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A CRITICAL ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF MAJOR DRINKING WATER SOURCES

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ABSTRACT

The Indian climate is notable for its reversal of winds, production of alternately high- and low-pressure regions over the country, seasonal and variable rainfall, and various seasons. India's rainfall is primarily caused by the south-west monsoon. In recent years, there has been increased interest worldwide in the effects of seasonal shift on water quality. Diarrhea, a water-borne illness, is frequently brought on by poor drinking water quality. Water supply and quality are influenced by climatic factors such as precipitation, rainfall duration and intensity, and evaporation rate. Water quality and quantity are also affected by the local geology, the state of the soil, and contamination from seepage. The river is the main source of surface water in India. The water quality of the Indian riverine system has been directly impacted by seasonal changes. Aquatic species' biological niches, as well as the flora and fauna and the river's self-purification, are altered by a lean river flow, particularly during the pre-monsoon. Process indicator, faecal indicator, index, and model organisms were used to evaluate water quality during the 20th century. A process indicator is a collection of organisms that shows how effective a process is, for as total heterotrophic bacteria or total coliforms in the case of chlorine disinfection. A collection of thermotolerant coliforms or E. coli that detects the presence of faecal contamination is known as a faecal indicator. Last but not least, index and model organisms are a group or species that represent pathogen behaviour and presence, respectively.

KEY WORDS: PHYSICO-CHEMICAL PROPERTIES, DRINKING WATER, SOURCES.

1. INTRODUCTION

Unsafe water, poor sanitation and hygiene, urban air pollution, indoor smoke from solid fuels, lead exposure, and climate change are some environmental risk factors that have an impact on human health. Unsafe water, inadequate sanitation, and poor hygiene are the main contributors to mortality and morbidity in a number of developing nations. The physical, chemical, or biological qualities of water are what the World Health Organization (WHO) describes as its quality. The physico-chemical and bacteriological quality of water determines whether it can support different uses or processes. The quality of the water can be determined by its physical, chemical, and biological characteristics. Water quality is assessed using a variety of Water Quality Indices (WQI) around the world. In order to quantify water quality, a mathematical computation is used. The WQI methodology varies from nation to nation. The computation of WQI uses the permissible level of several parameters in international standards or national standards. According to DCA (2012), the Bureau of Indian Standards (BIS) is the National Standard Body in India and is responsible for the creation of standardisation operations, marking, and quality certification of items, including water.

Surface water and ground water are the two basic categories of water sources. In contrast to groundwater, particularly shallow groundwater, which is regularly contaminated with heavy metals, surface water from growing South Asian nations such as Bangladesh, Pakistan, and India frequently contain human faecal microbes. These nations experience high child mortality rates as well as subpar economic, educational, and cognitive development as a result of the inadequate provision of clean, potable water. The Government of India (GOI) launched the National Rural Drinking Water Quality Monitoring and Surveillance Programme (NRDWQM &SP) in February 2006 in order to achieve this. As part of this initiative, rural communities were trained to conduct water testing to determine the quality of their drinking water. One of the goals of the programme was to raise awareness about poor drinking water quality, hygiene, sanitary surveys, and the importance of environmental sanitation.

1.1 WATER CONTAMINATION CAUSES

Although a community's access to clean water is essential for maintaining its health, both natural and artificial water bodies are frequently contaminated by a variety of anthropogenic, agricultural, and industrial activities. The freshwater ecosystem, including rivers, streams, and lakes, is mostly impacted by agriculture. By discharging fertilisers and organic farm waste into rivers, agricultural operations contaminate fresh water. The principal agricultural water contaminants in India include nitrates, phosphate, heavy metals, and pesticides. Agricultural contamination spreads across a large area and is scattered in nature, making its sources difficult to find. The sediment load is also mixed with streams by agriculture. By Sub Divisioning sunlight, this floating dirt hinders aquatic life.

Diverse industrial processes discharge nutrients, oils, heavy metals, colours, and untreated wastewater into various bodies of water. Mining and mineral processing may potentially directly or indirectly damage groundwater. Small-scale industrial operations in India are responsible for 40% of the industrial water pollution. Large amounts of sewage are discharged into India's major rivers, including the Ganga, Yamuna, and Mahanadi. For the past three decades, the Ganga river's pollution has drawn a lot of attention. The main causes of the contamination include inadequate water flow in the river, uncontrolled sewage discharge from cities along the river, and insufficient enforcement against point-source pollution from businesses that dump trash into the river. The Government of India (GOI) has implemented a number of programmes, including the Ganga Action Plan (GAP) and Namami Gange, to enhance the quality of the Ganga's water. These programmes' goals are to stop pollution and raise the river water's quality to acceptable levels. In order to reduce pollution, the Ganga Action Plan (GAP) suggests a several measures, including providing water in the river for ecological flow and dilution, redesigning garbage conveyance, and raising additional money for Ganga cleaning initiatives. The Ganga is still contaminated despite these initiatives and the funding made available for them. According to recent research, the Ganga's upper reaches, which were once thought to be pristine, are now more polluted.

