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Climatic variables and its implications in ground water potability in Kamrup district,Assam, India.

Sutapa Chakrabarty*and Hari Prasad Sarma

Department of Environmental Science, Gauhati University, India

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ABSTRACT

Water scarcity is expected to become an even more important problem than it is today. Water use has been growing at more than twice the rate of population increase in the last century, and, although there is no global water scarcity as such, an increasing number of regions are chronically facing shortage of water. The present investigation is an attempt to analyse the impact of climate change on water resources and its correlation with drinking water quality in Kamrup district, Assam, India. Water quality parameters with respect to Temperature, pH, Dissolved Oxygen, Nitrate, Sulphate, Total coliform and fecal coliform were studied to establish the probable impact of climate change with the studied parameters. Data have been statistically presented to determine the distribution pattern, localization of data and other related information.

Key words: Drinking water; climate change; rainfall; temperature; nitrate, coliform bacteria.

INTRODUCTION

India is rich in water resources, being blessed with a network of great rivers and vast alluvial basins to hold groundwater. Though the rainfall over India is slightly above global average, its uneven distribution leads to occasional floods and droughts, in different parts of the country. This disparity in rainfall is reflected in water resources and this is a permanent issue in water management in India. Under the pressure of rapid population growth, the available resources of water are being developed and depleted at a rate faster than its replenishment. Today water is one of those several current and future critical issues that India is facing.

Water supplies from rivers, lakes and rainfall are characterized by their unequal natural geographical distribution and accessibility, and unsustainable water use. Climate change has the potential to impose additional pressures on water availability and accessibility. Higher water temperatures and changes in the timing, intensity, and duration of precipitation can affect water quality. Higher temperatures reduce dissolved oxygen levels, which can have an effect on aquatic life. Where stream flow and lake levels fall, there will be less dilution of pollutants; however, increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff [1]. Changes in water quality could have implications for all types of uses. For example, higher temperatures and changes in water supply and quality could affect recreational use of lakes and rivers or productivity of freshwater fisheries. Certain species of fish could find water temperatures too warm and migrate to more northern or higher altitude locations where water is cooler [2].

The vast majority of the Earth's water resources are salt water, with only 2.5% being fresh water. Approximately 70% of the fresh water available on the planet is frozen in the icecaps of Antarctica and Greenland leaving the remaining 0.7% of total water resources worldwide available for consumption. However of this 0.7%, roughly 87% is allocated to agricultural purposes. These statistics are particularly illustrative of the drastic problem of water scarcity facing humanity. Water scarcity is defined as per capita supplies less than 1700 m^3/year. [3]

Water scarcity is expected to become an even more important problem than it is today. There are several reasons for this. First, the distribution of precipitation in space and time is very uneven, leading to tremendous temporal variability in water resources worldwide [4]. Examples can be cited that of **Mawsynram**, in Meghalaya, India receiving highest rainfall in the world which is almost over 450 inches annually; on the other hand, the Atacama Desert in Chile receives imperceptible annual quantities of rainfall. If all the freshwater on the planet were divided equally among the global population, there would be 5 000 to 6 000 m^3 of water available for everyone, every year. Second, the rate of evaporation varies a great deal, depending on temperature and relative humidity, which impact the amount of water-available to replenish groundwater supplies. The combination of shorter duration but more intense rainfall (meaning more runoff and less infiltration) combined with increased evapo-transpiration (the sum of evaporation and plant transpiration from the earth's land surface to atmosphere) and increased exploitation is expected to lead to groundwater depletion. Freshwater bodies have a limited capacity to process the pollutant discharges of the effluents from expanding urban, industrial and agricultural uses. Water quality degradation can be a major cause of water scarcity [2].

Although the IPCC projects that global warming of several degrees will lead to an increase in average global precipitation over the course of the 21st century, this amount does not necessarily relate to an increase in the amount of potable water availability.

