Bina (Fig. 2a & 2b). Calcium of sewage water varies from 66.2 mg/l to 80 mg/l. Table 4 shows that the concentration of calcium in sewage water in all the samples is below the permissible limit (Fig. 2a & 2b). Concentration of iron in sewage water has been found in very less quantities at the time of analysis. Table 4 shows the spatial variation of iron concentration in the study area. Sulphate concentration in sewage water has been found to be below permissible limit. It varies from 99.5 mg/l to 164.0 mg/l at all sample sites of the study areas.

PHYSICO-CHEMICAL CHARACTERISTICS OF EFFLUENTS AND SURFACE WATER :

To know the physico-chemical characteristics of drinking water at industrial sites in District Sonbhadra sample from handpump and tap water have been collected from Churk Cement Factory, Aluminium factory Hindalco and Robertsganj urban area. Samples collected from these centres have been analyzed in laboratory by standard method to know the physical parameters like temperature, pH and hardness and in chemical characteristics calcium, sulphate, chloride, fluoride and magnesium (Table 4 & 5 and Fig. 3.1 & 3.2).

Table 4 District Sonbhadra : Physical characteristics of Drinking water in Industrial/Urban Areas

Sampling sites	Source	Temperature (^{0}C)	pH	Hardness ppm
Churk Cement Factory	Handpump	22.8	7.5	310
	Tap water	24.2	7.8	244
Hindalco	Handpump	24.6	7.9	496
	Tap water	24.5	8.2	322
Robertsganj Urban Area	Handpump	24.5	7.8	448
	Tap water	24.2	8.3	345

The physical and chemical characteristics reveal that the drinking water is not suitable for drinking purposes due to high level of fluoride concentration at Renukoot. In urban areas at Robertsganj the water is acidic in nature which is harmful for human ailment and causes gastro-intestinal problem and liver disorder. The use of fluoride contaminated water at Renukoot caused fluroisis and dental lession among man and animals. Another problem due to use to fluoride contaminated water caused falling of hair mostly among the male. Female are less affected by falling of hair either due to genital characteristics or covering their heads by sarees and dupatta.

Table 5: District Sonbhadra : Chemical characteristics (mg/l) of Drinking water in Industrial/ Urban Areas

Sampling sites	Source	Calcium	Sulphate	Chloride	Fluoride	Magnesium
Churk Cement Factory	Handpump	58.6	29.0	86.0	0.71	18.6
	Tap water	39.4	37.0	77.0	0.62	21.8
Hindalco	Handpump	51.0	41.0	68.0	0.94	15.8
	Tap water	38.4	31.0	61.0	0.84	18.4
Robertsganj Urban Area	Handpump	46.0	33.0	59.0	0.58	19.2
	Tap water	41.4	25.4	34.0	0.46	18.6

