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ASSESSMENT OF GROUNDWATER QUALITY IN ASANSOL CITY OF WEST BURDWAN DISTRICT IN WEST BENGAL, INDIA

Tanushree Paul[1] and [2] Manas Nath
[1]Assistant Teacher, Birbhum District, W.B. INDIA
[2]Assistant Teacher, Birbhum District, W.B. INDIA

ABSTRACT

This paper mainly focuses on the assessment of the groundwater quality to ensure the continuous supply of clean and safe drinking water for the public health protection. In this regard, the groundwater sample datasets of summer season were collected for five years (2014-2018) in different residential areas (Asansol North, Burnpur, Dadhka, Hirapur, Kalla and Kanyapur) of the Asansol city. The obtained values of each parameter were compared with the standard values set by the Indian standards (BIS) and local standards such as National Drinking Water Quality Standards (NDWQS) and measured the status of water quality of the study area using the Weight Arithmetic Water Quality Index Method. The analysis reveals that the water quality rating is increasing day by day. In 2014-15 the WQI was 138.2 which reached in 2018-19 about 203.6 indicating unfit for drinking purpose and other human use due to severe deteriorate of water quality of the Asansol city. Therefore, ground water quality becomes a serious issue in this area which should be taken the proper steps to reduce the impact.

Key words: *WQI, Relative weight, Rating Scale, Unit weight, BDL*

INTRODUCTION

Rapid urbanization, especially in developing countries like India has affected the availability and the quality of the groundwater due to its overexploitation and improper waste disposal, especially in urban areas (Ramakrishnaiah et.al. 2009). Scarcity of clean and potable drinking water has emerged in recent years as one of the most serious developmental issues in many parts of West Bengal, Jharkhand, Orissa, Western Uttar Pradesh, Andhra Pradesh, Rajasthan and Punjab (Tiwari & Singh 2014). The rate of depletion of groundwater level and deterioration of groundwater quality is of immediate concern in major cities and towns of country (Meenkumari and Hosmani 2003, Dhindsa et al. 2004, Ramakrishnaiah et al. 2009: Jain et al. 2010; Singh et al. 2011; Singh et al. 2012; Singh et al. 2013; Tiwari and Singh 2014, Singh et al. 2014, Tiwari et al. 2014).

Groundwater is valuable only when its quality is suitable for which it is being explored. Suitability of groundwater or surface water for a particular purpose depends upon the acceptable water quality standards for which it is being used (WHO, 1984; USPHA, 1993). For evaluating the suitability of groundwater for different purpose, understanding the chemical composition of groundwater is necessary. Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than defined limits (BIS, 2012; EPA, 2009). Therefore different uses require different criteria of water quality as well as standard method for reporting and comparing result of water analysis (Babiker 2007). The WQI result represent the level of water quality in a given water basin such as lake, river or stream. WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use. It is one of the most effective ways to describe the quality of water. The indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and in water quality management. Mostly it is done from the point of view of its suitability for human consumption.

This study aims to determine the status of water quality in the Asansol city using the Weight Arithmetic Water Quality Index Method (WQI). It is expected that the results of this study can provide basic information and outputs that can be useful for local governments and the public, so that it can be used as input in water management in the Asansol City.

2. MATERIALS AND METHODS
2.1 STUDY AREA

The study area is located in West Burdwan district in West Bengal. The graticular extensions are $23^0 41'$ N to $23^0 68'$ N and $86^0 59'$E to $86^0 98'$ E. It has an average elevation of 97 metres (318 ft). Asansol City lies on exposed Gondwana rocks and consists mostly of undulating laterite soil. Asansol city is the 2^{nd} largest city after Kolkata in the West Bengal and it is the 29th most populous city in India, with over a million residents. Asansol city has been experiencing a high rate of population growth. This rapid urbanization is creating stress on the infrastructure in the region and emerging several issues among them inadequate, clean and potable water supply for the purposes of agriculture and drinking is of present concern in the city.