One of the most significant sources of water degradation results from an increase in water temperature. The increase in water temperatures can lead to a bloom in microbial populations, which among other things can have a negative impact on human health. Additionally, the rise in water temperature can adversely affect different inhabitants of the ecosystem due to a species' sensitivity to temperature. The health of a body of water, such as a river, is dependent upon its ability to effectively self purify through biodegradation, which is hindered when there is a reduced amount of dissolved oxygen. This occurs when water warms and its ability to hold oxygen decreases [5].

Consequently, when precipitation events do occur, the contaminants are flushed into waterways and drinking reservoirs which has significant health implications. Studies on rainfall and the temperature regimes of northeast India indicate that there is no significant trend in rainfall for the region as a whole i.e. rainfall is neither increasing nor decreasing appreciably for the region as a whole. The summer monsoon rainfall is found to be decreasing over this region significantly during the last century at an approximate rate of 11 mm per decade [6]. Assam including the other North-Eastern states has received reduced rainfall than the normal during 2004 to 2007 and some parts of the state have already been affected by drought like situation.

MATERIALS AND METHODS

For the present study, 184 water samples were collected from forty six sampling locations (Table 1) in Kamrup district spread over two seasons (Winter and Pre monsoon season and Monsoon and Post monsoon season) during 2006-2008. Kamrup district is the capital district of Assam. It is situated between 25.43 and 26.51 degree north latitude and between 90.36 and 92.12 degree east latitude. The greater parts of the district consist of wide plains, through the lower portion of which the mighty river Brahmaputra makes its way as a steady course from east to west. It covers an area of 4345 sq km. and receives an average rainfall of 1500 mm – 2600 mm. The region enjoys a climate of the sub tropical type with semi-dry summer & cold in winter.

Table 1. Water Sampling stations in the study area.

Sl. No.	Sampling stations	Source	Sl. No.	Sampling stations	Source
1	Naukata	TW	24	Lokhra	TW
2	Rangia	RW	25	Bezera	RW
3	Karara	TW	26	Noonmati	SW
4	Kendukona	TW	27	New Guwahati	TW
5	kamalpur	TW	28	Pan Bazar	SW
6	Puthimari	TW	29	Narengi	TW
7	Baihata Chariali	TW	30	Dispur	SW
8	Hajo	RW	31	Silpukhuri	RW
9	Changsari	RW	32	Bhangagarh	TW
10	North Guwahati	DTW	33	Kamakhya	DTW
11	Sualkuchi	TW	34	Gauhati University	TW
12	Palashbari	TW	35	Basistha	DTW
13	Chhaygaon	TW	36	Khanapara	TW
14	Sonapur	TW	37	Bhralumukh	DTW
15	Chandrapur	RW	38	Chandmari	TW
16	Khetri	DTW	39	Fancy Bazar	SW
17	Narengi	TW	40	Panjabari	RW
18	Boko	TW	41	Azara	TW
19	Dumunichowki	TW	42	Lankeswar	TW
20	Dimu	RW	43	Satmile	TW
21	Maligaon	TW	44	Jalukbari	TW
22	Boragaon	DTW	45	Satgaon	TW
23	Tetelia	TW	46	Panikhaiti	TW

All the investigated parameters were determined according to standard protocols [7]. The instruments were used in the limit of précised accuracy and chemicals used were of analytical grade. SPSS® statistical package (Window Version10.0) was used for data analysis. All statements reported in this study are at the $P < 0.05$ levels.

RESULTS AND DISCUSSION

Temperature influences physical, chemical and biological qualities of water. Increase in temperature above normal results in volatilization of trace compounds in water and may be responsible for imparting taste and odour. Disinfection of water is largely dependent on temperature and the bacterial survival is also influenced by it. Temperature variation may be one of the factors responsible for seasonal variation of coliform organisms in water bodies. In the present situation water sample temperature are slightly higher (Fig 1).

