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Assessment of Nitrate levels in Groundwater's of Budgam District, Kashmir Valley, India

KEYWORDS: Baseline study, Anthropogenic impacts, Organic nitrogen, Hazardous, Health, Methemoglobinemia

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ABSTRACT *Sampling was carried out during October 2008, with a view to understand the source of nitrate ions in the groundwater of Budgam District. Eleven sampling sites were selected and samples were taken for a baseline study and overall physico-chemical characteristics were studied. Results showed that NO3− concentration ranged from 7.4 mg/L to 9.8 mg/L with an average of 8.2 mg/L. All the samples collected were having nitrate concentrations below than 50 mg/L, the maximum acceptable nitrate concentration for drinking water.*

Presence of nitrate in Ground waters can be attributed to anthropogenic impact as NO-3 that enters the water systems originates as NO-3 in animal wastes or fertilizers applied to the land surface. These are designated as direct nitrate sources. In other cases, NO-3 originates by conversion of organic nitrogen or NH+4, which occur naturally or are introduced to the soil zone by man's activities. There is a narrow spatial variation in the nitrate concentration in the groundwater, lowest concentrations of nitrate were found at site 7 while the highest concentrations were found at site 5.

Nitrate water pollution is very hazardous to humans. The best-known health problem arising from nitrate consumption is methemoglobinemia, a fatal disease characterized by cyanosis.

Introduction

Many regions all over the globe entirely depend on groundwater resources for their water requirements. Land use practices have greatly polluted the groundwater quality. Nitrate is a widespread contaminant of ground and surface waters worldwide (Hallberg, 1989; Puckett, 1995). As stated in the EPA publication "Is Your Drinking Water Safe?"(US EPA Office of Water (WH-550)) "Only two substances for which standards have been set pose an immediate threat to health whenever they are exceeded: bacteria and nitrate." Nitrate is the most frequently introduced pollutant into groundwater systems (Imran A Dar et al, 2010; Spalding and Exner, 1993). Many local sources of potential nitrate contamination of groundwater exist such as, "sites used for disposal of human and animal sewage; food processing wastes "(Hallberg and Keeney, 1993). Significant portion of nitrate export from catchments is due to non-point source; fertilizer runoff (Howarth et al, 2002). Recent studies revealed that groundwater contamination by nitrate is a globally growing problem due to the high rate of population growth and increasing consumption (Imran A Dar et al, 2010). The best-known health problem arising from nitrate consumption is methemoglobinemia, a fatal disease characterized by cyanosis. It is noteworthy that infants are more susceptible to this disease (Canter, 1987). Numerous studies indicate a possible link between nitrate and cancer (Tannen and Correa, 1985; Dissanayake and Weerasooriya, 1987). The quality of water in the developing countries like India has been so degraded that it is very difficult to find out good quality drinking water. An attempt has been made in this work to evaluate the nitrate content of the study area.

Study area

Budgam District, of Kashmir valley lies between 33° 20´ and 34° 54´ North latitudes, and 73° 55´ and 75° 35´ East longitudes and is located at an average elevation of about 5,281 ft above mean sea level and covers an area of about 1371 sq. km (Fig:1). The Physiography of area consists of mountains towards south, south –west and North, plain towards town.

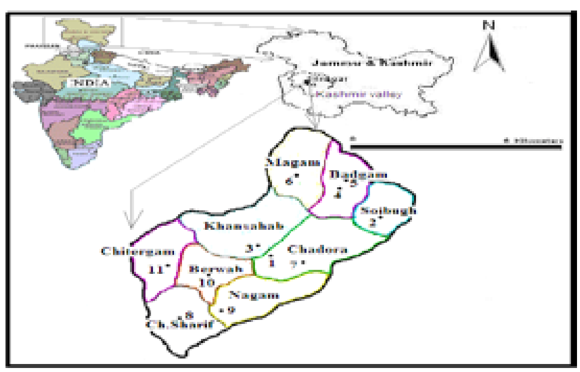

Fig.1. Study area Map and sampling locations

Materials and Methods

Groundwater samples were collected at 11 locations (Fig.1.) in high density polyethylene (HDPE) bottles during October 2008. Measurements of electrical conductivity, pH, and temperature were carried in the field with the help of digital water analysis kit. For major ion characterization, the samples were filtered through <0.45 μm

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nucleopore filter paper and brought to the laboratory and were analyzed for the major ions as per the standard methods (APHA, 1998). CO_3^- and HCO_3^- were determined by titrating with HCl. Total hardness as $CaCO_3$ and Ca^{++} were analyzed titrimetrically, using standard EDTA. Magnesium (Mg^{++}) was calculated from the total hardness and Ca^{++}. Cl^- was determined by standard $AgNO_3$ titration. Flame emission photometry has been used for the determination of Na^+ and K^+.

