INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 4, No 5, 2014

Research article ISSN 0976 – 4402

Correlation study to predict water quality for drinking purpose

Sunita Verma, Ajay Verma
Christ Church College, Kanpur - 208001, Uttar Pradesh, India
sunitaverma2k11@gmail.com
doi:10.6088/ijes.2014040404522

ABSTRACT

The present study on river Pandu was carried out to assess water quality indicators and correlation between physico-chemical parameters. The study clearly revealed that river is polluted to a considerable extent all through its entire stretch passing through Kanpur. High values of pollution indicating parameters noticed in the present study. The severely polluted stretch lies between stations 2 & 4 and to a considerable distance further downstream of station 4.Water at none of the stations is fit to be used as a source of potable water in the light of mandatory values recommended by I.S.I (IS;2296,1982). Association analysis established strong positive correlation between temperature, pH, total solids phosphate and sulphate. Total algal species established positive relation with DO and negative with COD.

Keywords: Water quality, Karl Pearson Correlation, water pollution, drinking water; physico-chemical parameters.

1. Introduction

One of the prime needs of the modern society is an ample and assured supply of water of an acceptable quality for its diverse needs. Inhabitants of the urban areas somehow get the treated water to meet out their needs but the rural folk generally rely on the raw river water within its reach, as they often lack any access to safe water supply. More than 80 % of the Indian population that inhabits in rural areas depends on hazardous Polluted and contaminated water (Biswas and Boruah, 2000; Singh and Mathur, 2005). Polluted water is the prime cause of 80% ailments e.g. cholera, gastro-enteritis, jaundice, diarrhoea, amoebiasis, infectious hepatitis etc (Ayeni et al, 2011). Factual information, about the water quality status at regular intervals of time and its related effects (Papita Das et al 2012). It is therefore highly imperative for an effective control of water quality. To safeguard our natural water resources, the government of India passed the Water (Prevention and Control of Pollution) Act, 1974 and made provisions in the constitution to this effect. Articles 48 A, 49 and 51 A of the Indian Constitution deal with the subject. Water to be used for a specified purpose should be of a specific standard, which differ according to its use (Wesley 2000; Khan et al 2004). No single parameter can, therefore serve as an index of over-all quality of water for diverse uses (Sami et al, 2011). To surmount this dilemma, Indian Standard Institute (I.S.I.) has specified, specific standards for specific use of water and has further specified diverse categories of water as A, B, C, D, and E (IS: 2296, 1982).

Kanpur a major industrial city situated about 90 Km west of the capital of Uttar Pradesh. The district forms part of Indo-Gangetic plain and is situated on the bank of river Ganga. The district is surrounded by Unnao in north, Fatehpur in east, Hamirpur in south and Kannauj from west. The district is unique in having most advance metropolitan cities like urban area

Received on October 2013 Published on March 2014

in and around the district headquarter, while the outskirts still have rural areas. At present the industrial expansion, the increase number of vehicles and large concentration of people, together with an unfortunate lack of environmental policies are forecasting serious water pollution in the district. Correlation analysis measures the closeness of the relationship between two variables at a time. The values of correlation coefficient nearer to +1 or –1, shows the probability of linear relationship between the variables x and y. This analysis attempts to establish the nature of the linear relationship between the variables and thereby provides a mechanism for prediction (Mulla et al. 2007, Kumar et al.2005; P. Lilly Florence et al. 2012).

2. **Material and methods**

The present study has been undertaken for a consecutive two years and Investigations have been made round the year but greater details could be worked out only during winter and summer because in monsoon period survey and study could not be carried out properly and got hampered due to overflow and inapproachability of the river.

At least five major drains pollute Kanpur frontage of the river namely

1. Panki Thermal Power Plant drain
2. Panki Municial drain
3. GandaNala drain
4. Halwakanda drain
5. Central Ordinance Depot (C.O.D.) drain

Table 1: Details of six sampling sites on River Pandu

Number and name of site	Location of site
Station 1	Upstream of confluence of Panki Power Plant Drain
Station 2	Downstream approx. 0.25 Km of confluence point
Station 3	Downstream Panki municipal Drain
Station 4	Approx. 30 Km downstream station 3
Station 5	Approx. 15Km downstream station 4
Station 6	Approx. 30 Km downstream station 5

Waste effluents from drains and water samples from the selected stations of the river were periodically collected as per standard procedure. Samples were invariably collected from the proper mixing zones. Random sampling was done at each station and the samples were then compounded to get a composite sample. Physical and Chemical analysis of the samples has been done as per Standard procedure prescribed by American Public Health Association (APHA, 1998).

