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Seasonal variation in nitrate concentration in groundwater of Kolar District, Karnataka, India

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ABSTRACT

The Karnataka state's Kolar Region, which is in the drought - prone agroclimatic zone, experiences less than normal rain fall during monsoon rainy season and it does not have any major dams or canals, main occupation of people is agrochemical based agriculture and is mainly dependent on groundwater for domestic, agriculture and livestock, Hence quality of water is important. The key factors used to assess the quality of water are its various physico-chemical characteristics. Among them nitrate (No3) is common anion that contaminates groundwater. The present study focuses on the examination with nitrate concentration into groundwater samples drawn on 50 different borewells of various villages of Kolar District. The result shown that the nitrate level in some samples higher than acceptance level, similarly in some samples shown below the acceptance level. Increased nitrate levels are typically a sign of pollution.

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Introduction:

Nitrate is indeed a natural substance that is created in the soil as nitrogen and oxygen combine. Nitrate in groundwater is typically obtained from non-point sources including groundwater pollution from septic and sewage discharges, leaching of chemical fertilizers, and animal manure and so on. During the monsoon rainy season, nitrogen cycle and other natural processes result in the production of nitrate and highly intervention of anthropocentric activities the concentration of nitrate in groundwater greatly changed. Nitrate is most common groundwater contaminant in intensive agrochemical based agriculture area and it is increased sharply during rainfall season but then gradually decreased after rainfall termination (Hong Wang *et al.*,2015). The concentration of nitrate in groundwater has significantly increased to a concerning level due to the heavy use of fertilizers and the reuse of irrigation water (Abdel Madjid *et al.,* 2013). Nitrate level of concentration among groundwater has correlation with level of agricultural activity and live stock farming area. The live stock farming area dominating the largest surplus of nitrate in groundwater (Hasen *et al.*,2012). The primary cause of nitrate concentration is the leaching of nitrate from the unsaturated zone (vadose zone) of agricultural fields that are irrigated (Binita Kumari *et al.*,2019). 87% of nitrate concentration of groundwater influenced by anthropogenic activity (JingLi *et al*.,2014). The elevated concentration of nitrate in groundwater is solely attributable to the utilization of agrochemicals. it is concern both national and international (Spalding *et al.,*1993). The concentration of nitrate in groundwater is typically lower in center pivot-irrigated areas than in gravity-irrigated areas (Pongpun *et al.*,2019). Among all the agricultural concerns agrochemicals have given rise to grave environmental contamination especially it causes increasing concentration of nitrate in ground water (Sunitha *et al.*,2013). Globally, intensive agricultural practices can result in the loss of nitrogen, which can accumulate in groundwater as excessive nitrate concentrations, leading to long-term deterioration of groundwater quality (Birgitle *et al.,*2017)**.** Due to overexploitation of groundwater and continuous depletion of the groundwater table caused by insufficient rainfall and inadequate groundwater recharge, the concentration of nitrate in the groundwater is increasing (Maruthesh Reddy *et al.,* 2015). The occurrence of elevated nitrate levels in groundwater is a significant hazard to humans and animals. It can cause unexpected incidents of infant Methaemoglobinaemia and nitrate poisoning in livestock at various times and locations (Sunitha,2013). In the present study nitrate ranged from 12.3775 to 183.5 mg/ liter (Table). Desirable limit for nitrate is 45 mg/liter and no relaxation in permissible limit. Some values observed in the present study is in the range below permissible level. It may be due to minimum usage of fertilizers and pesticides because of rain fall is lesser than minimum and lesser agricultural activities.

Materials and Procedures

Field Study

The Kolar District covers an area of 4,012 square kilometers and has a population of approximately 1.65 million people. It comprises five taluks, namely Kolar, Bangarpet, Malur, Mulbagal, and Srinivaspur, and is situated between 12 degrees 45 minutes 54 seconds north latitude and 77 degrees 50 minutes 29 seconds east longitude.

