Shrimp Culture Impact on the Surface and Ground Water of Bangladesh

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Abstract

A case study was carried out to see the impacts of shrimp culture on the surface (pond) and ground water (tube-well) quality in three coastal sub-districts of Bagherhat Sadar, Rampal and Morrelganj of Bangladesh. The people of Rampal (100%), Morrelgonj (87.5%) and Bagherhat (75.5%) expressed that salinity of both surface and ground water increased for shrimp culture, and water becomes more turbid, odorous and less tasty compare to pre-shrimp culture scenario. The ground water pH was found to little acidic (6.07– 6.71) but the surface water was mild alkaline in nature (7.00–7.46). Ground water was more saline (1893.12–2673.33 ppm) than surface water (513.31-2253.33 ppm). Potassium level of surface water was very high (97.75-242.42 ppm) compare to ground water (11.73-27.37 ppm), which exceeds the WHO Guideline Value (10 ppm) and Bangladesh Standard for Drinking Water (12.0 ppm). The pollution level of phosphorous and iron was found to little higher but other pollutants like nitrate, boron and zinc was found to very low in surface and ground water in the shrimp culture area of Bangladesh.

1.0 Introduction

In Bangladesh Shrimps are mainly cultivated in two coastal regions – South-west coastal region comprising the districts of Khulna, Bagerhat, Sathkhira and South-east costal region includes Chittagong ang Cox's Bazar. It is estimated that 250,000 ha of land have a good potential for coastal aquaculture (Ahmed, 1995). In 1983-84, the total shrimp area in Bangladesh was 51,812 ha and it rose to 217,877 ha in 2005-06 indicating a 420.51% increase sharply in last 22 years. In 2005-06, south-west region produced 78.9% of the Bangladesh's total shrimp production (DoF, 2006). Shrimp, the white gold bar of Bangladesh is the second highest foreign exchange earner accounts for 5.2% of the total export following the ready made garments (RMG) sector. At present Bangladesh is the 8th largest shrimp producer of the world and produces 2.5% of the global shrimp output (DoF, 2006 and BCAS, 2001). Mainly bagda (*Paeneus monodon*) is cultivated nearby the coast where water salinity is very high and golda (*Macrobrachium rosenbergi*) cultivated in the interior low saline water areas.

The shrimp culture of Bangladesh has both beneficial and detrimental effects. Shrimp culture caused increasing salinity, destruction of mangrove resources and other vegetation, biodiversity reduction, declining land productivity and reduction of forest area in the south-western coastal region of Bangladesh (Alauddin and Hamid, 1998). Considering these environmental effects, a study on surface and ground water quality was carried out in shrimp cultivation areas under the coastal sub-districts of Bagherhat Sadar, Rampal and Morrelganj of Bangladesh. Therefore, this study was done considering the following objectives,

i) To analyze the water quality of the surface (pond) and groundwater (tube-well) of the shrimp culture area, and
ii) To assess the impact of shrimp culture on the water quality

2.0 Methodology

2.1 Water Sample Collection

For assessment of water quality, 33 surface (pond) and 33 ground (tube-well) water samples were collected from 18 villages under the coastal sub-districts of Bagherhat Sadar, Rampal and Morrelganj of Bangladesh for summer and rainy seasons during the period of 2003-2004. Each tube-well was pumped 30 minutes prior to water sample collection in plastic bottle. The surface water was collected from 10-cm below the surface level of water.

2.2 Water Analysis

The pH was measured by HACH pH meter. Electrical conductivity was measured by using Metrohm EC Meter at 25 ^{o}C. Potassium, calcium, iron and zinc of water samples were measured by Atomic Absorption Spectrophotometer (AAS). The concentration of phosphorous, sulphur, boron and nitrate in water was measured by spectrophotometric method (Trivedy & Goel, 1986).

