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TEMPORAL AND SEASONAL VARIATION OF ARSENIC IN BALLIA DISTRICT OF EASTERN U. P.

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AUTHOR'S CONTRIBUTION

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

It was reported a clear temporal and seasonal variability of As concentrations in different water samples of Ballia district of eastern U. P. During post monsoon season As concentration decreases in Samples. A definite relationship exists between the behavior of arsenic and rainfall intensity. With increasing rainfall intensity rate of dilution increases which minimizes the arsenic concentration in the groundwater. During monsoon period there is considerable decrease in the arsenic concentration. Groundwater stream design is influenced by water level surface and subsurface redox potential because of seasonal rainfall. During monsoon seasons groundwater level is increased due to its low-land shallow basin and flooding condition also help in rising its groundwater level. For an extensive stretch of the year, the land remains water-logged and this prompts low groundwater flushing rates. In this manner, the watched varieties in mean As concentrations during storm season contrasted with pre rainstorm season. During monsoon time arsenic goes into groundwater by disintegration of Fe(III)- oxy hydroxides and in pre monsoon time arsenic reversibly adsorb on Fe(III)- oxyhydroxides. So these two processes control arsenic concentration during pre monsoon and post monsoon time.

Keywords: Temporal and seasonal variability; pre and post monsoon; groundwater stream; rainfall intensity; oxy hydroxides; seasonal rainfall.

1. INTRODUCTION

Vicky-Singh et al. 2010 published arsenic data in middle Ganga plain. Srivastava and Sharma, 2013 Presented As data in fertile soil of Ballia district in U. P. Many research studies have shown that arsenic level is regularly increasing in soil and groundwater [1-3]. Location of U. P. is in middle Ganga plain and it has tropical monsoon climate. It has 75 districts which are further divided into divisions and tehsils. Eastern part of U. P. is severely affected by As contamination. Many investigation agencies like U. P. Jalnigam, UNICEF AND WHO have reported more than 63 ppb As in drinking water of inhabitants which is very fatal for human life [4-6]. Water sampling data reported high level of As contamination in many districts of eastern U. P. like Ballia, Ghazipur, Varanasi, Chandauli, Siddharthnagar, Gorakhpur, Basti, Lakhimpur Khiri etc. I focused on some villages of districts Ballia and Ghazipur affected by As in my research studies [7,8].

As is one of the poisonous elements found in deep groundwater and a large population affected by As poisoning relying on it. I collected my samples from deep wells, tube wells and hand pumps located in villages Haldi, Bairiya, Dubhad, Mohan Chapra, Sikandarpur, Dipran kalan, Premchapra & Suremanpur (Ballia district) and villages of Ghazipur district Reotipur, Deokali, Mohammadabad, Karanda,

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Ghazipur city etc. Previous studies and my observations also reported variation of As concentration during Pre and Post monsoon seasons [9,10]. Variation in concentration is affected by many factors like surface elevation, depth of water table and redox reactions occurring during dissolution of As.

2. MATERIALS AND METHODS

2.1 Geographical Study of Sampling Area

Ballia district is eastern part of state U. P. Geographical location of Ballia district is between

Fig. 1. (a) Water channels of Ganga and Ghaghara rivers flowing through district Ballia, (b) Arsenic Contaminated villages of Ballia

25º 23' - 26 º 11' N and 83 º 38'- 84 º 39' E (Fig. 1a). Acharya and Shah [11] and Ahamed et al. [12] studied geographical and geomorphological aspect of Ballia district. Ballia district is surrounded by two rivers Ganga and Ghghra (Fig. 1b). Main source of income of its population is agriculture and so they rely on irrigation done by tube wells and other water reservoirs [12,13]. Many parts of districts have arsenic sedimentation which is carried by water flood during monsoon season. So many villages of Dubhad, Bairiya and Reoti blocks located near bank of rivers are affected by arsenic contamination. Ballia district is located in Ganga alluvium plain which bifurcated into two strata on basis of its time of development.

