IMPACT OF SOCIO-CULTURAL EVENT ON WATER QUALITY: A CASE STUDY OF DHANUYATRA AN OPEN AIR ROVING DRAMA

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ABSTRACT :

In the present study we have examined the effect of gathering during socio cultural activities on various water sources of Bargarh town which includes 5 community pond (CP) representing surface water , 5 tube wells representing ground water (GW) , 1 river and I canal representing flowing water(FW) located in different parts of Bargarh town, basically where different activities of Dhanuyatra are perfomed . The present study deals with the study of physico-chemical parameters like Chlorides, Fluoride , Iron, Total dissolved solid, Hardness , Turbidity , Dissolved oxygen, , Total alkalinity , pH along with Bacteriological examination . The correlation analysis on water quality parameters revealed that all parameters are more or less correlated with each other Person's Correlation matrix. It is observed that some of the parameters do not have significant correlation among them indicating the different origin source of pollution.

KEYWORDS : Dhanuyatra, Solid waste , Correlation , Biodegradable

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INTRODUCTION

Water is an elixir of life and an important component for human survival. It is the responsibility of every individual to conserve water resources (Jothivenkatachalam et.al. 2010) .According to Central Pollution control Board, 90% of the water supplied in India to the towns and cities is polluted, out of which only 1.6% gets treated. Therefore, water quality management is fundamental for the human welfare .(Gupta, S.C.1991 & Madhuri, U et.al. 2004) Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substances and facilitates industrial cooling and transportation (Upadhyay, M & Kumari, K., 2013). The quality of water is of vital concern for mankind since it is directly linked with human welfare and sustainable development. It is necessary, therefore, to regularly monitor the quality of water. Water quality is based on the physical and chemical soluble constituents due to weathering of parent rocks and anthropogenic activities (Akinbile, C. O. & Yusoff, M. S. 2011). Drinking water quality is affected by the presence of different soluble salts (Sonawane, V. Y. & Khole, A. M. 2010) . Eutrophication is another big source; it occurs due to daily activities like washing clothes, utensils near lakes, ponds or rivers; this forces detergents to go into water which blocks sunlight from penetrating, thus reducing oxygen and making it inhabitable. Some water pollution effects are recognized immediately, whereas others don't show up for months or years . Estimation indicates that more than fifty countries of the world with an area of twenty million hectares are treated with polluted or partially treated polluted water (Hussain, I et.al 2001) including parts of all continents(Kan, H. ,2009, Khan, A. ,2010, M. A. Khan , A. M. Ghouri) and this water of poor quality causes health hazards and death of human being, aquatic life and also disturbs the production of different crops (Ashraf, M. A., 2010,). In fact, the effects of water pollution are said to be the leading cause of death of humans across the globe, moreover, water pollution affects our oceans, lakes, rivers, and drinking water, making it a widespread and global concern (Scipeeps, 2009).

In India ponds, rivers and ground water are used for domestic and agricultural purposes. The quality of water may be described according to their physico-chemical and micro-biological characteristics. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential. However it is a very difficult and laborious task for regular monitoring of all the parameters even if adequate manpower and laboratory facilities are available. Therefore, in recent years an alternative approach based on statistical correlation, has been used to develop mathematical relationship for comparison of physico-chemical parameters. (Mayur C Shah. et.al 2007, Garg D K et.al. 1990, M. Sarkar et.al 2006)The present study deals with study of physico-chemical parameters like Chlorides, Fluoride , Iron, Total dissolved solid, Hardness , Turbidity , Dissolved oxygen, , Total alkalinity , pH along with Bacteriological examination . The temperatures of the samples were noted at the sampling point itself. The reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions. The Bacteriological contamination was examined using a specially designed kit in a qualitative way. The analyzed data were compared with standard values recommended by organization like WHO, ICMR (M. Kumar & A. Puri. 2012.)etc. Systematic calculation of correlation coefficient between water quality parameters has been done with the objective of minimizing the complexity and dimensionality of large set of data.

