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Drinking water Quality assessment for pH and Total Dissolved Solids

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Abstract

Physical assessment of drinking water quality was carried out for the samples taken from the urban peripheral regions of Bangalore, India. Being one of the fastest growing cities in India, inevitably Bangalore is facing the pressure of supplying safe and healthy drinking water to such a huge population. Therefore, it is of high importance to assess the drinking water quality in such places. In this present study water samples were collected from all over Bangalore peripheral regions as well as a proportion from the central region as well. Test for pH and Total dissolved solids were carried out for a total of 1581 water samples. The whole city was divided in six regions for well-organized sampling and interpretation. Both the parameters were found to fairly exceed the standard values in certain places. All the unfitness of the water may have been occurred due to the poor storage and maintenance system.

Keywords: pH, total dissolved solids, water analysis, quality assessment.

Introduction

Urbanization and Industrialization has not always been a boon for a civilization, especially in the developing countries like India. The above mentioned much required factors inevitably results in an upward graph of population, consequently increasing the pressure of distribution of several basic factors of life, water is one of the most important among those. Safe drinking water is a scarce material due to its existence in significantly small proportion, though the planet has it's almost 75% covered with water. Among which only 2.5% is fresh water, out of which only around 30% is ground water and is acceptable for drinking purpose.

Bangalore, being the fastest growing and one of most important industrially developed city in India, is under the same pressure as well. The core or the central region is quite well equipped with proper pipelines for obtaining drinking water supplied by BWSSB (Bangalore Water Supply and sewage Board) which is basically the Cauvery river water, but the supply in the peripheral region, the chief area of industrial growth, is yet to be developed from the water supply point of view. This is not only a city development concern, but also a concern of health. Many instances have been documented in past regarding the occurrences of severe health concerns due to the inadequacy of safe drinking water throughout the world. Hence; it is of profound importance to scrutinize the water quality of these regions as safety of drinking water has always been proved to be in concern priority list in the developing countries.

A number of research studies have been organized to address the issue in Bangalore as well as in other states in India, such as in Haryana, Maharastra[1,2], Tamil Nadu[3] to mention a few. Similar studies conducted in various parts of Bangalore pertaining to the quality of water, depicted alarming pH values, TDS in Anekal taluk, a Bangalore Urban District[4]. In 2011, Bangalore West Zone was reported to have 60% of samples above the permissible limits for TDS[5]. 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[6].

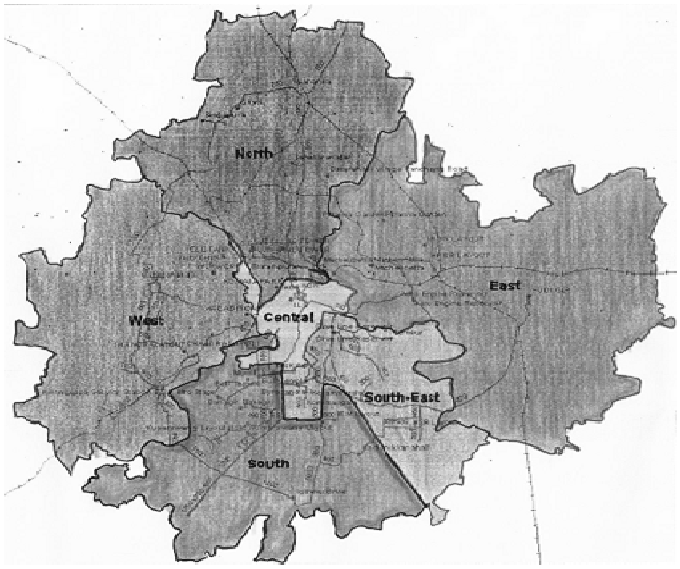

Figure-1
Six Meta-divisions of Bangalore City used in this study '2013

The objective of this particular study is to determine the drinking water quality as far as physical contamination is concerned. The parameters tested in this study are pH and TDS. Both the parameter has its own biological importance in the human health, at the same time can impart severe health concerns if consumed in higher amount than the permissible

values for a longer period of time. Thus, the relevance of this study lies in determining the extent of safe and healthy drinking water consumption in the peripheral as well as central regions of Bangalore, which, in turn, will certainly indicate the considerable health concerns and will help in eliminating those risks in future.