Fig 1. Histogram showing water temperature variations in the sampling locations

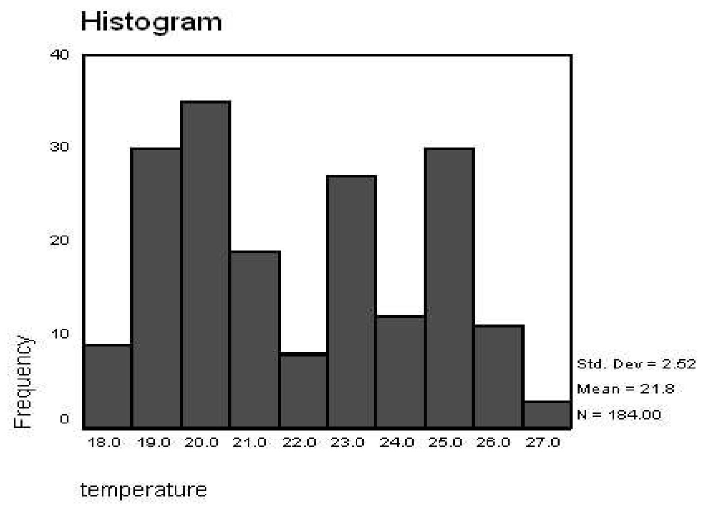
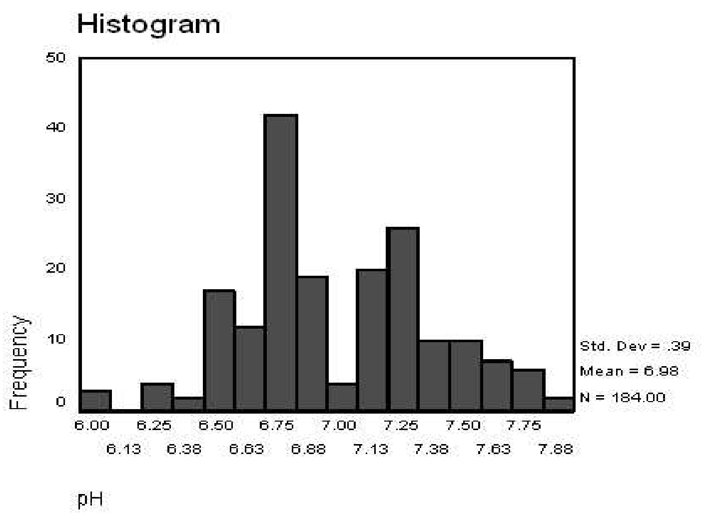


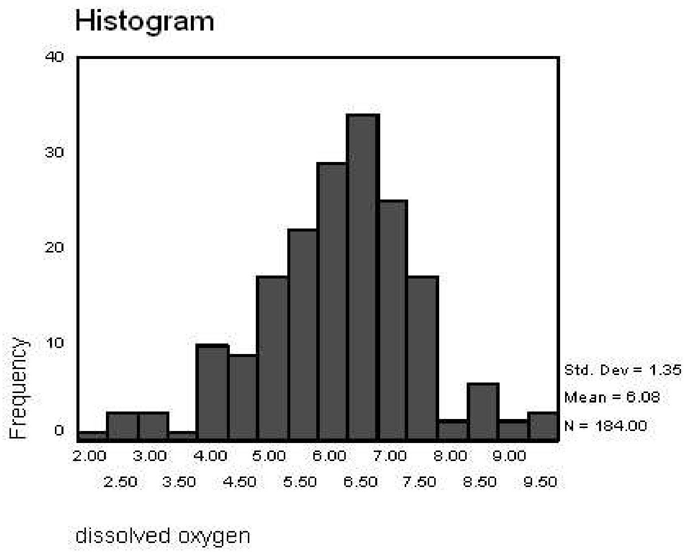
Fig 2: Variation of pH in water samples



In the present study the pH values of all the samples are found within the prescribed limit. The values ranged from 6.0 to 7.88; the variation of pH is narrow and in general, the pH is towards the alkaline side (Fig2).

Dissolved oxygen is a good indicator of water quality because adequate amounts are needed for aquatic organisms, such as fish, to live. When above 6 ppm, water will support aquatic life, but below 2 ppm (anoxia) it will not. Oxygen is added to water through diffusion from the atmosphere, but also as a byproduct of photosynthesis by phytoplankton. In the present case DO is measured slightly above 2 in sampling station no. 40 (Fig3), which points towards an alarming situation.

