International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July 2016

Water Quality Assessments for 5 Major Drinking Water Bodies for Carcinogenic and E.Coli Contaminants Pollution in Hyderabad

Mr. Rafid Ahmed Taha

Master in science, Department of Environmental science, Osmania University, Hyderabad, India
University of Basrah, Albasrah, Iraq

ABSTRACT

The pollutants from sewage and industrial discharge besides finding their way to surface water reservoirs and rivers they also percolate into ground to pollute ground water. Pollution of surface waters such as rivers, lakes, ponds, ground waters, sea water are harmful for human and animal health. Pollution of the drinking water is the most worry-some aspect. There are numerous ill effects of pollution, each type of pollutants having different effect, on human and animal health and ecology. Some of the pollutants like arsenic (As), nickel (Ni), barium (Ba), cadmium (Cd), cobalt (Co), selenium (Se), mercury (Hg), chromium (Cr) specially hexavalent chromium, lead (Pb), vanadium (V), oils and grease, pesticides, etc are very harmful, toxic even in ppb (parts per billion) range. A more serious aspect of water-pollution is that which is caused by human activity, and industrialization.

There are also various micro-biological agents that include bacteria, viruses and protozoa which can also cause water pollution and may cause various water-borne diseases. In this project hazardous contaminants like Arsenic, Asbestos, Benzene, Bisphenol A (BPA) are tested in water samples collected from five deinking water bodies in and around Hyderabad which are Osman Sagar, Himayat Sagar, Singur Lake, Manjira, Krishna River. Other water tests such as pH, dissolved oxygen, nitrates and phosphorus levels are also tested along with the coliform microbial analysis. All the water bodies have shown positive result in coliform tests which means that the coliform bacteria are present in all the five water bodies. Batch WB3S3 has shown high arsenic levels, WB5S3 has shown high asbestos levels than the rest of the batches along with benzene levels and bisphenol A levels. Dissolved oxygen is reported to be more in WB5S3 batch followed by Ph levels, nitrates and phosphorus levels.

Keywords: micro-biological agents, pollutants, sewage and industrial discharge, WB5S3

INTRODUCTION:

Hyderabad the capital city of Andhra Pradesh State in India, has a population of about 6 million. With an area of about 778 square kilometers, it is the sixth largest city in India. Hyderabad city contain a number of natural and man-made water bodies locally known as Cheruvus, Kuntas etc. These water bodies acted as water storage reservoirs for drinking water, irrigation and groundwater recharge, and have been an inalienable part of the urban ecology of the city. Water is essential for survival. It has been stated that our existence is "intimately connected with the quality of water available to us." According to F.Batmanghelidj, MD, author of "Your Body's Many Cries for Water", "25% of the human body is made up of solid matter while the remaining 75% is water." Therefore, if our bodies are not continuously supplied with water, our bodies become dehydrated and the vital organs will deteriorate until they are no longer viable for human life. Water sources must be protected from contamination by human and animal waste, which can contain a variety of bacterial, viral, and protozoan pathogens and helminth parasites. Failure to provide adequate protection and effective treatment will expose the community to the risk of outbreaks of intestinal and other infectious diseases. Those at greatest risk of waterborne disease are infants and young children, people who are debilitated or living under unsanitary conditions, the sick, and the elderly. For these people, infective doses are significantly lower than for the general adult population. The potential consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised.

The assessment of the risks associated with variations in microbial quality is difficult and controversial because of insufficient epidemiological evidence, the number of factors involved, and the changing interrelationships between these factors. In general terms, the greatest microbial risks are associated with ingestion of water that is contaminated with human and animal excreta. Microbial risk can never be entirely eliminated, because the diseases that are waterborne may also be transmitted by person-to-

person contact, aerosols and food intake; thus, a reservoir of cases and carriers is maintained. Provision of a safe water supply in these circumstances will reduce the chances of spread by these other routes.

MATERIAL AND METHODOLOGY

Sample Collection

The samples were collected during the monsoon (December 2014) with the stuff from five different water bodies in Hyderabad. samples were collected from 5 water bodies (Osman Sagar WB1, Himayat Sagar WB2, Singur Lake WB3, Manjira River WB4, Krishna River WB5) each water body were collected 3 samples of triangle shape (3 points) and acidified immediately to bring the ph of the solution to < 2.0. clean polythene bottle of litre capacity soaked with 1:1 HNO3 and washed using detergent was used for surface water sampling. These bottles were allowed to for several hours in double distilled water befor taking to the field. The sample bottle were rinsed two to three times using the representative surface water samples. Water samples were collected 30 cm below the water level in lakes using water sampler.

Sample Analysis

Water pollution may be analyzed through several broad categories of methods: physical, chemical and biological. Most involve collection of samples, followed by specialized analytical tests.

Carcinogenic Analysis

Estimation of Arsenic

Arsenic chemical element symbol AS has three solid forms (gray, black, yellow) Sam has no apparent beneficial health effects for humans, the first to separate the arsenic is a German scientist Albertus Magnus in 1250 year, and can detect arsenic after death in the bones, hair and nails The soil under the body. There is arsenic in nature sometimes pure or mix with other elements or metals, found in most water sources (natural focus with water less than 0.01 mg / L) as found in many sources as pesticides algae, insects, rodents and food Sea, marine animals as shrimp which includes focused high arsenic compounds are the most dangerous toxic arsenic compounds and arsenic trioxide between lethal dose (20-60) mg, and there is another image of arsenic which is arsine gas.

Estimation of Asbestos

Asbestos is introduced into water by the dissolution of asbestos-containing minerals and ores as well as from industrial effluents, The health hazards associated with the inhalation of asbestos in the occupational environment have long been recognized and include asbestosis, bronchial carcinoma, malignant mesothelioma of the pleura and peritoneum, and possibly cancers of the gastrointestinal tract and larynx. In contrast, little convincing evidence has been found of the carcinogenicity of ingested asbestos in epidemiological studies of populations supplied with drinking-water containing high concentrations of asbestos. the ability of asbestos fibres ingested in drinking-water to migrate through the walls of the gastrointestinal tract in sufficient numbers to cause adverse local or systemic effects is the subject of considerable disagreement.

Principle

A light source (a), which is fiber optic light source from Nikon, is used. The beam initially polarized by 45° after passing through a polarizer (b) is spatially separated by the first Wollaston prism (c) into two beams that have orthogonal polarization to each other. These two beams are focused by the condenser (d) for passage through the sample (e). They are focused so they will pass through the sample with a very small distance to each other – shear distance. Usually, it is slightly less than the resolution of the objective. As these two beams pass through a specimen, they experience different optical path lengths and refractive index changes since they target different spatial areas. After passing through the sample, the rays travel through the objective lens (f) and are focused for the second Wollaston prism (g), which removes the spatial separation between them. Then the analyzer (h) polarizes the beam at 135°. Similar to an interferometer, now two beams can interfere to produce amplitude contrast. Therefore, a specimen such as asbestos can be imaged.