There are 156 gram panchayats in the Kolar District, comprising a total of 1,798 villages. Agriculture is the primary occupation in the region, and it relies solely on borewell water for irrigation. The district experiences a dry agro-climate and a semi-arid climate, with tropical monsoons and hot summers but mild winters. The study area does not have any significant surface water sources, and the primary source of drinking water is from borewells that extract groundwater.

Samples of Water

During the pre-monsoon and post-monsoon seasons of 2014 and 2015, groundwater samples were gathered from 50 separate borewells located in villages across the Kolar District. The samples were collected in 2-liter capacity bottles that were pre-cleaned and rinsed to avoid contamination, and they were transported to the laboratory for analysis of nitrate concentration.

Sample Analysis

All of the collected samples were tested for nitrate concentration, as well as other parameters like pH, fluoride, total hardness and chloride. Standard analytical techniques were employed to evaluate the water samples, and double-distilled water and SD-fine chemicals were utilized create the chemical solutions that were used in the analysis. Table 1 provides a summary of the precise information regarding the analytical techniques used.

Table1: Measurements and techniques for evaluating the quality of ground water

Sl. No.	Parameter	unit	Methods employed
1	Nitrate	mg/ liter	Spectrophotometric method

Waste from synthetic fertilisers is incredibly rich in nitrates. The by-products of the aerobic stabilisation of organic nitrogen are nitrates.

Nitrates and 1,2,4 phenol-di-sulphonic acid react to create 6-nitro 1,2,4 phenol-di-sulphonic acid, which can then be transformed into an alkaline salt to produce a yellow solution. The phenol-di-sulphonic acid technique was used to calculate the concentration of nitrate.

Suitable quantity with well mixed samples was taken in glass dish and evaporated in water bath. In order to ensure that the residue was completely dissolved, 2 ml of phenol-di-sulphonic acid was added. To this 50% sodium hydroxide (NaOH) was added till the red litmus changed to blue, filtered and made upto 50 ml in Nessler's tube. A blank was prepared by treating 50 ml distilled water in the same manner as sample. Reading was taken at 450 nm on a spectrophotometer.

Results and discussion :

The inorganic form of nitrogen that occurs naturally in smaller proportions in groundwater, downpours, and stream water is designated as nitrate. The biologically significant organic molecules nitrogen is a crucial part of include amino acids, proteins, pigments, nucleic acids, and vitamins. Furthermore, with nitrogen making up about 79 percent of the atmosphere, nitrogen is the main component of the atmosphere. In natural water nitrogen compounds generally occurs in three ionic forms such as ammonia (NH_4^+), nitrite (NO_2) and nitrate (NO_3^-). High-level concentration of nitrate in drinking water causes reduction in oxygen carrying capacity of erythrocytes and exhibit disease called blue baby syndrome or methemoglobinemia (Haemoglobin that cannot carry oxygen to the tissues). Many symptoms, including headache, dizziness, exhaustion, shortness of breath, nausea, vomiting, a rapid heartbeat, lack of muscular coordination, and blue skin, are connected to methemoglobinemia, which can be brought on by nitrate exposure. Nitrate has also been connected to a higher risk of thyroid issues, stomach or bladder cancer, and birth malformations.

Table 2 : An illustration of the seasonal variations in the concentration of nitrate from various sources in the research area of Kolar District for the time periods prior to and following the monsoon seasons in 2014 and 2015