Globally, marine pollution is rising, just like river contamination. Ballast water, oil spills, and the discharge of municipal trash into the ocean are the principal causes of marine water pollution. Water pollution is also a result of several natural occurrences, including volcanoes, algae blooms, storms, and earthquakes.

2. MATERIALS AND METHODS

2.1 STUDY AREA AND SAMPLING SITES

The study area encompassed ten villages from Delhi, which is located in western Delhi/NCR, India. Villages were chosen based on historic mean rainfall from obtained from Indian Meteorological Data centre (IMD) located in Delhi. The villages were classified into low and high rainfall zones based on annual precipitation in millimetre (mm). Rainfall zones are classified as heavy (2000 mm and above), moderate (1000-2000mm) and low (500-1000mm) rainfall regions by IMD. In the present study, the moderate rainfall region was split into two viz. above and below 1250 mm. Villages which received annual rainfall below 1250 mm were classified in the low rainfall zoneand above 1250 mm in the high rainfall zone. Additionally, average annual precipitation data for different Sub Divisions in Delhi was collected from the IMD for 2022, the year of actual water sampling. As the rainfall influences water quality and availability, 2022 rainfall data was givenimportance while classifying the villages in different rainfall zones. Since emphasis was on drought prone areas, 7 villages were selected in the low rainfall zone and 3 in the high rainfallzone.

A survey of the area was undertaken to map factors which had the potential to alter water quality such as recent droughts or floods, type of industries along the river bank and anthropogenic activities near water sources such as bathing, washing clothes and bathing of animals. Based on these observations, villages and the sampling sites within them were selected.

The sampling sites were divided into:

- Rivers which comprise of rivers, lakes, percolation tanks, backwaters from dams,
- Ground water was divided into two subgroups viz. open-wellsand bore-wells.

Along with open-wells, underground seasonal and annual springs which havea small opening above the ground from which water is collected and storage tanks into which water from open- wells is pumped were considered in open well group. Deep, closed wells withand without hand pumps fitted on top were considered in bore-wells. Information about selected water sources is included.

2.2 SAMPLING

The samples were collected four times in a twelve-month period. Sampling was done once during post-monsoon and pre-monsoon whereas monsoon sampling was undertaken twice, during onset and end of monsoon. A total of 3700mL of water was collected at each sampling spot in autoclavable polypropylenebottles. One bottle containing 125 mL water was used for the analysis of temperature, pH, conductivity, total dissolved solids, salinity and turbidity whereas the second bottle containing125 mL of water was used for analysis of dissolved oxygen. In order to analyse total suspendedsolids (TSS) 1000mL of water was collected. To analyse ammonia, total phosphorus, calciumnitrate and 2,4_D, 2000 mL of water was collected. Approximately 400 mL was collected in previously sterilized 500mL bottles for bacteriology and the bottles were kept on icepacks immediately and transported to the laboratory on the same day, stored at 4-8°C and sample processing for the bacteriology was undertaken on the following day. To collect water from previously chlorinated open-wells or storage tanks, 300µL of 3% Sodium thiosulphate was added to the bottles before sterilization.

2.3 ANALYSIS OF WATER

2.3.1 PHYSICO-CHEMISTRY

Basic physico-chemical analysis was performed in the field. The parameters temperature, pH,conductivity, total dissolved solids and salinity were measured with the help of previously calibrated probes for soil and water analysis as per manufacturer's instructions. To check residual chlorine, stripswere used. Turbidity was estimated by the Nephelometric method.

Using Winkler reagents, Dissolved Oxygen (DO) in water was fixed on site and the values were titrated later on the same day. To estimate concentrations of the remaining parameters, the water samples for were transported. TotalSuspended Solids was determined by filtering water through the glass fibre filters and expressed as mg/L. The phenol-hypochlorite method was used for the estimation of Ammonia. Nitrate, total phosphorous, calcium, fluoride and 2,4_Dichlorophenoxyacetic acid (2,4_D) were estimated by outsourcing.

