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Microbiological Quality Analysis of Groundwater in Mhadei River Watershed, Goa, India

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ABSTRACT: Mhadei River watershed is an important watershed in the small coastal State of Goa. A large number of people living in the watershed depend on groundwater drawn from open dug wells for their daily water requirements. Twenty five groundwater samples were collected from the open dug wells to assess the microbiological quality of water. The water samples were analysed for total coliform, *Escherichia coli, Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Salmonella typhinurium* bacteria. It was found that most of the water samples were contaminated by these pathogenic bacteria. The bacterial population was found to be having higher densities in the post-monsoon season water samples as compared to the pre-monsoon water samples. This implies that the high infiltration rates during rainy season facilitate transport of waste matter to the groundwater thereby polluting the same. Since most water samples collected showed luxuriant growth of microorganisms, they are unfit for drinking purpose.

Key words: Mhadei River watershed, groundwater, microbiological quality, *E. coli*, Goa.

INTRODUCTION

Groundwater is fresh water located in the pore spaces of soil and rocks. It is the prime source of water for domestic, agricultural and industrial uses in many parts of our country. The progressive increase in groundwater consumption and the consequent over drafting, together with deterioration of water quality is now considered as one of the most serious environmental concern in India. Degradation of groundwater quality occurs either by lithogenic sources or anthropogenic sources. Sea water intrusion is also a matter of serious concern in the coastal regions. The lithogenic pollutants such as arsenic and fluoride have affected ground water in several parts of India. Anthropogenic contamination derived from industrial effluents, fertilizers, pesticides, domestic waste water and landfills has also caused groundwater quality deterioration in various parts of the country. Goa is a tiny State of India located along its West Coast having an area of 3702 sq.km and a population of over 1.45 million people. It is a popular international and domestic tourist destination owing to its natural beauty and rich cultural heritage. More than 2 million tourist visits this small place every year. This floating population puts tremendous stress on its natural resources, especially its water resources. The tourism activity is restricted to the coastal zone and degradation of groundwater quality in coastal aquifers has been witnessed all along this belt (Chachadi *et al,* 2001).

The loads of bacterial contents, COD, BOD, NO_3 and phosphate have been found to be exceptionally high in coastal groundwater in Goa (Chachadi, 2009). Gonsalves (1998) has reported high coliform content in groundwater in Calangute area. Though many studies have been carried out in the coastal region not much work has been done to understand the quality of groundwater in interior regions of Goa.

Presence of coliform organisms in water is regarded as an evidence of faecal contamination as their origin is in the intestinal tract of human and other warm blooded animals. The occurrence of fecal coliform in water poses a great danger to human health. These pathogenic organisms are responsible for the infection of the intestinal tracts and the diseases caused include diarrhea, cholera, bacillary dysentery, typhoid, hepatitis and so on. Contamination of water by human waste deposit constitutes the most common mechanism for transmission of micro-organisms to humans (WHO, 1985).

The present study area, Mhadei River watershed, is located in the Midland and Western Ghats regions of Goa, and forms an important drainage system in the State of Goa. A large number of people living in the watershed depend on groundwater drawn from open dug wells for their daily water requirements. However, in the recent years, many cases of dysentery, diarrhea and typhoid fever have been reported from this region. Pathogenic bacteria, if present in the drinking water, usually cause such diseases. Thus, the present study aims to understand the microbiological quality of groundwater in Mhadei River watershed. The possible relation between the groundwater quality and pollution aspects has been envisaged.

MATERIALS AND METHODS

A. Study Area

The Mhadei River watershed is a sub-watershed of Mandovi River in Goa, India which drains into the Arabian Sea. It lies between latitudes N 15° 22’ 14.85" and N 15° 42’ 8.3" longitudes E 74° 02’ 25.6" and E 74° 25’ 00 covering a total area of 899 km^2 of which 573 km^2 (64%) lies in Goa and 326 km^2 (36%) lies in Karnataka.

The climate across the watershed is tropical and is characterised by high monsoon rainfall (3933mm), moderate temperature (24-34°C) and high humidity (75-90%). Over 90% rainfall occurs during the monsoon months (June to September) while the remaining 10% rainfall is received during the non-monsoon months. Rainfall is the main source of groundwater recharge in the watershed.

B. Sampling

A survey work was conducted using SOI toposheets for identification of sampling wells. The selection of wells was done in order to represent the entire Mhadei River watershed which will give a clear picture of the groundwater quality conditions of this region. Twenty five open dug wells were selected as the source for the groundwater quality study. A household survey and field observations were conducted to assess the hygienic conditions and practices, in and around the water sources during sample collection.

Water samples were collected in 250ml pre-sterilized sample bottles that were fitted with screw caps, and labeled. The samples were transported to the laboratory promptly and were stored in the refrigerator between 4- 6°C. The samples were analyzed within six hours of collection.

