Understanding shallow groundwater contamination in Bwaise slum, Kampala, Uganda

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1.INTRODUCTION

Lack of proper sanitation in slums in sub-Saharan Africa is becoming an important source of nutrients (N, nitrogen and P Phosphorus) leaching into groundwater. The mass loads and fate of nutrients in these areas are not well known. In excess, these nutrients can ex-filtrate into streams causing eutrophication in Lakes.

2. OBJECTIVES

This study aims to understand:

1) the nutrient pollution from two common onsite sanitation activities in slums; pit latrines and solidwaste dumps
2) The fate of these nutrients in the shallow groundwater system of Bwaise slum

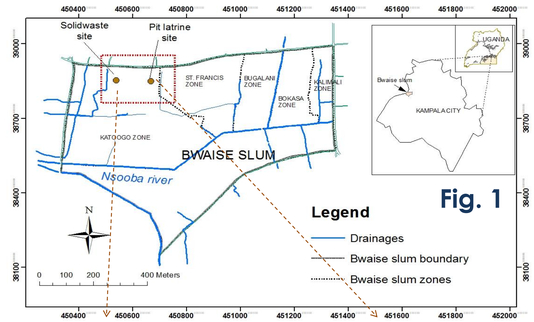


Fig. 1

Solid waste dump site

Elevated pit latrine unlined at the bottom

3. MATERIALS AND METHODS

Piezometers were installed to determine groundwater flow (using slug tests and levels) and water quality including nutrients and hydrochemistry from March – Aug 2010 (Fig. 2). Data was analyzed by comparing the upstream and downstream concentrations and loads. Processes affecting fate of nutrients were described using redox potential (NO_3/NH_4 couple) and saturation indices of P minerals.

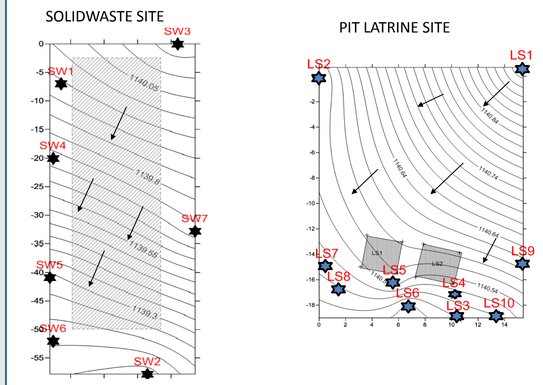
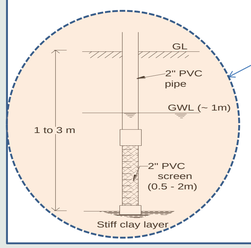


Fig. 2 Monitoring network at pit latrine and solid waste sites (= piezometer)



Nutrient loads

$Load = C_{avg}\ Q_{avg}$

C_{avg} = average concentration

Q_{avg} = average discharge

4. RESULTS

Table 1: Average concentrations (mg/L) upstream and downstream of pit latrine and solidwaste

Site	Location	EC (µs/cm)	pH	mg/L NH_4	NO_3	PO_4	Ca	Cl	HCO_3	Na	Mn	Fe	Si $MnHPO_4$	Si $Ca_5(PO_4)_3(OH)$	Si $Fe_3(PO4)_2$
Pit latrine	Upstream	1306	6.6	5	85	0.05	22	110	322	48	0.9	0.0	1.2	-6.4	-8.2
	Downstream	5061	7.5	57	228	2.4	61	380	1114	172	0.4	0.1	2.2	1.2	-5.1
Solidwaste	Upstream	859	6.3	3	69	0.3	25	67	171	37	0.8	0.0	2.0	-8	-7.4
	Downstream	795	6.5	5.1	16	0.2	12	66	233	28	0.7	-	-	-6.7	-2.6

Significant pollution was from the pit latrine. Relatively high redox potential (pe 5.6 – 7.2) hence nitrification took place. Fe was absent. High potential for P to co-precipitate with Mn & Ca (Si +ve)

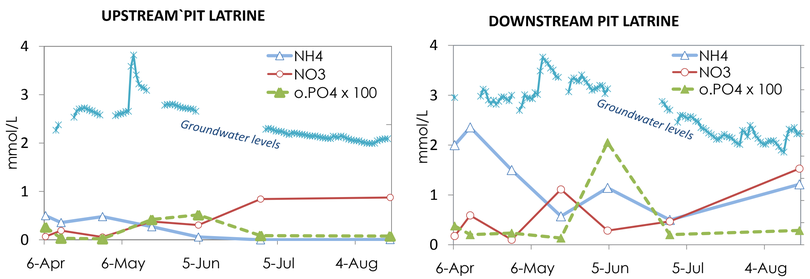


Fig. 3 Temporal Variations in Nutrients a Pit Latrine Site

Variations were due to changes in groundwater level and leaching from the pit latrine

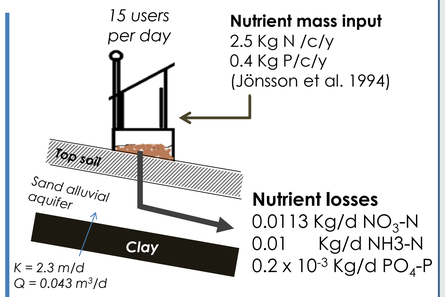


Fig. 4 Nutrient loads at pit latrine

Only 21 % of N and 1.2 % of P input into the pit latrine was leached

5. CONCLUSIONS

Although the pit latrines seemed to significantly pollute groundwater, most of the nutrients were actually retained in the pit. P removal was almost complete due retention in the pit and due to precipitation with Mn and Ca minerals in the soil. Hence, use of the pit latrine – aquifer system can be good for removal of nutrients in unsewered slum areas and for controlling eutrophication.