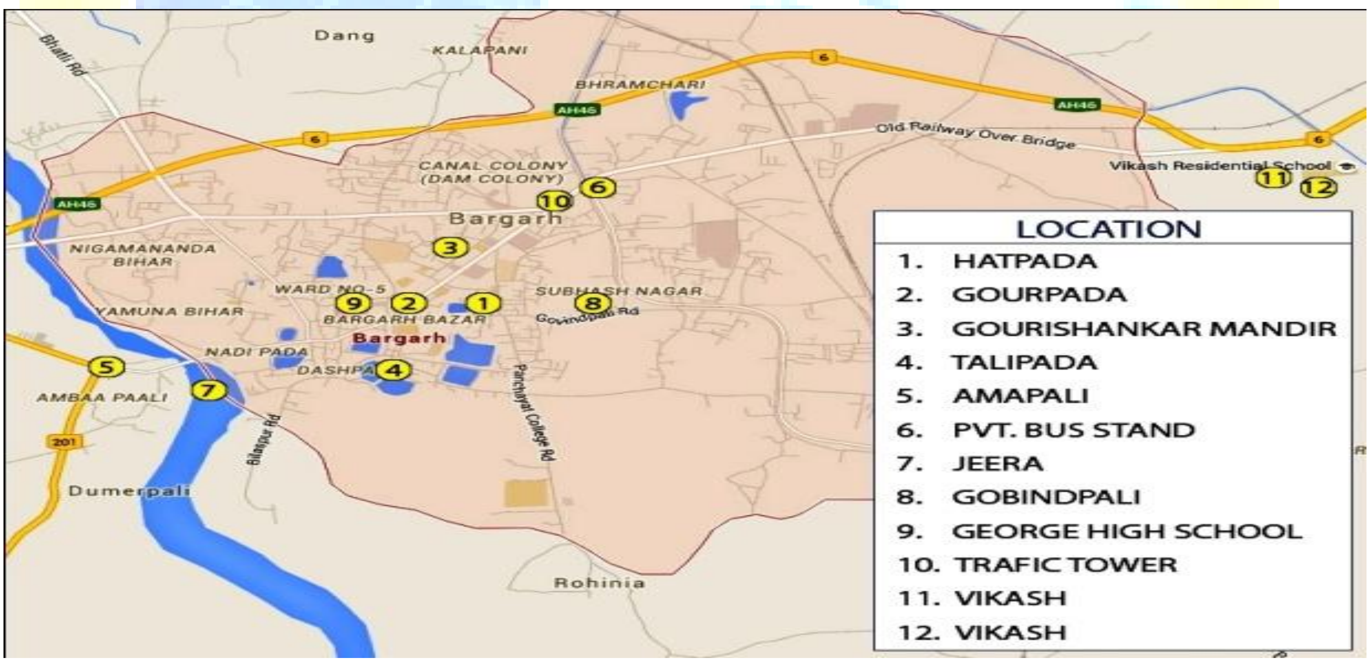
PROFILE OF DHANUYATRA AT BARGARH

Indian society is of many religions, faiths, festivals and events. Owing to its composition, there are mass gathering events being organized at various levels involving large number of people. In such situations how environment is getting affected in terms of certain vital parameter is a real concern for the civil society. The present piece of presentation is also an attempt to study the nature and magnitude of water pollution during festive occasion through a case study of world famous mass gathering event DhanuYatra of Bargarh district. It is a socio- religious festival having the rare distinction of an open air roving drama with no ceiling on dimension of stage, number of characters and also script. Dhanuyatra with a large number of turnout, within a short span of time in a very limited space and with limited resources creates a lot of pressure on nature in this locality. With almost 15 lac people gathering (S.N. Panda, K.K.Pradhan, S.R.Mishra 2015) in an area of less than 15 square kilometers, it becomes difficult for the organizers to take care of the needs of every single citizen. This is similar to establishing and running a whole new city for a short period with all amenities.

Bargarh is located in Western Odisha, close to the border of neighboring state of Chhattisgarh. The population of Bargarh town is about 83, 651 as per 2011 census and there is floating population of another 25,000 people every day because it is a trading town. It gets around 1527 mm rainfall a year. The economy of Bargarh is largely dependent on agricultural products. A part of the district is well irrigated with a network of canals originating from river Mahanadi, ensuring a good crop. (Mahananda & et.al. 2010)

Solid wastes during Dhanuyatra are of mixed composition (S.N. Panda, K.K.Pradhan, S.R.Mishra 2015 & S. Kaushik, B. Datt Joshi 2011). The total amount of solid waste may contain biodegradable waste, non biodegradable and miscellaneous waste with different proportion depending upon the activities on that site. The waste materials are produced by various activities like eating, purchasing, human excreta, religious activities etc. Neither exact nor approximate quantification of solid waste is recorded yet . The human excreta, food waste, polythene , other chemicals and moreover improper habit of urination make the situation more complex . So the nature of pollutant is non specific in nature and difficult to characterize .

Figure-1 SAMPLE COLLECTION SITE MAP OF BARGARH TOWN



METHODOLOGY

In the present study the water sources include 5 community ponds (CP) representing surface water , 5 tube wells representing ground water (GW) , 1 river and I canal representing flowing water(FW) located in different parts of Bargarh town, basically where the different activities of Dhanuyatra are perfomed . Only 2 tube wells are free from any sort of festive activities.

In the present work bacteriological examination is done with the help of a special kit to know the quality of water in a qualitative manner. All the samples are free from serious contamination as the entire samples gave negative result after 24 hours but after 36 hours all open source sample (CP and FW) gave positive result indicating moderate level contamination. All the GW samples are free from contamination. In addition to this the other methods are analyzed by using standard procedures . (American Public Health association ,Water work association, Water Environment Federation Edited by E.W.Rice, R. B. Baird, A. D. Eaton, L. S. Clesceri)

RESULT AND DISSCUSSION

The pH value of drinking water is an important index of acidity or alkalinity. A number of minerals and organic matter interact with one another to give the resultant pH value of the sample. In the present study, pH ranges from 8.5- 6.07 in phase 1 and it is 10.1- 5.34 in phase 2. But most of the values are within the range prescribed by WHO13. The highest value of 10.1 and 9.23 are found in case of flowing water which is not a serious concern. Normally all the CP and FW are having pH more than the GW in both the phases. But the difference in different types of sample is more in phase 1 as compared to phase 2 because the pH value increases in case of CP and FW sample as compared to GW sample. The SD and CV both are more in phase 2 sample as compared to phase 1 sample. This clearly indicates the deterioration of water quality in case CP after the Dhanuyatra . In all the ponds, pH is always alkaline. These shifts towards higher pH in case of CP may be due to increase in alkaline detergent during the festival time.(Chang, H. ,2008) In all most all the cases the pH value is within the permissible limit.