Material and Methods

Study area: The chemical analysis of drinking water study was performed in Bangalore Urban District dividing the whole city into six meta divisions i.e. North, East, South-East, South, West and Central. Bangalore is the capital city of Karnataka with a geographical location of latitude $12^{o}.58'$N and longitude of $77^{o}.35'$E, 921 m above the sea level. Historically, Bangalore Water Supply and Sewage Board (BWSSB) used to supply the drinking water i.e. Cauvery river water, to the central region of the Bangalore as it was the main populated and core region of the city. But, the peripheral regions have recently being populated because of the rapid urbanization and industrialization. Hence, the drinking water supply has become inadequate enough to supply water throughout the city now developed. The current situation, obviously compelling the dwellers to procure drinking water from alternative sources such bore wells, tankers which is in turn is nothing but the ground water. This urbanization phenomenon in developing countries like India with still developing sanitation and safe water supply protocols is leading to consumption of contaminated water in several occasions leading to serious health concerns. Hence; it is of urgent and immense importance to scrutinize the drinking water quality in these areas and the same has been determined in this study.

Sampling: In order to keep the sample collection and analysis less complex and well organized, the whole Bangalore was divided into six meta-divisions as North, East, South-East, South, West and Central, each of these divisions containing several numbers of wards. Each house in each of these wards was assigned with a number and was then selected by generating random number generating tools. The house owners were questioned about the cleanliness measures followed to ensure the drinking water safety and with their consent 500 ml of drinking water sample was collected in a sterilized polyethylene bottles and were carried to lab and were stored at 4^{0}C. Later the samples were tested for the mentioned parameters.

Analysis: The collected and stored samples were subjected to testing for pH according EPA method. TDS was tested by calibrated ion electrode method (HM Digital TDS meter) which actually measures the inorganic and small proportion of organic ions present in the water.

Results and Discussion

Ultimate result obtained from the chemical analysis of the collected 1581 drinking water samples from six meta divisions of Bangalore Metropolis have been subjected to statistical analysis which in turn enlights the drinking water quality of these meta divisions and thus; drinking water quality of the entire Bangalore Urban Peripheral regions. The result of the samples in each parameter varies considerably but to a larger context without affecting the potability of drinking water. The results have been tabulated as well as graphically represented for a better understanding of the Bangalore drinking water quality obtained in this study.

Table-1
Number of Samples procured from each meta-divisions

Meta-divisions	Number of samples	Percentage to total samples	Total samples
North	285	18.02	1581
South	350	22.13	
East	256	16.19	
West	490	30.99	
Central	20	1.26	
South-East	180	11.38	

pH: The pH values of the samples ranged from 5.0-9.0, where most of the water samples (77.86%) tested in the study were found to be in the permissible range of pH value recommended by several health and pollution control organizations e.g. WHO, CPCB, BIS i.e. 6.5-8.5. 22.01% of the total samples showed a value of lesser than 6.5 depicting the acid nature of the water and only 2 samples out of 1581 (i.e. 0.13%) showed more than 8.5 pH values. As far as the pH of safe drinking water is concerned North and West meta division of Bangalore had most Potability with 82.1 and 85.92% respectively, where as south-east and central region had a poorest proportion of the same with 55% for both. One sample each from North and South-east showed pH values above permissible range, which can question the storage system as other sample from the same areas were found to be safe and in range. The proportion of each meta divisions contributing towards the total number of potable and non-potable water samples also have been demonstrated in graph 1a and b.

TDS: Total dissolved solid describes the amount of inorganic salts of calcium, magnesium, sodium etc. and small proportion of organic matter present in the water, where a high value of the same have been reported to be related to acute myocardial infarction as well as ischemic heart diseases in few studies. In this study, TDS values showed a considerable variability ranging from < 10 ppm - >1500 ppm. While analyzing the result obtained from TDS test, 82.66% of the total samples were found to be below permissible range i.e. <500 ppm. Rests 17.34% were above the limit. Central region of Bangalore demonstrated 100% potability, east and west regions showed >90% percentage of the same, where as south-east was poorest of all with 63.88%. Two areas in south-east, in particular, showed alarming level of TDS of > 1000ppm consistently raising the question of water quality from total dissolved solid point of view. The proportions of the sample in each region and their contribution to total potable and non-potable samples have been depicted in figures 2a and 2b.

