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Studies of Ground water quality assessment at industrial belt of Kashipur, Uttarakhand, India

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Abstract

Pollution of ground water is one of the areas of major concern to environmentalists. Water quality is an index of health and well being of a society. Industrialisation, urbanisation and modern agriculture practices have direct impact on ground water resources. These factors influence the ground water quantitatively and qualitatively. Ground water is an important source of potable water supply for Kashipur as well as adjoined areas of the U. S. Nagar district for all purposes. Ten different locations were selected for the study and compared. Attempts were made to study and analyze the physico-chemical characteristics of the water. The parameters studied were temperature, pH, total alkalinity, total hardness, chloride, sulphate, total dissolved solids, calcium, magnesium and conductivity. By observing the result it can be concluded that the parameters of the water quality are found below the pollution level for ground water which satisfy the requirement for the use of various purposes like domestic, agricultural, industrial etc.in Kashipur area.

Keywords*:Ground water, dissolved oxygen, water quality, kashipur, monitoring.*

Introduction

India has experienced substantial increases in industrial growth and expansion in recent years. The industry has resulted in increased pollutant emissions and the deterioration of environmental quality and human health in major cities in India. After formation of Uttarakhand as a new State rapid industrialization and urbanization took place due to this there is great pressure on the environmental components. Kashipur is an old industrial town of Uttarakhand State, earlier belonging to Uttar Pradesh. This town experienced industrialization with few major type of industries working in this area belongs to distillery, chemical, paper and other small industries.Human needs are growing rapidly and the need for water is also growing. Much of the current concern with regards to environmental quality is focused on water because of its importance in maintaining the human health and health of the ecosystem. The availability of water determines the location and activities of humans in an area and our growing population is placing great demands upon natural fresh water resources (Oladipo*et al*., 2011).The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to water quality and depletion of aquatic biota. Water sources were polluted by domestic wastage in rural areas whereas industrial wastages discharged into natural water sources in urban areas (Sayyedand Bhosle*et al*., 2010). It is therefore necessary that the quality of drinking water should be checked at regular time interval because due to use of contaminated drinking water, human population suffers from a variety of water borne diseases (Ogbonna*et al*., 2011). Fresh water is a finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible (Kumar, 1997). Fresh water resource is deterotating day-by-day at the faster rate and the water quality is now a global problem (Mahanand*aet al*., 2005). Discharge of toxic chemicals, over pumping of aquifer and contamination of water bodies with substance that promote algae growth are some of the today's

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major cause for water quality degradation. Direct contamination of surface water with metals in discharges from mining, smelting and industrial manufacturing, is a long-standing phenomenon. Today there is trace contamination not only of surface water but also of groundwater bodies, which are susceptible to leaching from waste dumps, mine tailings and industrial production sites (Moore *et al*., 1998). Water quality reflects the composition of water as affected by natural cause and man's cultural activities expressed in terms of measurable quantities and related to intended water use (Kumar, 1997). The composition of surface and groundwater is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal difference in runoff volumes, weather conditions and water levels (Muller *et al*.,2001). One of the major reasons of ground water pollution in India is unplanned urban development without adequate attention to sewage and waste disposals (Yadavand Kumar, 2011).Pollution caused by fertilizers and pesticides used in agriculture, often dispersed over large areas is a great threat to fresh groundwater ecosystems. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is another major concern in many cities and industrial clusters in India. Hence there is a need and concern for the protection and management of ground water quality. The major problem with the ground water is that once contaminated, it is difficult to restore its quality. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to water quality and depletion of aquatic biota. It is well known that no straightforward reasons can be advanced for the deterioration of water quality, as it is dependent on several water quality parameters. It is therefore necessary that the quality of drinking water should be checked at regular time interval because due to use of contaminated drinking water, human population suffers from a variety of water borne diseases. Water quality is based on the physical and chemical soluble constituents due to weathering of parent rocks and anthropogenic activities (AkinbileandYusoff, 2011). The main object of the physicochemical analysis of water is to determine the status of different chemical constituents, which are present in the natural and disturbed aquatic ecosystem. The quality of water may be affected in various ways due to pollution.The present investigation aims towards analysis of the water quality of the 10 different sites in Kashipur city/ industrial area, Udham Singh Nagar district, Uttarakhand, India with special reference to total dissolved solids, total hardness, total acidity, total alkalinity, pH, calcium, magnesium, sulphates, and chlorides.