The level of TDS is one of the characteristics, which decides the quality of drinking water. In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. In the present study, TDS ranges from 309.4 - 687.4mg/L in phase-1 and 366.5 – 854.8mg/L in phase-2 against the standard value according to WHO, as compared to total dissolved solid permissible values for drinking. In both the phases the TDS value of sample no 5 (Rural based CP) is maximum and also the magnitude of change is also very high. This can be attributed to excessive dependence of local people for bathing , washing and other daily activities. In all the cases there is an increase in trend .The highest change is recorded in case of GW sample no. 9 , a borewell which is located at the centre of trading area with highest crowd density . The SD value is almost constant where as CV value is less in phase 2. The low CV value of phase 2 can be attributed to the fact that, in most of the cases the samples with low TDS value are effected more as compared to sample with higher TDS value in phase1 as a result of festival activities .High level of TDS may aesthetically be unsatisfactory for bathing and washing(A. Abdul Jameel, ,J. Sirajudeen, 2006). The TDS concentration is a secondary drinking water standard.

The Total Hardness is an important parameter of water quality whether it is to be used for domestic, industrial or agricultural purposes. The hardness of water is not pollution parameter but indicates water quality mainly in terms of Ca^{2+} and Mg^{2+}expressed as $CaCO_3$ (De, A.K, 2006). The total hardness ranges between 40 – 100 mg/L in phase-1 and 160 – 260 mg/L in phase-2 which is within the permissible value of less than 500mg/L . But in Phase-2 analysis hardness increases in the entire sample as compared to phase-1 .The SD value increases in phase-2 as hardness value in all samples increases but CV lowers in the phase-2 as compared to phase 1 shows lowering of magnitude of variation among the samples. The increase in hardness may be due to a combination of carbonate and non carbonate hardness.(P. Chris Wilson m ,2013) The presence of non carbonate hardness can be established from the fact that the value of total hardness is greater than total alkalinity in all the samples in phase 2. (Barbara Hauser , Drinking Water Chemistry: A Laboratory Manual)

Turbidity is a measure of the cloudiness or murkiness of water due to suspended particles. The turbidity level ranges from 3-23 NTU in phase -1 and 0-27 NTU in phase -2 as compared to the prescribed limit of 10NTU and permissible limit of 25 NTU . Almost in all CP (except sample no 2) there is increasing trend of turbidity reflecting the presence of unwanted particles in the water as a result of people, animals or boats disturbing the waterbed . In sample 1, 3 and 4 turbidity level is almost unacceptable. There is an increase in SD value and sharp rise in CV value which indicates the wide variation in this parameter in different types of water sources as well as fall in the water quality. The increase in turbidity in sample 1 can be attributed to the mythological activity performed in that pond. Primary contributors to turbidity include clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and microscopic organisms. It can flag a potential problem and may indicate new source of contamination of the water.(Tan Kah Hern, 2014)

The chloride content in the samples lies between 21.27- 304.87 mg/L in phase1 and 21.27 – 340.32 mg/L. According to ICMR the maximum permissible limit for chloride in drinking water is 250- mg/L 25. In the present study; the value of chloride content is the highest in sample no 5 representing the rural based CP. The entire CP samples (except sample no 2) and two samples of GW i.e. sample no 9 & 10 are found to have higher chloride content. Both the SD and CV value are found to be higher in Phase-2 which reflects contamination of water with respect to chloride. High concentration of chloride is also due to invasion of domestic waste and disposal by human activities .**(** Saadia Rashid Tariq 2014**)** The contamination is not a threat as the chloride level is within permissible limit.

The fluoride content in the samples lies between 0.1 – 0.49 mg/L in phase1 and .01- 0.69 mg/L. The values are lower than the prescribed value. In all the samples the value is quite low which clearly points out the excellent quality of water with reference to fluoride in both the phases. Either marginal variation or consistency is recorded in the trend SD remains constant in both the phases whereas CV increases by 1 unit in phase 2 which confirms no impact of festive activities on the water quality as far as fluoride is concerned.

Iron can be present in water in two forms; the soluble ferrous iron or the insoluble ferric iron. Water containing ferrous iron is clear and colorless, and when exposed to air the water turns cloudy causing a reddish brown precipitate of ferric iron appears. The combination of naturally occurring organic material and iron can be found in shallow wells and surface water. This water is usually yellow or brown but may be colorless. The Iron content in the sample lies between `0.1 -0.9 mg/L in phase1 and 0.1 – 2.1 mg/L in phase 2. In all the cases (except sample no. 6 representing a FW) increase in the value is witnessed. GW Sample no 8 and 10 exceeds the prescribed limit in phase 2 whereas all other samples are within the prescribed limit in both the phases. The SD value increases and CV value decreases in phase 2 as compared to phase1 shows lowering of magnitude of variation among the samples in phase 2.