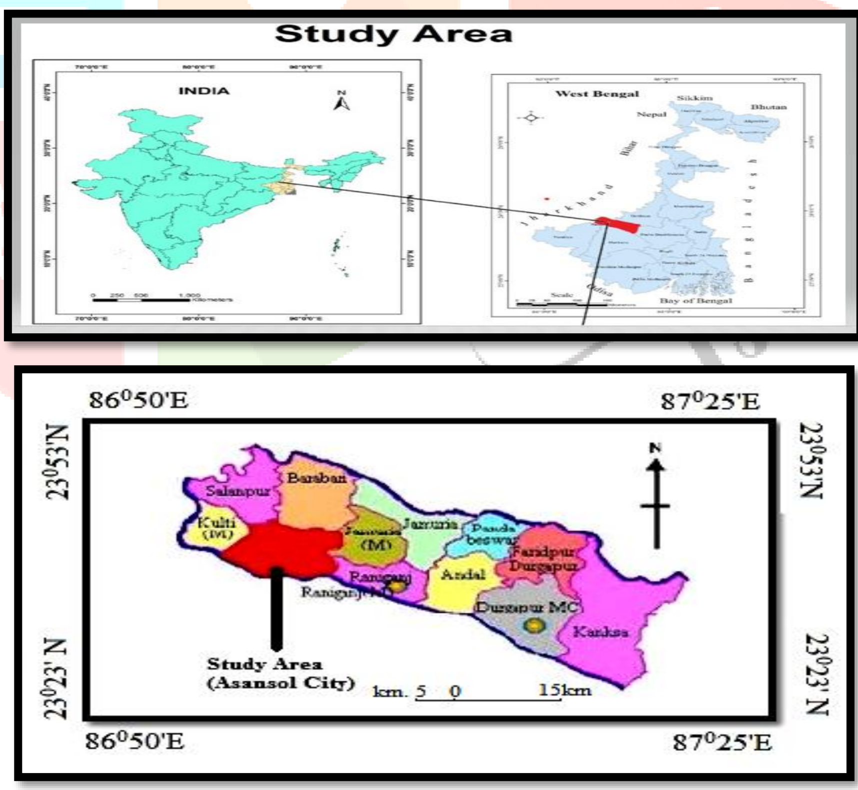

Fig.1: Location Map of the study area

2.2 METHODOLOGY

Firstly, study the Indian Standard (BIS 2004) for drinking water specification. Here, the physicochemical parameters along with the desirable limits and related health effects are given. The data of physicochemical parameters in groundwater have been acquired from Central Ground Water Board (CGWB) during summer seasons. In West Bengal, ground water monitoring was started since 1976 by Central Ground Water Board, Eastern Region from open dug well. Total 6 sample sites of the study area were selected and from the year of 2014 to 2019 data were collected and calculated based on the value of water parameters with water quality standards of BIS, WHO and NDWQS.

Analytical Methods

Water quality of study area was evaluated by Water Quality Index (WQI) technique. WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use. A water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. In order to calculate WQI, 15 parameters have been selected. Water quality index was calculated for assessing the suitability of water for biotic communities and also drinking purposes.

Calculation of Water Quality Index (WQI)

WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use. The indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and in water quality management. Mostly it was done from the point of view of its suitability for human consumption.

Weighted Arithmetic Water Quality Index Method:

In this paper the WQI was calculated using the Weight Arithmetic Water Quality Index (WAWQI) method which was proposed by Horton (1965), developed by Brown et al. (1970) and then by Cude (2001) using a simple arithmetic mean by the following equations.

The steps for WQI are:

(1) Weightage

For water quality index calculation, we first have to know the weightage of each factor (Table 2). Factors which have higher permissible limits are less harmful because they can harm quality of water when they are present in very high quantity. So weight age of factor has an inverse relationship with its permissible limits. The assigned wi values for each parameter were shown in Table no.1. Weighted values were assigned from 1 to 5 according to relative importance in the overall quality of water for drinking purposes. The highest weight of 5 was assigned to parameters which have the major effects on water quality.