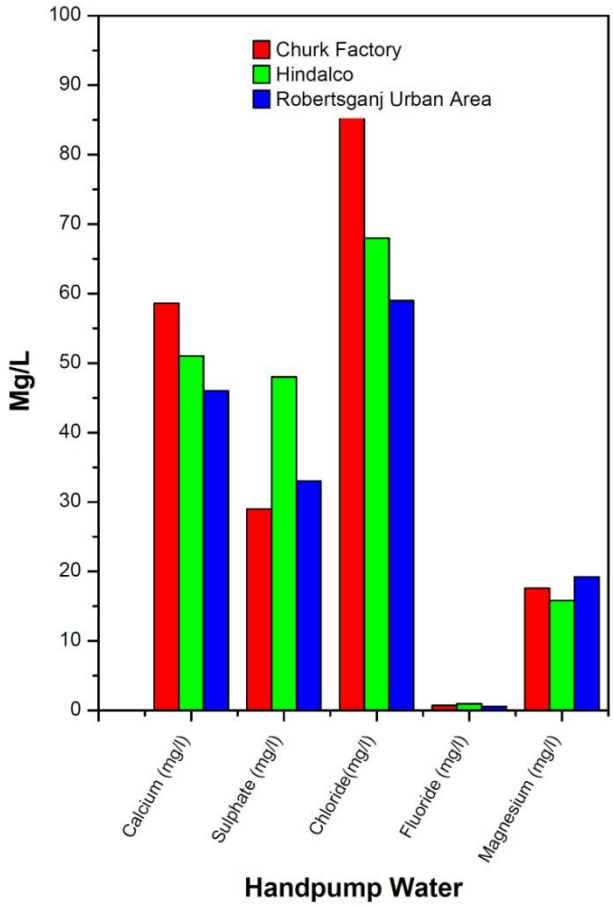

Fig. 3.1: Chemical characteristics of Handpump drinking water in Industrial/urban areas.

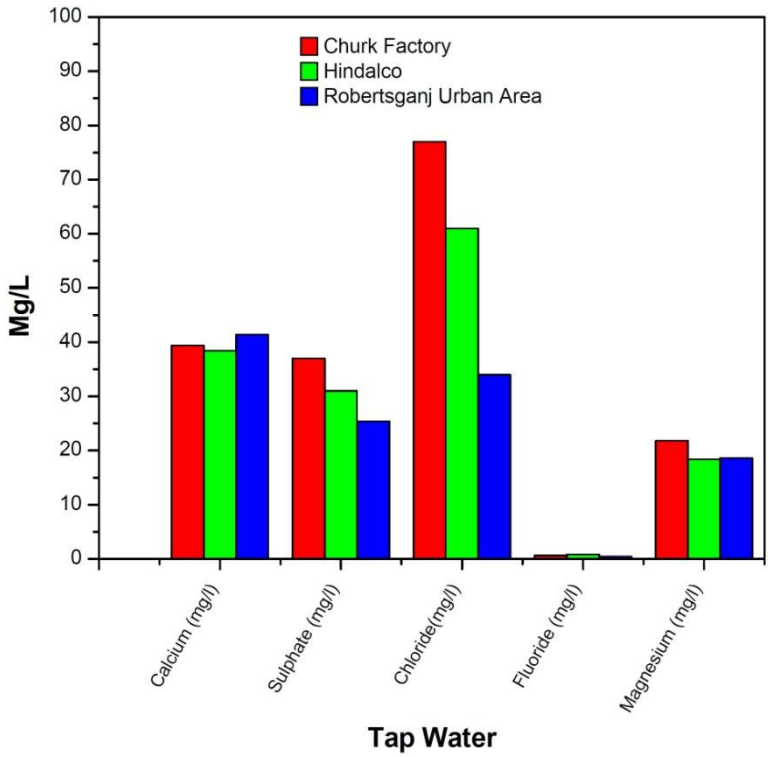

Fig. 3.2: Chemical characteristics of tap water in Industrial/urban areas.

IMPACT OF WATER POLLUTION ON HUMAN HEALTH :

Man's physical and mental health depends on the genetic and environmental factors that influence it. To assess the impact of environmental pollution on human health, it is essential to apply approaches to medical geography (*Kumra, 1982*). Medical geography deals with the spatial pattern of diseases in study area. For studying the impact of environmental pollution on particular diseases and for this, perception survey is the best technique. It is also necessary to correlate the diseases with concerned pollutants.

Water pollution may be accidental and sometimes with grave consequences, but it is most often caused by the uncontrolled disposal of sewage and other liquid wastes resulting from domestic use of water, industrial wastes containing a variety of pollutants, agricultural effluent, from animal husbandary, drainage of irrigation water and mines runoff. The recent advancement in understanding the relation between water pollutants and diseases has been developed as a scheme evolved by (*Bradley* 1971) in which diseases are classified according to the specific nature of their relation in water. According to his scheme water related diseases are classified into four categories: water borne, water-washed, water based, and diseases with water related insect vectors depending upon the mechanism.