Table-1 COMPARATIVE DATA FOR ALL PARAMETERS PHASE-1 & PHASE-2

SAMPLE NO	SOURCE	CHLORIDE 1	CHLORIDE 2	HA-1	HA-2	TA-1	TA-2	TDS-1	TDS-2	pH1	pH2	Fe-1	Fe-2	TUR-1	TUR-2	FLOURIDE-1	FLOURIDE-2	DO-1	DO-2
1	CP	120.5	141.8	40	170	176	160	220	620	8.5	8.85	0.2	0.5	17	27	0.25	0.25	11	5.2
2	CP	49.63	49.63	60	250	160	160	280	440	7.3	7.74	0.2	0.4	7	5	0.17	0.22	1.8	2.8
3	CP	156	163.1	70	220	204	200	460	520	7.86	9.06	0.6	0.9	23	25	0.1	0.01	2.4	3
4	CP	120.5	156	80	260	336	160	460	580	6.84	9.2	0.1	0.5	4	25	0.41	0.18	2.4	2.8
5	CP	304.9	340.3	100	220	168	152	760	360	7.44	8.12	0.1	0.4	5	9	0.48	0.48	2.8	3.2
6	FW	28.36	21.27	60	230	88	88	520	100	8.29	10.14	0.1	0.1	8	4	0.27	0.27	5.4	4.2
7	FW	21.27	21.27	60	230	128	80	360	20	7.9	9.23	0.3	0.5	14	5	0.15	0.28	6	5.8
8	GW	99.26	99.26	60	220	104	132	220	40	6.15	5.67	0.9	2.1	7	0	0.3	0.3	2.4	2.8
9	GW	163.1	198.5	100	250	180	176	400	200	6.43	5.99	0.1	0.4	3	6	0.49	0.69	3	4.4
10	GW	212.7	226.9	80	220	148	132	680	20	6.07	5.34	0.7	1.4	6	3	0.33	0.4	2.2	2.6
11	GW	56.72	35.45	90	230	120	40	240	220	6.57	5.4	0.1	0.3	3	0	0.42	0.07	4.8	6.8
12	GW	63.81	63.81	70	160	124	132	880	100	6.59	6.42	0.1	0.3	3	2	0.38	0.52	4.6	8.2
13	WHO	200	200	500	500					6.5-8.5	6.5-8.5	0.1	0.1			1.5	1.5		
14	ISI	250	250	300	300			300	300	6.5-8.5	6.5-8.5	0.3	0.3	10	10	1.2	1.2		
15	ICMR	1000	1000	600	600					6.5-9.2	6.5-9.2	1	1	25	25	1.5	1.5		
16	CPCB	1000	1000	600	600	600	600			6.5-8.5	6.5-8.5	1	1	10	10	1.5	1.5		

Table -2 CALCULATED VALUES OF AVARAGE VALUE , STDV & CV FOR ALL PARAMETERS IN BOTH THE PHASE

PARAMETER	AVARAGE VALUE	STDV	CV
CHLORIDE 1	116.3941667	83.36861797	71.62611354
CHLORIDE 2	126.4383333	97.44012416	77.06533422
HARDNESS-1	72.5	18.15338686	25.03915429
HARDNESS-2	221.6666667	29.79729498	13.44238871
TA-1	161.3333333	64.66323015	40.08051456
TA-2	134.3333333	45.07636618	33.55560758
TDS-1	420.273	156.5880307	37.25864632
TDS-2	592.74	159.1670172	26.85275453
PH1	7.161666667	0.837993636	11.70109801
PH2	7.596666667	1.74015325	22.90680013
IRON-1	0.291666667	0.281096338	96.37588748
IRON-2	0.65	0.566488386	87.15205931
TURBIDITY-1	8.333333333	6.37228849	76.46746189
TURBIDITY-2	9.25	10.2169645	110.4536703
FLOURIDE-1	0.3125	0.191665349	61.33291172
FLOURIDE-2	0.305833333	0.191665349	62.66986893
DO-1	4.066666667	2.595567317	63.82542583
DO-2	4.316666667	1.835921039	42.53098932

DO is one of the important parameters in water quality assessment. Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution or level of free, non-compound oxygen present in water. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. In our study DO of surface water ranged from 1.8- 11 mg/L in phase1 and 2.6 – 8.2 mg/L. In most of the cases slight increasing trend is recorded but there is a significant fall in sample no1 from 11mg/L to 5.2 mg/L. That sample source is the direct platform for a particular mythological act on a particular day of that festival. Both SD and CV value decrease in phase 2 as compared to phase 1 which can be attributed to aeration and decomposition of various kinds of substances as human activities is more in all CP. The higher value of dissolved oxygen can impart good aesthetic taste to drinking water .