C. Methodology of Microbiological Analysis

Microbiological testing includes the presence/absence and enumeration of various microorganisms. Water quality analysis was based on the Most Probable Number (MPN) of colony forming units (cfu) per 100 ml for the Total coliform, *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus* and *Salmonella typhinurium* bacteria. Results of the tests were compared with the prescribed World Health Organization (WHO) desirable limits. Membrane filtration technique was used to isolate the microorganisms present in the water samples. The funnel of the membrane filtration unit with a capacity of 50ml was used for the purpose. The funnel was mounted on a receptacle which was fixed to the vacuum pump which allowed the water to flow over the porous sterile membrane filter (0.45μm). Aseptically, the membrane filters were placed on each microbial growth medium using sterile forceps after passage of 100ml of water sample. The following media: McConkey agar, Plate count agar, Pseudomonas agar, Baired-Parker agar were prepared and autoclaved at 121°C for 15 minutes at 15Ib before being inoculated with membrane filters. (APHA, 1992, Balogun, 2000).

RESULTS AND DISCUSSION

The 25 well water samples from Mhadei River watershed were examined for its microbiological quality. The purpose of this study was to determine whether pathogenic bacteria were present in water sources used by rural communities residing in Mhadei River watershed for their daily water needs.

Such information may allow determining to what extent the water sources may influence infection and disease in the community. The results are given in table 1. The occurrence of various pathogens in water samples during pre-monsoon and post-monsoon season was observed, which is discussed further.

Table 1: Pre-monsoon season 2011.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	15	10	0
2	*Escherichia coli*	6	12	7
3	*Salmonella typhinurium*	3	13	9
4	*Pseudomonas aeruginosa*	5	13	7
5	*Staphylococcus Aures*	6	11	8

Table 2: Post-monsoon season 2011.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	17	3	5
2	*Escherichia coli*	25	0	0
3	*Salmonella typhinurium*	7	17	1
4	*Pseudomonas aeruginosa*	8	6	11
5	*Staphylococcus Aures*	9	7	9

Table 3: Pre-monsoon season 2012.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	12	8	5
2	*Escherichia coli*	11	10	4
3	*Salmonella typhinurium*	5	10	10
4	*Pseudomonas aeruginosa*	7	14	4
5	*Staphylococcus Aures*	5	13	7

Table 4: Post-monsoon season 2012.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	16	3	5
2	*Escherichia coli*	23	2	0
3	*Salmonella typhinurium*	6	14	5
4	*Pseudomonas aeruginosa*	6	8	11
5	*Staphylococcus Aures*	8	5	12

Table 5: Pre-monsoon season 2013.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	12	7	6
2	*Escherichia coli*	9	11	5
3	*Salmonella typhinurium*	4	12	9
4	*Pseudomonas aeruginosa*	6	13	6
5	*Staphylococcus aures*	8	12	5

Table 6: Post-monsoon season 2013.

Sr. No.	Microrganisms	Luxuriant Growth	Poor Growth	No Growth
1	*Total Microbial Count*	15	4	6
2	*Escherichia coli*	24	1	0
3	*Salmonella typhinurium*	6	16	3
4	*Pseudomonas aeruginosa*	7	8	10
5	*Staphylococcus Aures*	6	6	13

A. Observation tables of microbiological Parameters

Bacteriological analysis of the 25 samples showed that most of the selected wells in Mhadei watershed are contaminated with the path ogens like *E. coli, Salmonella, Pseudomonas aeruginosa*, *Staphylococcus aureus* and also denotes the potential public health hazards. The bacterial genera such as Escherichia coli and *Staphylococcus* sp, are predominant in the water samples. The bacterial population was found to be having higher densities in the post -monsoon season water samples compared to the pre-monsoon water samples. This implies that in areas where the waste matter is not properly disposed, for example, a pit latrine, open discharge of kitchen and bathroom sewage, etc; the waste matter is washed away during rainy season and percolates through the ground which ultimately leaches to the groundwater. It was observed that a large number of households in the study area discharge their kitchen and bathroom sewage in open drains. Also a substantial number of populations, especially migrant laborers staying in rental houses, defecate in open areas. Since most water samples collected showed luxuriant growth of microorganisms, they are unfit for portability because they could also contain other microorganisms implicated in gastro-intestinal water borne diseases.

The incidences of water borne diseases in the area can therefore be attributed to untreated or poorly treated groundwater that contains pathogens.

CONCLUSIONS

All the water samples collected from ground water sources over a period of 3 years for pre-monsoon and post-monsoon season tested positive for the pathogens. An analysis of the water samples obtained from the drinking water sources (wells) resulted in the isolation of presumptive E. coli during the study period. The study revealed that the prevalence of pathogenic E. coli was more implicated in post-monsoon season than the pre-monsoon season for groundwater sources. The bacteriological counts in the well water samples make the water unfit for human consumption.

The quality of the water may be improved by cleaning of the groundwater sources, removal of organic matter and sediments from the water, addition of a disinfectant or the boiling of drinking water before use. The study recommends regular monitoring of drinking water sources in the Mhadei area for the presence of pathogenic bacteria. However, providing better sanitation facilities and a common sewage collection and treatment facility should be a priority.

Educating people about pathogenic waterborne bacteria and enlightening them about the dangers of consumption of untreated water from shallow wells by the government, is also recommended. This will control pollution and prevent deterioration of the quality of well waters.

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