ANALYSIS OF WATER QUALITY OF BHARATPUR AREA IN POST-MONSOON SEASON, JANUARY 2007

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ABSTRACT

Bharatpur is the well known place because of "Keoladeo Ghana National Park" due to which it is a world fame tourist place. The present study deals with the water quality of Bharatpur area, which is assessed by examine various physico-chemical parameters of open wells, bore wells and hand pumps. The studies reveal that the water of most of the sampling area is hard and contaminated with higher concentration of total dissolved solids.

Keywords: *Water pollution, Health problems, Bharatpur, Analytical techniques, Standard Data*

INTRODUCTION

Water pollution means contamination of water by foreign matter such as micro-organisms, chemicals, industrial or other wastes, or sewage. Such matters deteriorate the quality of the water and renders it unfit for its intended uses. Water pollution is the introduction into fresh or ocean waters of chemical, physical, or biological material that degrades the quality of the water and affects the organisms living in it.

Although some kinds of water pollution get occur through natural processes, it is mostly a result of human activities. The water we use is taken from lakes and rivers, and from underground [ground water]; and after we have used it and contaminated it – most of it returns to these locations. Water pollution also occurs when rain water runoff from urban and industrial area and from agricultural land and mining operations makes its way back to receiving waters (river, lake or ocean) and in to the ground[1-3].

Bharatpur (Fig.1: Study Area), eastern gate of Rajasthan is situated between 26^o 22' to 27^o 83' north latitude and 76^o 53' to 78^o 17' east longitude. Bharatpur is well known place because of Keoladeo Ghana National Park. Keoladeo National Park is the only the largest bird sanctuary in India. "Ajan Bandh" is the main water source to fill the various lakes, ponds of the park and villagers use this water for drinking purposes. In the present study several points of ground water sources such as open wells, bore wells and hand pumps have been selected to check the potability of water.

EXPERIMENTAL

Water quality is the physical, chemical and biological characteristics of water in relationship to a set of standards. Water quality is a very complex subject, in part because water is the complex medium intrinsically tied to the ecology of the earth.The physico – chemical quality of drinking water was assessed during the month of January, 2007 by standard methods as suggested by APHA[4] and compared with the values as guided by ICMR.

Twelve different sites at the distance of 2 kms were selected for collection of water samples. The areas which were selected for sampling include Ghana, Bus Stand, Railway Station, Ranjeet Nagar, Namak Katra, Jawahar Nagar, Krishna Colony, Ganga Mandir, New Adarsh Colony and Chaumukha Mahadev. Samples for analysis were collected in sterilized bottles using the standard procedure for grab or catch samples in accordance with the standard methods[4,5]. Water samples were collected from open wells, bore wells and hand pumps. All the samples were properly labeled as 1,2,3,4,5,6,7,8,9,11 and 12 and a record was prepared which is indicated in Table 1.

The various physico-chemical parameters which were analyzed are detailed in Table-2. Health effects of chemical parameters are discussed in Table-3. The parameters for water quality characterization are listed

in Table-4. The permissible limits; laid down by the United States Public Health drinking water standards [USPH] and Indian Standard Institution [ISI] are also listed for comparison.

RESULTS AND DISCUSSION

The physico-chemical parameters which were analysed in Post-monsoon season, January 2007 have been shown in Table-2.

Colour:

The colour of a small water sample is caused by both dissolved and particulate material in water, and is mesured in Hazen Units [HU]. Colour in water may be caused because of the presence of natural metallic ions (iron and manganese) humus, planktons etc. The presence of colour in water does not necessarily indicate that the water is not potable. Colour is not removed by typical water filters; however, slow sand filters can remove colour, and the use of coagulants may also succeed in trapping the colour causing compounds with in the resulting precipitate. In the present study water is almost colourless.

Odour:

When minerals, metals and salts from soil etc. come in contact with water, they may change its taste and odour. Analysed water samples are found odourless.

Temperature:

Water temperature affects the ability of water to hold oxygen, the rate of photosynthesis by aquatic plants and the metabolic rates of aquatic organisms. Temperature of water samples is varied from 26.0^{o}C to 27.2^{o}C the variation of the water temperature having more effect directly or indirectly on all life processes.