Procedure

The water solution was dispersed by an ultrasonic wave.

A drop of each asbestos solution was placed on a 75 × 25 mm2 slide glass and covered with 18 × 18 mm2 cover glass.

They were connected by epoxy.

After drying the epoxy, the obtained samples were examined with DIC.

The differences in shape and structure, which can be clearly visible in this image, allow easy differentiation. Asbestos fibers have long and thin shape there is quite a bit of variability within asbestos fibers, e.g., amphiboles versus chrysotile. Therefore, distinction among different asbestos fibers is also possible.

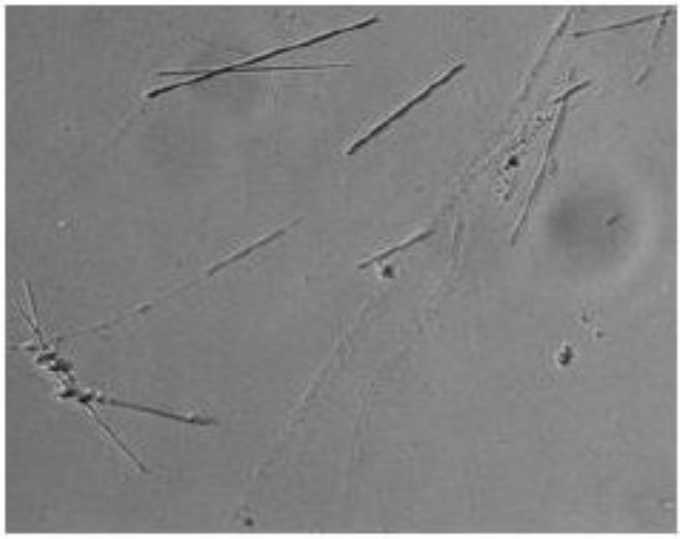

Figure 1: Results of Asbestos

CHEMICAL TESTS

Estimation of Dissolved Oxygen

The Winkler Method is a technique used to measure dissolved oxygen in freshwater systems. Dissolved oxygen is used as an indicator of the health of a water body, where higher dissolved oxygen concentrations are correlated with high productivity and little pollution. This test is performed on-site, as delays between sample collection and testing may result in an alteration in oxygen content.

Procedure:

fill a 300-mL glass Biological Oxygen Demand (BOD) stoppered bottle brim-full with sample water. Immediately add 2mL of manganese sulfate to the collection bottle by inserting the calibrated pipette just below the surface of the liquid. Squeeze the pipette slowly so no bubbles are introduced via the pipette. Add 2 mL of alkali-iodide-azide reagent in the same manner. Stopper the bottle with care to be sure no air is introduced. Mix the sample by inverting several times. If oxygen is present, a brownish-orange cloud of precipitate or floc will appear. 6- After the floc has settle to the bottom, mix the sample by turning it upside down several times and let it settle again. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample. Carefully stopper and invert several times to dissolve the floc. Sample is stored for 8 hours in a cool, dark place. . As an added precaution, squirt distilled water along the stopper, and cap the bottle with aluminum foil and a rubber band during the storage period. In a glass flask, titrate 201

mL of the sample with sodium thiosulfate to a pale straw color. Titrate by slowly dropping titrant solution from a calibrated pipette into the flask and continually stirring or swirling the sample water. Add 2 mL of starch solution so a blue color forms.

Continue slowly titrating until the sample turns clear. As this experiment reaches the endpoint, it will take only one drop of the titrant to eliminate the blue color. Be especially careful that each drop is fully mixed into the sample before adding the next. It is sometimes helpful to hold the flask up to a white sheet of paper to check for absence of the blue color. The concentration of dissolved oxygen in the sample is equivalent to the number of milliliters of titrant used.

Estimation of PH

pH is a measure of hydrogen ion concentration. It is an indicator of relative acidity or alkalinity of water. Values of 9.5 and above indicate high alkalinity while values of 3 and below indicate acidity. Values below 4 generally do not support living organisms in the marine environment. Drinking water should have a pH between 6.5 and 8.5. Harbour basin water can vary between 6 and 9.

Materials Required

Waste water collected from lake. Acetate buffer (pH = 4).

Ammonium buffer (pH = 10). pH meter.

Tissue paper.

Procedure

Collect water from the polluted lake and transfer it into a beaker. Switch on the pH meter. Remove electrodes from storage solution and rinse with water. Bloat with soaked tissue paper. Standardize the instrument with electrodes immersed in a buffer solution (Acetate buffer pH = 4). Rinse, bloat and dry the electrodes to each tie. Check the pH on the pH meter (pH = 7). Rinse, bloat and dry the electrodes. Standardize the instrument with electrodes immersed in a buffer solution (Ammonium buffer pH = 10). Rinse, bloat and dry the electrodes and check the pH on the pH meter (pH = 7). Dip the pH electrode in the beaker containing waste water to be tested. Note the pH. Replace the electrodes in the storage solution.

Citrate Agar Test

The citrate test screens a bacterial isolate for the ability to utilize citrate as its carbon and

energy source (3, 7). A positive diagnostic test rests on the generation of alkaline by-products of citrate metabolism. The subsequent increase in the pH of the medium is demonstrated by the color change of a pH indicator. The citrate test is often part of a battery of tests used to identify gram-negative pathogens and environmental isolates (10). For instance, test kits such as the API-20E (bioMerieux) and Enterotube II (BD Diagnostics) include citrate utilization medium as one of the diagnostic tests.

Table 1: Simmons citrate medium.