Description of Study area

Kashipur has been identified as one of the potential Industrial developing area in Uttarakhand. The study area located in the industrial area of Kashipur in Udham Singh Nagar district of Uttarakhand between 29°10'32.1798' North latitude and 79°0'24.3457" East longitude. Major industries in the study area can be categorized broadly into three: viz., Pulp & Paper, Chemical and Steel as given below in Table 1.This town experienced an industrialization way back in 1988 – 1989. Few major type of industries working in this area belongs to Distillery, Chemicals, Paper and other small industries. After formation of Uttarakhand in the year 2000 and due to fiscal benefits various kinds of industries are coming up in this area, which includes paper, distillery, chemical, and gas based thermal power.The major sources of pollutants of Kashipur are domestic wastage due to unplanned urban development and industrial waste from the process of chemical plant, paper industries and mining activity without adequate attention to sewage and waste disposals.

Selection criteria of siting the monitoring station

Total of 10 different location were identified to collect the ground sample. Each such sited station represents a unique category of microenvironment. Sampling point selected based on the criteria mentioned below:

1. Zone of possible pollutant concentration.
2. Area of population exposure.
3. Dispersion of pollutants from other sources located outside the study area.
4. Non-Industrial reference station providing background level

Table 1. Industrial Activity in Kashipur Area

Industry	Location	Product
India Glycols Limited	Bazpur Road	Chemicals
Goraya Straw Board Mills Pvt Ltd	Bazpur Road	Paper
Multiwal Pulp & Board Mills (P) Ltd.	Bazpur Road	Paper
Prolific Papers (P) Limited	Village Girdhai, Aliganj Road,	Paper
Cheema Papers Ltd	Nainital Road	Paper
Shravanti Energy	Aliganj Road	Electricity (yet to start)
Gama Energy	MahuaKheraGanj	Electricity (yet to start)
Beta Energy	MahuaKheraGanj	Electricity (yet to start)
Naini Paper	Ramnagar Road	Paper
SRF	Ramnagar Road	Chemical
KashiVishwanth Steels Ltd	Bazpur Road	Steel, Special Alloys
Jindal Baverages	Bazpur Road	Frozen Foods, Edible Oils

Sampling points were selected within the 10 Kms radius of study area. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc. Location plan of the sited Ground water monitoring point is presented in Figure 1 and each station site is briefly described below:

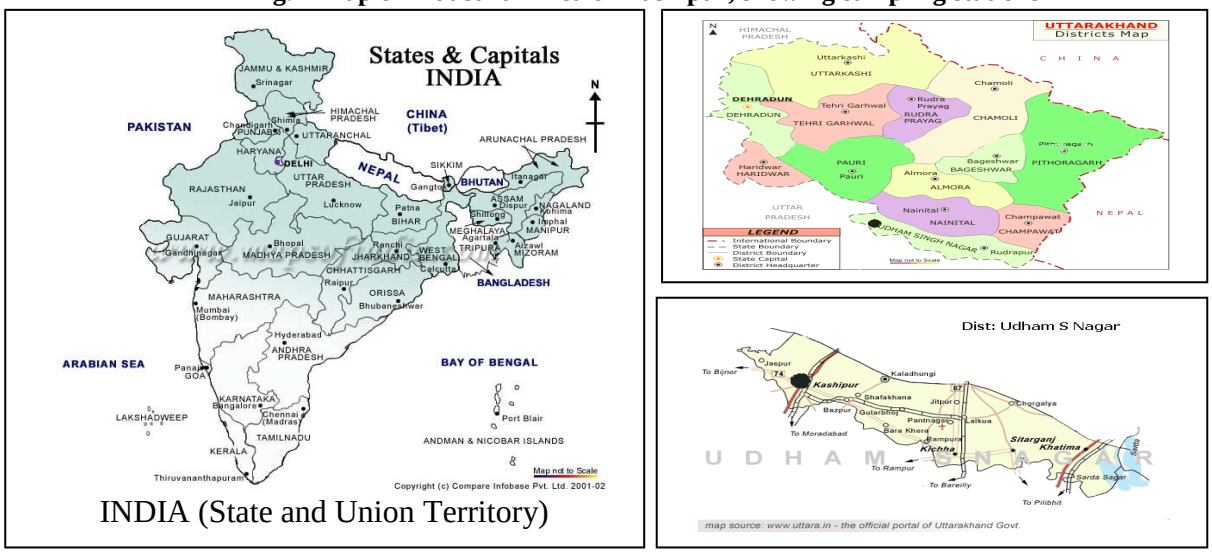
A-1 Industrial area is located around 7 km east of Kashipur city. Uniqueness of this sampling point is the fact that all other samples are collected within 10 km radius of this sampling point. *GinniKhera*is a very small village located around 3 km of Prolific Papers (P) Limited. Uniqueness of this station is that, it is away from industries (except a paper plant) and city. The selected sampling point is considered to be agriculture land and exhibit intense agri-business and rural activity. *Nandrampur*is a village located near A-1 industrial area Kashipur. *DhakiaKalan*is a village located around 7 km north east of A-1 industrial area. Uniqueness of this station is it is away from industries but mining activity has been noticed near this area, thus it can give impact of leaching from dumps, mine tailings. *DabhauraMustahkam*is a village located around 3.5 km south east of India Glycols and around 2.5 and 2 km east of Chima Paper and Multiwall Paper respectively. *Barkheri*is a village located around 2 km west of Chima Papers and around 2 km South of A-1 industrial area. Uniqueness of this station is the fact that it is affected with pollution load of paper and chemical industry and unpaved road. *KharakpurDevipura* is a village located around 4 km west of India Glycols Limited and in between A-1 Industrial area and Kashipur City. Uniqueness of this station is that, it is away from industries and city. The selected study station is considered to be agriculture land and exhibit intense agri-business and rural activity. *Kashipur sampling point* will represent the pollution load domestic sewage penetrate to round water. Gangapurgosain is located in aproximaely 6 km north of A-1 Industrial area. The sampling point is considered to be agriculture land and exhibit agri-business.