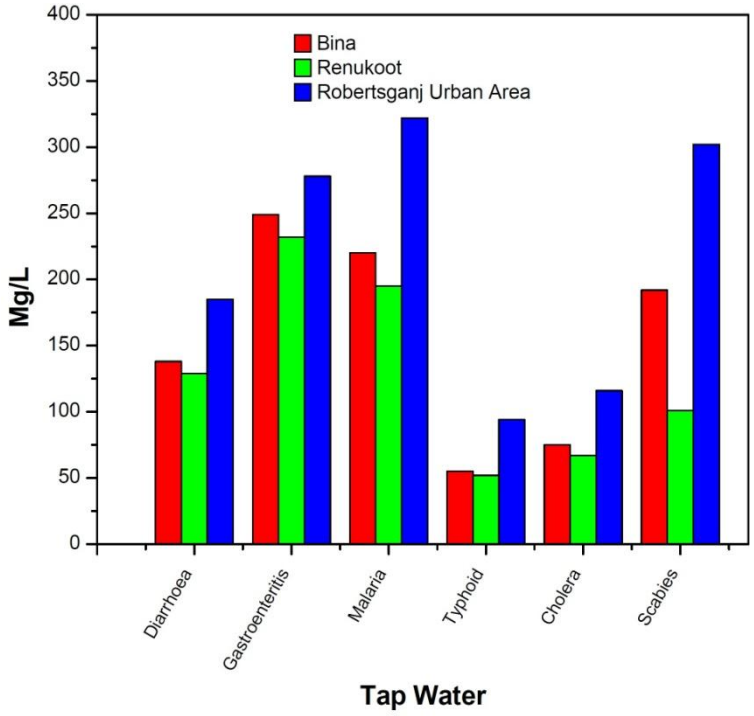

Fig. 4: Annual Incidence rate of water borne disease (patients/1000 persons).

In the mines and residential area of district Sonbhadra, large amount of toxic chemical discharged from mine, workshop and coal handling plant, thermal power plant (NTPC) and domestic waste water into water bodies may came back to human body in various ways, i.e. in the form of drinking water, through fish consumption, use of vegetables, etc. The most important water related diseases occuring

frequently in coal mining urban and industrial areas are diarrhoea gastroenterities, scabies, cholera, typhoid, malaria, jaundice and different kinds of skin diseases. There is lack of accurate statistical data regarding incidence of waterborne diseases, yet efforts have been made to collect data from hospitals, dispensaries and private practitioners of these mines as well as residential area of Robertsganj, Renukoot and Bina. The Annual incidence rate of water borne diseases has been computed to every 1000 person of study are reflecting the average incidence of disease (Table 6, Fig. 4)

Table. 6: Annual Incidence Rate of Water Borne Disease (patients/1000 persons)

Area	**Diseases**					
	Diarrhoea	**Gastro-enteritis**	**Malaria**	**Typhoid**	**Cholera**	**Scabies**
Bina	138	249	220	55	75	192
Renukoot	129	232	195	52	67	101
Robertsganj	185	278	322	94	116	302
Total	**151**	**253**	**246**	**67**	**86**	**199**

Source: Data collection from Nehru Hospital primary Health Centre, Private Medical Practitioners and Personal Field Survey,

In Table 7 data shows that the water born disease pattern in mining as well as residential areas of Bina coal mines and urban residential areas of Renukoot and Robertsganj. The study indicates that the incidence of water-borne diseases varies from one area to another depending upon the protection of people health. Diarrhoea is a water related disease which is caused by food poisoning. The maximum 253 patients/1000 persons are reported due to Gastro-enteristitis while the minimum 67 patients/1000 persons due to typhoid.

CONCLUSION:

It was found that the quality of drinking water in Bina and NTPC areas was worst affected by iron and sulphate. On the basis of cationic and anionic composition of groundwater it can be concluded that the drinking water of Sonbhadra district is district is Ca, Mg and Na type. The concentration of chlorides was comparatively higher in well than handpump and tap water. The quality of water in Rihand reservoir was influenced by the effluents of mines and power plants. In case of Kachani stream all the parameters were below permissible limits. Physico-chemical characteristics of mine water quality were also analysed from different sites of both the coal mining areas. Colour, temperature, oil, grease, iron etc. concentrations were examined in mine sump water, workshop effluent and coal handling

plant. It was observed that people of these areas were affected by different water born diseases like dysentery, diarrhea, jaundice, typhoid and skin diseases.

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