Magnesium sulfate (heptahydrate)	0.2 g
Ammonium dihydrogen phosphate	1.0 g
Dipotassium phosphate	1.0 g
Sodium citrate (dehydrate)	2.0 g
Sodium chloride	5.0 g
Agar	15.0 g
Bromothymol blue	0.08 g
Deionized water	1,000 ml

RESULTS

Osman Sagar Lake	Water Body 1		
Water body 1 samples	WB1S1	WB1S2	WB1S3
Arsenic [MFL]	4.9	5.4	6.9
Asbestos [MFL]	0.004	0.005	0.0032
Benzene [MFL]	0.0016	0.0025	0.0053
Bisphenol A (BPA) [PPB]	9.95	10.45	12.94
Dissolved Oxygen [mg/l]	10.42	10.98	11.31
Ph Level	6.5	7.1	7.5
Nitrates [ppm]	2	2.5	3.4
Phosphorus [mg/L]	0.0023	0.0043	0.0054

Table 2: Osman Sagar Lake Tests WB1

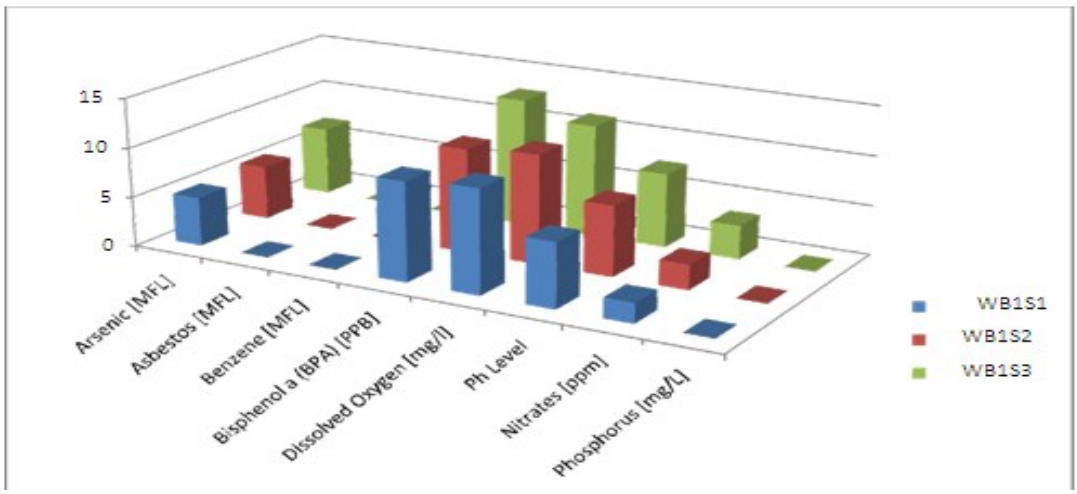

Figure 2: Osman Sagar Lake Tests WB1

Result: From the above mentioned graph for water body 1 various samples are collected viz; arsenic ,asbestos ,benzene ,dissolved oxygen ,ph level ,nitrates and phosphorus . The following values were obtained respectively; Arsenic 5.73(MFL), Asbestos 0.00406(MFL), Benzene 0.0031(MFL), Bisphenol a 11.113, Dissolved Oxygen 10.903, ph level 7.03, Nitrates 2.63, phosphorus 0.004.

Himayat Sagar Lake Tests WB2

Table 3: Himayat Sagar Lake Tests WB2

Himayat Sagar Lake		Water Body 2	
Water body 2 samples	WB2S1	WB2S2	WB2S3
Arsenic [MFL]	5.2	5.6	7
Asbestos [MFL]	0.0046	0.0041	0.0032
Benzene [MFL]	0.0084	0.0194	0.0145
Bisphenol A (BPA) [PPB]	8.32	9.43	10.99
Dissolved Oxygen [mg/l]	12.5	12.89	13.42
Ph Level	6.9	7.6	8
Nitrates [ppm]	3.1	3.7	4.2
Phosphorus [mg/L]	0.0062	0.0078	0.0058

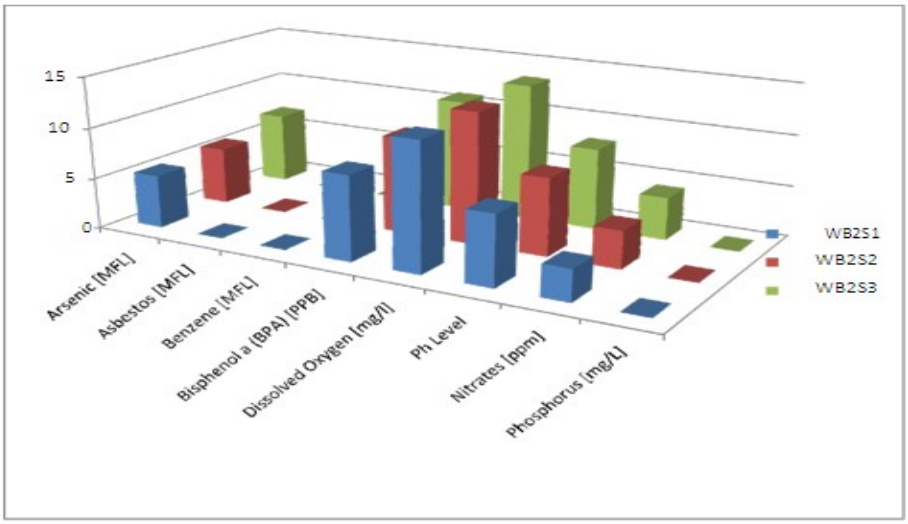

Figure 3: Himayat Sagar Lake Tests WB2

Result: From the above mentioned graph for water body 2 various samples are collected viz; arsenic ,asbestos ,benzene ,dissolved oxygen ,ph level ,nitrates and phosphorus . The following values were obtained respectively; Arsenic 5.93(MFL), Asbestos 0.00396(MFL), Benzene 0.0141(MFL), Bisphenol a (BPA) 9.58, Dissolved Oxygen 12.936, ph level 7.5, Nitrates 3.66, Phosphorus 0.0066.

Singur Lake Tests WB3

Table 4: Singur Lake Tests WB3

Singur Lake	Water Body 3		
Water body 3 samples	WB3S1	WB3S2	WB3S3
Arsenic [MFL]	4.4	6.3	7.4
Asbestos [MFL]	0.0053	0.0063	0.0072
Benzene [MFL]	0.0234	0.0289	0.0329
Bisphenol A (BPA) [PPB]	12.56	14.63	16.93
Dissolved Oxygen [mg/l]	10.48	11.98	12.84
Ph Level	7.3	7.9	8.2
Nitrates [ppm]	4.7	4.9	5.09
Phosphorus [mg/L]	0.007	0.0081	0.009