Sl.No.	Sources Numbers	Pre-monsoon season 2014 March–May	Post-monsoon season 2014 October-December	Pre-monsoon season 2015 March-May	Post-monsoon season 2015 October-December	Average
1	I	30.2	30.3	39	25	31.125
2	II	35.69	39.5	50	85	52.5475
3	III	63.1	305	25	125	129.525
4	IV	39.4	40	40	50	42.35
5	V	45.69	46	30	45	41.6725
6	VI	15.45	15.47	32	15	19.48
7	VII	45	46	35	40	41.5
8	VIII	40.1	42.1	40	45	41.8
9	IX	35.6	35	30	52	38.15
10	X	35.69	35.7	36	5	28.0975
11	XI	36.9	35.8	36	125	58.425
12	XII	40.2	16	41.6	12	27.45
13	XIII	126	45	20	42	58.25
14	XIV	35	34	115	125	77.25
15	XV	35.62	35	36.6	37	36.055
16	XVI	18	19	0.51	12	12.3775
17	XVII	63	65	140	120	97
18	XVIII	40.1	41.1	16	150	61.8
19	XIX	26.53	27.31	10	52	28.96
20	XX	12.05	12.5	10	62	24.1375
21	XXI	45.8	4	9	5	15.95
22	XXII	25.6	60	27	40	38.15
23	XXIII	15.5	15	26.1	12	17.15
24	XXIV	42.2	40	43	42	41.8
25	XXV	25.6	26.6	51	40	35.8
26	XXVI	32	12	350	340	183.5
27	XXVII	14.45	14.45	6	15	12.475
28	XXVIII	45	45	10	55	38.75
29	XXIX	25.32	25.35	5	42	24.4175
30	XXX	36	37	11	40	31
31	XXXI	49.23	50	51	30	45.0575
32	XXXII	33.4	24	50.1	25	33.125
33	XXXIII	25.4	10	26.5	10	17.975
34	XXXIV	18.3	44	20	45	31.825
35	XXXV	29.9	40	31	39.1	35
36	XXXVI	44.8	44.45	39	44	43.0625
37	XXXVII	11.1	11.45	40	84	36.6375
38	XXXVIII	50	6	58	6	30
39	XXXIX	61	65	50	21	49.25
40	XL	45	45.1	41	35	41.525
41	XLI	25.7	26	30.1	25.21	26.7525
42	XLII	29	29.31	15	26.2	24.8775
43	XLIII	16	26	44	25	27.75
44	XLIV	36	36.7	36	35	35.925
45	XLV	35.1	50	81	55	55.275
46	XLVI	27.1	36	42	35	35.025
47	XLVII	26	26.27	20	12	21.0675
48	XLVIII	46	46.5	10	46	37.125
49	XLIX	22	22.25	30	10	21.0625
50	L	23	60	24	50	39.25

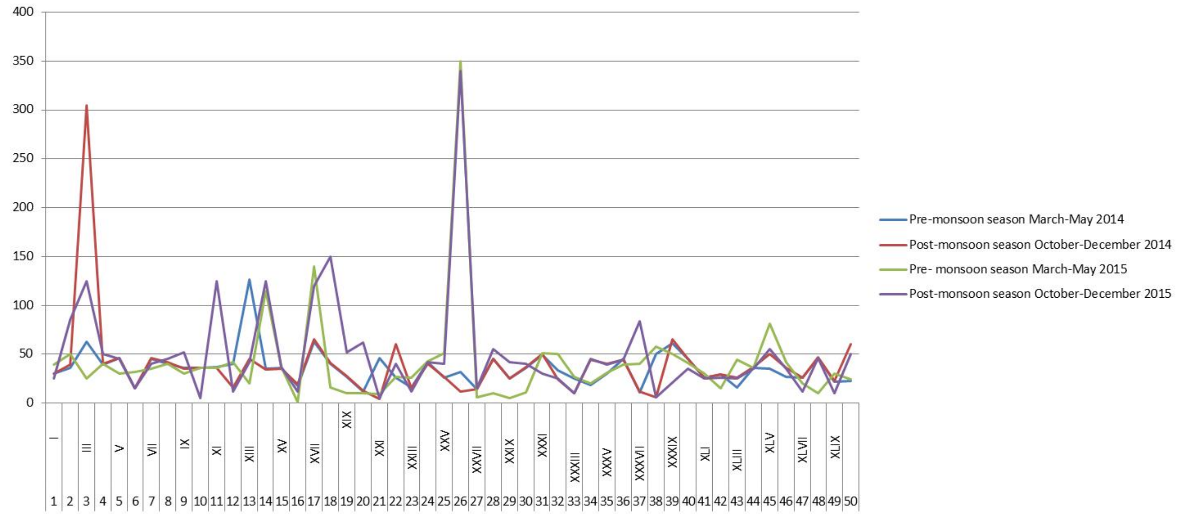

Fig . 1 : An illustration of the seasonal variations in the concentration of nitrate from various sources in the research area of Kolar District for the time periods prior to and following the monsoon seasons in 2014 and 2015