The method used to determine the NO_3^- concentration can be summarized in the following steps: (1) stock nitrate solution: 7.218 g of dried and pure KNO_3 was dissolved in 1,000 mL deionized water. Concentration equals to 4,430 mg/L of NO_3^-. (2) Intermediate nitrate solution: an aliquot of 100 mL stock nitrate solution was diluted to 1,000 ml with deionized water. Concentration equals to 443 mg/L of NO_3^-. (3) Standard calibration curve: NO_3^- calibration standard solutions in the range of 0-40 mg/L NO_3^- were prepared from the intermediate nitrate solution. (4) Spectrophotometric measurements: the absorbance was read at 220 nm to obtain NO_3^- readings and at 275 nm to determine the interference due to dissolved organic matter. The absorbance at 275 nm was subtracted from the absorbance at 220 nm to obtain absorbance due to nitrate. (5) A standard calibration curve was constructed by plotting absorbance due to nitrate against NO_3^- concentration of the standards. NO_3^- concentration in the sample was directly read from the standard calibration curve.

Result and Discussions

The different water quality parameters of the study area were determined at 11 sites in October 2008 and the results are presented in Table 1. Groundwater was alkaline in nature (pH: 6.7-7.8); characterized by medium electrical conductivity (EC: 170.3-235.9µS/cm); medium total dissolved solids (TDS: 109–151mg/l); medium Dissolved oxygen (D.O: 6.7-10.8 mg/l); Calcium concentration ranged from (21.5 to 29.8 mg/l); Magnesium concentration ranged from (14.6 to 22.2 mg/l); Na concentration ranged from (4-7 mg/l); K concentration ranged from (1-3 mg/l), chloride concentration ranged from (11.3 to 17.6 mg/l) and nitrate concentration ranged from (7.4-9.8 mg/l).

Calcium ion dominates the cation chemistry concentration in the study area with average value of 26.2 mg/l; the principal sources of calcium in ground water are some members of the silicate mineral group like plagioclase, pyroxene, and amphibole among igneous and metamorphic rocks and limestone gypsum among sedimentary rocks. Silicate minerals are not soluble in water, but weathering breaks them down into soluble calcium products and clay minerals (Karanth 1987; Imran et al, 2010). Average concentration of magnesium of the study area was recorded 18.6 mg/l, besides sewage and industrial wastes, presence of olivine, augite, biotite, and talc magnesium-bearing minerals are responsible for the presence of magnesium in ground water (Karanth, 1987). Average value of Na was recorded 4.8 mg/l, the major sources of sodium in ground water are from weathering of different types of plagioclase feldspars and clay minerals, etc. The average value of chloride was recorded 14.2 mg/l. The most important source of chloride ions in the water may be the decomposition of pyroxene chloride. The average value of nitrate was recorded 8.2 mg/l, unlike most other elements nitrate is not derived primarily from the minerals in rocks (Driscoll, 1986) Instead, nitrate generally originates from nitrate sources on the land surface.

Site No.	Location	Temp. C°	pH	E.C µS/cm	T.D.S mg/l	D.O mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	Nitra. Mg/l
1	Ichgam	12	7.5	175	112	6.8	26.6	19.2	04	01	14.4	8.6
2	Soibugh	11	7.4	223.4	143	10.8	28.0	20.7	05	02	16.0	7.9
3	Kremshair	10	6.7	185.9	119	7.9	29.8	22.2	07	03	17.6	9.3
4	Budgam Town	13	7.8	235.9	151	6.7	28.2	21.0	04	02	16.1	7.8
5	Ompora	12	7.6	170.3	109	6.8	27.8	19.6	04	01	15.5	9.8
6	Magam	12	7.1	181.2	116	7.1	28.1	19.7	05	02	16.1	7.6
7	Chadoora	12	7.2	229.6	147	7.0	22.4	15.4	04	01	10.2	7.4
8	Ch-Sharif	10	6.8	171.8	110	6.8	27.6	19.2	05	02	15.4	7.8
9	Babawani	11	6.9	171.8	110	6.9	21.5	14.6	04	02	11.3	8.5
10	Berwah	11	7.3	184.3	118	7.2	23.7	15.8	05	03	11.5	7.6
11	Chitergam	9	7.1	179.6	115	7.8	24.6	16.9	06	03	12.4	7.6

Table1: Physico-chemical analysis of Groundwater samples from District Budgam.