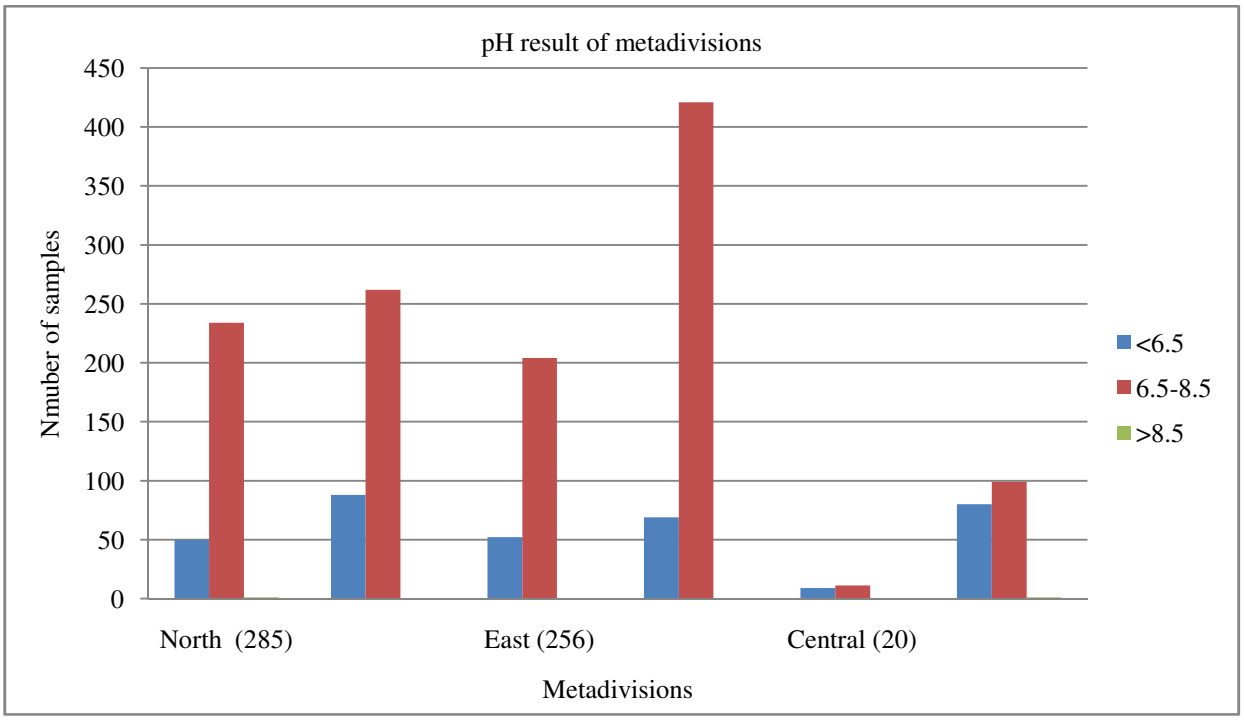

Figure-2a
Number and percentage of samples obtained in each range of pH from each Meta regions

