Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(4):1303-1307

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Impact of urbanization on groundwater quality of Bhagalpur city: Deterioration of water quality and its sustainable management

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ABSTRACT

With the explosion of population the world over, the deterioration of water quality is quite obvious, particularly usable water. Urbanization has played great role in lowering of water table and deterioration of water quality in Bhagalpur city. The quantity as well as quality of drinking water of this region is highly affected. Last five years study revealed that groundwater level has been declining nearly 5 ft. per year. Similarly ground water contamination is increasing day by day. Arsenic and fluoride contamination have become menace for this area. Microbial contamination is also in the race. The inhabitants of this area have been suffering from fluorosis (fluoride contamination), skin lesion, di-pigmentation (arsenic contamination) and water born diseases. The study report is mainly based on the detection of Coli form in drinking water sources of the city. Out of 20 samples, 17 were found positive to coliform test.

Keywords: Urbanization, Contamination, deterioration, Sanitation, coli form bacteria

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INTRODUCTION

Clean water is life. Sixteen percent of human body is water. Ninety percent of human blood and brain are water. Without water life, as we know, cannot exist. But the water we drink is not free from contaminants. Urbanization is the root cause for the contamination of drinking water in the city, The WHO estimated that up to 80 % of all sickness and diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water are related to the quality and quantity of water (WHO, Basic Environmental Health, Geneva, 1997; Daunders and Warford, 1976) [6] [13]. A review of 28 studies carried out by the World Bank water sanitation associated diseases are related to the quality and quantity of water and sanitation available to users (Abebe, 1986, Kalbermatten, 1990) [1]. Deterioration of water quality is assessed by increase in permissible limit of Total dissolved solids, Total hardness, Nitrate, Iron, Fluoride, Arsenic and Coli form count. Coliform bacteria are the most reliable IDICATORS for the index of quality of POTABLE WATER. They are Gram-negative mono spore forming bacilli usually gives the evidence that incidence of certain water born, water washed, water based and found in the intestine and urinary tract of man. The source is either faecal or sewage contamination of water. The study report is mainly based on the microbial assessment of drinking water quality of Bhagalpur city.

EXPERIMENTAL SECTION

1.1 Location and Climate:

Bhagalpur is situated in planes of Gang basin, at about 141 ft above sea level, Bhagalpur is a city in the state of Bihar in Eastern India, and one of the oldest district of Bihar is located in Southern region. It is known as “Silk city” and covers an area of 2569.5Km2 and lies between 25 ^{o} 07’-25 ^{o} 30’’N Latitude and between86 ^{o} 37’-87 30’ Longitude, with urban population above 500000. Bhagalpur is proud to have a lone Asian sanctuary known as “Vikramshila Gangetic Dolphin Sanctuary” for one of the fresh water Dolphin (Platinista gangeticus) that has been

declared recently as a national aquatic animal. The climate of this region is influenced and characterized by its hot humid to temperate. The weather is pleasant with occasional rains. The temperature varies between 26^{o}C to 38^{o}C.

1. Water sample collection for coli form test: Hands were washed with sprit first.
The samples were collected from different locality of the city in sterilized plastic container (PVC 125-250 ml.) and in 20 ml strip H2s vials. Full precautionary measure was taken to inhibit aerial contamination of the sample i.e., Mouth of the hand pump or tap was flamed to eliminate the chance of accidental contamination (a false positive), then water was allowed to run freely for 2-4 minutes. H2s vial was placed in running water under the hand pump or tap and appropriate amount (20 ml. calibration mark) of water sample was collected in it - as shown in image 1and 2.

Image 1-Flaming before sampling

Image 2 Author collecting sample in H2s vial

1.4 Method of analysis:
The physical parameters like Ph, TDS, TH and turbidity were tested using pH meter (systronic-model 362), TDS meter (systronic-model 308), turbidity meter(systronic-model 135).Analysis of nitrate content in water samples were determined using Merckoquant Nitrate kit (1.10020.0001-Merck). Iron by Merckoquant Iron kit(1.10004.001). Arsenic metals were analyzed using Merckoquant arsenic kit and fluoride content was analyzed by piccofluoride meter and iono-selective electrode. Bacteriological investigation was done by H2s kit (Transchem).