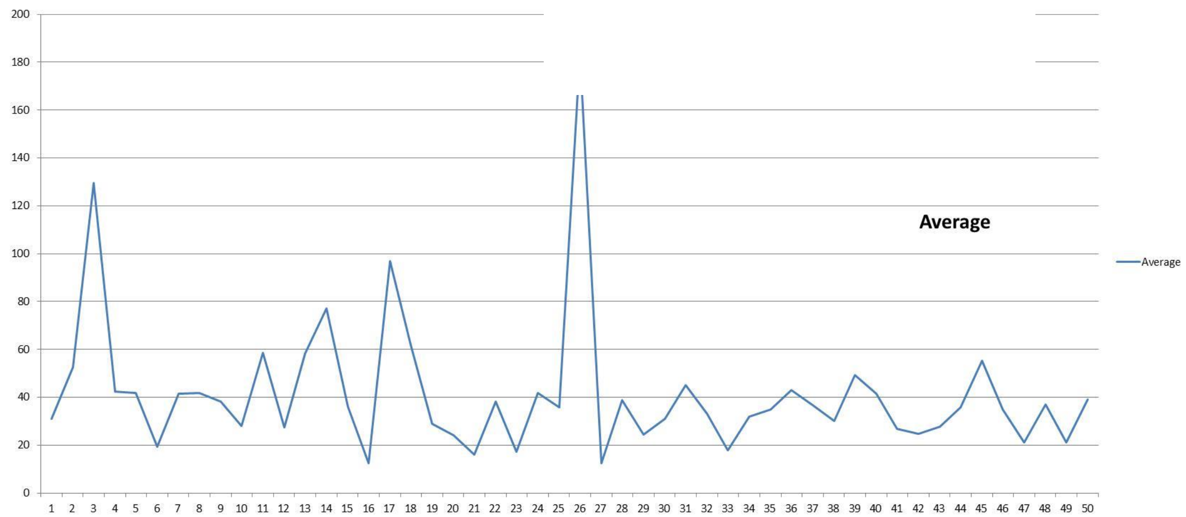

Fig . 2 : An illustration of the seasonal variations in the concentration of nitrate from various sources in the research area of Kolar District for the time periods prior to and following the monsoon seasons in 2014 and 2015

Observe: The graph's Y-axis displays the concentration level of nitrate in mg/L, while the X-axis displays the source number.

Nitrate concentration varied from source to source and season to season. Nitrate concentration values during pre-monsoon season (summer, March-May) of 2014 exhibited minimum as 11.1 mg/L and maximum as 126.0 mg/L. While during same season of 2015 exhibited minimum as 5.0 mg/L and maximum as 350.0 mg/L. Similarly, the nitrate concentration values during post-monsoon season (October -December) of 2014 exhibited minimum as 40.0 mg/L and maximum as 65.0 mg/L. While during same season of 2015 exhibited minimum as 5.0 mg/L and maximum as 340.0 mg/L. When compared to total average values, the pre-monsoon season of 2014 exhibited as 35.6 mg/L, whereas same season of 2015 exhibited 41.2 mg/L. Similarly, the post-monsoon season of 2014 exhibited as 33.5 mg/L, whereas same season of 2015 exhibited as 50.3 mg/L.

Conclusion:

The results showed that the nitrate levels in samples from some sources were above the maximum standard level It was due to intensifying agriculture with NPK fertilizers as well as use of pesticides. Majority, in some samples from some sources were lesser than minimum. Lesser concentration of nitrate is due to erratic distribution of rainfall and least rejuvenation of groundwater. henceforth, The suggestion is that the water be adequately treated before drinking.

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