Alkalinity of water is defined as the ionic concentration, which can neutralize the hydrogen ions. It is the concentration of soluble alkalis in a solution. In the study the TA value ranges from 88—336 mg/L in phase1 and 40- 200 mg/L in phase 2 .Except sample no 8 and 12 (both are groundwater sample) in all the cases there is a fall in the value in phase 2 as compared to phase1 . The SD and CV value also dropped in phase 2 which shows that the buffering capacity of water to resist pH change has declined. Aerobic degradation of organic waste may be a cause of decrease in alkalinity.

Figure -2 COMPARISON OF CV IN BOTH PHASE

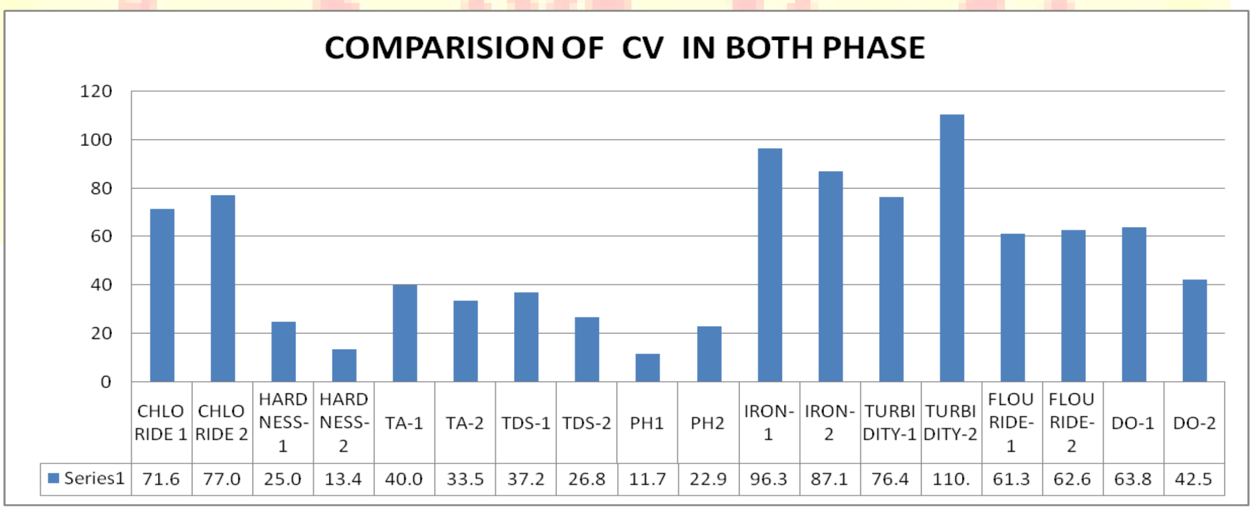
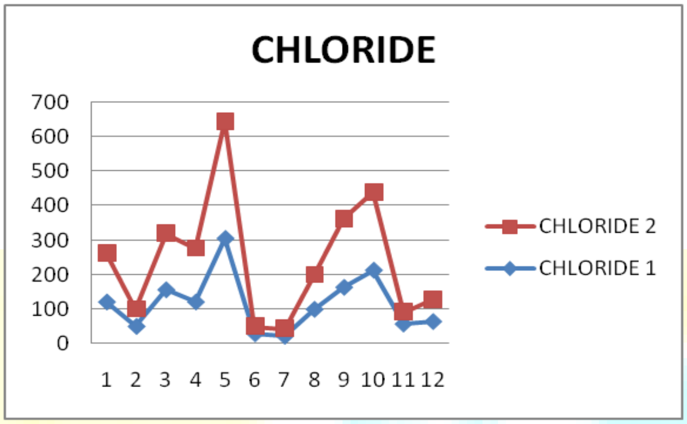
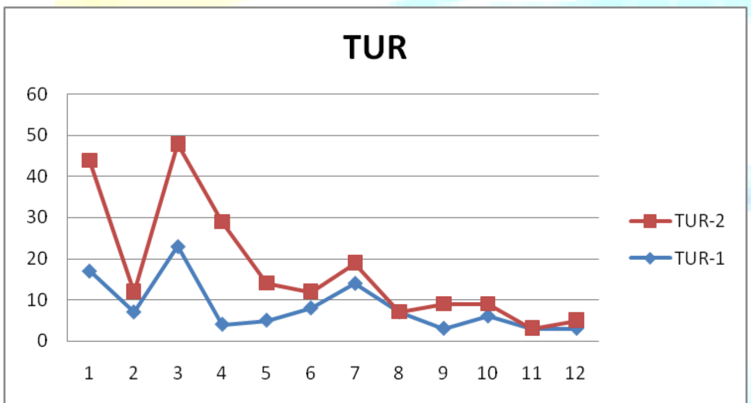
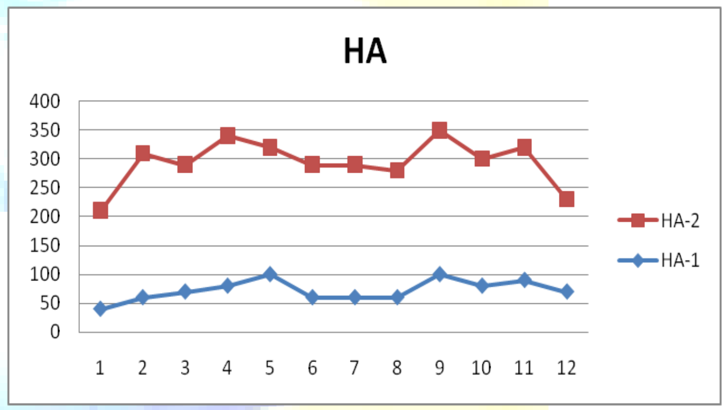
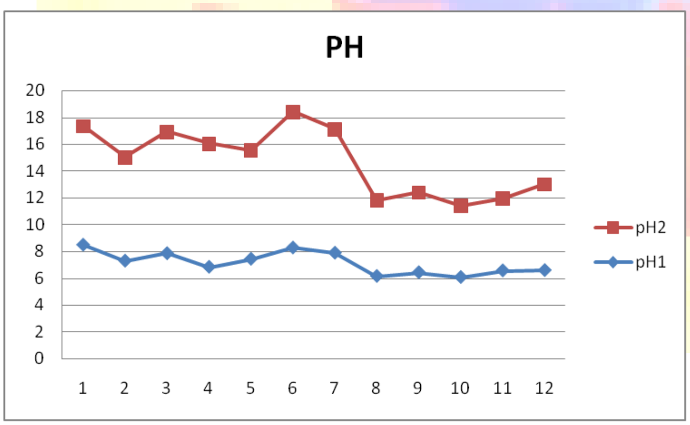