Ballia district is located in Ganga alluvium plain which bifurcated into two strata on basis of development of time period. One is older alluvium formed during Pleistocene age and other is younger alluvium formed during Holocene age. Older alluvium soil is also called as Bhangar soil. It is hard in nature due deposition of calcium carbonate and made of sands gravels, silts and kankars mixed in different ratios. Khadar form upland area near river side with a very less amount of clay. Younger alluvium is also called as Khadar soil. It regularly deposit near river side with deposition of flood sediments. It consist of large amount of clay and little amount of kankar particles. It forms a low land area with river bank.

3. RESULTS AND DISCUSSION

3.1 Temporal and Seasonal Variability of Arsenic in Groundwater

It was reported a clear temporal and seasonal variability of As concentrations in different samples. During post monsoon season As concentration decreases in Samples. The variability in As concentrations is likely to be associated with the seasonal fluctuations in groundwater recharge and the impact of irrigation drawdown [14]. Difference in Arsenic concentration during pre and post monsoon seasons is correlated in terms of its concentration [15-17]. A definite relationship exists between the behavior of arsenic and rainfall intensity. With increasing rainfall intensity rate of dilution increases which minimizes the arsenic concentration in the groundwater [18]. During monsoon period there is considerable decrease in the arsenic concentration. Thus it can be said that there is a strong correlation exists between rainfall condition, dilution effect and arsenic concentration. Contrary to this, during winter season and pre monsoon seasons there are an increase in the concentration which is associated with the decrease in dilution effect.

Groundwater stream design is influenced by water level surface and subsurface redox potential because of seasonal rainfall. During monsoon seasons groundwater level in Ballia is increased due to its low-land shallow basin and flooding condition also help in rising its groundwater level. For an extensive stretch of the year, the land remains water-logged and this prompts low groundwater flushing rates [19,20,14]. In this manner, the watched varieties in mean As concentrations during storm season contrasted with pre rainstorm season (Table 1). It was observed during the study period that there is interaction between sediment rocks and water due to slow flow of water current make long time contact and reducing condition all leads to high As concentration in groundwater. During monsoon time arsenic goes into groundwater by disintegration of Fe(III)- oxy hydroxides and in pre monsoon time arsenic reversibly adsorb on Fe(III)- oxyhydroxides. So these two processes control arsenic concentration during pre monsoon and post monsoon time. The sampling sites selected in Ballia are Belhari, Bansdeeh, Sikandarpur, Bairiya, Hanumanganj and Murli Chapra.

Table 1. Distribution of arsenic during post monsoon and pre monsoonin Bairiya block

Villages in Bairiya block	As in ppb	
	Post monsoon	Pre monsoon
Bairiya	547	730
Chaubey Chapra	512	712
Chapra Sakhi	432	722
Dalan Chapra	516	711
Dava Chapra	512	713

Table 2. Distribution of arsenic during post monsoon and Pre monsoon in Belhari block

Villages in Belahri block	As in ppb	
	Post monsoon	Pre monsoon
Belhari	542	731
Bandhuchak	601	850
Gayghat	612	867
Gudari Chapra	610	854
Rikini Chapra	622	835
Swayember Chapra	621	890