Microbial analysis:
Several studies have found that H2s test gave generally good agreement with standard MPN and membrane filtration methods commonly used for determining the presence and number of coliform and faecal coliform organisms (Hazbun & Parker1983; Dutka, 1990; Castillo et al 1995; Martin et al, 1997; WHO, 2002) [11,13]. Hence this cost effective H2s kit test was adopted for microbial analysis of drinking water of the sources. In this case, bacteria can produce hydrogen sulphide through the anaerobic catabolism of cystein, an amino acid containing the sulphahydril group, or by the use of elemental sulphur or some oxidized sulphur compounds as the terminal electron acceptor in their metabolic processes. The H2s test uses a medium with thiosulphate as a sulphur as a sulphur source and ferric ammonium citrate as an ‘indicator“. Only certain enteric bacteria produces H2s resulting in the development of a black precipitate (insoluble black ferrous sulphide)- good indicator for faecal contamination

After sampling all test samples in H2s vials were placed in incubator at 37^{o}C for a total of 3 days and observation was followed at every 12 hours as shown in Table -3

RESULTS AND DISCUTION

2.2 Impact of urbanization on groundwater quality of Bhagalpur city: Deterioration of water quality
20 samples were collected from different places of the city for microbial analysis in which 17 samples were positive and rest three samples were found negative. Among the positive samples, sample nos.1,2, 3,4, 7, 8, 9, 11,12,13,14,17 and 20 showed high density of coli form colony(+++) while sample nos. 5, 10, 15 and 18 showed moderate density of coli form colony (++).Sample nos. 6, 16, and 19 were found negative. Noticeably black samples denote +++ and high risk (image-5) where as partially black samples denote ++ and moderate risk. As per study report, areas of high risk include Bhatta Bahrepura, Police line HP. water, Nawab colony, Sandis compound, Ghantaghar, Tatarpur, Ishak chak police station Tap water, CTS Madwadi patti, Maulana chak- Tatarpur, Sarai near university, Sarai near rekab ganj, S.P.office Ng, and Saheb Ganj near masjid and areas of moderate risk include police line Bgp. Sandis compound, Registry kachehri, CTS Compound, Budhanath road and

Refugee colony Barari. Railway station Bgp, G. B. College and Mojahidpur Masjid showed no microbial risk as shown in Table no.3

Following table 2- showed that increase in groundwater contamination of the City was followed by rise in population in the urban part. Previous work noted in this table is based on the report of CGWB.2006 [5] which indicates that water was safe for drinking. But now it is no longer safe to drink this water as per present sudy report of the author.

Table 2. Comparative study report of physical-chemical quality of groundwater of Bhagalpur city of previous time (up to 2006) and present time (urban impact)

SELECTIVE	PREVIOUS	WORK	PRESENT WORK		Differences	Acceptable limits
Physical & chemical	minimum	maximum	minimum	maximum	In contaminants	(mg/l)
PARAMETERS	limit	limit	limit	limit	level	
EC	450m.hos	1400m.hos	200micr.hos	4600mh.	3200m.h.	
pH	7	8.05	6.8	8.3	ND	7.0-8.5
TDS	145ppm	826ppm	110ppm	2609ppm	983ppm	500ppm
TH	70ppm	488ppm	40ppm	1200ppm	712ppm	200ppm
Calcium	12ppm-	158ppm	12ppm	400ppm	242ppm	75ppm
magnesium	9-7ppm	60pp	03ppm	96ppm	36ppm	30ppm
Chlorides	10.6pppm	200ppm	12ppm	740ppm	540ppm	200ppm
sulphates	>2ppm	>40ppm	03ppm	110ppm	<70ppm	200ppm
Nitrate	>1ppm	>50ppm	1.1ppm	249ppm	199ppm	45ppm
Iron	>0.1	>1.40ppm	0.1ppm	6.5ppm	5.1ppm	0.1ppm
Fluoride	0.01ppm	1.80ppm	0.1ppm	18.6ppm	16.8ppm	1.0ppm
Arsenic	10ppb	150ppb	10ppb	986ppb	836ppb	0.05/10ppb