PH:

The balance of positive hydrogen ions (H^+) and negative hydroxide ions (OH^-) in water determines how acidic or basic the water is. In pure water, the concentration of positive hydrogen ions is in equilibrium with the concentration of negative hydroxide ions, and the pH measures exactly 7. pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. In the present study area the pH value ranged from 7.70 to 8.76. A pH range from 7.0 to 8.5 is desirable concentration as per guided by ICMR. It is known that pH of water does not cause any severe health hazard. Water of study area is somewhat alkaline.

Dissolved Oxygen (D.O.):

DO is the most important water quality parameter which shows the amount of oxygen present in water. It gets there by diffusion from the surrounding air, aeration of water that has jumbled over falls and rapids; and as a waste product of photosynthesis. In general, rapidly moving water contains more dissolved oxygen than slow or stagnant water and colder water contains more dissolved oxygen than warmer water. In the studied water samples DO ranged from 1.5 to 7.1 mg/l. As DO level falls; undesirable odours, tastes and colours reduce the acceptability of water. The lowest DO value indicates not good healthy condition for the community[6].

Total Alkalinity:

Alkalinity is not a pollutant. It is a total measure of the substance in water that have “acid-neutralizing” ability. The main sources of natural alkalinity are rocks, which contain carbonate, bicarbonate, and hydroxide compounds, borates, silicates, and phosphates may also contribute to alkalinity.Total alkalinity is the total concentration of bases in water expressed as parts per million (ppm) or milligrams per liter (mg/l) of calcium carbonates ($CaCO_3$). These bases are usually bicarbonates (HCO_3) and carbonates (CO_3), and they act as a buffer system that prevents drastic changes in pH. Water with high total alkalinity is not always hard, since the carbonates can be brought into the water in the form of sodium or potassium carbonate.The desirable limit of total alkalinity is 200 mg/l (ICMR). The value of study area is ranged from 50 to 310 mg/l. Alkalinity in itself is not harmful to human being, but in large quality, alkalinity imparts bitter taste to water.

Total Hardness:

The total hardness is the sum of the hardness formers in a water (Ca, Mg, Ba and Sr ions) in mmol/l. Originally hardness was understood to be a measure of the capacity of water to precipitate soap. Soap is precipitated chiefly by the calcium and Mg ions present. The maximum limit of hardness in drinking water is 600 mg/l (ICMR). Total hardness is measured in grains per gallon (gpg) or parts per million (ppm). If water contains less than 3.5 gpg, it is considered soft water. If it contains more than 7 gpg, it is considered hard water.

Hardness	
Description	Hardness range (mg/l as $CaCO_3$)
Soft	0-75
Moderately hard	75-100
Hard	100-300
Very Hard	>300

The total hardness value ranged in the studied area from 120 to 2320 mg/l. So, the water of almost all sampling stations is hard.

Calcium Hardness:

A measure of the amount of calcium in water measured in ppm. High levels can cause scale buildup. Low levels can cause etching and equipment corrosion. Calcium hardness is sometimes confused with the terms water hardness and total hardness. Too little calcium hardness and the water are corrosive. Too much calcium hardness and the water are scale forming.The maximum permissible limit of calcium hardness is 200 mg/l (ICMR). The value of sampling stations ranged from 40 to 1060 mg/l. Thus sampling stations 5 and 12 have greater calcium hardness.

Magnesium Hardness:

Magnesium salts have a laxative and diuretic effect. The maximum permissible limit of magnesium hardness is 150 mg/l (ICMR). Mg hardness value in studied area ranged from 60 to 1680 mg/l.

Carbonate and Non-Carbonate Hardness:

Carbonate hardness is often called “temporary hardness” because it can be removed by heating the water. When the water is heated, the insoluble carbonates will precipitate and tend to form bottom deposits in water heaters.Carbonate hardness also known as KH, refers to the concentration of bicarbonate (HCO_3^-) and carbonate (CO_3^{--}) dissolved in water. It is usually expressed either as parts per million (ppm or mg/l/). The carbonate hardness value ranged from 50-310 mg/l. The maximum permissible limit for carbonate hardness is 200 mg/l (ICMR). So, the water of almost all the sampling stations is in the range of the permissible limit except points 7, 8 and 11.

