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Assessment of coli forms in drinking water

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ABSTRACT:

Drinking water quality assessment was carried out from biological point of concern for the samples taken from the urban peripheral regions of Bangalore. Being one of the oldest and fastest growing industrial areas in India, it is of immense importance to analyze the drinking water sample of the city, as developing countries like India are not extremely well equipped with water supply systems, storage and maintenance systems etc. In this study, Bangalore was divided into six meta divisions namely South. East, North, West, South East and Central based on wards, and houses were randomly selected from each of these wards. A total of 1581 samples were tested and compared with water quality standards for coliform contamination chiefly to determine the fecal contamination. This particular parameter, to certain extent were found to exceed the permissible values of drinking water, Based on this parameter and in comparison to the six meta divisions of Bangalore, South-East region was observed to be equipped with poorest water with significant higher proportion of contamination of coliform bacteria. All the unfitness of the samples may have been occurred due to the poor supply system, storage and maintenance protocols and has to be controlled by better water treatment plans and well developed city planning in order to ensure a good hygiene of the population, thus of the city.

Keywords: Drinking water quality; water quality standard; coliform contamination; biological; water analysis

Introduction:

An excellent instance of an irony is that a planet having more than 70% of water, yet suffers from diseases occurring due to inadequacy of it. Out of the total water available on earth, fresh water contributes only 2.5% to it & out of which approximately 30-31% is ground water, 0.3% surface water (University of Michigan, 2006; National Academy of Sciences, 2008), bears the responsibility to meet the drinking water requirement of such an enormous population.

History has documented a number of times, the magnitude & occurrences of life threatening diseases due to the inadequacy of safe and clean drinking water. A number of physical, chemical as well as biological parameters have been assigned to define the safety and potability of drinking water. As far as coliform contamination is concerned, according to WHO guidelines, drinking water should contain no coliform contamination (Thomas & Andrew, 2003) as even a small proportion of these contaminants can cause several diarrheal diseases (Stephen et. al., 2004; Moe et. al., 1991), hence; screening of drinking water for the presence of these contaminants is mandatory in order to prevent such health concerns.

In the developing countries like India, rapid industrialization, resulting in dramatic growth of population is continuously seeking attention in supplying safe drinking water. Drastic urbanization in the peripheral regions and increase in population as its consequence have promoted Bangalore to the third most

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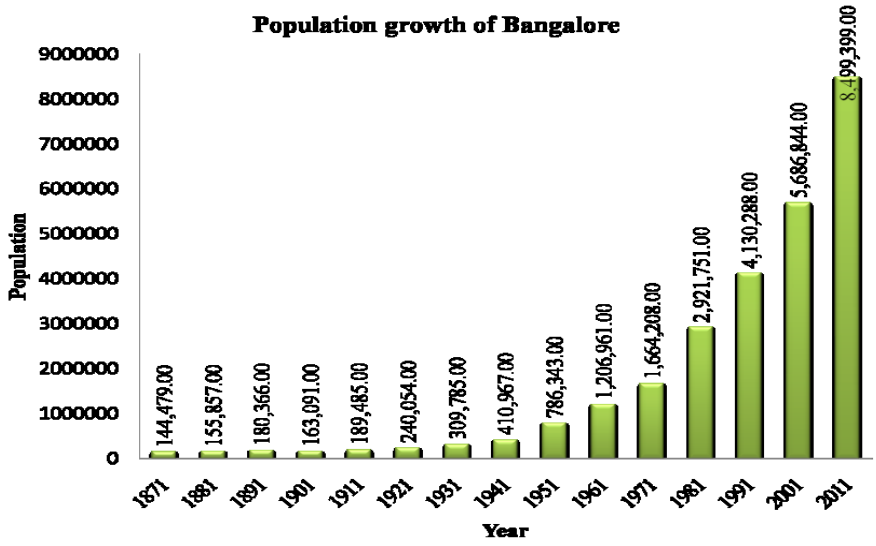
populated and the fastest growing city in India. At the same time, accommodating river i.e. Cauvery as the sole source of drinking water supplied by Bangalore Water Supply and Sewage Board (BWSSB) (http;//bwssb.org/mission/history/) , is under pressure to fulfill the drinking water requirement of the entire city. Thus, compelling its habitants to opt for alternative water sources like bore wells, tankers and private water supplies. Taking into consideration the variety of drinking water sources, it is of immense importance to scrutinize the water quality in regular intervals as incidence of water borne diseases is of high concern in developing states and countries.