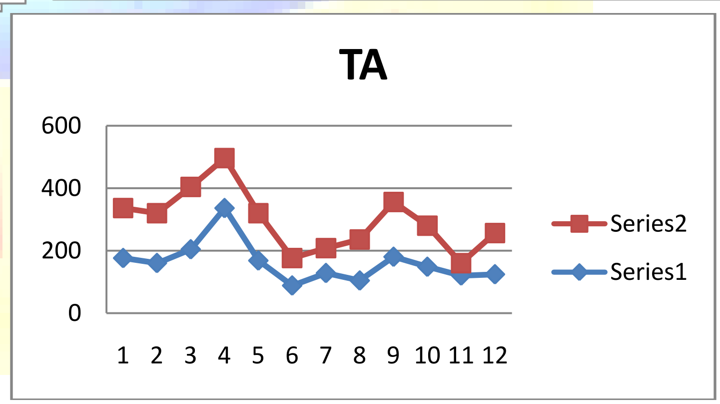
Figure -3 COMPARATIVE PLOT FOR ALL PARAMETERS PHASE-1 & PHASE-2

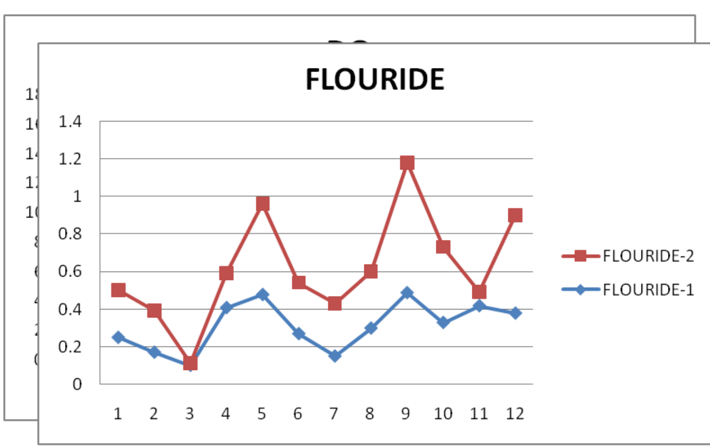


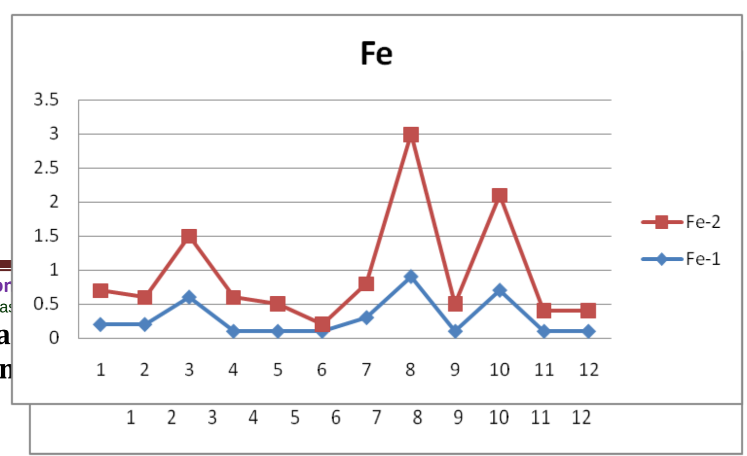












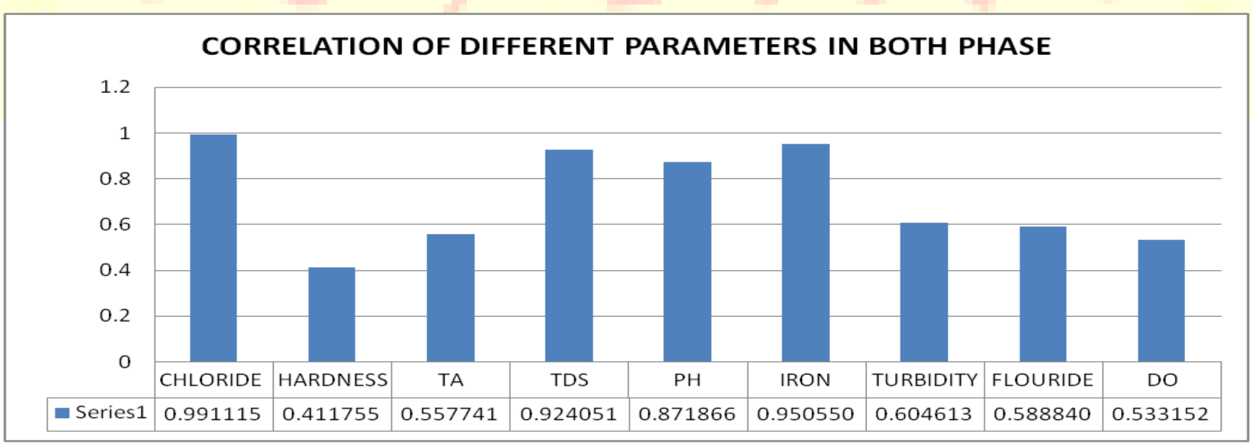
Correlation analysis

Correlation analysis measures the closeness of the relationship between chosen variables. If the correlation coefficient is nearer to +1 or –1, it shows the perfect linear relationship between the two variables. This way analysis attempts to establish the nature of the relationship between the water quality parameters. (Mulla, J.G. et. al. 2007. & J.Y. Patela ,M.V. Vaghanib , 2015). The Karl Pearson correlation matrix calculated for the water quality parameters is displayed in Table -3 .

Table -3

	CHLORIDE 1	CHLORIDE 2	HARDN	HARDNESS-2	TA-1	TA-2	TDS-1	TDS-2	PH1	PH2	IRON-1	IRON-2	TURBID	TURBID	FLOUR	FLOURID	DO-1	DO-2
CHLORIDE 1	1																	
CHLORIDE 2	0.991115292	1																
HARDNESS-1	0.565363562	0.552040183	1															
HARDNESS-2	0.003027059	0.031818967	0.4118	1														
TA-1	0.311020889	0.394725869	0.2137	0.35543506	1													
TA-2	0.512543923	0.569473033	0.0144	-0.003158554	0.5577	1												
TDS-1	0.8716643	0.905613746	0.6062	0.606242343	0.724	0.6059	1											
TDS-2	0.902962548	0.935304465	0.2353	0.246950884	0.5594	0.7575	0.924	1										
PH1	-0.196589225	-0.173711778	-0.536	-0.183978766	-0.013	0.0472	-0.164	-0.15	1									