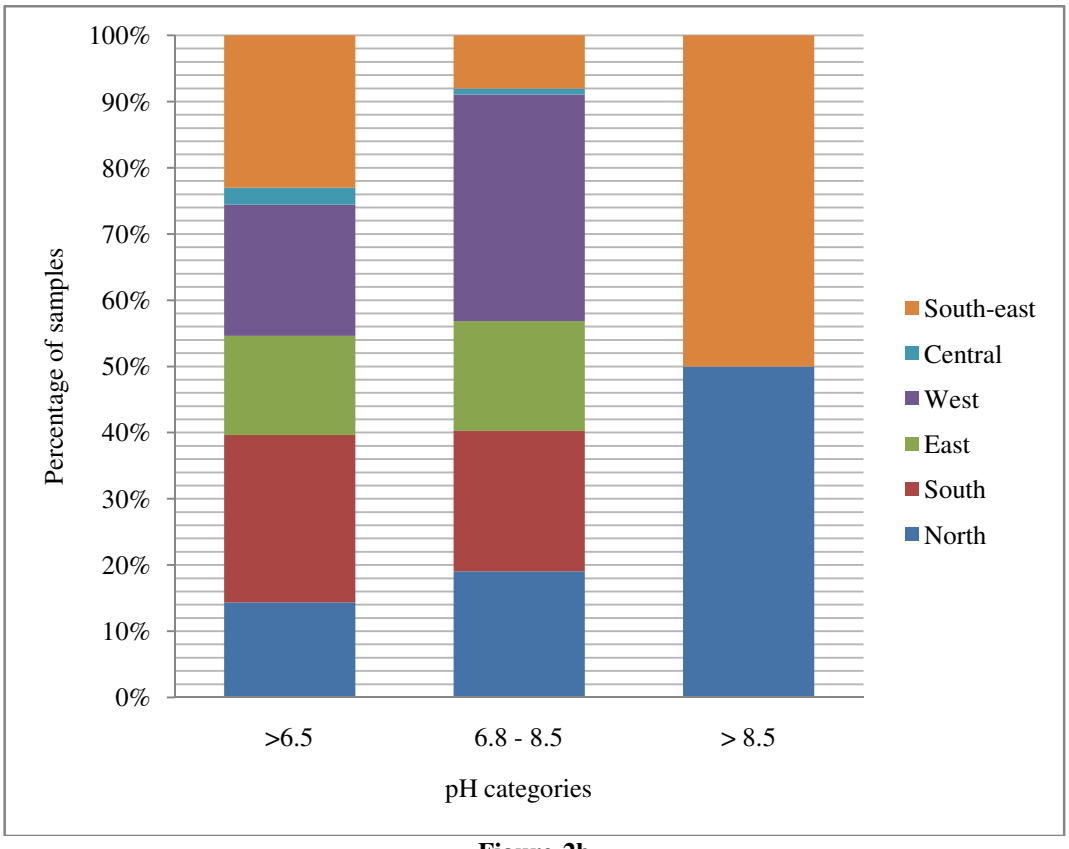

Figure-2b
Percentage of positive and negative samples from each Meta divisions contributing to total number of positive and negative samples

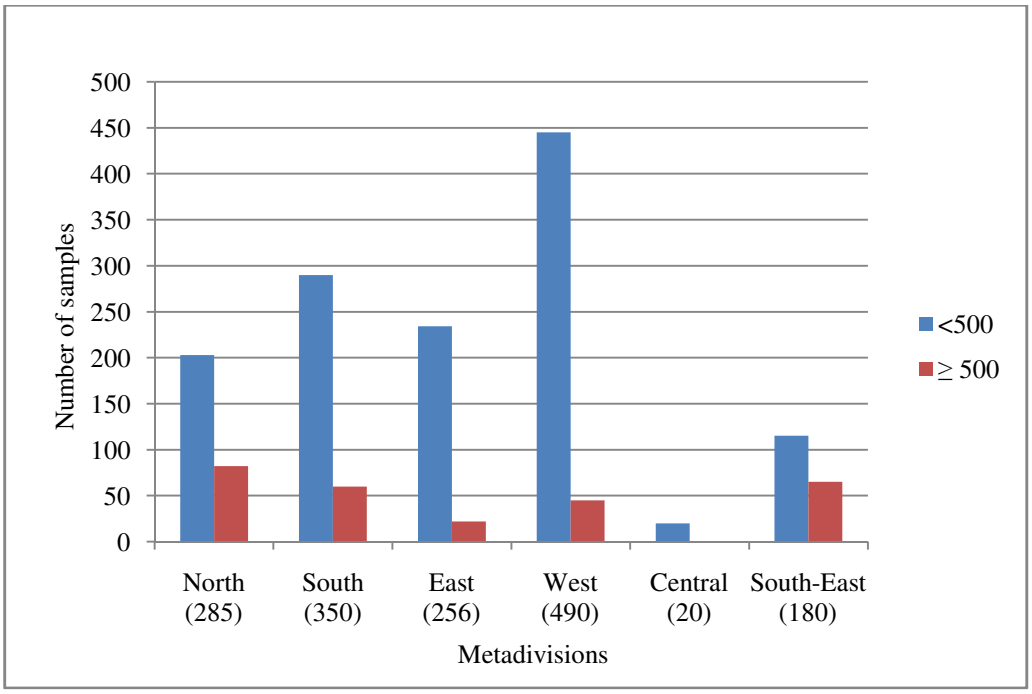

Figure-3a
Number and percentage of samples obtained in each range of Total Dissolved Solids from each Meta divisions