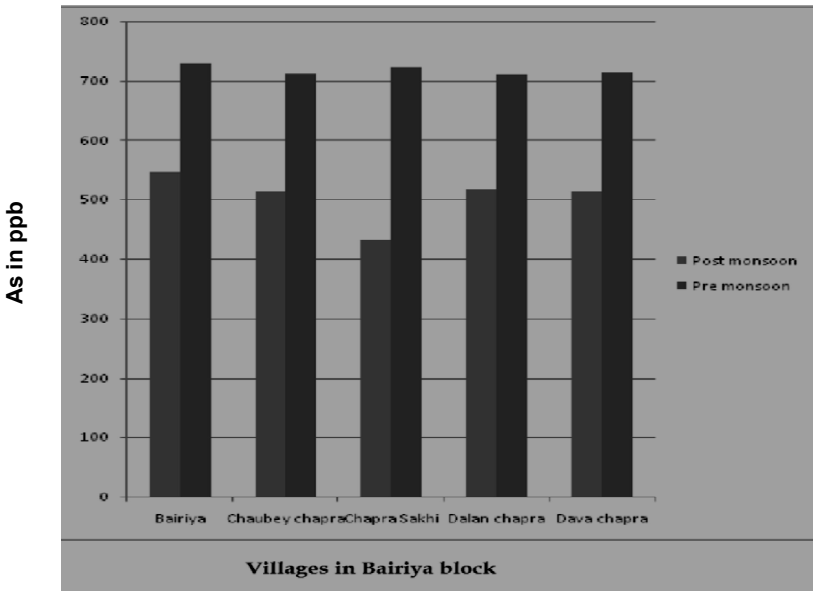

Fig. 2. Histogram diagram of distribution of arsenic in Bairiya block

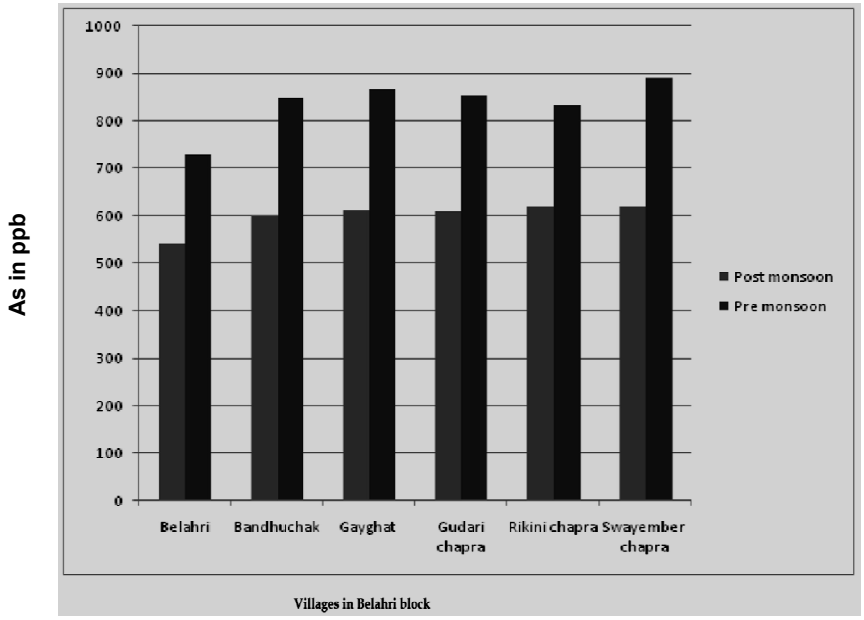

Fig. 3. Histogram diagram of distribution of arsenic in Belhari block

Table 3. Distribution of arsenic during post monsoon and pre monsoonin Murli Chapra block

Villages in block Murli Chapra	As in ppb	
	Post monsoon	**Pre monsoon**
Murli Chapra	620	830
Dalan Chapra	647	840
Wajidpur	746	850
Gangapur	762	850
Dharamarpur	745	839
Dokari	753	865