Non-carbonate hardness is called permanent hardness, because it is not removed when the water is heated. It is much more expensive to remove non-carbonate hardness than carbonate hardness. Non-carbonate hardness is caused primarily by calcium and magnesium nitrates, chlorides, and sulphates. The value of non-carbonate hardness ranged from nil to 2260 mg/l.

Chloride:

The maximum permissible concentration of chloride is 1000 mg/l. (ICMR). So except some points the chloride contents of water samples are in limit. It varies from 40 mg/l. to 2100 mg/l.

Sulphate:

The maximum permissible limit of sulphate is 400 mg/l (ICMR). In the sampling areas the sulphate concentration ranged from 20 to 552 mg/l. Almost all the water samples content sulphate is in the permissible limit except points- 3, 6, 7, 8, 9 and 12. Waters with higher concentration of sulphate may cause intestinal disorders.

Nitrate:

Nitrate is a major ingredient of farm fertilizer and is necessary for crop production. Nitrate stimulates the growth of production. Nitrate stimulates the growth of plankton and waterweeds that provide food for fish.Maximum permissible limit of nitrate is 50 mg/l (ICMR). Nitrate in water supplies in concentration over 100 mg/l. causes "methamoglobinamia[7]".

Generally NO_3^- concentration is found in higher concentration in rural areas because of runoff of nitrate rich fertilizers and animal manure into the water supply. The nitrate value ranged in investigated area is between 4 and 620 mg/l. So points 3, 6, 7, 8, 9, 11 and 12 have higher nitrate concentration.

Total Dissolved Solids (TDS):

The term TDS describes all solids [usually mineral salts] that are dissolved in water. Desirable limit of TDS is 500 mg/l (ICMR). All the values obtained are much higher than the limit except points-1 and 2. It is an important parameter for imparts a peculiar taste to water and reduce its potability.

Fluoride:

Fluoride is more common in ground water than in surface water. The main sources of fluorine in ground water are different fluoride bearing rocks[8]. The guideline value of fluoride is 1.5 mg/l in drinking water. In studied area, it ranged between 0.0579 mg/l to 1.28 mg/l and which is under acceptable limit.

Electrical Conductivity:

Electrical conductivity estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. Its SI derived unit is the siemens per meter, ($A^2S^3m^{-3}$ Kg^{-1}) or more simply, Sm^{-1}. It is the ratio of the current density to the electric field strength or, in more practical terms; is equivalent to the electrical conductance measured between opposite faces of a 1-meter cube of the material under test. Pure water is a poor conductor of electricity. Acids, bases and salts in water make it relatively good conductor of electricity. Electrical conductivity in studied area ranged between 4.3×10^2 to 1.3×10^4 μmhos/cm.

CONCLUSIONS

The present results of water investigation shows that the waters of study area are highly contaminated with total dissolved solids. Because of high concentration of TDS water loss its potability and high concentration of TDS also reduces the solubility of oxygen in water. Water of almost all study points are hard also because of this people of Bharatpur area are facing many problems like stomach diseases, gastric troubles etc. At some points nitrate level is also high than the permissible limit.

It is recommended that water should be used after boiling by the people of Bharatpur because after boiling the water, temporary hardness [carbonate hardness] can be removed and concentration of total dissolved solids can also be decreased. Alum treatment is also a good option to make potable the water.

Table 1 : Area, source and approximate depth of the sampling stations.

Sample No.	Area	Source	Appropriate Depth
1.	Ghana	Open Well	75 – 80 feets
2.	Ghana	Hand Pump	60 – 65 feets
3.	Jawahar Nagar	Bore Well	50 – 55 feets
4.	Jawahar Nagar	Bore Well	50 – 55 feets
5.	Tilak Nagar	Hand Pump	50 – 55 feets
6.	Ranjeet Nagar	Bore Well	40 – 55 feets
7.	Namak Katra	Hand Pump	25 – 30 feets
8.	Pai Bag	Hand Pump	35 – 40 feets
9.	Krishna Colony	Hand Pump	35 – 40 feets
10.	New Adarsh Colony	Hand Pump	25 – 30 feets
11.	Ganga Mandir	Hand Pump	30 – 35 feets
12.	Chaumukha Mahadev	Hand Pump	25 – 30 feets

Table 2 : Parameters, methods, standard values and unit employed in physico-chemical analysis of the samples.