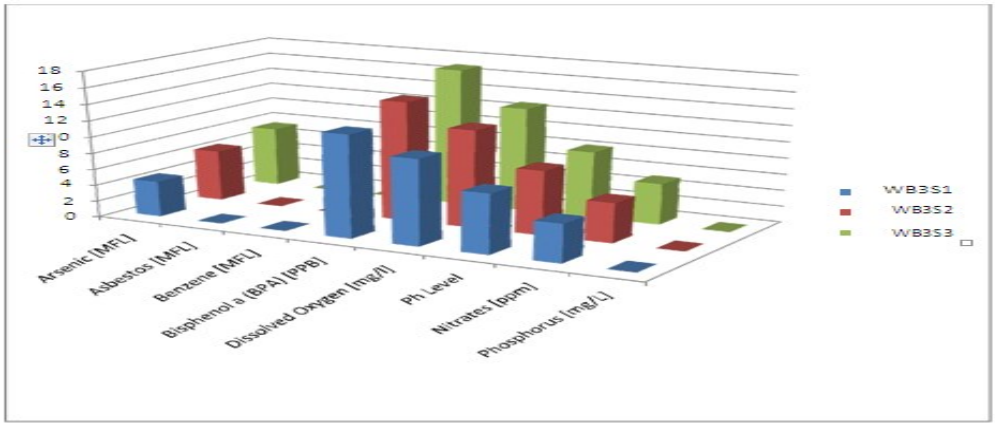

Figure 4: Singur Lake Tests WB3

Result: From the above mentioned graph for water body 3 various samples are collected viz; arsenic, asbestos, benzene, dissolved oxygen, ph level, nitrates and phosphorus. The following values were obtained respectively; Arsenic 6.03(MFL), Asbestos 0.0062(MFL), Benzene 0.0284(MFL), Bisphenol a (BPA) 14.706, Dissolved Oxygen 11.766, ph level 7.8, Nitrates 4.866, Phosphorus 0.00803.

Manjira River Tests WB4

Table 5: Manjira River Tests WB4

Manjera River	Water Body 4		
Water body 4 samples	WB4S1	WB4S2	WB4S3
Arsenic [MFL]	4.1	4.9	5.7
Asbestos [MFL]	0.0021	0.0089	0.0095
Benzene [MFL]	0.0104	0.0285	0.0321
Bisphenol A (BPA) [PPB]	15.34	17.9	19.01
Dissolved Oxygen [mg/l]	9.41	10.51	11.04
Ph Level	7.8	8.5	9
Nitrates [ppm]	5.32	6.78	7.54
Phosphorus [mg/L]	0.014	0.0156	0.0245

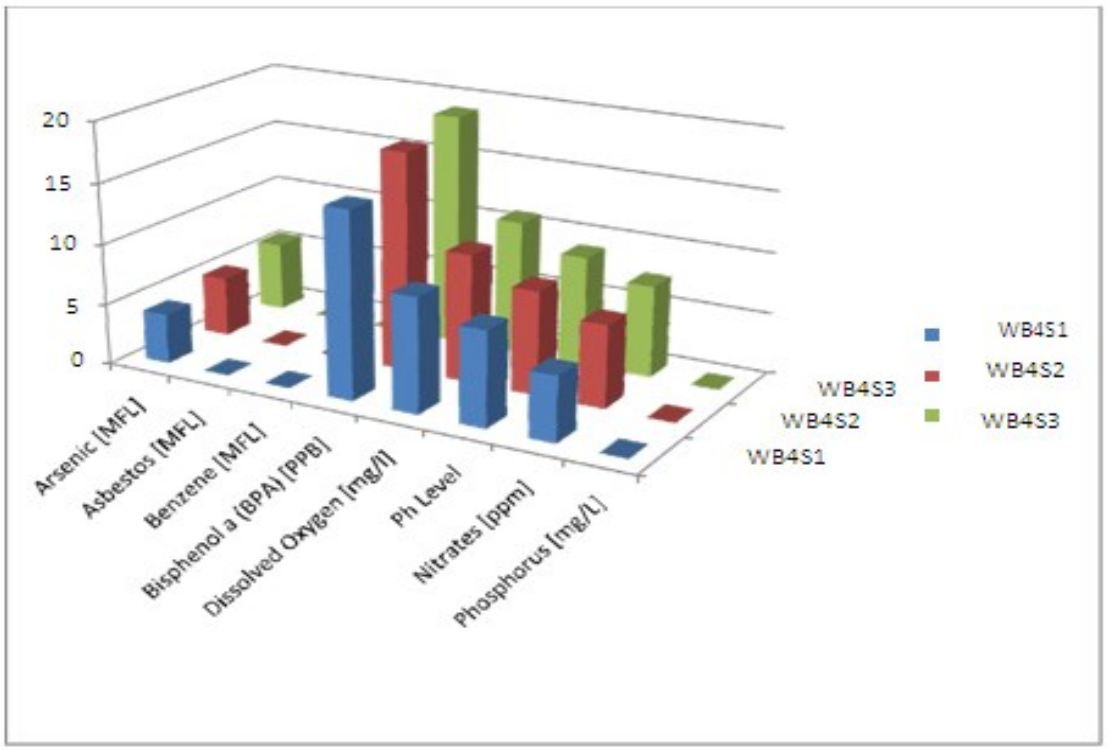

Figure 5: Manjira River Tests WB4

Result:

From the above mentioned graph for water body 4 various samples are collected viz; arsenic ,asbestos ,benzene ,dissolved oxygen ,ph level ,nitrates and phosphorus . The following values were obtained respectively; Arsenic 4.9(MFL), Asbestos 0.00683(MFL), Benzene 0.0236(MFL), Bisphenol a (BPA) 17.41, Dissolved Oxygen 10.32, ph level 8.43, Nitrates 6.546, Phosphorus 0.0180.

Krishna River Tests WB5

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July 2016

Table 6: Krishna River Tests WB5

Krishna River	Water Body 5		
water body 5 samples	WB5S1	WB5S2	WB5S3
Arsenic [MFL]	4.6	5.3	5.7
Asbestos [MFL]	0.0059	0.0082	0.01
Benzene [MFL]	0.0356	0.0421	0.0492
Bisphenol A (BPA) [PPB]	18.54	19.95	21.89
Dissolved Oxygen [mg/l]	12.38	13.52	13.98
Ph Level	8.4	8.7	9.2
Nitrates [ppm]	8.01	9.34	10
Phosphorus [mg/L]	0.0378	0.0489	0.0578

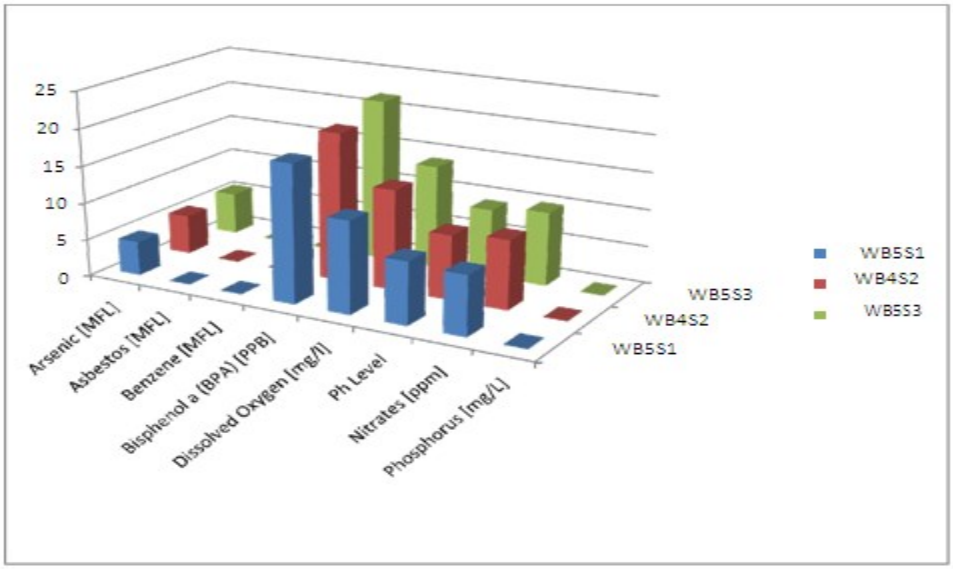

Figure 6: Krishna River Tests WB5

Result:

From the above mentioned graph for water body 5 various samples are collected viz; arsenic, asbestos, benzene, dissolved oxygen ,ph level ,nitrates and phosphorus . The following values were obtained respectively; Arsenic 5.2(MFL), Asbestos 0.0080(MFL), Benzene 0.0423(MFL), Bisphenol a (BPA) 20.11, Dissolved Oxygen 13.293, ph level 8.76, Nitrates 9.11, Phosphorus 0.0481.

Estimatiom of Arsenic

Estimation of Arsenic in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

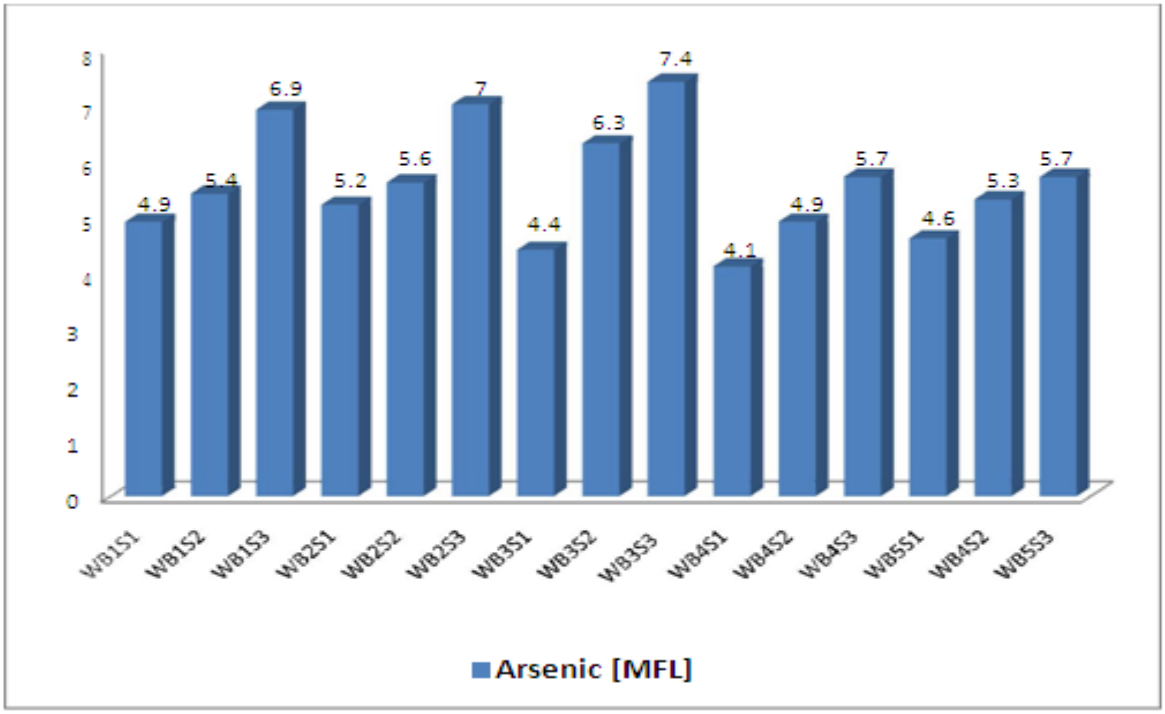

Figure 7: Estimation of Arsenic in 5 water bodies

RESULT:

From the above mentioned graph highest value exhibited by Arsenic WB3S3 7.4 (MFL) compared to other samples.

Estimation of Asbestos

Estimation of Asbestos in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

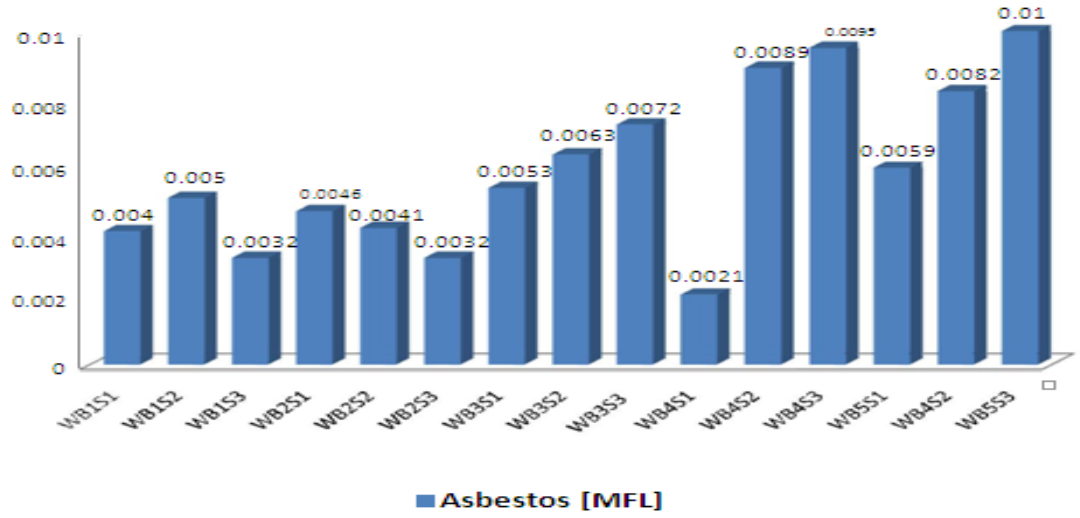

Figure 8: Estimation of Asbestos in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Asbestos WB5S3 0.01(MFL) compared to other samples.