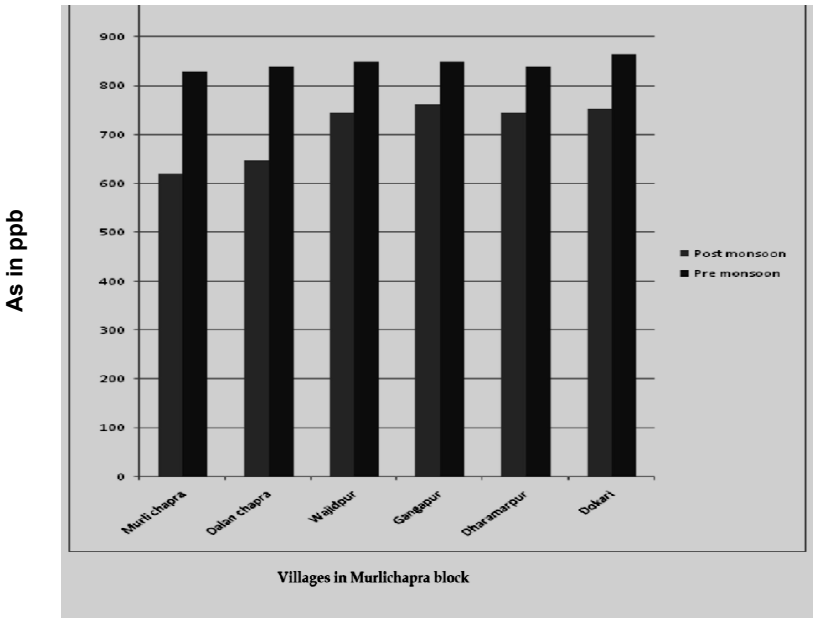

Fig. 4. Histogram diagram of distribution of arsenic in Murli Chapra block

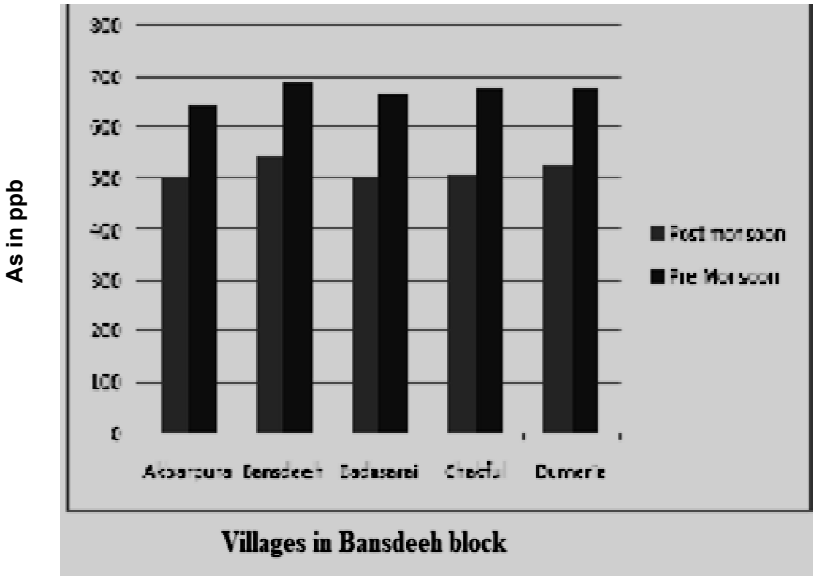

Fig. 5. Histogram diagram of distribution of arsenic in Bansdeeh block

Table 4. Distribution of arsenic during post monsoon and pre monsoonin Bansdeeh block

Villages in block Bansdeeh	As in ppb	
	Post monsoon	Pre monsoon
Akbarpura	502	645
Bansdeeh	545	690
Badasarai	505	667
Chakful	510	678
Dumeria	525	680
Akbarpura	502	645

Table 5. Distribution of arsenic during post monsoon and pre monsoon in Sikandarpur block

Villages in block Sikandarpur	As in ppb	
	Post monsoon	Pre monsoon
Baheri	110	170
Dewakali	128	172
Dharamarpur	128	172
Eakel	127	175
Pranpur	128	180
Sikandarpur	129	180