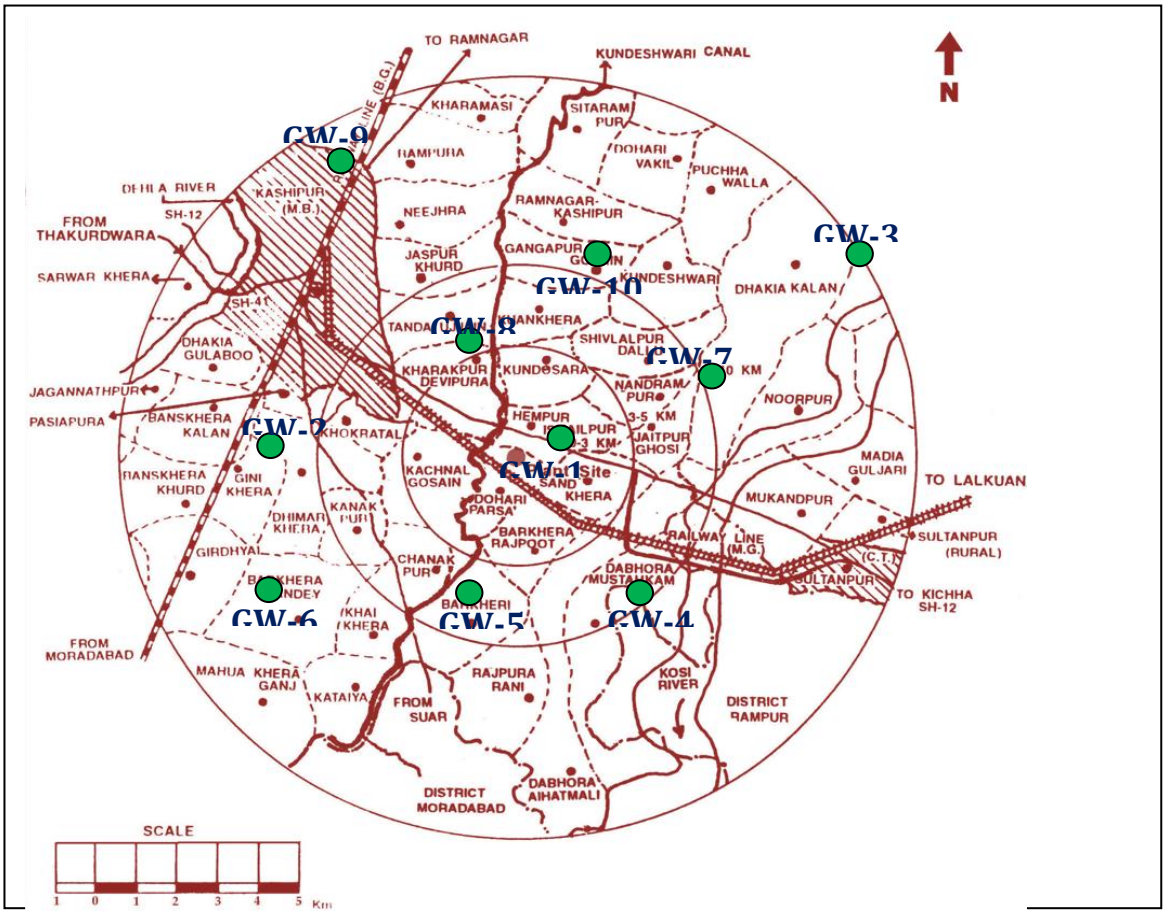
Water Sampling

The samples were collected in pre-cleaned and sterilized polyethylene bottles of two litre capacity. The depth of the bore wells varied between 250 and 700 feet. The groundwater samples were analyzed using APHA (1995) procedure, and suggested precautions were taken to avoid contamination.The various parameters determined were pH, color, EC (electrical conductivity), total dissolved solids (TDS), total hardness (TH), calcium (Ca^{2+}), magnesium (Mg^{2+}), carbonate (CO_3^{2-}), bicarbonate ($HCO3^{-}$), chloride (Cl^{-}), sulfate ($SO4^{2-}$), Sodium (Na^{+}), potassium (K_{+}), Nitrate ($NO3^{-}$), BOD(3 days at 27 degC), COD. Various physicochemical parameters such as pH, electrical conductivity, total alkalinity, total hardness as well as calcium, magnesium, sodium, potassium,

chloride, nitrate, carbonate, and bicarbonate were analyzed with the determination of BOD, COD, total coliform and Fluoride. In general, the ground water had no colour, odour and turbidity except few samples.

Fig. 1 Map of Industrial Area of Kashipur, showing sampling stations





Methodology (Sampling and Analysis)

Table 2: Techniques used for water quality monitoring

Parameter	Technique
1. Water temperature	Water temperature was recorded in the field using mercury thermometer.
2. pH	The pH of the samples was determined by using digital pH meter
3. Turbidity	Turbidity was determined by Naphelo-turbidity meter
4. Total hardness	Total hardness was determined tetrimetrically using EDTA method
5. Total alkalinity	Total alkalinity was determined by tetrimetrically method.
6. BOD	BOD was determined as per standard method. (3days at 27 degC)
7. COD	COD was determined by potassium dichromate open reflex method
8. Chlorides	Chlorides were determined by Mohr's argentometry method.
9. Nitrate and phosphate	Nitrate and phosphate content is determined per standard method
10. Fluoride	Fluoride content is determined using ELICO-52 UV spectrophotometer

Results and Discussion

The maximum value of pH of the water samples was recorded as 7.61 at station GW6 and minimum value of pH was recorded as 6.86 at station GW7. In general pH was within the limits of standard value. For drinking water source, a pH range of 6.5-8.5 is recommended.The present study shows the turbidity in the range of 0.2 -1.1 NTU. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU. The value of turbidity present is within permissible limits.The alkalinity of water is its capacity to neutralize acids. The maximum alkalinity was recorded as 172 mg/l at station GW1 and minimum value is recorded as 121 mg/l at station GW7. BIS has set a desirable level of alkalinity in drinking water to be 200 mg/l where as its value has been prescribed to be 600 mg/l in the absence of alternative source. So in maximum stations value of total alkalinity present in water are within limit. In the present study water samples of different locations was observed in the range of 115-240 mg/l. The amount of dissolved calcium and magnesium in water determines its "hardness." The hardness of water is not a pollution parameter but indicates water quality. Hardness has no known adverse effects on health. However, maximum permissible level prescribed by WHO for drinking water is 500 mg/L.Biochemical oxygen demand is usually defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives an idea about the extent of pollution. In present study BOD was found in the range of 1.5-2.5 mg/l, it indicatesthat the pollution affects the water quality. As water can be use as drinking water without conventional treatment but after disinfection if BOD is 2 mg/l or less.The chemical oxygen demand is a measure of oxygen equivalent to the requirement of oxidizing organic matter contents by a strong chemical agent. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. The maximum COD value was recorded 52.8 mg/l at GW1 and the minimum values was recorded as 25 mg/l at GW3. The high value of COD due to high level of pollutants present in water samples.In water, total dissolved solids (TDS) are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. The maximum TDS value was recorded 414 mg/l at GW7 and the minimum values was recorded as 258 mg/l at GW6. The permissible limit of TDS of drinking water is 500 mg/L. The observation shows that the TDS is within the permissible range as prescribed by WHO (2004).Chlorides occur in all natural waters in widely varying concentrations. The chloride contents normally increases as the mineral content increases. In present study the chloride concentration were found in the range of 13-28 mg/l. The maximum chloride contents were due to addition of natural contaminants and pollutants at A-1 industrial area. According to WHO, maximum permissible limit for chloride is 500 mg/L. The value observed in present study is in the range of permissible limit.The nitrate content of