Estimation of Benzene

Estimation of Benzene in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

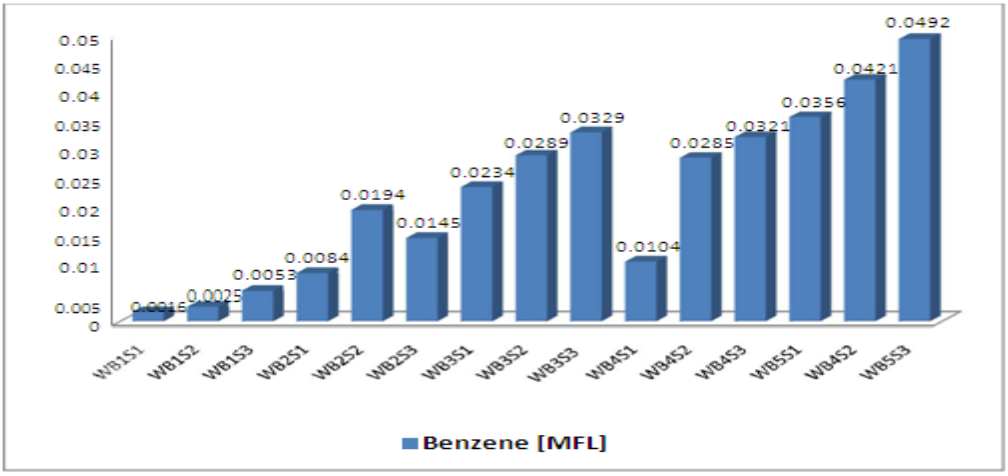

Figure 9: Estimation of Benzene in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Benzene WB5S3 0.0492(MFL) compared to other samples.

Estimation of Bisphenol A

Estimation of Bispenol A in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

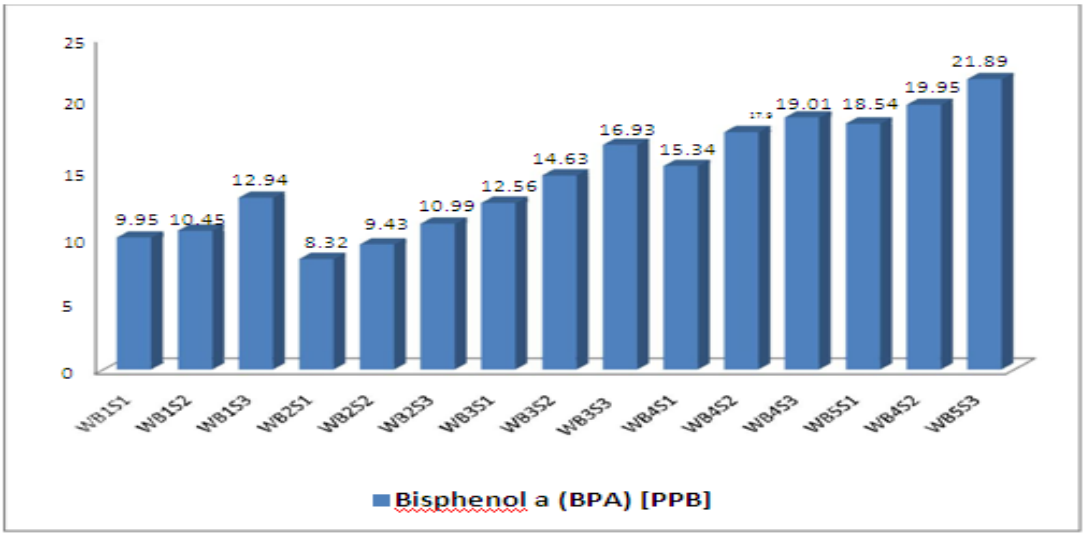

Fig. 10: Estimation of Bisphenol A in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Bisphenol a WB5S3 21.89(MFL) compared to other samples.

Estimation of Dissolved Oxygen (D.O)

Estimation of Dissolved Oxygen in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

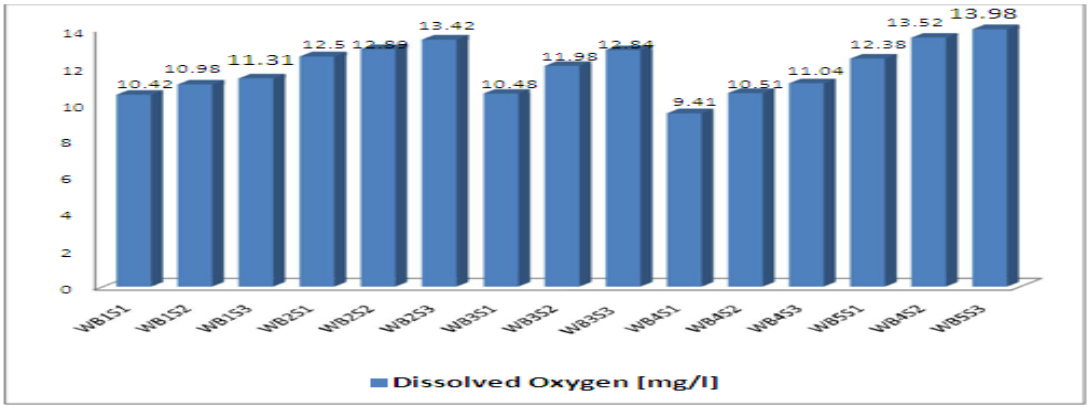

Figure 11: Estimation of Dissolved Oxygen in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Dissolved Oxygen WB5S3 13.98 (mg/l) compared to other samples.

Estimation PH Level

Estimation of Ph level in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

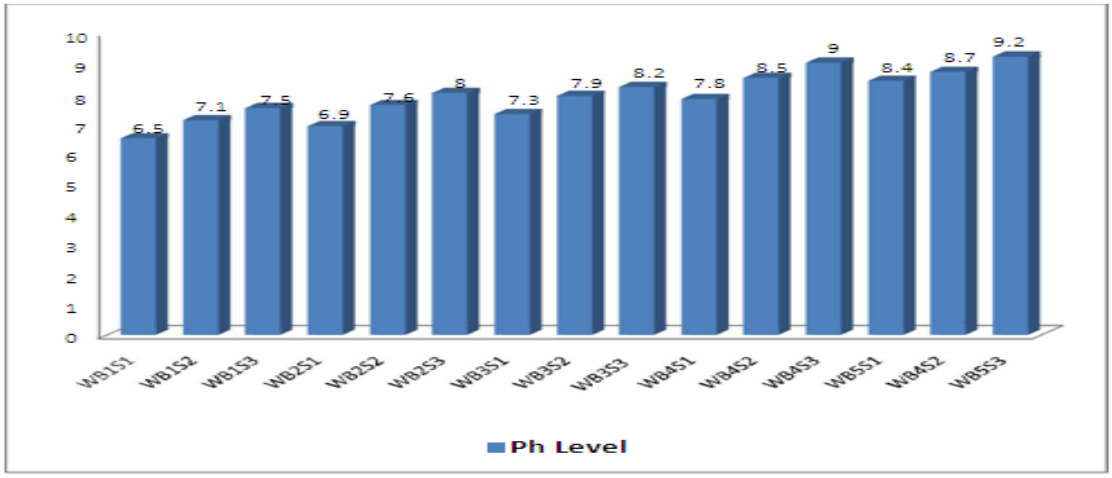

Figure 12: Estimation of Ph Level in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by ph level WB5S3 9.2 compared to other samples.