S.No	Parameters of Water Analysis	Methods	Standard values as guided by ICMR		Unit
			Desirable concentration	Max. Permissible Concentration	
1	Colour	By sight	-	-	-
2	Odour	Smelling	-	-	-
3	Temperature	Thermometric	-	-	^{o}C
4	pH	pH Meter	7.0 – 8.5	6.5 – 9.2	-
5	Dissolved Oxygen (DO)	Axide Modification	7 mg/L at 35^{o}C	-	Mg/L
6	Total Alkalinity	Titrimetric	200	600	Mg/L
7	Total Hardness	Titrimetric	300	600	Mg/L
8	Calcium Hardness	Titrimetric	75	200	Mg/L
9	Magnesium Hardness	Titrimetric	50	150	Mg/L
10	Carbonate Hardness	Titrimetric	300	600	Mg/L
11	Non-Carbonate Hardness	Titrimetric	300	600	Mg/L
12	Cloride	Argentometric	200	600	Mg/L
13	Sulphate	Turbidity meter	200	400	Mg/L
14	Nitrate	Ionemtric	20	50	Mg/L
15	Total Dissolved Solids	Conductivity meter	500	1500	Mg/L
16	Fluoride	Ion selective electrode	1.0	1.5	Mg/L
17	Electrical Conductivity	Conductivity meter	7.1×10^{2}	6.0×10^{2}	Mg/L
18	Calcium	Titrimetric	-	-	Mg/L
19	Magnesium	Titrimetric	-	-	Mg/L

Table 3 : Health effects of chemical parameters

Parameters	BIS Guideline value (maximum allowable)	General and Health effect
TDS	2000 mg\L	Undesirable taste; gastro-intestinal irritation; corrosion or incrustation
pH	6.5-8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	600 mg\L	Boiled rice turns yellowish
Hardness	600 mg\L	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation.
Calcium	200	Poor lathering and deterioration of the quality of clothes; incrustation in pipes
Magnesium	100	Poor lathering and deterioration of clothes; with sulphate laxative
Iron	1.0	Poor or sometimes bitter taste, color and

		turbidity; staining of clothes materials;
Manganese	0.3	Poor taste, color and turbidity; staining; black slime
Aluminium	0.2	Neurological disorders; Alzheimer's disease
Copper	1.5	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	15	Astringent taste; opalescence in water; gastro-intestinal irritation; vomiting, dehydration, abdominal pain nausea and dizziness
Ammonia	-	Indicates pollution; growth of algae
Nitrite	-	Forms nitroso-amines which are carcinogenic
Nitrate	100	Blue baby disease [methemoglobineamia] algal growth.
Sulphate	400	Taste affected; laxative effect; gastro-intestinal irritation
Chloride	1000	Taste affected; corrosive
Fluoride	1.5	Dental and skeletal fluorosis; non-skeletal manifestations
Phosphate	-	Algal growth
Arsenic	0.05	Toxic; bio-accumulation; central nervous system affected; carcinogenic
Mercury	0.001	Highly toxic; causes 'minimato' disease neurological; mutagenic
Cadmium	0.01	Highly toxic; causes 'itai-itai'disease-painful rheumatic condition; gastro intestional upsets and hyper tension
Lead	0.05	Causes plumbismtiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-accumulation; impaired neurological and motor development, and skin complaints
Chromium	0.05	Carcinogenic; ulcerations; respiratory problems and skin complaints
Pesticides	0.001	Affects central nervous system
Detergent	-	Undesirable foaming.

Table 4 : Parameters for water quality characterization and standards [Domestic water supplies]

S. No.	**Parameters**	**USPH standard**	**ISI Standard (IS : 2296-1963)**
	1	2	3
1.	Colour, Odour, Taste	Colourless, Odourless, Tasteless	-
2.	Inorganic Chemicals pH		6.0-8.5 6.0-9.0
3.	Specific Conductance	300 mmho cm^{-1}	-
4.	Dissolved Oxygen [DO]	4.0-6.0 (ppm)	3.0
5.	Total Dissolved Solids	500	-
6.	Suspended Solid	5.0	-
7.	Chloride	250 mg/L	600

