

Groundwater Contamination around in Paddy Terrace in Badulla; special focus on nutrients and tracer element mobility

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Introduction

Groundwater is the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations[4]. Pollution of groundwater due to contaminated soil and fertilizer/pesticide is hurt animals, plants or humans and it may cause serious health problems, such as, hepatitis, blue baby syndrome, kidney disease, *etc* (Dissanayake *et al.*, 1984).

Paddy terrace is artificial replacement of nutrients in damage land. Due to erosion, nutrients were removed from top soil. Therefore, farmers are needed to apply especially N, P, and K fertilizer in artificial replacement. As a result of artificial nutrients added, groundwater can be highly contaminated around paddy terraces. Previous researchers investigated the sediment and nutrient (N, P, and K) movement behavior in terraced paddy fields system and groundwater contamination around paddy terraces has not been conducted in Sri Lanka. Thus, this research aims at identifying the excess nutrients and tracer elements with the excess pesticides/fertilizers from terrace paddy farming on groundwater and surface water. Also, it is attempted to identify mobility of them to groundwater and surface water during the different stages of the paddy cultivation.

Materials and methods

A total number of 80 water samples were collected from Rabukpotha area in Badulla, Sri Lanka, at frequent intervals during February to early July 2014, which coincides with the *Maha* season. The sampling was carried out in two stages of the intermediate period. Before and after cultivation two sample sets were collected and sample sets were renamed as A and B, respectively. Eighty water samples were analyzed for 25 chemical parameters (temperature, pH, Eh, turbidity, NO_3^- , PO_4^{3-} , NH_4^+ , SO_4^{2-} , CO_3^{2-} , HCO_3^- , F^- , Cl^- , Na, K, Mg, Ca, Cu, Pb, Zn, Mn, Fe, Rb, Li, Sr, Cs). Nutrients and tracer elements were measured using titrimetric, spectroscopic methods such as atomic absorption spectrometer and UV/Visible spectrophotometer[1].

Results and Discussions

Measured parameters are summarized in Table 01. pH levels vary in both stages in the eighty water samples. The values were a range from 6.0 to 8.53. The normal recommended pH range for irrigation water is from 6.5 to 8.4 [2]. All the tested wells were within the range irrigation water and there were no influence of cropping system on pH. EC levels were a range from 0.28 mS/cm to 5.72 mS/cm. Some of the wells EC values were increased after cultivation due to the leaching of salt from soil. Fluoride concentration on groundwater is not in detectable level. With the accuracy of instrument, low concentration might not be detected. Data analysis showed that higher Cl, Fe and

Mn concentration was present in groundwater with the usage of fertilizer. Also, after adding fertilizer, some elements (NO_3^- , NH_4^+ , Cu and Sr) are present in elevated concentration, except other elements. Those tracer elements and nutrients are leached to shallow wells faster than others.