PH2	-0.179728837	-0.125809223	-0.416	0.08409739	0.2977	0.149	-0.031	-0.02	0.872	1								
IRON-1	0.149667566	0.098442584	-0.245	-0.041605608	-0.189	0.171	-0.169	0.121	-0.32	-0.32	1							
IRON-2	0.223140137	0.186829174	-0.146	-0.016157	-0.109	0.1773	-0.183	0.194	-0.48	-0.44	0.951	1						
TURBIDITY-1	-0.051765955	-0.057439034	-0.566	-0.233005754	0.0527	0.3135	-0.284	0.012	0.68	0.543	-0.09	0.123	1					
TURBIDITY-2	0.235147411	0.298789645	-0.244	-0.070174036	0.7458	0.6011	-0.139	0.408	0.511	0.591	-0.09	-0.12	0.6046	1				
FLOURIDE-1	0.441341808	0.457945985	0.7421	0.072099838	0.1495	-0.092	0.339	0.321	-0.54	-0.47	-0.4	-0.16	-0.803	-0.241	1			
FLOURIDE-2	0.35056517	0.390735149	0.39	-0.145118555	-0.166	0.1831	0.482	0.317	-0.35	-0.36	-0.19	-0.06	-0.523	-0.379	0.589	1		
DO-1	-0.296474401	-0.274387733	-0.563	-0.593985884	-0.205	-0.255	-0.261	-0.42	0.614	0.323	-0.3	-0.33	0.3635	0.292	-0.16	-0.0809	1	
DO-2	-0.464836748	-0.477634907	-0.064	-0.568886548	-0.376	-0.515	0.144	-0.65	0.05	-0.15	-0.47	-0.48	-0.15	-0.264	0.154	0.14412	0.53	1

Figure -3 **CORRELATION OF DIFFERENT PARAMETERS IN BOTH PHASES**



The correlation analysis on water quality parameters reveals that all parameters are more or less correlated with each other Person's Correlation matrix. It is observed that some of the parameters do not have significant correlation among them indicating different origin sources of pollution.