(2) Relative Weight

The Relative Weight (Wi) of each parameter was calculated a value inversely proportional to the Bureau of Indian standard drinking water specifications. Computation of a relative weight (Wi) of the chemical parameter using the following equation:

$$Wi = wi / \sum wi \ (i = 1 \text{ to } n)$$

Where, Wi is the relative weight, wi is the weight of each parameter and 'n' is the number of parameters.

(3)Rating Scale

Rating scale (Table 3) was prepared for range of values of each parameter. The Quality Rating Scale (*Qi*) for each parameter is calculated by using this expression:

$$Qi = (Ci / Si) \times 100$$

Where,
Qi is Quality Rating Scale
Ci is the concentration of each chemical parameter in each water sample in mg/l
Si is the guide line value/desirable limit of ith parameter as given in Indian drinking water standard

(3) Water Quality Index (WQI)
WQI is a compilation of a number of parameters that can be used to determine the overall quality of water. The numerical value was multiplied by a weighting factor that was relative to the significance of the test to water quality. The values of Qi, Wi and QiWi are given in Tables 2 and 3. Hence by multiplying Wi and QiWi we can get the value of WQI. It is basically a mathematical means of calculating a single value from multiple test results.

$$WQI = \sum QiWi / \sum Wi$$

Based on the calculated WQI, the category of water quality types was shown in Table 2 according to Shweta et al. (2013).

National Sanitation Foundation Water Quality Index (NSFWQI)	
91-100	Excellent water quality
71-91	Good water quality
51-71	Medium water quality
26-50	Bad water quality
0-25	Very bad water quality
Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI)	
95-100	Excellent water quality
80-94	Good water quality
60-79	Medium water quality
45-59	Bad water quality
0-44	Very bad water quality
Oregon Water Quality Index (OWQI)	
90-100	Excellent water quality
85-89	Good water quality
80-84	Fair water quality
60-79	Marginal water quality
0-59	Poor water quality

Table 1: Water Quality Rating as per different Water Quality Index methods

WQI Value	Rating of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very Poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Table 2: Water Quality Rating as per Weight Arithmetic Water

3. DATA ANALYSIS

Sl. No.	Sample sites	Location	Graticular Extension	
			Latitude	Longitude
GW-1	Asansol North	Ward no.14	23.6850	86.9772
GW-2	Burnpur	Ward no.44	23.6728	86.9458
GW-3	Dadhka	Ward no.13	23.7072	86.9803
GW-4	Hirapur	Ward no.45	23.6617	86.9364
GW-5	Kalla	Ward no.15	23.7061	86.9967
GW-6	Kanyapur	Ward no.20	23.7275	86.9475

Table 3 : Location of some Sample sites of Asansol City

Sample no.	GW-1		GW-2		GW-3		GW-4		GW-5		GW-6		Indian Standards for quality of drinking water (IS:10500)
Sample Name	Asansol North		Burnpur		Dadhka		Hirapur		Kalla		Kanyapur		
Year	2014	2019	2014	2019	2014	2019	2014	2019	2014	2019	2014	2019	
P^H	8.0	7.29	7.8	7.54	7.9	7.36	8.1	7.36	7.5	7.78	7.5	7.95	6.5-8.5
EC	1230	1033	1720	1301	1190	1089	1060	838	930	946	464	250	400-1000
TH	255	310	410	305	215	250	285	185	280	375	130	90	300-600
Ca	60	70	102	26	60	44	74	32	52	42	36	18	75-200
Mg	26	32.8	38	58	16	34	24	25.5	36	65.6	9.7	11	30-100
Na	166	85	207	85	173	108	113	98	105	39	58	19	30-200
K	0.42	19.6	8.1	98.1	2.3	11.6	3.9	42.3	11	1.85	0.11	3.39	2.5-12
CO_3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	60-120
HCO_3	244	366	250	366	226	323.3	305	195.2	171	323.3	214	116	200-600
Cl	171	71.1	152	145	85	110.2	75	188.4	114	131.5	36	21	250-1000
SO_4	165	89	432	41	278	49	168	20	170	10	14	11	200-400
F	0.75	0.58	1.45	1.16	0.45	0.37	0.54	0.41	0.5	0.12	1.0	1.20	1-1.5
PO_4	0.15	0.60	0.075	0.26	0.075	0.05	0.02	0.02	0.02	0.04	0.02	0.01	0.15-5
SiO_2	5.0	20	5.0	13	5.0	17	5.0	18	5.0	22	5.0	11	5-28
Fe	0.5	0.84	0.34	0.13	0.48	0.84	0.38	0.84	0.1	1.73	0.1	0.01	0.30-1.00