Graph 1: Growth of population in Bangalore since 1871 (Census of India 2007b, Census of India 2011, Govt. of India)

Water quality testing have been performed all over the world including India, such asin Maharastra (Pradhan & Pirasteh,2001), TamilNadu (Saravanakumar&Ranjit, 2011) to mention a few. Similar studies conducted in various parts of Bangalore pertaining to the quality of water, depicted alarming coliform contamination in Anekal taluk, a Bangalore Urban District, (Prakash &Somashekar, 2006). In 2011, in another recent study, conducted by Janagraha, a Center for Citizenship and Democracy, have found that 72% of water consumed by Bangalore dwellers are contaminated (WQS Databook, Janagraha, 2013).

In this present study, we were dedicated towards determining the drinking water quality for Coliform contamination parameters, at the end user level, rather than the water being supplied by suppliers, which not only gives the water quality but also represents other factors such as quality of water storage, maintenance etc.

Materials and Methods

Study Area

The study was conducted in the peripheral regions of Bangalore, the capital of Karnataka state. The city is located at latitude $12^{o}.58'$N and longitude of $77^{o}.35'$E at an altitude of 921m above the sea level with a geographical area of 749square kilometers. The central region of Bangalore, by virtue of being the nucleus of the city, is well equipped with drinking water supply from BWSSB. On the other hand, the peripheral regions have encountered sudden

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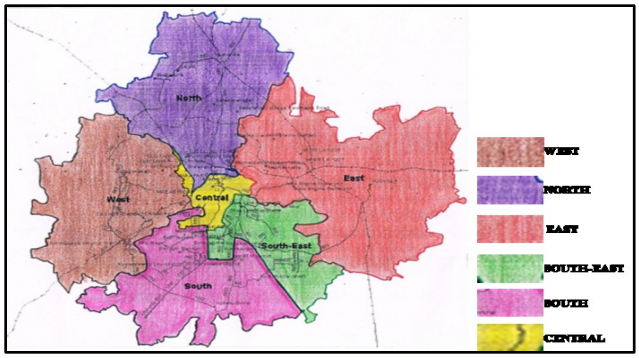
increase in urbanization & population rendering the water supply inadequate. In order to simplify the sampling and analysis, the city was divided into six meta-divisions, namely, South, North, East, West, Central and South-east.



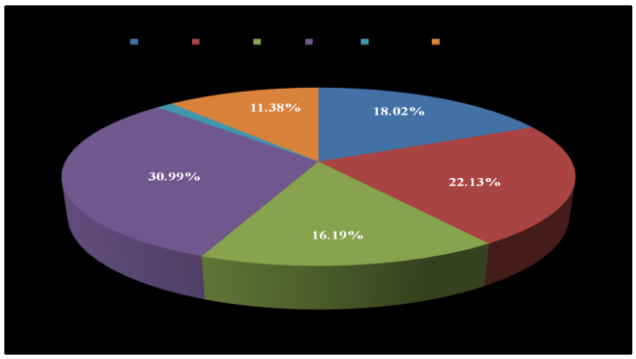


Figure (1a): Bangalore map divided in six meta regions. **(1b):** Percentage of samples taken from each meta regions.

Sampling: The households from each of the six meta divisions were assigned with listing numbers and were randomly selected using random number generator at a bar of 4. Each selected household was questioned regarding the taste, odor and hygienic procedures followed to ensure consumption of safe water. 500ml of drinking water were collected in sterilized polyethylene bottles and were stored at 4^0 C. Another 20 ml of samples were filled in sterilized borosilicate bottles equipped with lead acetate strips to determine the presence of coliform bacterial contamination.