Table 01: Minimum , maximum and average values of parameter in groundwater

Parameter	Sample Type A (n=40)				Sample Type B (n=40)			
	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.
pH	6.47	8.40	7.50	0.49	6.01	8.53	7.65	0.71
Trubidity (NTU)	0.13	33.70	5.33	6.84	0.14	45.10	3.05	7.34
Conductivity (mS/cm)	0.46	2.14	0.86	0.33	0.20	5.72	0.98	1.01
ORP (mV)	-145.00	58.00	-39.20	52.71	-78.00	32.00	-11.73	26.05
Cl ⁻ (mg/L)	1.234	65.980	12.650	13.503	3.999	59.981	16.995	10.705
F ⁻ (mg/L)	0.000	ND	ND		0.000	ND	ND	
NO ₃ ⁻ (mg/L)	0.229	4.040	0.809	0.901	-0.397	12.505	2.068	2.363
PO ₄ ³⁻ (mg/L)	-0.001	0.001	0.000	0.000	-0.002	0.003	0.000	0.001
NH ₄ ⁺ (mg/L)	0.064	0.287	0.143	0.055	0.119	0.361	0.168	0.079
Cu (mg/L)	0.003	0.084	0.026	0.017	0.000	0.140	0.020	0.028
Fe (mg/L)	0.000	1.940	0.280	0.403	0.000	1.701	0.107	0.388
Zn (mg/L)	0.002	2.242	0.032	0.384	0.000	0.185	0.020	0.044
Mn (mg/L)	0.000	0.709	0.012	0.151	0.004	0.310	0.021	0.076
Cs (mg/L)	0.895	1.827	1.311	0.233	0.009	1.377	0.460	0.476
Sr (mg/L)	0.001	0.368	0.085	0.065	0.015	0.464	0.108	0.096
Li (mg/L)	0.000	0.008	0.006	0.002	0.002	0.014	0.005	0.004
Rb (mg/L)	0.014	0.177	0.096	0.046	0.007	0.170	0.090	0.041
Na (mg/L)	5.435	30.358	6.129	4.051	4.978	48.375	7.857	10.802
Ca (mg/L)	2.288	26.670	10.571	5.027	2.468	47.408	10.298	11.261
K (mg/L)	1.625	15.963	3.361	2.328	1.655	12.563	5.231	3.733
Mg(mg/L)	0.024	19.220	9.521	3.368	4.170	31.729	7.664	6.552

Ca-Mg-HCO₃ type groundwater facies was presented in study area (Figure 1).

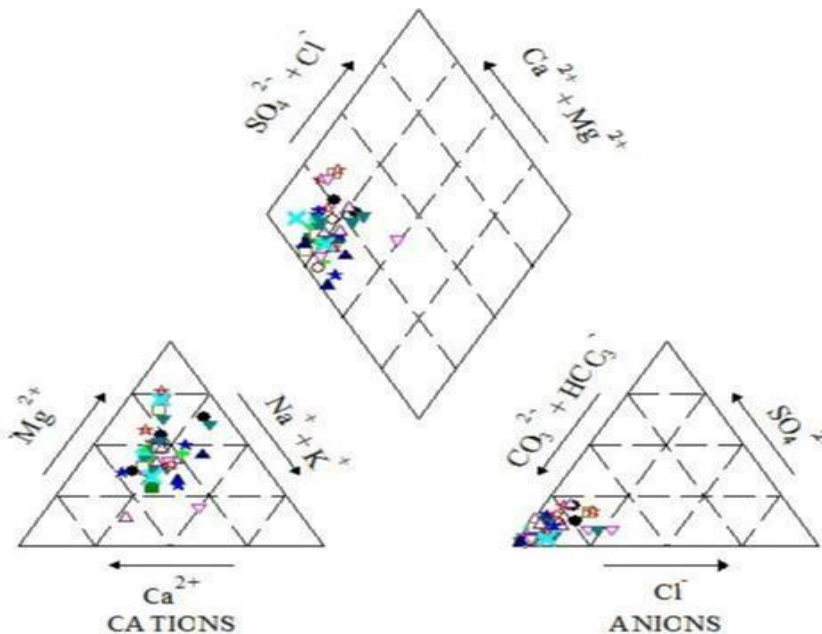


Figure 5: Piper diagram showing the major ions water quality

Conclusions

Some of the elements are (Cl, Fe, NO, Mn, NH, Zn, Sr) leach to groundwater with highly usage of artificial fertilizer. Samples which are collected from near the paddy terrace present higher nutrients and tracer elements concentration beyond others. There is significant different between before and after cultivation. With the terrace arrangement, tracer elements and nutrients are enriched in low land areas as compared with other areas. The overload of nitrogenous fertilizers to the soil is help to provide elements to soil. But some nitrogenous fertilizers are not subject to immediate leaching. Also phosphorous fertilizer is less subject to leaching, but it loss through surface runoff. Therefore it is difficult to say some elements directly contributed by agrochemicals.

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