Fig 3: Histogram showing dissolved oxygen concentration in the study area



Nitrate in drinking water usually originates from fertilizers or from animal or human wastes. Nitrate concentrations in water tend to be highest in areas of intensive agriculture or where there are many septic systems. Nitrate has a primary drinking water standard that was established to protect the most sensitive individuals in the population (infants under 12 months of age, pregnant women, and people with certain blood disorders). These segments of the population are prone to methemoglobinemia (blue baby disease) when consuming water with high nitrate. The primary drinking water standard or MCL is 10 mg/L as nitrate nitrogen (NO_3^-N). The permissible limit of nitrate for drinking water has been set by WHO to be 50 mg/l. In the present investigation in regards to nitrate concentration the drinking water sources of the study area are by and large safe, but its distribution is still not uniform in the area as observed from the box plot (Fig4). The median is observed to lie between 1ppm-2ppm.

The sulphate concentration in the present investigation ranged from 0-90 ppm. Although it is way below the MCL (200ppm) but it has a tendency to cross the boundary if proper management steps are not taken (Fig 5).

Microbiological examination of water enjoys a special status in studying water quality. In the present work, it is found that the total coliform organisms are present in excessive amount in all the water samples except supply water. Their presence indicates the contamination of the water sources from sewage and faeces of animals from different ways. It also indicates the possibilities of outbreak of water borne diseases among the public.

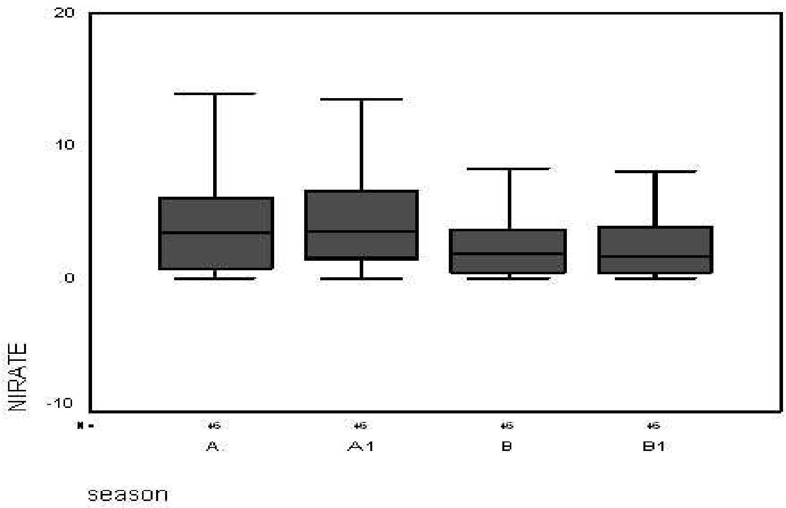


Fig 4. Box-plot showing distribution of nitrate in the study area.

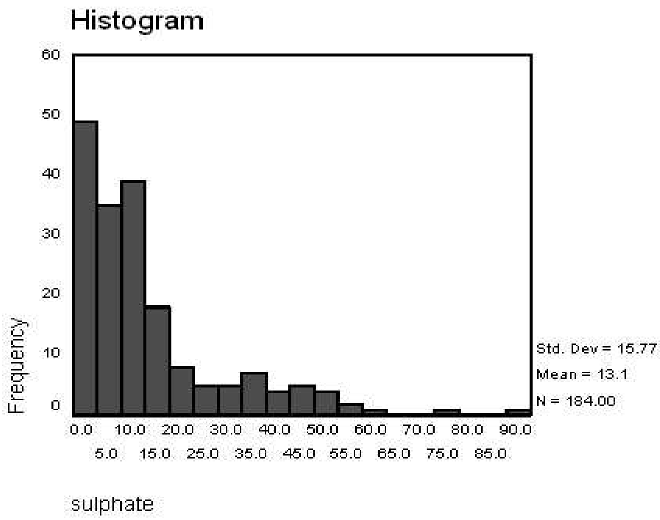


Fig 5. Histogram showing concentration of Sulphate in the study area.