Unit: Concentration in mg/L except in pH, EC (µs/cm). BDL = Below Detection Limit.

Table: 4 Hydro chemical data of Ground water samples collected from Dug well in different parts of Asansol City in the year of 2014 & 2019

Sl. No.	Water Parameters	Standard value	Unit Weight (wi)	Relative Weight (Wi)
1	P^H	7.0	4	0.0833
2	EC	400	3	0.0625
3	TH	300	3	0.0625
4	Ca	75	2	0.0416
5	Mg	30	2	0.0416
6	Na	30	2	0.0416
7	K	2.5	2	0.0416
8	CO_3	60	4	0.0833
9	HCO_3	200	4	0.0833
10	Cl	250	3	0.0625
11	SO_4	200	4	0.0833
12	F	1.0	4	0.0833
13	PO_4	0.15	3	0.0625
14	SiO_2	5.0	4	0.0833
15	Fe	0.30	4	0.0833
			$\sum wi = 48$	**$\sum Wi = 0.9995$**

Table: 5 Computed table of Unit weight and Relative Weight (Wi) of Chemical Parameters of the Asansol City

Sl. No.	Water Parameters	Quality Rating											
		Asansol North		Burnpur		Dadhka		Hirapur		Kalla		Kanyapur	
		2014	2019	2014	2019	2014	2019	2014	2019	2014	2019	2014	2019
1	P^H	123.1	104.1	120	107.7	121.5	105.1	124.6	105.1	115.4	111.1	115.4	113.6
2	EC	307.5	258.3	430	325.3	297.5	272.3	265	209.5	232.5	236.5	116	62.5
3	TH	85	103.3	136.6	101.6	71.67	83.3	95	61.7	93.3	125	43.33	30
4	Ca	80	93.3	136	34.7	80	58.7	98.7	42.7	69.3	56	48	24
5	Mg	86.7	109.3	126.6	193.3	53.3	113.3	80	85	120	21.8	32.3	36.6
6	Na	553.3	283.3	690	283.3	576.6	360	376.7	326.6	350	130	193.3	63.3
7	K	3.5	784	67.5	3924	19.17	464	32.5	1692	91.7	74	0.917	135.6
8	CO_3	50	50	50	50	50	50	50	50	50	50	50	50
9	HCO_3	122	183	125	183	113	161.7	152.5	97.6	85.5	161.6	107	58
10	Cl	68.4	28.4	60.8	58	34	44.08	30	75.36	45.6	52.6	14.4	42
11	SO_4	82.5	44.5	216	20.5	139	24.5	84	10	85	5	7	5.5
12	F	75	58	145	116	45	37	54	41	50	12	100	120
13	PO_4	100	400	50	173.3	50	33.3	13.3	13.3	13.3	26.6	13.3	6.66
14	SiO_2	100	400	100	260	100	340	100	360	100	440	100	220
15	Fe	166.6	280	113.3	43.3	160	280	126.7	280	33.3	576.6	33.33	3.33

Table: 6 Computed Table showing the change of Quality Rating of Chemical Parameters in different sample sites of Asansol City between 2014 & 2019

Table: 7 Computed Table showing the change of Subindex (SI) of water samples in different sample sites of Asansol City