Estimation of Nitrates

Estimation of Nitrates in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

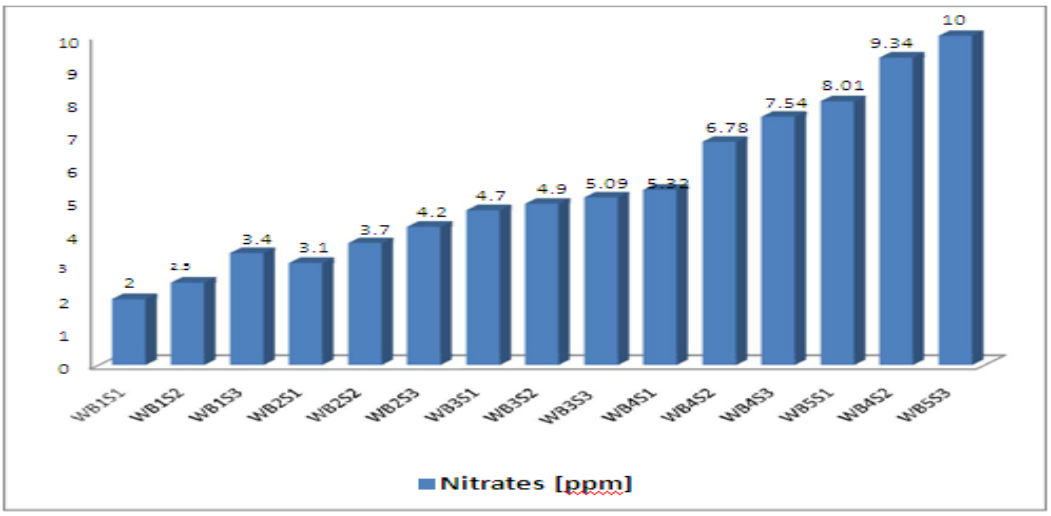

Figure 13: Estimation of Nitrates in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Nitrates WB5S3 10 compared to other samples.

Estimation of Phosphorus

Estimation of Phosphorus in 5 water bodies (WB1, WB2, WB3, WB4, WB5)

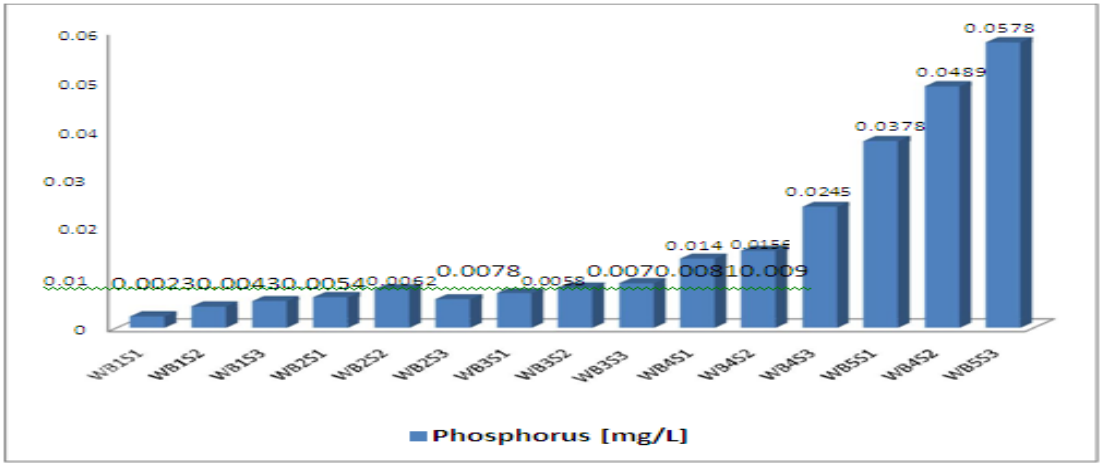

Figure 14: Estimation of Phosphorus in 5 water bodies

RESULT: From the above mentioned graph highest value exhibited by Phosphorus WB5S3 0.0578(mg/l) compared to other samples.

E.coli Testing Techniques (all the bodies)

Carbohydrate Fermentation Test

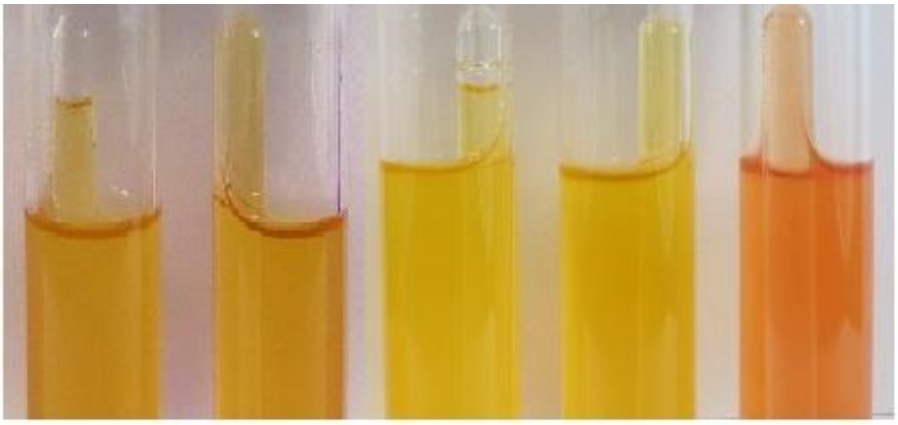

Figure 15: Carbohydrate Fermentation

RESULT: Fermentation is noted by acid production which can be observed by a colour change in Durham tubes. A small "space" at the top of the small tube, it means that gas is trapped in the small inverted tube inside the bigger tube. Therefore, gas is produced from the breakdown of carbohydrates.

Coliform Testing

Figure 16: ColiformTtesting

RESULT: A positive reaction is denoted by the appearance of a blue to blue-green color change on the bacterial smear within 10 seconds. Negative reactions remain colorless or light pink.