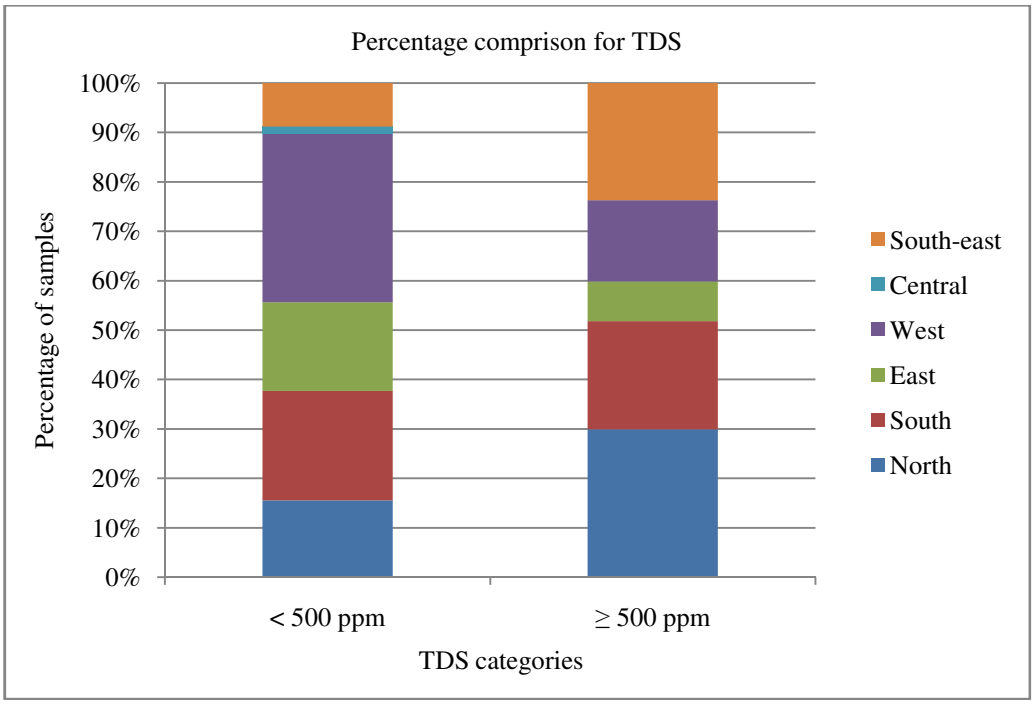

Figure-3a
Percentage of positive and negative samples from each Meta divisions contributing to the total number of positive and negative samples

Discussion: It is 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.

Lower or higher concentration of hydrogen ions in ground water might be caused by contamination with salt deposits or minerals, has direct health effects e.g. mucus, skin irritations and indirect effects as well e.g. corrosion of water pipelines resulting in distribution of iron in drinking water. In this regard, Bangalore was found to be equipped with quite unacceptable drinking water as none of the regions could show even 90% safety. South-east division showed more than 40% samples to be unfit. Several studies have been done in past considering the ground water quality in various regions of Bangalore. In a study performed by Davis et. al., pH was found to be below the permissible limits indicating acidic and alkaline nature[7]. A study in Jakkur sub water shed of Bangalore demonstrated a pH range of 5.3-7.4 in ground water in rainy season indicating the acidic nature of it[8]. The west region of Bangalore showed a pH range of 7.0-8.3 showing marginally permissible potability in a study done by Khayum et al[5]. Ramesh et. al. has also reported in a study performed in Peenya Industrial Area, the bore-well samples to marginally exceed lower limit of pH[9]. pH values almost similar to this study was obtained in an ground water assessment study in Anekal Taluk, a Bangalore Urban District which showed a pH range of 5.51-9.93 indicating both highly acidic and alkaline water[4].