Water Prameters	S1		S2		S3		S4		S5		S6	
	Asansol North		Burnpur		Dadhka		Hirapur		Kalla		Kanyapur	
	Qi Wi		Qi Wi		Qi Wi		Qi Wi		Qi Wi		Qi Wi	
	2014	2019	2014	2019	2014	2019	2014	2019	2014	2019	2014	2019
P^H	10.25	8.67	9.99	8.97	10.12	8.75	10.38	8.75	9.61	9.26	9.61	9.46
EC	19.21	16.1	26.9	20.3	18.59	17.01	16.56	13.09	14.53	14.8	7.25	3.91
TH	5.31	6.45	8.53	6.35	4.48	5.21	5.94	3.86	5.83	7.81	2.71	1.88
Ca	3.33	3.88	5.65	1.44	3.33	2.44	4.10	1.78	2.88	2.33	1.99	0.99
Mg	3.61	4.54	5.27	8.04	2.22	4.71	3.33	3.54	4.99	0.91	1.34	1.52
Na	23.01	11.8	28.7	11.8	23.9	14.9	15.66	13.6	14.56	5.41	8.04	2.63
K	0.146	32.6	2.81	163.2	0.80	19.3	1.35	70.4	3.81	3.08	0.038	5.64
CO_3	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
HCO_3	10.16	15.2	10.4	15.2	9.41	13.5	12.70	8.13	7.12	13.5	8.91	4.83
Cl	4.28	1.77	3.8	3.63	2.13	2.76	1.88	4.71	2.85	3.29	0.9	2.63
SO_4	6.87	3.70	17.9	1.70	11.58	2.04	6.70	0.83	7.08	0.42	0.58	0.45
F	6.25	4.83	12.07	9.66	3.75	3.08	4.50	3.42	4.17	0.99	8.33	9.99
PO_4	6.25	25	3.13	10.8	3.13	2.08	0.831	0.83	0.831	1.66	0.831	0.42
SiO_2	8.33	33.3	8.33	21.7	8.33	28.3	8.33	29.9	8.33	36.7	8.33	18.3
Fe	13.88	23.3	9.44	3.61	13.33	23.3	10.55	23.3	2.77	48.03	2.78	0.28
	∑125.06	**∑195.4**	**∑157.09**	**∑290.7**	**∑119.27**	**∑151.55**	**∑106.98**	**∑190.4**	**∑93.53**	**∑152.4**	**∑65.81**	**∑67.1**

between 2014 & 2019

Year	2014-15			2015-16			2016-17			2017-18			2018-19		
Water Parameters	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
P^H	8.1	7.5	7.8	8.1	7.5	7.8	8.28	7.71	7.99	8.1	7.5	7.8	7.95	7.29	7.62
EC	1720	464	1092	1242	419	830.5	1378	462	920	1301	250	775.5	1301	250	775.5
TH	410	130	270	305	80	192.5	470.19	85.05	277.6	305	90	197.5	375	90	232.5
Ca	102	36	69	68	20	44	124	18	71	58	18	38	70	18	44
Mg	38	9.7	23.9	36	7	21.5	38	9.72	23.9	58	11	34.5	65.6	11	38.3
Na	207	58	132.5	112	31	71.5	114	37	75.5	85	19	52	108	19	63.5
K	11	0.1	5.55	17	0.5	8.75	13.7	1.98	7.83	98.1	3.4	50.8	98.1	1.85	49.9
CO_3	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
HCO_3	305	171	238	329	61	195	574	146.6	360.3	366	116	241	366	116	241
Cl	171	36	103.5	145	39	92	142	42.60	92.3	145	21	83	188.4	21	104.7
SO_4	432	14	223	63	18	40.5	18	4.0	11	41	0.1	20.6	89	10	49.5
F	1.45	0.45	0.95	0.97	0.44	0.71	0.98	0.48	0.73	1.20	0.22	0.71	1.20	0.12	0.66
PO_4	0.15	0.02	0.08	0.60	0.02	0.31	0.26	0.02	0.14	0.26	0.1	0.18	0.15	0.02	0.085
SiO_2	26	5.0	15.5	26	18	22	33	16	24.5	20	11	15.5	20	11	15.5
Fe	0.5	0.1	0.3	0.5	0.1	0.3	0.20	0.1	0.15	0.22	0.01	0.12	1.73	0.01	0.87