3.0 Results and Discussions

3.1 Analytical Results of Surface and Ground Water

The water quality data of surface (pond) and ground water (tube-well) of the shrimp culture areas of three sub-districts (Rampal, Morrelgonj and Bagherhat) of Bangladesh is presented season wise in Tables 1 & 2. The pH of surface water varies from 7.29-7.46 in summer season (Table 1), which is higher than the ground water pH (6.46-6.71). However, pH of both surface and ground water was found little low during rainy season (Table 2). Surface water pH in summer and rainy seasons and the ground water pH in summer season are found within the WHO Guideline (6.5-8.5) and Bangladesh Standard for Drinking Water Quality (6.5-8.5).The causes of low pH (6.07) in ground water of Morrelgonj and Bagerhat areas during rainy season may be for the higher organic mater content of under ground soils. The salinity in the ground water was higher than surface water both summer and rainy seasons (Tables 1 & 2). The salinity in the ground water was higher in summer (2053.20-2673.33 ppm) than rainy season (1893.12-2573.29 ppm). Similarly, the salinity of surface water was higher in summer (1286.66-2253.33 ppm) than rainy season (513.31-993.30 ppm). During rainy season, rain water diluted the salt and therefore, a low salinity was observed in that period.

The nitrate content of surface water in summer season varies from 0.43-0.61 ppm, which is higher than the rainy season (0.15-0.19 ppm). However, the nitrate content of groundwater in summer and rainy seasons was higher than the rainy season value of surface water (Tables 1 & 2). The nitrate level of surface and ground water not exceeded the Bangladesh Standard for Drinking Water, 10 ppm (ECR, 1997).

Potassium content of surface water was found to very high compare to ground water. The potassium content of surface water was 140.7-242.4 ppm in summer and 97.7 ppm-125.12 ppm in rainy season. The potassium content of ground water ranges from 11.73 to 27.37 ppm in rainy season and 11.73-23.37 ppm in summer season. Both surface water and ground water

potassium content exceeded the WHO Guideline Value (10.0 ppm) and Bangladesh Standard for Drinking Water, 12.00 ppm (ECR, 1997).

Calcium content in surface and ground water is nearly same during summer season (Table 1). In that season, the calcium content of surface and ground water ranges from 82.10 – 118.20 ppm and 46.05 to 122.15 ppm, respectively. The main source of calcium is the result of weathering (Hossain *et al.*, 1991). The high concentration of calcium in the studied area is mainly responsible for the hardness of water.

Phosphorous content in ground water was found to higher than the surface water both summer and rainy seasons. It is because of the weathering of the phosphate rocks and decomposition of organic substances in the soil (Arms, 1989). The ground water phosphorous level is nearly same in two seasons and varies from 0.13 to 1.70 ppm. However, the phosphorous content of surface water in summer season ranges from 0.26 to 0.35 ppm and in rainy season it varies from 0.17 to 0.42 ppm. In the study area, phosphorous content of surface and ground water exceeded the Bangladesh Standard for Drinking Water (0 ppm).

Sulphur content in the surface water is much higher than the ground water. The sulphur level in surface water in summer season lies between 10.19 to 22.98 ppm, which is higher than the rainy season (10.57-13.78 ppm). However, the sulphur level in ground water is 2.22 -5.71 ppm in summer season and 0.76-5.78 ppm in rainy season.

The ground water of the study area contained a high level of boron than surface water and it varies from 0.35 to 0.55 ppm in summer and 0.31 to 0.49 ppm in rainy seasons. The boron content in the surface water is nearly same for both summer (0.15-0.20 ppm) and rainy (0.18-0.21 ppm) seasons. Boron level in surface and ground water is found within the range of WHO guideline values (0.5 ppm) and Bangladesh Standard for Drinking Water, 1 ppm (ECR, 1997).

Iron content in the ground water varies from 2.07 to 2.36 ppm. The sediment of Bangladesh is rich in iron and therefore, a high level of iron was found in ground water (Khanam *et al.*, 2000). Iron level in surface water ranges from 1.51 to1.61 ppm in summer and 1.21 to 1.42 ppm in rainy seasons. Both surface and ground water iron level exceeded the WHO guideline value (0.3 ppm) and Bangladesh Standard for Drinking Water (0.3-1.0 ppm). Zinc content in surface and ground water is very low and it varies from 0.02 to 0.04 ppm.

