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Short Communication

Study on Arsenic Contamination in Soil and Water in Five-selected Agro Ecological Zone (AEZ) of Bangladesh

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A research was carried out at the five different Agro-Ecological Zones (AEZ) of Bangladesh, viz. Tista Meander Floodplain (FP), High Ganges FP, Low Ganges FP, Active Ganges FP and Gopalganj-Khulna Bills during January 2001 to January 2002. The objectives were to assess the arsenic (As) concentration in the soil and water as well as to test tube well water samples and examines whether these exceed the acceptable limit of As. Water of shallow tube wells (STW) and soil samples were collected from ten sites under five AEZs of Bangladesh. Considerable number of water samples showed high contents of arsenic, which ranged from 0.032 to 203.9 µg/l. Out of 428 water samples, 155 were found unsafe (>10-<50 µg/l) and 78 were toxic (>50 µg/l) for drinking purpose. However, out of 2648 soil samples collected from different Upazilas, only 4 samples collected from Chargat showed toxic level (>20 µg/kg).

Keywords*:* Arsenic contamination, toxic, food chain.

Environmental pollution now a days is a great threat to human being and animals. Water resource, being the prominent component of the environment, is getting polluted over the years. Arsenic contamination of ground water appears to be a severe problem in Bangladesh. At present out of 64 districts, 59 are affected by arsenic poisoning. Consequently, more than 80 million people are now exposed to arsenic poisoning and more than 10,000 people have shown the symptoms of arsenicosis (Chowdury, 2001). Arsenic contamination is higher in shallow aquifers than in deep aquifers. Arsenic concentration is higher in the depth between 9 and 30 Meters (BGS, 1999). Ground water from depth of more than 150 to 200 m might be arsenic free (BGS, 1999). The forms of arsenic present in soils depend on the type and amount of sorbing component of the soil, the pH and the redox potential (Nriagu, 1994). Several strains of bacteria accelerate the oxidation of arsenite to arsenate and are also involved in methylation and alkylation of arsenic. Thus, microbiota may highly govern the processes of arsenic migration, precipitation and volatilization as cited by Boyle and Jonasson (1973). The source and the underlying process involved in the contamination of ground water of some regions of Bangladesh are not clear. There are, however, some assumptions. It is possible that the contamination of soil sediment and water might have occurred both from natural and anthropogenic sources. Indiscriminate use and over exploitation of ground water for irrigation during last two decades is one of the main reasons for arsenic poisoning in drinking water and contamination of many surface soils. In the contaminated soils arsenic may get entry into the plant body along with other nutrients and edible parts may thus become unsuitable for human consumption.

Studies on arsenic contamination in Bangladesh indicated that greater Faridpur, Rajshahi, Jessore

areas are badly affected by arsenic. That is why ten sites of these districts have been selected for present study. The present research program has been undertaken to determine the magnitude of arsenic contamination in the drinking water and its distribution to soils.

An investigation was carried out at five different Agro Ecological Zones (AEZ) of Bangladesh, viz. Tista Meander Floodplain (FP), High Ganges FP, Low Ganges FP, Active Ganges FP and Gopalganj-Khulna Bills, during January 2001 to January 2002.Ten sites of six districts namely Rangpur, Kurigram,Chapai Nawabgonj, Jessore, Rajshai and Gopalgonj under five different Agro Ecological Zones (AEZ) were selected for present study. The design of study and sampling sites are given below (Table 1).

Ten of each of the above mentioned samples were collected randomly from each zone. Composite soil samples from 0-30 and 30-60 cm below ground surface were collected using a 6 cm diameter hand auger and immediately stored in a sealed zip lock bag. Tube-well water was sampled in a pre-sterilized 250 ml polythene bottle after these being rinsed thrice with distilled water and tube wells were pumped at least for 5 minuets (for 50 ft depth)and only than those water were preserved

Table 1. List of location/sampling sites for collection soil and water samples.