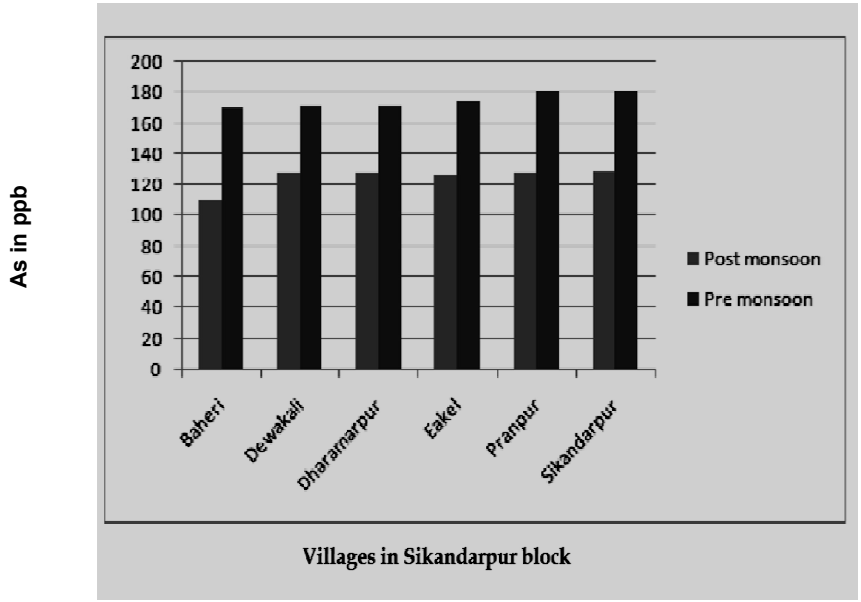

Fig. 6. Histogram diagram of distribution of arsenic in Sikandarpur block

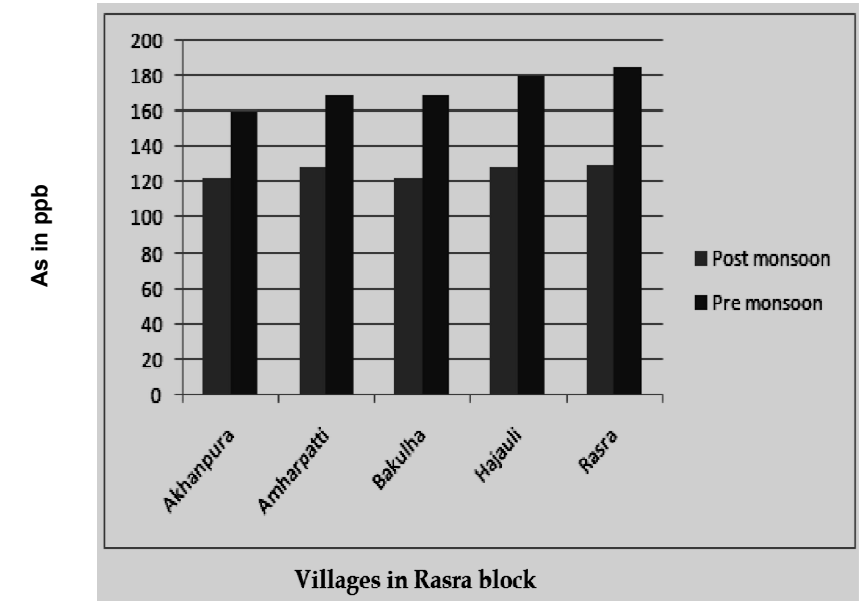

Fig. 7. Histogram diagram of distribution of arsenic in Rasra block

Table 6. Distribution of arsenic during post monsoon and pre monsoon in Rasra block

Villages in block Rasra	As in ppb	
	Post monsoon	Pre monsoon
Akhanpura	122	160
Amharpatti	129	170
Bakulha	122	170
Hajauli	129	180
Rasra	130	185
Akhanpura	122	160

4. CONCLUSION

It is concluded that the watched varieties in mean As concentrations during storm season contrasted with pre rainstorm season. During monsoon time arsenic goes into groundwater by disintegration of Fe(III)-oxy hydroxides and in pre monsoon time arsenic reversibly adsorb on Fe(III)- oxyhydroxides. So these two processes control arsenic concentration during pre monsoon and post monsoon time.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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