Analysis: The collected and stored samples were subjected to Coliform test based on the principle that coliform bacteria are able to produce hydrogen sulphide (WHO) which in turn can react to lead acetate in order to produce lead sulphide imparting a black color to the water sample. The presence of coliform bacteria was also confirmed by inoculating the sample on EMB agar plate which produces green metallic sheen colonies upon *E. coli* growth, the blackening of water and the green metallic sheen confirms the presence of coliform bacteria e.g. *E. coli, Salmonella sp* .

Result: The results obtained from the physical and biological tests have been statistically analyzed in order to determine the overall drinking water quality of the entire Bangalore urban peripheral regions. The data have been represented in the tabulations. The 1581 samples tested in this study have demonstrated significant variation and few of them have showed to exceed the permissive values up to a considerable extent and hence; indicating several health issues. By the virtue of a well-planned sample collection methodology it was possible to determine the quality of the drinking water at each Meta-divisions level i.e. South, North, East, West, Central, and South-East, which in turn might help in addressing any concern related to the water quality.

Presence of coliform bacteria in drinking water is an excellent indicator for the fecal contamination of water as coliform bacteria are predominant in the fecal matter. These bacteria are the concerns for the occurrences of bacterial diarrheal diseases, and hence; of immense importance. We found around 40.54% samples among 1581 samples collected from six meta divisions were positive (Graph 2a and 2b) ,implying a considerable high amount of bacterial

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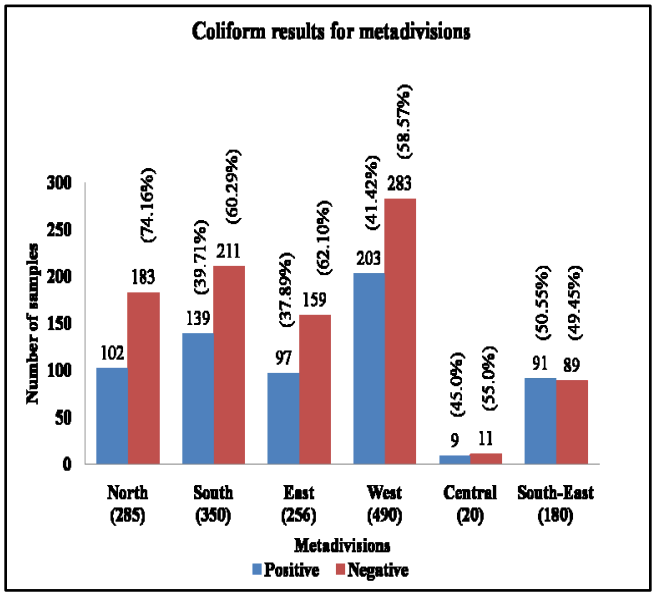
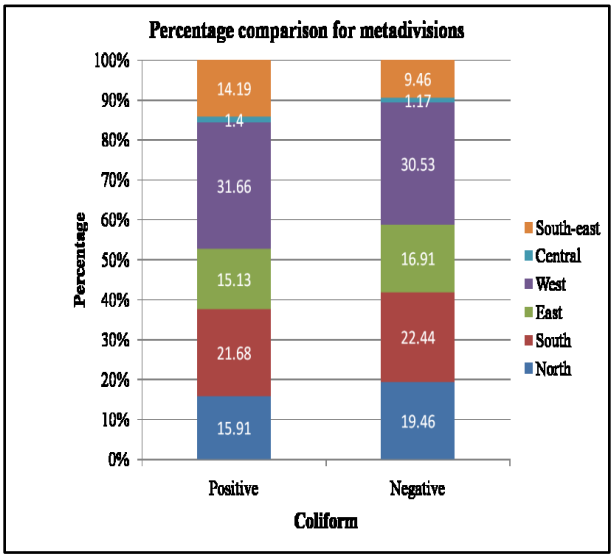
contamination which may indicate a fecal contamination as well a poor storage system.

None of the divisions could show more than 65% of negative samples, in fact, south-east has more than 50% samples positive for coliform test. North region was found to be the best among all with a 64.21% of negative samples whereas, south-east was the poorest with 50.55% of positive samples, west region took lead with showing 31.66 positive samples of all the samples found positive around Bangalore urban areas. All the positive samples were confirmed with inoculating the water sample on EMB agar plates which gave green metallic sheen, confirming the presence of *E. coli* bacteria.