The measured MPN indices of coliform organisms are given in Table 2 for tube well, deep tube well, ring well and PWS sources of drinking water in Kamrup district of Assam. The MPN index of coliforms shows that all the sampling points were contaminated with coliform group of organisms. The degree of contamination was low in case of PWS compared to other sources of drinking water in the study area. Literature shows that tube wells and deep tube wells are good as a source of drinking water in many parts of India. They yield water which is bacteriologically safe. In the present study area the contamination of tube well and deep tube well waters have been found mainly due to leakage on the bore pipes and improper maintenance. The values of coliform bacteria are found considerably high in ring wells. This may be due to unlined sewage system and sanitary conditions. Positive confirmatory test for E.coli as the predominant coliform organism in most of the sampling points indicates the contamination to be faecal in origin.

Table 2 Seasonal Variation of TC and FC of water samples in MPN/100 ml

Sampling station	Winter and pre monsoon season		Summer and post monsoon season	
	TC	FC	TC	FC
Naukata	14	4	54	6
Rangia	35	8	43	7
Karara	46	2	42	4
Kendukona	21	5	63	2
kamalpur	35	4	20	4
Puthimari	64	8	30	3
Baihata Chariali	55	6	11	1
Hajo	84	22	20	3
Changsari	40	8	31	11
North Guwahati	48	18	65	4
Sualkuchi	13	8	29	6
Palashbari	23	11	57	15
Chhaygaon	50	6	48	12
Sonapur	40	17	84	4
Chandrapur	12	8	39	8
Khetri	35	6	65	12
Narengi	21	11	43	13
Boko	46	12	19	8
Dumunichowki	22	9	31	11
Dimu	24	2	31	6
Maligaon	13	2	11	3
Boragaon	49	12	88	12
Tetelia	97	5	50	5
Lokhra	5	1	11	3
Bezera	5	3	9	5
Noonmati	4	1	5	00
New Guwahati	35	8	40	2
Pan Bazar	16	2	29	2
Narengi	40	2	30	6
Dispur	30	8	30	1
Silpukhuri	14	2	10	2
Bhangagarh	10	12	30	27
Kamakhya	10	5	05	00
Gauhati University	20	8	20	2
Basistha	50	32	60	15
Khanapara	00	00	05	01
Bhralumukh	30	5	30	7
Chandmari	18	8	40	8
Fancy Bazar	22	8	30	1
Panjabari	30	12	40	3
Azara	7	3	7	2
Lankeswar	10	7	30	8
Satmile	50	45	80	45
Jalukbari	70	4	80	8
Satgaon	76	63	85	3
Panikhaiti	70	11	80	4

CONCLUSION

The present investigation reveals a significant relationship between weather elements and the inherent water quality of the region. Although there is no significant trend in rainfall for the region as a whole but the decreasing trend in the summer monsoon rainfall may be significantly affecting the studied parameters especially the water temperature. Incidence of total coliform bacteria and faecal coliform in the ground water samples directly points toward a low and poor drinking water sources. Declining water quality results from an increase in runoff and precipitation that carries with it higher levels of nutrients, pathogens and pollutants.

When drought conditions persist, and easily recoverable groundwater reserves are depleted, the residual water that remains is often of inferior quality due to the leakage of saline or contaminated water from the land surface, confining layers, or adjacent waters that have highly concentrated quantities of the trace element(s). This occurs because decreased precipitation and runoff results in a concentration of effluent in the water, which leads to an increased microbial load in waterways and drinking-water reservoirs. Assam including the other North-Eastern states has received reduced rainfall than the normal during 2004 to 2007 and some parts of the state have already affected drought like situation. This has probably affected the nitrate concentration in the study area which is towards an increasing trend and might cross the maximum contamination level in the near future.

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