In case of all parameters there is a positive correlation in their values in phase1 and phase 2. The nature of variation in both the phases is of the same pattern. The correlation coefficient R is maximum .99 in case of chloride where as minimum in case of Hardness (R= 0.41). Higher correlation is found in case of Iron, TDS and pH. The parameters are not, highly interrelated with each other. Except TDS- Chloride correlation (R= 0.9) in both the phases no other correlation coefficient value is close to 0.9 though individual parameter is highly correlated among them in both the phases . (Patil, V. T., and Patil, P. R. ,2010)

Chloride is having negative correlation coefficient with pH and DO, positive R value with TA, Fluoride, TDS and Fe in both the phases but in case of turbidity it changes from negative to positive. The shift is also not unusual .The maximum correlation (R = 0.87 – 0.94) is found with TDS in both the phases which may be because of free chloride ion.

The coefficient of correlation between Turbidity and TDS shifts from - 0.284 to 0.86 established the presence of various kind of suspended particles which may be from organic waste, human excreta, food waste, polythene , other chemicals contributed by various human activities as a result of high density population .**(**Jothivenkatachalam et.al. 2010**)**

The R value (0.72 and 0.75 in phase1 and phase 2) for TDS and TA remains almost constant but with pH, TDS is having a very small negative correlation (R = -0.16 and - 0.02) . This relationship indicates that the natures of suspended particles are such which is not having a significant influence on pH and TA. Hardness is having low negative correlation with all the parameters except TDS (R= 0.25) and pH (R = 0.08).

DO is having negative correlation with all the parameters except pH (R= 0.6) and turbidly (R= 0.3) in phase1 . In phase2 all the R value almost decreases to make the change of DO mostly independent of other factors. From correlation analysis, the negative relationship DO with other parameters reveals the high organic pollution with anthropogenic activities (N. Khatoon, A. H.Khan M. Rehman, V. Pathak, 2013), Alkalinity and hardness are related through common ions formed in aquatic systems. Specifically, the counter-ions associated with the bicarbonate and carbonate fraction of alkalinity are the principal ions responsible for hardness (usually Ca^{2+} and Mg^{2+}).As a result, the carbonate fraction of hardness (expressed as $CaCO_3$ equivalents) is chemically equivalent to the bicarbonates of alkalinity present in water in areas where the water interacts with limestone. Any hardness greater than the alkalinity represents non carbonate hardness. Though noncarbonated hardness is minor contributor but in our analysis as pointed out earlier , the difference of Hardness and TA establishes the presence of non carbonate hardness in phase 2 which is contributed by salts such as calcium chloride ($CaCl_2$), magnesium sulfate ($MgSO_4$), and magnesium chloride ($MgCl_2$) and ions like iron (Fe^{2+}), strontium (Sr^{2+}), and manganese (Mn^{2+}) may also contribute to hardness This interrelation of Hardness and TA may also be getting effected by the dissolution of carbon dioxide (CO_2) from the atmosphere. The idea of non carbonate hardness is further strengthened by the drop in correlation coefficient value from 0.31 to - .003.(Barbara Hauser , Drinking Water Chemistry: A Laboratory Manual)

Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. Alkalinity is related to pH because alkalinity establishes the buffering capacity of water. The alkalinity of water is caused mainly due to OH, CO_3, HCO_3 ions. In general, the alkalinity of most natural water supplies is caused by dissolved bicarbonate salts. Dissolved bicarbonates such as calcium bicarbonate ($Ca(HCO_3)_2$), sodium bicarbonate ($NaHCO_3$), and magnesium bicarbonate $Mg(HCO_3)_2$); and carbonates such as calcium carbonate ($CaCO_3$) are the major chemicals contributing to alkalinity in irrigation water. Dissolved hydroxides are but a minor contributor in most cases. Ammonia, borates, organic bases, phosphates, and silicates can also be minor contributors to alkalinity.

When the pH exceeds 8.2–8.4, the free CO_2 disappears and the bicarbonate begins to convert to the carbonate ion. This progresses to a pH of about 9.8–10, at which point all of the CO_2 originating alkalinity is essentially in the form of carbonate. The value of R increases slightly in all cases for TA with almost all parameters except turbidity where it changes from 0.05 to 0.6. From the correlation data the interdependence of pH and TA does not appear to be significant but influence of TDS on TA appears to be more prominent which is further supported by the R value of TA-Turbidity .

CONCLUSION

The presen study leads to the following conclusions:

1. Data reveals that all the open sources are getting affected more than GW samples but to a small extent which is not so alarming. The main sources of pollution are the increase in the human activities around the different sample sites.
2. Data also indicates that in all the sources values of all parameters are found to be within the permissible limits as prescribed by ISI and ICMR but in some cases it is beyond the permissible limits as prescribed by WHO in both the phases .
3. The correlation studies of the water quality parameters have a great significance in the study of water resources. The linear correlation is very useful to get fairly accurate idea of quality of the ground water by determining a few parameters experimentally.
4. To improve the quality of water there should be continuous monitoring of the pollution level.

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