Table-3 Bacteriological quality of groundwater of Bhagalpur city

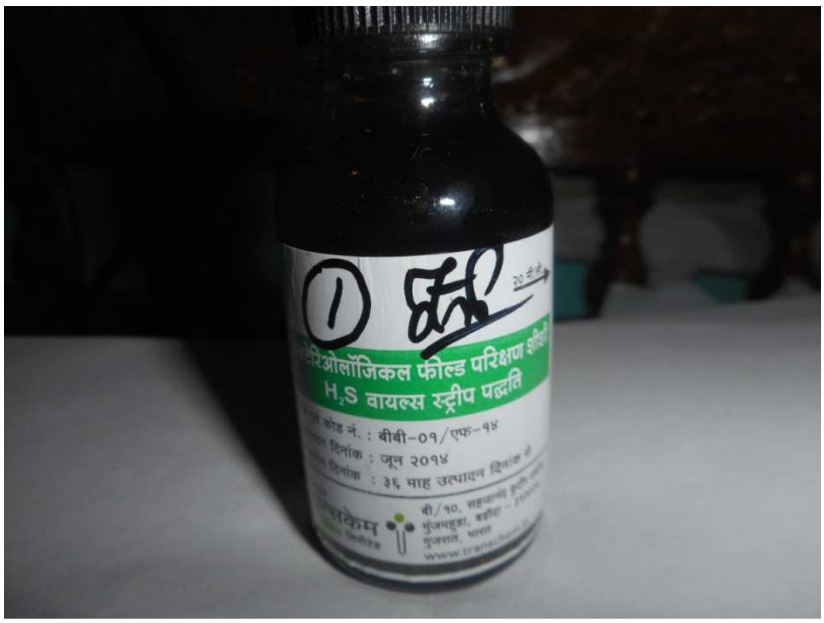
Sample Numbers	AREA / SPOT NEARBY LOCALITY	Depth of tubewell / H.pump	BIOLOGICAL PARAMETER OR H2s TESTED VIALS Obs.					Remark
			DAY-1	DAY-2		DAY-3		
			COLOUR CHANGE NOTED					BACTERIAL DENSITY
			12 hrs	24hrs.	36hrs.	48hrs.	60hrs.	
GB-01	Bhatta,Bahrepura	70ft	full black					Strong positive
GB-02	Police line(2a)	80ft	full black					Strong positive
GB-03	Lal Bagh/Nawab col	90ft	full black					Strong positive
GB-04	Sandis comound	110ft	full black					Strong positive
GB-05	Registry kachehri	350ft		partially black				Weak positive
GB-06	police line(2b)	160ft	No change	No change	No change	No change	No change	negative
GB-07	Ghantaghar	90ft	full black					Strong positive
GB-08	Tatarpur/M.Chak	70ft	full black					Strong positive
GB-09	Ishak chak P.S.	350ft	full black					Strong positive
GB-10	C.T.S.Compound	350ft		partially black				Weak positive
GB-11	CTS Madwari tola	100ft	full black					Strong positive
GB-12	Maulana chak(l.f.)	110ft	full black					Strong positive
GB-13	Near Univ.gate	120ft	full black					Strong positive
GB-14	Rekab ganj	120ft	full black					Strong positive
GB-15	Budhanath road	160ft			partially black			Weak positive
GB-16	G.B.College	110ft	No change	No change	No change	No change	No change	negative
GB-17	S.P.Office Ng.	100ft	full black					Strong positive
GB-18	Refugee col.Barari	70ft			partially black			Weak positive
GB-19	Mojahidpur masjid	90ft	No change	No change	No change	No change	No change	negative
GB-20	Sahebganj masjid	80ft	full black					Strong positive

Strong positive = +++ (high risk); Weak positive = ++ (moderate risk)

As noted above, a colour change indicated faecal origin. Speed of reaction had determined the density of organism present.

Bacteriological standards: E-coli should be zero in sample of 100ml and coliform should not be more than 3 per 100ml (for individual/small community supply) (Kudesia VP, Retu VP,2011;WHO, 1993) [10],[13]

Image-5: a strong positive sample GB-01within 12 hr. observation



CONCLUSION

Groundwater recharging, sanitary care and filtration of drinking water are the need of hour. For the first time this area was analyzed for coliform and results obtained through H2s strip kits were also confirmed by membrane filtration method using Mac Conkey agar. Inhabitants were made aware of quantitative and qualitative changes of their groundwater (drinking water) along with remedy.

Recommendation to manage groundwater quality: Shallow and permeable water table are the most susceptible to contamination, but susceptibility of all aquifers to contaminate is determined largely by-

1. Distance from the contamination source and residence time of water in the unsaturated zone.
2. Presence of clay and organic matter in unsaturated zones materials.
3. Potential of a particular contaminant biodegradable and decompose.
4. Amount of precipitation, which affects recharge and rate at which contaminants move downward.

Hence strict cleanliness should be enforced in the vicinity of the wells, personal ablution, washing clothes and pets, dumping of waste and refuge in the vicinity of the well should be prohibited. The study suggest that prevention is the best approach to groundwater contamination. Thus, it is necessary to make groundwater free from germs before human consumption. Clean water is life. Sand, charcoal and muslin clothes are effective water filters. We must use this chemical free and cost effective Domestic technology to purify drinking water (Firoze Ahmad, 2015) [8].

Acknowledgements: The author is grateful to Prof. Ramashanker Dubey (Vice chancellor, T.M.B.U., Bhagalpur, Prof. Syed Ehteshamuddin (Ex-Vice chancellor, T.M.B.U., Bhagalpur, Prof. B. Lal (H.O.D., Univ. Dept. of Zoology, T.M.B.U., Bhagalpur, Prof. Razia Hasan (Ex-H.O.D, Univ. Dept. of Zoology), T.M.B.U., Bhagalpur and Dr. D. K. Das, P. G. Biotech. for valuable suggestions and encouragement.

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