3.2 People's Perception on Surface and Ground Water Quality

The scarcity of good quality water is a common phenomenon in the study area. The people's perception on the shrimp culture impact on the surface and ground water quality was assessed through household questionnaire survey. This opinion survey data is presented in Table 3. From the people's perception study, it is found that the water quality of both surface and ground water was lost due to shrimp culture. The local people thought that underground water aquifers become saline for longtime holding of saline water in shrimp fields. As like as the groundwater, the surface water of the study area becomes more saline. All the peoples of Rampal (100%), and most of the people of Morrelgonj (87.5%) and Bagerhat (75.5%) sub-districts opined that water salinity increased due to shrimp culture (Table 3). Peoples of the study area also thought that water becomes more turbid, odorous and less tasty for shrimp cultivation.

4.0 Conclusions

Peoples of the shrimp culture area opined that the water salinity and turbidity was increased and water taste was deteriorated for shrimp culture in three coastal sub-districts of Rampal, Morrelgonj and Bagerhat of Bangladesh. From physical analysis, pH was found within the limit of drinking water but salinity level is very high. From chemical analysis of water, nitrate, boron and zinc levels were found within the limit of Bangladesh Standard for Drinking Water and WHO guideline value. However, the level of potassium, phosphorous and iron in surface and ground water exceeded the limit of drinking water quality.

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Table 1: Surface (ponds) and Ground Water (Tube-wells) Quality of Shrimp Culture Area of Coastal Zone of Bangladesh during Summer Season

Parameters	Water Quality in three Sub-districts					
	Rampal		Morrelgonj		Bagerhat	
	Surface	Ground water	Surface	Ground water	Surface	Ground water
pH	7.46	6.71	7.35	6.47	7.29	6.62
Salinity, ppm	2253.33	2053.20	1466.70	2673.33	1286.66	2380.00
NO_3, ppm	0.44	0.53	0.61	1.34	0.43	1.09
K, ppm	222.87	11.73	140.76	23.37	242.42	15.51
Ca, ppm	118.20	46.05	82.10	100.13	90.11	122.15
P ppm	0.31	0.13	0.26	1.70	0.35	0.35
S ppm	22.47	2.22	22.98	4.81	10.19	5.71
B ppm	0.20	0.46	0.15	0.55	0.17	0.35
Fe ppm	1.51	2.09	1.61	2.36	1.61	2.26
Zn ppm	0.04	0.03	0.03	0.04	0.03	0.02

Table 2: Surface (ponds) and Ground Water (Tube-wells) Quality of Shrimp Culture Area of Coastal Zone of Bangladesh during Rainy Season

Parameters	Water Quality in three Sub-districts					
	Rampal		Morrelgonj		Bagerhat	
	Surface	Ground water	Surface	Ground water	Surface	Ground water
pH	7.00	6.56	7.04	6.07	7.03	6.08
Salinity, ppm	993.30	1893.12	686.61	2573.29	513.31	2266.51
NO_3, ppm	0.15	0.06	0.16	0.34	0.19	0.24
K, ppm	113.39	11.73	97.75	27.37	125.12	15.64
Ca, ppm	50.06	16.02	28.03	62.08	22.03	50.06
P ppm	0.17	0.16	0.21	1.66	0.42	0.70
S ppm	13.73	0.76	10.57	5.78	13.78	5.19
B ppm	0.18	0.48	0.21	0.49	0.20	0.31
Fe ppm	1.21	2.07	1.42	2.26	1.30	2.22
Zn ppm	0.02	0.03	0.03	0.02	0.03	0.03

Table 3: Peoples Perception on Pond and Ground Water (Tube-well) in Shrimp Culture Area of Bangladesh

Parameter	People's Perception (%) on Water in three Sub-districts					
	Rampal		Morrelgonj		Bagerhat	
	Pond	Ground Water	Pond	Ground Water	Pond	Ground Water
Increased salinity	100.0	100.0	87.5	87.5	75.0	75.0
Increased turbidity	66.7	33.4	83.3	20.8	54.2	58.3
Odor	75.0	4.2	54.2	0.0	62.5	4.2
Loss of water taste	95.8	100.0	91.7	100.0	83.3	20.8