water bodies was found in the range of 0.13-0.32 mg/l. The highest value of 0.32 mg/l was recorded at station GW1 (A-1 industrial area) while minimum at station GW6 (BarkheraPande). The value observed in present study is in the range ofpermissible limit of drinking water standards of ICMR. (Limit of Drinking water as per ICMR 20 ppm and ISI 45 ppm).The sulphate content varies between 7.2 to 21.5 mg/l. The sulphate value was also found to be within the prescribed limits.The fluoride content in water is below detectable limit.

Table 3: Average value of pollutants in 2011

S. No	Parameter	Unit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10
			A-1 industrial area Ginnikhera		Dhakiakalan	Dhaboramustakham	Barkheri	Barkerapande	Nand Rampur	Kharakpur Devipura	Kashipur	Gangapurgosain
1.	pH	-	7.42	7.54	6.95	7.42	7.39	7.61	6.86	7.33	7.46	7.24
2.	Color	Hazen	C.L.	C.L.	C.L.	C.L.	C.L.	C.L.	C.L.	C.L.	C.L.	C.L.
3.	Conductivity	µδ/cm	42.8	46.1	22	41.4	32.2	24.8	52.2	45.1	47.1	45.8
4.	Total Coliform	MPN/100 ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
5.	B.O.D. (3days at 27 deg C)	mg/l	1.5	2	2.2	1.8	2	1.6	2.5	2.5	1.8	2
6.	COD	mg/l	52.8	41.1	25	38.4	26.2	18.8	36	45.1	28.2	32.4
7.	Total Dissolved Solids	mg/l	378	370	387	330	376	258	414	315	358	347
8.	Turbidity	NTU	0.4	0.3	0.5	0.2	0.6	1.1	0.4	0.4	0.6	0.5
9.	Total Alkalinity as CaCO3	mg/l	172	122	136	132	143	142	121	140	135	141
10.	Total Hardness as CaCO3	mg/l	211	115	205	168	182	221	228	240	224	198
11.	Calcium Harness as CaCO3	mg/l	136	152	153	118	136	130	162	180	131	141
12.	Chlorides as Cl ion	mg/l	28	15	16	13	17	10	14	14	15	13
13.	Sulphates as SO4-	mg/l	12	21.5	9	7.2	15.2	17.8	10.2	14.4	20.4	18.2
14.	Nitrates as NO3	mg/l	0.25	0.32	0.19	0.17	0.23	0.13	0.26	0.15	0.28	0.16
15.	Sodium	mg/l	31.6	37.2	24.7	30.8	36.3	38.6	23.7	30.8	27.9	30.7
16.	Potassium	mg/l	22.2	16.4	19.8	26.6	23	28.1	20.6	23.7	21.3	26.4
17.	Iron as Fe	mg/l	0.07	0.15	0.16	0.12	0.13	0.13	0.08	0.1	0.18	0.15
18.	Fluoride as F	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19.	Zinc as Zn	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Conclusion

The result revealed that there was significant variation in some physicochemical parameters and most of the parameters were in the normal range and indicates better quality of water. It has been found that the water is best for drinking purpose in all the areas. In general all the parameters arewithin the range of standard values prescribed by various agencies.

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