2.3.1 BACTERIOLOGY

Thermotolerant Faecal coliforms (TFC) and intestinal enterococci (IE) were enumerated by membrane filtration of 100 mL, 10mL and 1mL aliquots through cellulose acetate 0.22 µ filters.The filter papers were placed face upward on (1) m-FC agar (Himedia) for faecal coliforms incubated at 44.5°C for 24 hours and observed for blue coloured colonies, (2) in case of IE, the membrane filter paper was placed on m-Enterococcus agar and checked for the countable and isolated pink colonies after incubation at37°C for 24 hours. The filter paper with pink colonies was then transferredon to Bile Esculin Azide agar (Himedia) with the colony side facing up and incubation was carried out at 44.5°C for 18 hours. The filter paper was then checked for blackening around the colonies. The m-FC agar plate with countable isolatedblue colonies or Bile Esculin Azide agar plate with black colonies were observed was used forenumeration and results expressed as Colony Forming Units (CFU) per 100 mL.

3. RESULTS AND DISCUSSION

3.1 ANNUAL RAINFALL AND CLASSIFICATION OF SAMPLING SITES

The details of the 10 villages selected from Delhi district along with the rainfall data for 2022 and the historic rainfallmean. The recorded historic mean rainfall data was used as the criterion for classification in the absence of 2012 data. Whilst in most of the villages rainfall data for 2012 was concordantwith the historic mean, except Chatesar wherein a discrepancy was observed. The historic data classified Chatesar in low rainfall zone, though 2012 data indicated high rainfall. For the purposeof this study Chatesar was placed in high rainfall zone based on the rainfall recorded in 2013 (1611mm).

3.2 PHYSICO-CHEMICAL WATER QUALITY OF RIVERS

Rivers are prone to pollution and tributaries carry pollutants to the major rivers. Analysis of physico-chemical parameters reflects the impact of atmospheric, geological and agricultural activities on riverine water quality. There are no permissible levels in BIS/WHO for temperature and salinity. Temperature ranged from 19-29.6ºC whereas salinity ranged from 0.05-0.75 ppt throughout the year. Values for pH, conductivity and total dissolved solids were within permissible levels. However, higher values of turbidity, total suspended solids were recorded during monsoon probably due to the mixing of surface runoffwith river water.

TABLE:1 MULTIPLICATION FACTOR FOR ASSIGNED INDEX VALUES OF PHYSICAL AND CHEMICAL PARAMETERS TO CALCULATE WQI

Parameter	Weight assignedbased on its influence onquality of water for surface water	Weight assignedbased on itsinfluence onquality of water for Open-wells	Weight assignedbased on its influence on quality of water for bore wells
Turbidity	2	1	1
pH	1	2	1
Salinity	1	1	2
Dissolved Oxygen	2	2	0
Total Suspended Solids	1	1	0
Total Dissolved Solids	0	1	2
Ammonia	1	0	0

Nitrate	0	0	1
Calcium	1	2	2
Sum weight	9	9	9

Dissolved oxygen (DO) plays crucial role in the survival of aerobic aquatic microbes, plants and animals. Too high or too low DO values can harm aquatic life and affect water quality. Stratification of rivers plays a key role in the distribution of dissolved oxygen. Various studies have recorded inverse relation between the bacterial load and DO. However, physico-chemical parameters can also influence DO viz. lower salinity and temperature can saturate rivers with oxygen. In the present study, DO values ranged from 0.5-13.9 ppm throughout the year. A DO value below 1ppm was recorded in Ujani dam backwaters (P20) at pre- monsoon/summer. The probable reason for this could be the raised temperature in summer andreleased industrial effluent into the dam backwaters and. Raised temperature in summer minimizes the oxygen holding capacity of water. Additionally, drying up of backwaters in pre-monsoon might have concentrated contaminants and bacterial load in backwaters which led to the low DO value. Percolation tank (P18) from Kondli also recorded low DO values viz. 1.8,1.5 and 3.13ppm during onset of monsoon, end of monsoon and in pre-monsoon respectively. Field observations suggested that there was algal bloom in stagnant P18 water. Algae consume more aquatic oxygen and deplete DO in surface water. In case of River Yamuna(P1) 2.4ppm and 2.92ppm of DO were recorded in onset of monsoon, end of monsoon and pre-monsoon respectively. The probable reason for low DO value in pre-monsoon could be the bloom of water hyacinth. A large stretch of P1 was covered with water hyacinth which could have utilized more aquatic oxygen resulting in low DO values. The reason for low DO value in end of monsoon was unknown. Although there was heavy load ofbacteria detected at River (P23) throughout the year, recorded DO values were not as low as expected during onset of monsoon (3.2ppm) and end of monsoon (3.8 ppm). During monsoon, the river flow regime widens considerably. Water surplus in the river and lower atmospheric temperature could be responsible for negating the effect of the high bacterial load and raising the DO level in P23.

