Spatial Variability of Arsenic in Soils in Arsenic Contaminated Shallow Tube Well Command Areas used for Irrigated Wetland Rice Cultivation

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INTRODUCTION

Shallow Tube Wells (STW), each with a small command area (i.e., the area irrigated using the water of a single STW) are the main source of irrigation water for Boro (dry season) rice cultivation in Bangladesh. A vast majority of the STWs pump arsenic contaminated ground water adding arsenic to topsoil, the critical soil layer for rice production. Variography and Kriging are two useful geostatistical tools to study the distribution of physical and chemical properties of soils under grain crops or pasture (Mohanty and Kanwar, 1994). The modeled relationships using sample semivariograms can be used by kriging to estimate values between sampled points (Mallarino, 1996). This paper assesses the distribution of arsenic concentration in the soils surrounding a single arsenic contaminated STW in four different locations in Bangladesh.

METHODS

Ground water irrigated rice fields of four different locations were intensively sampled on regular grid spacing during Boro 2003. Soil samples were collected from grid points geo-referenced by GPS for As analysis. Composite soil samples (0-15 cm) were collected from the grids.

Semivariograms were calculated to evaluate the spatial variability of soil As for each individual site by GS+ 5.3.2. Maximum lag distance and lag interval for the semivariance were determined iteratively to best fit the model having highest R^2 and the lowest residual sum of squares (RSS) values. Kriging interpolation was performed to spatially describe the distribution of As concentration in topsoil.

RESULTS AND DISCUSSION

Concentration of arsenic in water flowing through the irrigation channel reduces with the distance from the tube well indicating that a considerable amount of arsenic in water is absorbed in soils, probably more near the source. Soil arsenic concentration was spatially related with the distance from the tube well along the irrigation channel. The effective distance of this spatial dependency varied with the topsoil texture, the distance being longer for the soils with higher clay content and shorter with higher sand and or silt. Within a command area, the spatial variability in soil arsenic was not consistent throughout resulting from the micro differences in plot elevation. The concentration was higher in relatively depressed areas where the irrigation water could stay longer than the area with higher elevation.

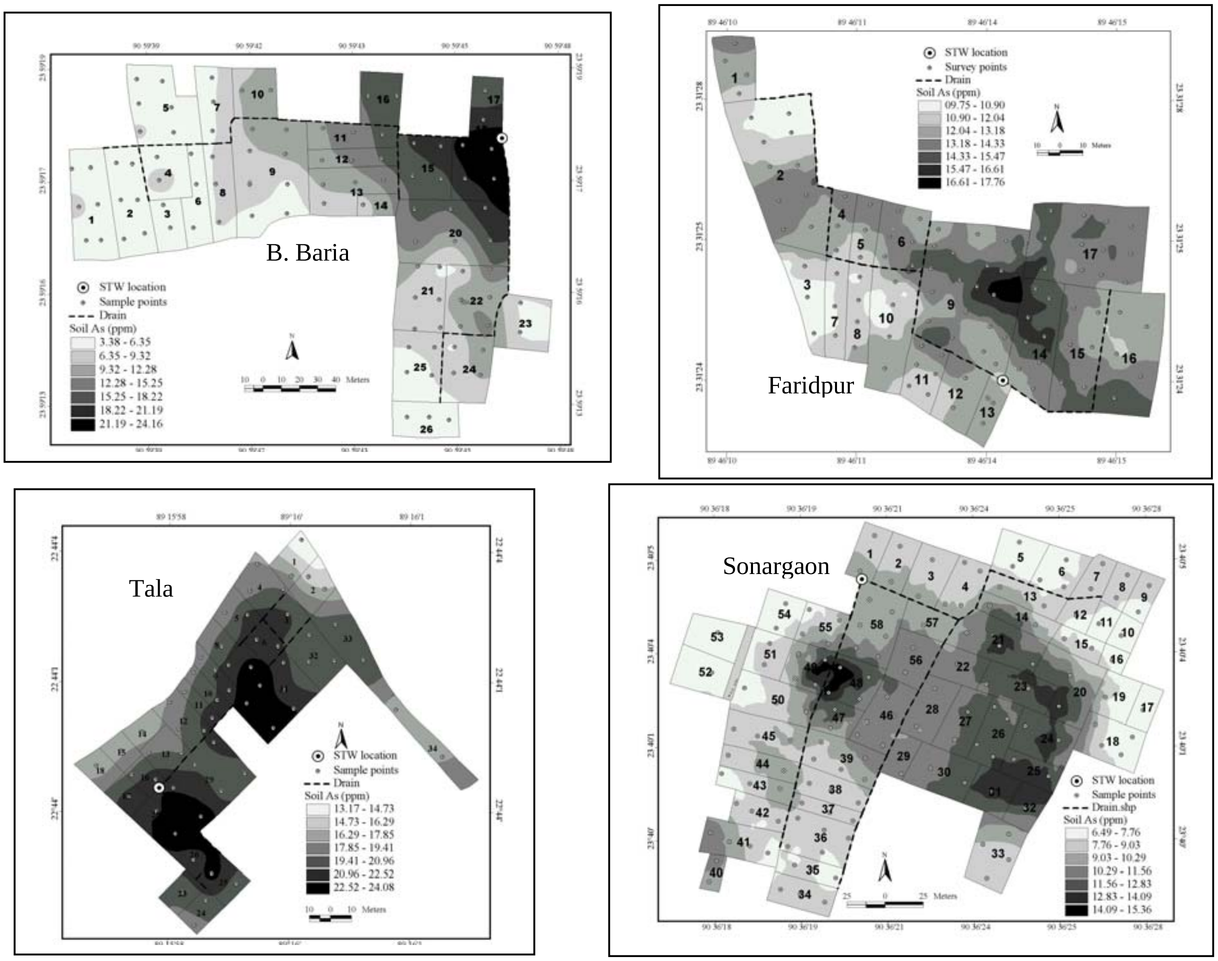

Fig. 1. Map of spatial variation of soil As in four locations

CONCLUSIONS

The spatial dependency of soil arsenic gives an indication that longer irrigation channels prior to inlets into rice fields and discouraging standing water for long periods in rice plots could be positive measures in reducing arsenic loading in irrigated rice soils.

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