Sl. No.	Name of Agro Ecological Zone (AEZ)	Name of the District	Name of the Upazila	Name of the site	No. of water samples	Number of soil samples
1	Tista Meander Floodplain(FP)(AEZ:3)	1.Rangpur 2.Kurigram	Pirgacha Razarhat	1)Pirgacha 2)Razarhat	87	780
2	a) High Ganges FP(AEZ:11) b)Active Ganges FP(AEZ:10)	Chapai Nawabganj	Sadar	1)C.nawabganj Pourashava 2)Maharazapur 3)Baragharia	60	90
3	a)High Ganges FP(AEZ:11) b)Active Ganges FP(AEZ:10)	Rajshahi	Chargat	Chargat	148	462
4	High Ganges FP(AEZ:11)	Jessore	1)Sadar 2)Monirampur	1.Sajiali,Sadar 2.Dodaria,Monirampur	98	980
5	a).Low Ganges FP(AEZ:12) b).Gopalganj-Khulna Bill(AEZ:14)	Gopalganj	1)Sadar 2)Muksudpur	1.Ghonapara 2.Muksudpur	35	336

All samples were sealed immediately after collection and an identification number was written on to a log of samples collected for that date. Water and soil samples were tagged accordingly and sent to the Soil Resource Development Institute (SRDI) laboratory, Dhaka. Ground water was collected from As affected areas of greater district of Faridpur, Jessore and Rajshahi districts. Water samples were acidified with 1:1 HNO_3 and transported to the Laboratory. Before acidified pH for all the water samples was determined by using pH meter. Soil samples were collected from these selected sites irrigated by contaminated ground water. All samples were dried, ground and sieved through 2 mm sieve. Soil samples (1g) were digested with 5 ml HNO_3 in a closed system. The digested samples were filtered and arsenic were determined by Atomic Absorption Spectrophotometer (AAS) using hydride generator. Arsenic in the ground water was measured directly after filtration. Thus, the generated database were analyzed using a statistical software package "SPSS/PC+". A frequency distribution table was generated at first to see whether the data are normally distributed or skewed.

A wider range of arsenic content in the water samples collected from Pirgacha and Rajarhat upazilas of Rangpur and Kurigram districts, respectively under Tista Meander Floodplain (AEZ:3) areas were observed (83-173 µg/l). Out of 87 samples, 40 were found safe (<10 µg/l), 28 unsafe (10-50 µg/l) and 19 toxic (>50 µg/l) for drinking (Tables 2a & 7). Arsenic contents of soils in Pirgacha and Rajarhat upazilas were with in tolerable limit, which ranged from 0.10-9.90 µg/g (Tables 2b & 8).

Table 2a. Categorization of water samples collected from Pirgacha and Rajarhat Upazilas.

Name of site	No. of samples under each category of As				Range of As content (µg/l)	
	<10 µg/l	10-50 µg/l	>50 µg/l	Total	Lowest	Highest
Pirgacha	18	13	14	45	5.0	171.0
Rajarhat	22	15	5	42	1.0	83.0

Table 2b. Categorization of soil samples collected from Pirgacha and Rajarhat Upazilas.

Name of site	No. of samples under each category of As					Range of As content (µg/g soil)	
	< 5 µg/g	5-10 µg/g	10-20µg/g	>20µg/g	Total	Lowest	Highest
Pirgacha	234	156	-	-	390	1.20	9.90
Rajarhat	257	133	-	-	390	0.10	9.32

Table 3a. Categorization of water samples collected from Monirampur and Jesssore Sadar Upazilas.

Name of site	No. of samples under each category of As				Range of As content (µg/l)	
	<10 µg/l	10-50 µg/l	>50 µg/l	Total	Lowest	Highest
Dodaria,Monirampur	14	29	3	46	1.0	98.6
Sajiali,Jessore Sadar	11	23	18	52	5.5	97.0

Diversity and variability in arsenic content of water samples collected from Monirampur and Sadar upazilas of Jessore district under Ganges Floodplain (AEZ:11) have been observed (Table 3a). Out of 98 water samples, 25 were found safe (<10 µg/l), 52 unsafe (10-50 µg/l) and 21 toxic (>50 µg/l) for drinking purpose (Table 7). However, arsenic content in soil samples of these areas were found acceptable for agricultural production (Tables 3b & 8).

A wider range of arsenic content in the water samples collected from Ghonapara and Muksudpur upazilas of Gopalgonj district under Low Ganges Floodplain (AEZ:12) and Gopalgonj-Khulna Bil (AEZ:14) areas were observed (4 -98 µg/l). Out of 35 samples 10 were found safe (<10 µg/l), 11 unsafe (10-50 µg/l) and 14 toxic (>50 µg/l) for drinking (Tables 4a & 7). Arsenic contents of soils in Ghonapara and Muksudpur upazilas were in toleable limit, which ranged from 0.25-10.66 µg/g (Table 4b & Table 8).