Although DO and the bacterial load are inversely related, there were exceptions in post- monsoon. This may be due to the impact of a reduction in atmospheric temperature and surface water temperature in post-monsoon, which increased the oxygen holding capacity of rivers.

Impact of agricultural and industrial activities on rivers was studied by detecting levels of ammonia, calcium and nitrate. Values for nitrate (<45ppm), calcium (<75ppm) and ammonia (<1ppm) were within permissible levels throughout the year.

Combined organic and inorganic phosphorus together encompass total phosphorus (TP). Agricultural runoff and industrial or domestic waste containing detergents contribute towards phosphorus contamination of water. High concentration of total phosphorus in surface water results in toxic algae blooms. Total phosphorus lacks permissible level in BIS, WHO and EU standards. In the present study, the TP values for mostsources were below detectable level (<0.05 mg/L). During monsoon, the recorded TP content was 27.2mg/mL and 56mg/mL in P12 and P13 respectively. The use of Di Ammonium Phosphate and Potassium phosphate fertilizers was found common which was reflected in the higher concentration of TP at the sampling points. Values of TP ranging between 6.8-43mg/mL was obtained throughout the year. The discharge of Delhi area waste into the river throughout the year may be responsible for higher concentration of TP in river (P24).

Rivers were also tested for the presence of herbicide 2,4_D. It is a carcinogenic chemical whichposes a health risk to humans above permissible levels. The permissible level for 2,4_D is <30µg per litre. It is commonly used by Indian farmers to control weeds however; it was not detected in any of the water samples.

Whilst the individual parameters have been discussed above an attempt was also made to reflecta water quality as a composite figure. This was undertaken by calculating modified WQI. Temperature, pH, conductivity, salinity, dissolved oxygen, total dissolved solids, ammonia, nitrate and calcium were considered for calculation of modified WQI. Parameters like 2,4-D and total phosphorus were exempted from calculating modified WQI.

TABLE 2: ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF RIVERS

Villags associated with rivers	**Sample Code For rivers**	**Temperature (°C)** (permissible limit: not available)				**pH** (permissible limit: 6.5-8.5)				**Conductivity (mS)** (permissible limit: not available)				**Salinity (ppt)** (permissible limit: not available)			
		A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Akbar Pur Mazara	P1	27.2	27.2	20	28	7.67	7.75	7.72	7.41	0.57	0.745	0.815	0.831	0.386	0.561	0.611	0.616
Harewali	P7	23.3	27.4	19	28.3	8.25	7.89	7.86	7.53	0.14	0.171	0.079	0.08	0.105	0.117	0.055	0.06
Joharipur	P10	23.7	26.5	20	30	8.04	8.36	7.76	8.2	0.153	0.11	0.17	0.113	0.115	0.083	0.142	0.08
Chatesar	P12	23.5	27.2	20	29	8.17	7.38	8.06	7.81	0.252	0.155	0.175	0.078	0.191	0.129	0.131	0.058
Kondli	P18	25.4	26.7	19	27	8.83	8.39	8.43	8.65	0.98	0.938	1.115	1.587	0.75	0.708	0.836	1.21

Naraina	P20	29.6	29.1	23	33	8.25	7.2	8.82	8.55	0.401	0.477	0.576	0.822	0.31	0.357	0.401	0.616
Kusumpur	P23	25.8	27.2	20	28	7.81	7.9	7.55	7.39	0.325	0.767	0.812	0.459	0.235	0.562	0.61	0.344
Rang Puri	P25	27	28.7	21	29	7.77	8.83	7.54	7.8	0.263	0.8	0.847	0.25	0.199	0.605	0.645	0.186

Key: A: Onset of monsoon, B: End of monsoon, C: Post-monsoon, D: Pre-monsoonmS: milliSiemence, ppt-parts per thousands.