In case of TDS, South-east region of Bangalore was again under high threat having 36.11% samples exceeding the permissible limit of TDS, among which alone showed more than 90% samples having TDS near to 1500mg/L, North and south region also had considerably higher proportion of unfit drinking water. Similar observations of TDS values exceeding permissible limits in different areas were seen in other studies as well[4, 5]. In other regions of Karnataka also reported similar observations of exceeding amount of pH and TDS e.g. Tumkur taluk[10]. Consumption of contaminated and unfit drinking water was also observed in other developing countries such as Indonesia, several cities of Pakistan as well.

Table-2
Percentage of potable and non-potable water samples from each Meta divisions for each parameter

Meta Divisions	No of sample	pH			TDS	
		<6.5	6.5-8.5	>8.5	<500	≥500
North	285 (18.02%)	50 (17.54%)	234 (82.10%)	1 (0.35%)	203 (71.22%)	82 (28.78%)
South	350 (22.13%)	88 (25.14%)	262 (74.16%)	0	290 (82.85%)	60 (17.15%)
East	256 (16.19%)	52 (20.31%)	204 (79.7%)	0	234 (91.40%)	22 (8.60%)
West	490 (30.99%)	69 (14.08%)	421 (85.92%)	0	445 (90.81%)	45 (9.18%)
Central	20 (1.26%)	9 (45%)	11 (55%)	0	20 (100%)	0
South- East	180 (11.38%)	80 (44.44%)	99 (55%)	1(0.55%)	115 (63.88%)	65 (36.11%)
Total	1581 (100%)	348 (22.01%)	1231 (77.86%)	2 (0.13%)	1307 (82.66%)	274 (17.34%)

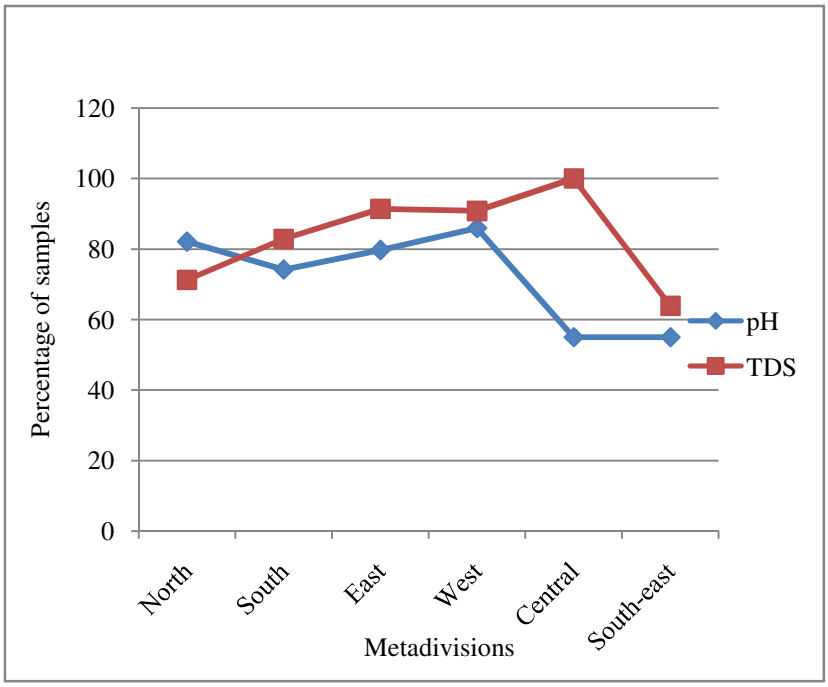

Figure-4
Percentage of potable samples for each parameter in each Meta divisions

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 non-potability for each of the parameters.

pH, as one of the quality assessment parameter, contributes to the occurrences of eye and gastrointestinal irritation leading to severe health concerns. Onset of cardio-vascular diseases as well as renal complications is enhanced by the presence of several inorganic and organic ions comprising TDS. Therefore, in order to reduce the propensity of morbidity, regular scrutinization and treatment of the contaminated drinking water such as use of neutralizer filter for pH, reverse osmosis, deionization, distillation, carbon filtering for TDS[11] etc and most importantly the awareness about occurrences of such deadly diseases in the end users are of profound importance. 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[12], will also help in representing the complex ground water quality data in a simpler way, which will facilitate an easier analysis, interpretation and further treatment measures.

There are existing treatments and 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 and better sanitary establishments will certainly complement the cause.

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