Diversity and variability in arsenic content of water samples collected from Nawabganj Paurashava, Maharajpur and Baraghaia of Chapai Nawabgonj and Chargat of Rajshahi districts under High Ganges Floodplain (AEZ:11) and Active Ganges Floodplain (AEZ:10) have been observed (Tables 5a & 6a). Out of 203 water samples, 120 were found safe (<10 µg/l), 64 unsafe (>10-<50 µg/l) and 24 toxic (>50 µg/l) for drinking purpose (Table 7). However, arsenic content in soil samples of these areas were found acceptable for agricultural production,which ranged from 0.98-40.08 µg/g (Tables 5b & 6b). Out of 462 soil samples, only 4 were found unsafe (>20 µg/g) for agricultural production (Table 6b & Table 8).

Table 3b. Categorization of soil samples collected from Monirampur and Jesssore Sadar Upazilas.

Name of site	No. of samples under each category of As					Range of As content (µg/g soil)	
	< 5 µg/g	5-10 µg/g	10-20 µg/g	>20 µg/g	Total	Lowest	Highest
Dodaria,Monirampur	330	265	5	-	600	0.43	10.28
Sajiali,Jessore Sadar	138	242	-	-	380	0.03	9.56

Table 4a. Categorization of water samples collected from Muksudpur and Gonapara Upazilas.

Name of site	No. of samples under each category of As				Range of As content (µg/l)	
	<10 µg/l	10-50 µg/l	>50 µg/l	Total	Lowest	Highest
Muksudpur	1	1	8	10	7.31	98.0
Ghonapara	9	10	6	25	4.00	74.0

Table 4b. Categorization of soil samples collected from Muksudpur and Gonapara Upazilas.

Name of site	No. of samples under each category of As					Range of As content (µg/g soil)	
	< 5 µg/g	5-10 µg/g	10-20µg/g	>20 µg/g	Total	Lowest	Highest
Muksudpur	133	86	1	-	220	0.25	10.66
Ghonapara	96	15	5	-	116	0.26	7.57

Table 5a. Categorization of water samples from Pourashava,Moharajpur and Baragharia of Chapai Nawabganj

Name of site	No. of samples under each category of As				Range of As content (µg/l)	
	<10 µg/l	10-50 µg/l	>50 µg/l	Total	Lowest	Highest
Nawabganj Pourashava	2	5	7	14	6.0	203.9
Moharajpur	1	8	1	10	8.6	53.0
Baragaria	13	15	8	36	3.6	99.0

Table 5b. Categorization of soil samples from Pourashava, Moharajpur and Baragharia of Chapai Nawabganj

Name of site	No. of samples under each category of As					Range of As content (µg/g soil)	
	< 5 µg/g	5-10 µg/g	10-20µg/g	>20µg/g	Total	Lowest	Highest
Nawabganj Pourashava	34	2	-	-	36	1.98	5.21
Moharajpur	15	3	-	-	118	2.02	5.95
Baragaria	26	10	-	-	36	0.98	7.84

Table 6a. Categorization of water samples collected from Chargat Upazila.

Name of site	No. of samples under each category of As				Range of As content (µg/l)	
	<10 µg/l	10-50 µg/l	>50 µg/l	Total	Lowest	Highest
Chargat	104	36	8	148	0.32	64.0

Table 6b. Categorization of soil samples collected from Chargat Upazila.

Name of site	No. of samples under each category of As					Range of As content (µg/g soil)	
	< 5 µg/g	5-10µg/g	10-20µg/g	>20µg/g	Total	Lowest	Highest
Chargat	387	63	8	4	462	0.20	40.08

Table 7. Categorization of water samples collected from different Upazila.

Name of site	Number of samples under each category ofAs			Total Number of sample
	Safe sample	Unsafe sample	Toxic sample	
Pirgacha	18	13	14	45
Rajarhat	22	15	5	42
Dodaria,Monirampur	14	29	3	46
Sajiali,Jessore Sadar	11	23	18	52
Muksudpur	1	1	8	10
Ghonapara	9	10	6	25
Nawabganj Pourashava	2	5	7	14
Moharajpur	1	8	1	10
Baragaria	13	15	8	36
Chargat	104	36	8	148

Table 8. Categorization of soil samples collected from different Upazila.

Name of site	Number of samples under each category of As			Total Number of sample
	Safe sample	Unsafe sample	Toxic sample	
Pirgacha	390	-	-	390
Rajarhat	390	-	-	390
Dodaria,Monirampur	600	-		600
Sajiali,Jessore Sadar	380	-	-	380
Muksudpur	220	-	-	220
Ghonapara	116	-	-	116
Nawabganj Pourashava	36	-	-	36
Moharajpur	118	-	-	118
Baragaria	36	-	-	36
Chargat	458	-	4	462

The distribution of arsenic in the water and soil samples indicated that there is a chance of arsenic contamination in food crops.

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