Villages associated with rivers	**Sample Code**	**Total suspended solids(ppm)** (permissible limit: not available)				**Turbidity (NTU)** (permissible limit :10NTU)				**Dissolved oxygen (ppm)** (permissible limit: 6ppm)				**Total Dissolved solids (ppt)** (permissible limit: 0.6 ppt)			
		A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Akbar Pur Mazara	P1	8	20	4.02	6.6	22.5	30.8	0.2	15.8	5.5	2.46	7.67	2.92	0.278	0.375	0.405	0.414
Harewali	P7	10.9	38.7	3.2	4.3	52.1	91.8	0	16.2	6	5.6	4.51	5.65	0.07	0.85	0.039	0.04
Joharipur	P10	23	2	5.1	7.42	73.1	3	0	20	5	5.6	4.74	5.65	0.076	0.055	0.085	0.056
Chatesar	P12	3.7	3.2	1.6	1.2	0.3	0.1	0	16.9	5.9	4.98	13.9	4.03	0.127	0.08	0.087	0.039
Kondli	P18	36.3	33	3.6	4.3	95	0.5	22.5	63	1.8	1.56	7.22	3.13	0.499	0.47	0.556	0.814
Naraina	P20	9.2	9.4	3.2	7.5	21	8.8	1	52	4.6	4.70	6.09	0.582	0.206	0.238	0.268	0.41
Kusumpur	P23	6	8	3	10.2	2	12	0	23.5	3.2	3.8	5.41	4.27	0.155	0.38	0.404	0.23
Rang Puri	P25	4.8	9.3	6.1	4	7.8	0	0	13.6	4.7	4.48	5.64	4.25	0.132	0.403	0.434	0.124

Key: A: Onset of monsoon, B: End of monsoon, C: Post-monsoon, D: Pre-monsoon ppm- parts per million, mg/L- milligram per litre, NTU- Nephelometric Turbidity Unit

3.3 WATER QUALITY OF MAJOR DRINKING WATER SOURCES

OPEN-WELLS

Physico-chemical water quality of open-wells was assessed with respect to the permissible values stated by BIS/WHO. Values for pH were within permissible limits (6.5-8.5). However,there are no permissible levels for temperature, conductivity and salinity. In the present study, the temperature ranged from 19 to 29.6°C, conductivity from 0.05-3.08mS and salinity rangedfrom 0.04-1.9ppt throughout the year. High TDS (1.5mS) and salinity values (1.9ppt) were reported in P16. The open well P16 was located in an agricultural field where chemical fertilizer use was common. Seepage of the fertilizers into the ground probably raised the TDS and salinity of the ground water. This corroborates the observations of high calcium content recorded in P16.

Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. The build-up of organic materialfrom anthropogenic activities is one source of oxygen depletion. Natural organic material suchas leaves when they accumulate and decompose in water bodies create more oxygen demand and result in oxygen depletion in the water. Apart from organic material, anthropogenic activities, physico-chemical parameters and a low temperature affect DO. Waterwith high salinity can lower DO content of water while, low surface water temperature increases DO. DO values should vary from 7.5 to 8.9 ppm when the temperature range is 21-31ºC. In the present study, though DO valueswere in the range of 0.4 to 8.3 ppm, majority of open-wells recorded a low DO (<2ppm) especially during end of monsoon. The plausible reason for this could be the mixing of surface runoff with well water during monsoonas the opening of these wells was at the ground level and they were poorly protected. As discussed earlier, if organic matter and contaminants from surface runoff accumulate in the stagnant well water, it decomposes using aquatic oxygen which results in the depletion of DO. In pre-monsoon/summer, many open-wells recorded DO values below 3ppm. As discussed earlier in water quality of rivers, during summer, atmospheric temperature rises causing an increase in the surface temperature of water and decreasing its oxygen holding capacity. Dissolved oxygen values above 4ppm were recorded in post-monsoon. This was probably dueto increased oxygen holding capacity of water as atmospheric temperature and surface water temperature were lower.