Citrate Agar Test

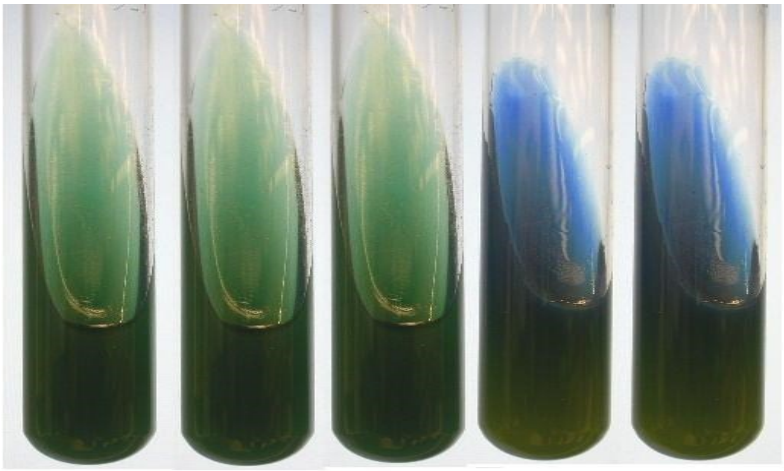

Figure 17: Citrate Agar Test

RESULT: The negative result of a citrate test done on Escherichia coli after a 24-hour incubation at 37°C. A negative result is indicated by a lack of growth and no color change.

DISCUSSION

Some drinking-water pollutants have carcinogenic and mutagenic properties, giving an appreciable risk for the user. hence water reserves, because of their importance to public health, should be safeguarded properly and protected to prevent contamination. Although disinfection brings about mutagenic and carcinogenic molecules, it should not be ignored to prevent the severe risks caused due to the presence of pathogens in water used for human consumption. all human activities produce some or the other kind of environmental disturbance that contaminate surrounding waters. After the tests for hazardous pollutants as well as common tests along with coliform testing are done the batch WB3S3 has shown a reading of 7.4 MFL of arsenic. The tests are then followed by Asbestos, Benzene, Bisphenol A, dissolved oxygen, pH levels, nitrate

levels and phosphorous levels. The reading are highest for batch WB5S3 showing 0.01MFL, 0.0492 MFL, 21.89 PPB, 13.98 mg/L, 9.2, 10 PPm, 0.0578 mg/l respectively. The negative result of a citrate test done on Escherichia coli after 24-hour incubation at 37°C. A negative result is indicated by a lack of growth and no color change. Fermentation is noted by acid production which can be observed by a colour change in Durham tubes. A small "space" at the top of the small tube, it means that gas is trapped in the small inverted tube inside the bigger tube. Therefore, gas is produced from the breakdown of carbohydrates. A positive reaction is denoted by the appearance of a blue to blue-green color change on the bacterial smear within 10 seconds. Negative reactions remain colorless or light pink.

RECOMMENDATION

Due to ever increasing industrialization, urbanization, this precious resource is continuously under stress. There are multiple dimensions to water quality and its deterioration. Water pollution is rendering much of the available water unsafe for consumption. The pressure of increasing population, loss of forest cover, untreated effluent discharge from industries and municipalities, use of non-biodegradable pesticides/ fungicides/ herbicides/insecticides, use of chemical fertilizers instead of organic manures, etc are causing water pollution. Moreover, there are numerous water borne diseases like cholera, diarrhoea, dysentery etc. which are transmitted by drinking contaminated water. In order to prevent the spread of water-borne infectious diseases should take the procedures below:

1. People should take adequate precautions. The city water supply should be properly checked and necessary steps taken to disinfect it. Water pipes should be regularly checked for leaks and cracks At home.
2. The need to water treatments include natural biological and chemical processes that remove solids and organic and micro-organisms or reduced to an acceptable degree of these operations are divided into stages and the process of cleansing to eliminate microorganisms.
3. support and expand the work of laboratories and bio-chemical analysis for the control of water and conducting periodic analyzes of water quality and to know they are free of heavy metals

contaminated or reduce its impact to the limit

CONCLUSION

Water pollution is any undesirable changes in water, contaminated with harmful substances. It is the second most important environmental issue after to air pollution. Any change in the chemical, physical and biological properties of water causing harmful effects on living things is termed water pollution. The immediate risk to health and life caused due to the presence of pathogenic microorganisms in water makes it unthinkable to abandon disinfection process; due to which the parameters proposed for the by-products of disinfection should not be restrictive as to impair its use. Water-borne epidemics and health hazards in the aquatic environment are mainly due to improper management of water resources. Proper management of water resources has become the need of the hour as this would ultimately lead to a cleaner and healthier environment.

REFERENCES

1. De Kok, T., Guidotti, T., Kjellstrom, T., and Yassi, A. (2001) Basic Environmental Health. New York: World Health Organization.
2. World Health Organization (WHO) (1993) Guidelines for drinkingwater quality, recommendations, 2nd Edn, Vol 1. WHO, Geneva.
3. Mellanby K (1942) Metabolic water and desiccation. Nature 150:21–21
4. "MDG Report 2008" (PDF). Retrieved 25 July 2010.
5. Baroni, L.; Cenci, L.; Tettamanti, M.; Berati, M. (2007). "Evaluating the environmental impact of various dietary patterns combined with different food production systems".European Journal of Clinical Nutrition 61 (2): 279–286.
6. Boundless. “The Structure and Properties of Water.” Boundless Chemistry. Boundless, 17 Nov. 2014. Retrieved 17 Apr. 2015 from https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/liquids-and-solids-11/liquid-properties-85/the-structure-and-properties-of-water-379-3642/
7. Ball, Philip (14 September 2007). "Burning water and other myths". Nature News. Retrieved 14 September 2007.

8. Van Andel, Tjeerd H. 1994. New views on an old planet: a history of global change. 2nd ed, Cambridge.
9. Shenkin A (2006) Micronutrients in health and disease. Postgrad Med J 82:559–567.
10. "WBCSD Water Facts & Trends". Retrieved 25 July 2010.
11. "Healthy Water Living". BBC. Retrieved 1 February 2007.
12. World Health Organization (1990) Environmental health criteria 101: methylmercury. Available via DIALOG:
13. Oklahoma Water Reservoir Board v. Central Oklahoma Master Conservancy District, 464 P. 2d 748 (1968).
14. Adams SB, Kolo RJ (2006). Public Health Implications of Gurara River around Izam Environs, Niger State, Nigeria. Fisheries Society of Nigeria (FISON) Conference Proceedings, 13th-17th Nov., 2006,Calabar, pp. 167-173.
15. Cheesbrough M (2000). District Laboratory Practice in Tropical Countries Part 2. Cambridge University Press, UK. p. 434.
16. Ademoroti CMA (1996). Environmental Chemistry and Toxicology. Foludex Press Ltd. Ibadan, Nigeria, p. 215.