Table l (a): Water quality parameters, units and methods of estimation

Parameters	Abbreviations	Units	Analytical methods
Temperature	Water temperature	^0C	Centigrade thermometer
TH	Total hardness	$CaCo3mgl^{-1}$	EDTA Titrimetrically
TS	Total solids	$mg\ l^{-1}$	
pH	Hydrogen Ion Concentration	pH unit	pH meter
DO	Dissolved Oxygen	$mg\ l^{-1}$	Winkler's Azide modification method
BOD	Bio-Chemical Oxygen Demand	$mg\ l^{-1}$	Dilution technique and seeding technique
COD	Chemical Oxygen Demand	$mg\ l^{-1}$	Open reflux method
Cl	Chloride	mg/l	Argentometric method
PO_4	Phosphate	mg/l	Stannous Chloride method
NO_3	Nitrate	mg/l	Phenol - di - sulphuric acid method
NH_4	Ammonia	mg/l	Nesslerization method
SO_4	Sulphate	mg/l	Turbidity method

The observations were expressed as mean ± S.E.M. (Standard Error Mean) and calculated via Statistical software. Further, the Karl Pearson's correlation coefficient, r for total data were computed using SAS software version 9.3.

3. Results and discussion

The comparative picture of sampled samples for studied parameters is reflected in Table 2. The correlation co-efficient analysis of physic-chemical parameters of water samples and total species had reflected in table 3. Temperature plays a crucial role in physical chemical and biological behaviour of aquatic systems and ranged from 25.7 to 27.84 °C. The pH plays important role in water treatment and for fixing alum dose in water supply. Higher values hasten the scale formation in water heating apparatus and reduce germicidal potential of chloride. The pH of the samples found to vary from 7.8 to 8.3.

High chloride content in water may be due to pollution from chloride rich effluent of sewage and municipal waste, however chloride in excess imparts salty taste to water and people who are not accustomed to high chloride are subject to laxative effect. Sharp variation has observed from 45 to 80.7mg/l values. Total hardness is mainly due to Ca, Mg and Eutrophication. The water containing excess hardness is not desirable for potable water as it forms scales on utensils when used for cooking and consume more soap during washing of clothes. The total hardness value varied from 557 to 1087mg/l.

The main sources of nitrate in water are human and chemical waste, industrial effluent, use of chemicals and fertilizers, silage from drainage system. When nitrate concentration is above 40 mg/dm3, t may leads to a disease called Methamoglobinemia or blue baby in children. The nitrate values were found between 0.05 to 1.56. High concentration of Sodium and magnesium sulphate exerts a cathartic action in human beings. It is also associated with respiratory illness. The higher values of sulphate 12.7 estimated at station 4. Biological oxygen demand is the measure of the extent of pollution in the water sample. The untreated discharge of municipal and domestic waste in water bodies increases the amount of organic contents. Therefore the microbes present in water require more amount of oxygen for its degradation. Thus the BOD of water gets increased. The estimated values are in range 21.2 to 67.1 mg/l.

Chemical oxygen demand test measures the oxygen demand of biodegradable pollutants plus the oxygen demand of non-biodegradable oxidisable pollutants. COD is a water quality measure used not only to measure the amount of biologically active substances such as bacteria but also biologically inactive organic matter in water. For drinking water the BOD should be less than 5ppm and COD less than 10ppm.Reports linked mortality due to liver cancer with COD in drinking water. Potable water should be free from such impurities, which cause offensive taste, smell and sense of sight (Gupta et al.2009; Patient Guedeon, 2011; Rai et al, 2012). As per I.S.I., any water to be used as potable water should satisfy the mandatory values specified under the head Class-A. It is evident from data in the table 1 that pH of the river water is within the prescribed limit of 6.5 to 8.5 at all stations, whereas total solids far exceed the prescribed limit of 500 mg-1 at all stations except station-1. Chloride and sulphate contents are within the prescribed limits of 250 mg-1 and 400 mg-1 respectively but the average hardness values at all the stations far exceed the mandatory value of 300 mg-1. Except station 1, average D.O. values are lower than the prescribed limit of 6.0 mg/l and at times declined to nil during summer when oxygen -stressed conditions prevail. BOD values are many fold higher than the mandatory value of 2 0 mg/l. All these factors indicate that river water is not up to the mark, throughout its entire stretch investigated and is unsuitable to be used as potable water without proper treatment. Intensity of pollution in the river has intensified in the course of time and has worsened severely the water quality and endangered algal community and biological diversity as a whole.