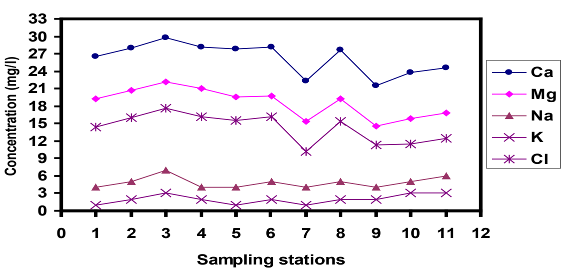

Fig.2. Concentrations of various ions in sampling stations

tion in the study area (Fig.3). The lowest value (7.4 mg/L) was recorded for Site 7, and the highest value (9.8 mg/L) was found for Site 5. The former site can be considered unpolluted as indicated by the low nitrate concentration and the higher value at site 7 can be attributed to anthropogenic impact as NO_3^- that enters the water systems originates as NO_3^- in wastes or fertilizers applied to the land surface. These are designated as direct nitrate sources. In other cases, NO_3^- originates by conversion of organic nitrogen or NH_4^+, which occur naturally or are introduced to the soil zone by man's activities (Freeze and Cherry, 1979)Fig.3. Nitrate concentration comparison at different sampling locations.

There was a narrow spatial variation in nitrate concentra-

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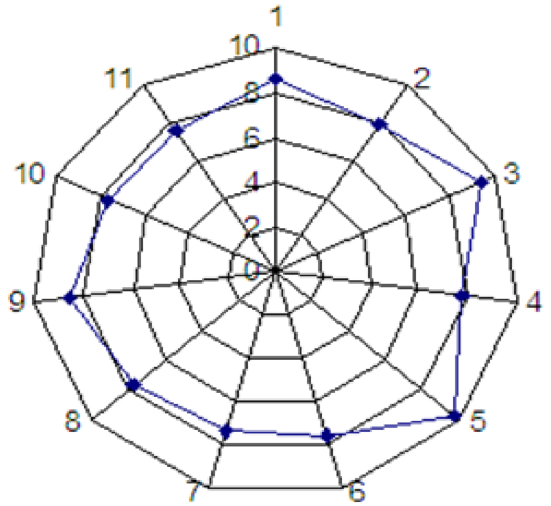

Fig.3. Nitrate concentration comparison at different sampling locations.

Impacts of Nitrate on Human Health

Nitrate water pollution is very hazardous to humans. The best-known health problem arising from nitrate consumption is methemoglobinemia, a fatal disease characterized by cyanosis. Methemoglobinemia is the condition in the blood which causes infant cyanosis or blue baby syndrome. Methemoglobin is probably formed in the intestinal tract of an infant when bacteria convert the nitrate ion to nitrite ion (Comly, 1987; Imran et al, 2010). One nitrite molecule then reacts with two molecules of hemoglobin to form methemoglobin. In acid mediums, such as the stomach, the reaction occurs quite rapidly (Comly, 1987). This altered form of blood protein prevents the blood cells from absorbing oxygen which leads to slow suffocation of the infant which may lead to death (Gustafson, 1993; Finley, 1990; Imran et al, 2010). Because of the oxygen deprivation, the infant will often take on a blue or purple tinge in the lips and extremities, hence the name, blue baby syndrome (Comly, 1987). Other signs of infant methemoglobinemia are gastrointestinal disturbances, such as vomiting and diarrhea, relative absence of distress when severely cyanotic but irritable when mildly cyanotic and chocolatebrown colored blood (Johnson et al, 1987). Numerous studies indicate a possible link between nitrate and cancer (Tannen and Correa, 1985; Dissanayake and Weerasooriya, 1987; Imran et al, 2010).

Conclusions

Nitrates are introduced in the ground and surface waters from a variety of sources which

Include agricultural activities, wastewaters, leaching from solid waste disposal locations, human activities. Ground waters in 11 locations of the Budgam District were sampled to evaluate the nitrate concentrations; the results indicated that nitrate levels do not exceeded the maximum allowed limits. In addition, narrow nitrate spatial variations do occur.

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