Graph (2a): Number and percentage of samples obtained in each range of Total Dissolved Solids from each meta divisions. **(2b):** Percentage of positive and negative samples from each meta divisions contributing to the total number of positive and negative samples.

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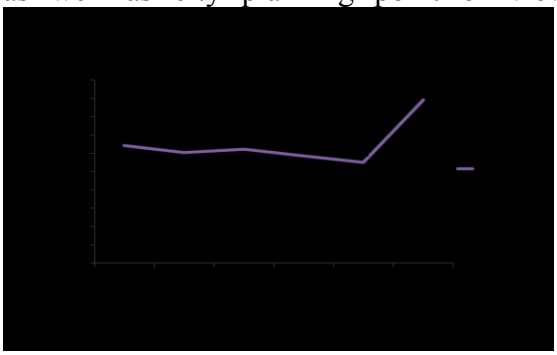
M.D.	No of sample	Coliform	
		+	-
North	285(18.02%)	102 (35.78%)	183 (64.21%)
South	350(22.13%)	139 (39.71%)	211 (60.29%)
East	256(16.19%)	97 (37.89%)	159 (62.1%)
West	490(30.99%)	203 (41.42%)	287 (58.57%)
Central	20(1.26%)	9 (45%)	11 (55%)
South- East	180(11.38%)	91 (50.55%)	89 (49.45%)
Total	1581(100%)	641 (40.54%)	940 (59.45%)

Table 1: Percentage of potable and non-potable water samples from each Meta-division**.**

Discussion:

It's not all boon to be urbanized, but also a limiting factor as far as supply of safe and clean drinking water is concerned, especially in the developing countries like India. Bangalore, being the third most populated and fastest growing city, is the area of concern in this study, the peripheral regions of it, to be precise. It is of great importance to analyze the ground water, which is a precious natural resource, from both health as well as city planning point of view.



Graph 3: Percentage of palatable samples obtained from each meta divisions.

Contamination of water by coliform were highly unacceptable in almost all the meta divisions including the central region which is supposed to be equipped with proper pipelines and supplied by BWSSB. All the regions showed more than 35% positive H_2S test and EMB plates confirming the presence of salmonella and E. coli indicating a high risk of diarrheal diseases, especially in children below 5 years of age. This high extent of coliform contamination in alternative source water was also reported by Prakash &Somashekar in 2006 in Anekal Region of Bangalore (Prakash &Somashekar, 2006), similar report was published by Jadhav&Gopinath as well (Jyothi&Gopinath, 2010).Consumption of contaminated and unfit drinking water was also observed in other developing countries such as Indonesia, several cities of Pakistan as well (Anwar et. al., 1999).

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Conclusion:

Among the water samples collected and tested from entire Bangalore, most of the samples were found to be potable, yet a considerable percentage in all the meta divisions especially South-east showed a significant ill-potability for each of the parameters.

Therefore, in order to reduce the propensity of morbidity, regular scrutinization& treatment of the contaminated drinking water and most importantly the awareness about occurrences of such deadly diseases in the end users are of profound importance as bacterial contamination is an issue of concern in developing countries where a large number of children every year die from diarrheal diseases caused by water. In addition to it, assigning a particular water quality index for ground water, e.g. Universal Water Quality index (UWQI) developed for surface water quality assessment (Boyacioglu, 2007), will also help in representing the complex ground water quality data in a simpler way, which will facilitate an easier analysis, interpretation & further treatment measures.

There are existing treatments & intense research works being organized all over the world to treat all such lethal diseases, predominantly, diarrheal complications occurring due to the consumption of enteric pathogen contaminated water, but are yet to be mastered from aspects such as availability, expensiveness in an epidemic settings. Hence; considering prevention as a better combating measures against these morbidities, it is strongly suggested to analyze and treat the drinking water at the point of use in a regular basis. From a social point of view, a better city foundation plan including proper water supply throughout the peripheral regions & better sanitary establishments will certainly complement the cause.

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