Table: 8 Computed table of Mean Value of Chemical Parameters of Asansol City from 2014 to 2019

Sl. No.	Water Parameters	2014-15		2015-16		2016-17		2017-18		2018-19	
		Qi	QiWi	Qi	QiWi	Qi	QiWi	Qi	QiWi	Qi	QiWi
1	P^H	111.4	9.28	111.4	9.28	114.1	9.50	114.4	9.53	108.8	9.06
2	EC	273	17.1	207.6	12.9	230	14.38	193.8	12.1	193.8	12.1
3	TH	90	5.63	64.16	4.01	92.5	5.78	65.8	4.11	77.5	4.84
4	Ca	92	3.83	58.7	2.44	94.6	3.94	50.6	2.11	58.6	2.43
5	Mg	79.6	3.31	71.7	2.98	79.6	3.31	115	4.78	127.6	5.31
6	Na	441.6	18.4	238.3	9.91	251.6	10.5	173.3	7.21	211.6	8.80
7	K	222	9.23	350	14.6	313.2	13.03	2032	84.5	1996	83.03
8	CO_3	50	4.17	50	4.17	50	4.17	50	4.17	50	4.16
9	HCO_3	119	9.91	97.5	8.12	180.2	15.01	120.5	10.03	120.5	10.04
10	Cl	41.4	2.58	36.8	2.3	36.9	2.30	33.2	2.08	41.8	2.61
11	SO_4	111.5	9.29	20.2	1.68	5.5	0.46	10.3	0.86	24.8	2.07
12	F	95	7.91	71	5.91	73	6.08	71	5.91	66	5.50
13	PO_4	53.3	3.33	206.6	12.9	93.3	5.83	120	7.5	56.6	3.53
14	SiO_2	310	25.8	440	36.7	490	40.8	310	25.8	310	25.8
15	Fe	100	8.33	100	8.33	50	4.17	40	3.33	290	24.2
			$\sum$138.1		**$\sum$136.2**		**$\sum$139.3**		**$\sum$184**		**$\sum$203.5**

Table: 9 Computed table of Quality Rating (Qi) and Subindex (SI=QiWi) of water parameters of the Asansol City from 2014 to 2019

4. RESULTS AND DISCUSSION

Sample Sites	2014			2019		
	WQI Value	Status of water quality	Grade	WQI Value	Status of water quality	Grade
Asansol North	125.12	Unfit for drinking purpose	E	195.4	Unfit for drinking purpose	E
Burnpur	157.2	Unfit for drinking purpose	E	290.7	Unfit for drinking purpose	E
Dadhka	119.32	Unfit for drinking purpose	E	151.6	Unfit for drinking purpose	E
Hirapur	107.03	Unfit for drinking purpose	E	190.4	Unfit for drinking purpose	E
Kalla	93.6	Very Poor water quality	D	152.4	Unfit for drinking purpose	E
Kanyapur	65.8	Poor water quality	C	67.1	Poor water quality	C

Table:10 Result of calculation of Water Quality Status in different sample sites of Asansol City from 2014 to 2019

Year	WQI Value	Status of Water Quality	Grade
2014-15	138.2	Unfit for drinking purpose	E
2015-16	136.3	Unfit for drinking purpose	E
2016-17	139.3	Unfit for drinking purpose	E
2017-18	184.1	Unfit for drinking purpose	E
2018-19	203.6	Unfit for drinking purpose	E

Table:11 Result of calculation of Water Quality Status of Asansol City from 2014 to 2019

Due to increase of urbanization and industrialization the status of groundwater quality become to unfit for drinking purpose in the study area. In 2014-15 the WQI was 138.2 which reached in 2018-19 about 203.6 indicating unfit for drinking purpose in Asansol city. In the whole of Asansol city WQI is very high in Burnpur and comparatively low in kanyapur. In 2014 WQI was 157.24 which reached in 2019 about 290.7 indicating unfit for drinking purpose in Burnpur. This is mainly due to presence of heavy industry of IISCO (The Indian Iron & Steel Company). Although, the status of ground water quality of all sample sites of the city is very poor quality and unfit for drinking purpose.