TABLE 3: ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF MAJOR DRINKING WATER SOURCES

OPEN-WELLS

Villages associated with open-wells	**Sample Code**	**Temperature (°C)** (permissible limit: not available)				**pH** (permissible limit: 6.5-8.5)				**Conductivity (mS)** (permissible limit: not available)				**Salinity (ppt)** (permissible limit: not available)			
		A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Akbar Pur	P4	24.4	26.2	23	27	7.42	7.62	7.45	7.33	2.88	1.95	3.08	2.43	2.16	1.56	2.29	1.88

Mazara																	
Badarpur Mazra Burari	P5	25.7	27.2	23	27	7.34	7.39	7.33	7.39	1.077	1.313	1.178	1.126	0.821	0.993	0.885	0.879
Harewali	P8	24.4	25	19	29.5	8.1	7.88	7.72	7.45	0.068	0.059	0.069	0.06	0.052	0.044	0.052	0.436
Joharipur	P9	24.4	26.5	21	27.2	8.02	8.45	7.3	7.3	0.586	0.535	0.581	0.582	0.446	0.41	0.443	0.436
Chatesar	P11	23.2	25.7	22	28	7.45	6.64	7.41	7.45	0.634	0.594	0.849	0.81	0.476	0.441	0.638	0.61
Chatesar	P13	24.6	24.2	24	28	7.33	6.91	7.36	7.17	0.683	0.597	0.767	0.76	0.517	0.449	0.575	0.57
Shakar Pur Brewad	P14	23.6	27.6	20	29	7.8	6.98	7.95	7.97	0.439	0.655	0.973	0.898	0.327	0.498	0.73	0.681
Shakar Pur Brewad	P15	23.9	26.5	19.5	30	7.96	6.59	7.45	8.26	0.817	2.67	2.45	0.502	0.617	2.2	1.901	0.38
Shakar Pur Brewad	P16	23.8	27.2	24	30	7.74	6.75	7.2	7.9	2.13	2.87	3.8	2.86	1.62	2.15	2.82	2.25
Kondli	P17	23.3	27.2	21.5	26	8.2	7.31	7.64	7.76	1.034	0.798	0.741	1.065	0.773	0.595	0.556	0.79
Naraina	P19	29.6	30.1	23	28	7.63	7.27	7.48	7.33	0.928	0.545	0.759	1.127	0.719	0.406	0.564	0.86

Open-wells were also checked for nutrients viz. ammonia, nitrate, total phosphorus and calcium. Ammonia, nitrate and calcium were recorded within permissible levels throughout theyear in most wells. However, P15 and P14 recorded 61ppm and 32ppm of nitrate respectively. Agricultural activities, industrial activities, soil properties, ion content andredox reactions in ground water influence nitrate content. Extensive cultivation of sugarcane and other cash crops was undertaken. Additionally, therewere chemical, heavy metal and packaging industries located. The probable reason for high nitrate content in P14 & P15 could be the excess use of chemical fertilizers (urea, diammonium phosphate, superphosphate) in agricultural activities and seepage ofindustrial effluents into the ground. Additionally, as per the village survey conducted, chemicalindustries polluted the air by releasing coal ash, red dust and particulate matter into the atmosphere. High nitrate content in drinking water may produce potential hazards to human health, such as birth defects, digestive cancers.

4. CONCLUCION

The soil type influences the calcium content of the water as black soil is rich with calcium compounds. Soils of Delhi areas are categorized in to 3 types viz., black, brown and red. The black soil in layers of several feet deep is found in easternparts of of Delhi.

In the present study, open-wells (P4) from Akbar Pur Mazara , (P16), Shakar Pur Brewad and (P5) Badarpur Mazra Burari reported calcium values above the permissible limit (75ppm) throughout the year.The probable reason for this could be the type of soil as Shakar Pur Brewad, Akbar Pur Mazara and Badarpur Mazra Burari werelocated in Purandar, Alipur and Shirur Sub Divisions where black soil occurs in abundance. The calcium content of Kondli was within permissible level though it was situated in Purandar Sub Division. The probable reason could be the presence of brown soil along with black soil in the western part of Purandar Sub Division which diluted the calcium content of the soil in Kondli. The investigation indicated above showed that during the monsoon in low rainfall areas, the load of faecal bacteria was significant. Rivers were more contaminated than significant sources of drinking water. Gradations in water quality were reflected by modified WQI and OIP. Despite claims made by OIP and the updated WQI that the majority of rivers had adequate water quality, the presence of TFC and IE rendered the water unfit for human consumption.

Many actions must be taken to protect the rivers, such as treating both urban and rural sewage properly before dumping it into them. Furthermore, untreated effluent must not be discharged into river segments where the water level has already declined during the summer. Since open-wells are vulnerable to contamination, proactive pollution control measures should be adopted. They include building suitable fencing, using a shared, protected bucket to gather water, routinely chlorinating, and occasionally desilting. Every area that contains a supply of drinking water should be off limits to children and animals. Increasing public knowledge of the effects of declining water quality and diminishing water supplies can aid in reducing anthropogenic pollution.

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