Association analysis establishes strong positive correlation between temperature and pH values. Moreover pH exhibited strong positive correlation with total solids, phosphate and sulphate observations under study. Total solids in various stations demonstrated very significant positive and negative correlations with chloride and transparency respectively. Total algal species established significant positive relation with DO and negative with COD. Total solids significantly positive correlated with COD, chloride and phosphate more over inverse relationship with transparency and DO values. Similar findings observed by Verma et al 2012 by regression equations among physiochemical water pollution indicators.

Table 2: Comparison of Physico – chemical properties of samples with BIS and WHO standards

	Stat1	Stat 2	Stat 3	Stat 4	Stat 5	Stat 6	Bureau of Indian Standards	WHO Standards
Temperature	25.11	27.84	25.7	26.85	25.8	27.1		
pH	7.8	8.2	8.1	8.3	8	8.2	6.5-8.5	6.5-8.5
Total solids	121	934	587	830	417	469	500	500
Transparency	17.2	3.3	8.4	7.2	14.9	13.7		
DO	6.0	2.4	1.8	2.3	3.2	4.1		
BOD	21.2	39.5	45.2	67.1	44.4	33		6
COD	20.23	222.4	164.6	143.6	98.02	67.93		10
Chloride	25.5	80.7	62	75	55	45	250	200
Total hardness	805	966	557	1087	775	672	300	100
Ammonia	0.46	2.6	18.6	9.1	9.1	2.5		
Nitrate	0.15	0.05	0.47	0.43	0.69	1.56	45	45
Phosphate	0.24	1.72	1.47	2.09	1.39	1.26		
Sulphate	0.78	5.3	4.4	12.7	3.12	4.8	200	200
TAS	35	16	16	25	22	25		

Table 3: Correlation coefficient analysis of physic-chemical properties of water and total algal species

	Temp	pH	Total Solids	Trans	DO	BOD	COD	Chloride	Total hardness	Ammonia	Nitrate	Phosphate	Sulphate	TAS
Temp	1.000													
pH	0.817*	1.000												
Total solids	0.811*	0.865*	1.000											
Trans	-0.712	-0.739	-0.957**	1.000										
DO	-0.447	-0.729	-0.828*	0.805*	1.000									
BOD	0.313	0.723	0.690	-0.564	-0.772	1.000								
COD	0.625	0.647	0.914*	-0.957**	-0.877	0.538	1.000							
Chloride	0.693	0.796	0.973**	-0.928**	-0.901*	0.755	0.940**	1.000						
Total hardness	0.462	0.361	0.514	-0.418	-0.106	0.477	0.283	0.477	1.000					
Ammonia	-0.275	0.213	0.224	-0.273	-0.711	0.551	0.394	0.363	-0.380	1.000				
Nitrate	0.151	0.274	-0.197	0.369	0.096	-0.059	-0.374	-0.259	-0.447	-0.034	1.000			
Phosphate	0.664	0.906*	0.905*	-0.781	-0.897*	0.884*	0.778	0.930**	0.415	0.433	0.044	1.000		
Sulphate	0.520	0.835*	0.727	-0.597	-0.592	0.899*	0.453	0.691	0.631	0.240	0.017	0.826*	1.000	
TAS	-0.488	-0.568	-0.725	0.747	0.891*	-0.415	-0.882*	-0.788	0.137	-0.571	0.046	-0.703	-0.224	1.000

*Significant at 5% and **significant at 1%

4. Conclusion

This study clearly reveals that river is polluted to a considerable extent all through its entire stretch passing through Kanpur. Water at none of the stations is fit to be used as a source of potable water in the light of mandatory values recommended by ISI (IS: 2296, 1982). Well directed efforts are absolutely imperative to alleviate and abate such menacing pollution.

Acknowledgment

The authors are grateful to the Principal, Christ Church College, Kanpur for providing research facilities and to UGC, New Delhi for financial support.

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