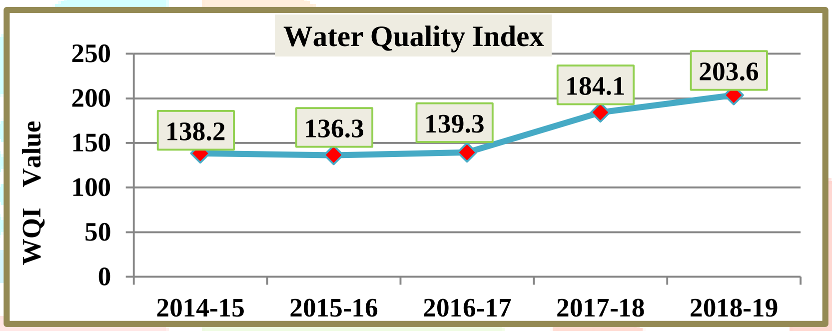

Fig.2: Annual Variation of WQI in Asansol City

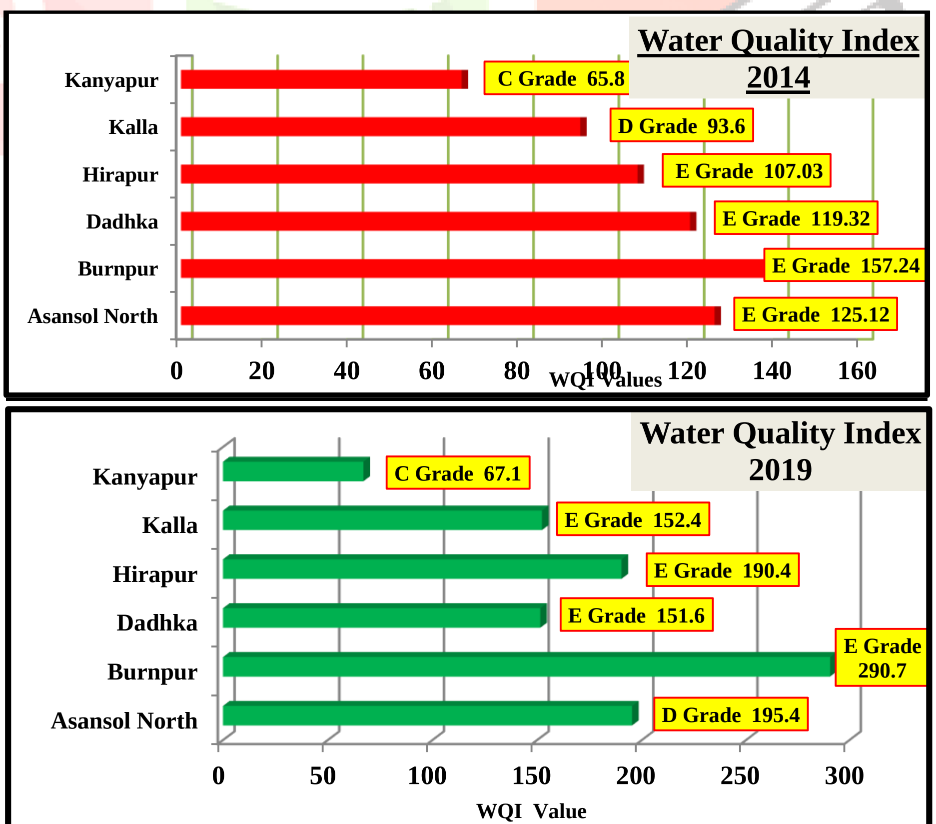

Fig. 3: Comparison of WQI in different parts of Asansol City between the years of 2014 & 2019