8.	Sulphate	250	1000
9.	Cyanide	0.05	0.01
10.	Nitrate + Nitrite	<10	-
11.	Fluoride	1.5	3.0
12.	Phosphate	0.1	-
13.	Sulphide	0.1 mg L^{-1} (ppb)	-
14.	Ammonia	0.5	-
15.	Boron	1.0	-
16.	Calcium	100	-
17.	Magnesium	30	-
18.	Arsenic	0.05	0.2
19.	Barium	1.0	-
20.	Cadmium	0.01	-
21.	Chromium (VI)	0.05	0.05
22.	Copper	1.0	-
23.	Iron (filterable)	<0.3	-
24.	Lead	<0.05	0.01
25.	Manganese (filterable)	<0.05	-
26.	Mercury	0.001	-
27.	Selenium	0.01	0.05
28.	Silver	0.05	-
29.	Uranium	5.0	-
30.	Zinc	5.5	-
31.	**Organics** COD	4.0	-
32.	Carbon $CHCl_3$ extract (CCE)	0.15	-
33.	Methylene blue active substances	0.5	-
34.	Phenols	0.001	0.005
35.	Pesticides (total)	0.005	-
36.	Polycyclic aromatic hydrocarbons [PAH]	0.2 ppb (0.002 ppm)	-
37.	Surfactants	200	-
38.	Radioactivity gross beta	1000 pc/L	-
39.	Radium-226	3 pc/L	-
40.	Strontium-90	10 pc/L	<5000
41.	Bacteriological Parameters Coliform cells\100 ml	100	-
42.	Total bacteria count/ 100 ml	$1X10^6$	

Table 5 : The physico-chemical characteristics of various sample stations.

Parameters	**Point 1 O.W.**	**Point 2 H.P.**	**Point 3 B.W.**	**Point 4 B.W.**	**Point 5 H.P.**	**Point 6 B.W.**	**Point 7 H.P.**	**Point 8 H.P.**	**Point 9 H.P.**	**Point 10 H.P.**	**Point 11 H.P.**	**Point 12 H.P.**
Temperature	26.1^o C	26.2^o C	27.0^o C	26.5^o C	27.0^o C	26.0^o C	27.2^o C	26.5^o C	26.0^o C	26.0^o C	26.5^o C	27.0^o C
pH	8.42	8.36	8.15	8.36	7.70	7.9	7.9	8.49	8.15	8.44	8.34	8.76
Dissolved Oxygen (DO)	7.0	7.1	2.5	4.1	3.2	2.0	2.6	3.5	3.5	2.6	2.7	1.5
Total	160	140	150	150	50	170	290	310	160	170	220	60

Alkalinity (as $CaCO_3$)												
Total Hardness (as $CaCO_3$)	160	120	1540	640	1380	660	640	500	900	800	880	2320
Calcium Hardness (as $CaCO_3$)	60	60	140	120	1060	200	60	40	100	80	160	640
Magnesium Hardness (as $CaCO_3$)	100	60	1400	520	320	460	580	460	800	720	720	1680
Carbonate Hardness (as $CaCO_3$)	160	120	150	150	50	170	290	310	160	170	220	60
Non Carbonate Hardness (as $CaCO_3$)	Nil	Nil	1390	490	1330	490	350	190	740	630	660	2260
Chloride	40	40	1100	720	1340	1040	980	1280	960	1160	1320	2100
Sulphate	20	20	520	248	288	520	552	408	500	312	368	528
Nitrate	10	4	324	42	32	306	152	236	150	52	272	620
Total Dissolved Solids	301	322	6090	2450	3570	4200	3710	4340	4340	3430	3780	9100
Fluride	0.0829	0.0579	0.652	0.3419	0.337	0.996	0.174	0.304	0.120	0.110	1.28	0.853
Ca^{+2}	24	24	56	48	424	80	24	16	40	32	64	256
Mg^{+2}	24	14.4	336	124.8	124.8	110.4	139.2	110.4	192.0	172.8	172.8	403.2
Electrical Conductivity	$4.3x10^2$	$4.6x10^2$	$8.7x10^3$	$3.5x10^3$	$3.5x10^3$	$6.0x10^3$	$5.3x10^3$	$6.2x10^3$	$6.2x10^3$	$4.9x10^3$	$5.4x10^3$	$1.3x10^4$

O.W = Open well, H.P = Hand Pump, B.W = Bore Well

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There is a sufficiency in the world for man's need but not for man's greed.
—Mohandas K. Gandhi