According to BIS and NDWQS the maximum allowable level of *electrical conductivity* is 1000 μs/cm. The results show that the measured conductivity of all water sample ranges from 1720 to 419 μs/cm and the average conductivity value is 1069 μs/cm indicating high enrichment of salts in the study area. *pH* is classed as one of the most important water quality parameters, measurements of pH relates to the acidity or alkalinity of the water. The normal drinking water pH range is between 6.5 and 8.5. The pH values of all the drinking water samples were found to be in the range between 8.1 to 7.5 and the average value 7.8 indicating the neutralization of the ground water.**)** *Total Hardness (TH)* of water is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. The principal hardness causing cations are calcium, magnesium bicarbonate, carbonate, chloride and sulphates. The average hardness values of the present study were found 245mg/L where as permissible limit is 300 mg/L. The average value of carbonate 30 mg/L (IS: 60 mg/L), chloride 103.5 mg/L (IS: 250 mg/L), calcium 61mg/L (IS: 75 mg/L), magnesium 21.5 mg/L (IS: 30 mg/L) of the present study was found within permissible limit 62 mg/L (IS: 200 mg/L). Whereas, the average value of HCO_3 was found 195 mg/L (IS: 200 mg/L) and SO_4 was 223 mg/L (IS: 200 mg/L) which is exceeded the standard limit. *Na^+ and K^+* is the dominant ion in the groundwater of the study region. The concentration of Na ranged from 207 mg/L to 31 mg/L and mean value 119 mg/L of ground water samples exceeded the acceptable limit of 30 mg/L for drinking. Whereas, K^+ ranged from 11 mg/L to 0.1 mg/L with mean value 5.55 mg/L which was also exceeded the acceptable limit (2.5 mg/L) for drinking. HCO_3 ranged from 329 mg/L to 61 mg/L with mean value 195 mg/L which was within the acceptable limit (200 mg/L). *Silicon* value plays a major role in managing and conserving the precious groundwater resource. Silicon is present in a number of minerals and abundant in sand. When silicon reacts with oxygen to form silicon dioxide (SiO_2) and is usually present as silicon acid in water. SiO_2 ranged from 26 mg/L to 5.0 mg/L with mean value 15.5 mg/L which was also exceeded the acceptable limit (5 mg/L) for drinking purpose.

Therefore from above discussion it is clear that the groundwater was mostly polluted by the four water elements namely Na+, SiO_2, SO_4 and HCO_3 in the Asansol City. These elements are resulting of municipal or industrial discharges. Asansol City has rich mineral resource-base and also the most industrialized area in West Bengal. A large number of steel plants, manufacturing industries, fertilizer plants, power plants, coal washeries and mining industries are concentrated within the city which may be the main causes for high concentration of above water elements in groundwater. Sodium salts has many uses in the mining industry, for example in water treatment including softening, disinfection, corrosion control, pH adjustment, coagulation etc. Besides, halite dissolution, weathering of silicate minerals and ion exchange were also the major sources of Na+ abundance. Cation exchange and frequent evaporation may be the also causes of the high Na concentration in groundwater of the study region. Silica released as a result of chemical breakdown of silicate minerals in rocks and sediments by chemical weathering. Relatively high silica content in groundwater implies more intense water-rock interaction.

5. CONCLUSION

It is concluded that WQI can be used as a tool to assess the water quality of any area. Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. This value gives the public a general idea of the possible problems with water in a particular region and communicates the information on water quality trends to the policy makers and water quality management.

By using of this technique it is shown in the year of 2014 WQI was 138.2 which reached to 203.6 in the year of 2019 indicating unfit for drinking purpose as per Weight Arithmetic Water Quality Index Method. The groundwater of this area is also characterized by near-neutral to alkaline conditions, represented by predominance of bicarbonate, sulphate, Sodium and silicon di oxide water types. Asansol City has rich mineral resource-base and the most industrialized area in West Bengal. A large number of steel plants, manufacturing industries, fertilizer plants, power plants, coal washeries and mining industries are concentrated within the city which may be the main causes for deteriorating the ground water quality in this area. Besides, leaching of materials from Overburden dumps, land filling, mine waste, heavy metals is also responsible for that. So, ground water quality becomes a serious issue in this area which will be environmental threats unless all necessary measures are taken to reduce the impact.

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