Groundwater contamination due to sanitation problems and it's relation to soil characteristics (Case study in Denipitiya, Sri Lanka)

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Introduction

After the Asian tsunami 2004 coastal groundwater resources were contaminated by saline water due to the destruction of shallow dug wells and the urgent need to supply safe, clean drinking water to the affected regions. Suitable dug well was selected from out skirt of tsunami belt in Weligama to supply drinking water to affected people. The present study assess the chemical and microbial contamination of groundwater in the unconfined aquifer in Denipitiya, which are used to supply drinking water to the Tsunami camps situated in the coastal belt. The main objective of the present study is to identify the sources and causes of contamination and their influence on water quality.

Study area

Denipitiya belongs to the Wet Zone low country (WL4) agro-ecological zone, where climate is tropical monsoonal with a distinct bimodal rainfall pattern (fig:2). Basement precrembrian metamorphic hard rock in the area is covered by quaternary sedimentary deposits. Topsoil mainly consists of sandy clay. The top unconfined alluvium sandy aquifer is distributed in the river basin area and on the coastal line and lower section consists of calcified sandstone.

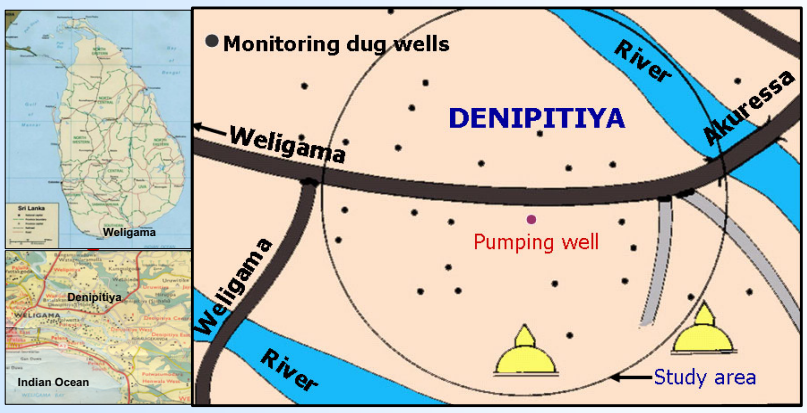


Fig. 1. study Area and Dug wells distribution

Methodology

Thirty dug wells were selected and monitoring conducted with respect to groundwater levels, electrical conductivity (EC), total dissolved solids (TDS), Coliform and E Coli. The informations were Collected on minimum distance between the well and latrine pit, depth of the latrine pit (fig:1). Three auger holes were drilled within the study area and collected soil samples to identify aquifer and unsaturated zone characteristics. From each auguring point, soil samples were taken from surface layer and followed by each 50 cm depth until reach water table and also water samples were taken from auger holes. Soil samples were analyzed with respect to physical and chemical parameters

Results and discussion

Most of the dug wells distributed in the study area are shallow, at 3-5 m depth range and 0.5- 1.5 m diameter. Accordingly 93.6 % of wells had EC valves above 500 µS/cm. 96.99% wells have TDS level above 200mg/l (Table 1).

Table 1: Distribution of EC, TDS, Turbidity and pH.

Parameter	Mean value	Max value	Min value	WHO standard
EC (µS/cm)	668.36	1120	394	350-1000
TDS (mg/l)	290.8	434	199	1000
Turbidity (NTU)	0.707	1.46	0.28	5
pH	7.38	7.69	7.1	6.5-8.5

Chemical analysis of the groundwater was conducted with respect to Ca^{+2}, Mg^{+2}, Na^{+}, K^{+1}, $Fe^{+2/+3}$, NO^{2-}, NO^{3-} (table 4.1).

Table 1: Distribution of EC, TDS, Turbidity and pH.

Component	Mean value	Max value	Min value	WHO standard
Ca (ppm)	81.466	121	5.7	75
Mg (ppm)	6.678	8.12	3.0	50
Na (ppm)	1.706	2.28	1.456	200
K (ppm)	1.688	1.936	1.376	Ns*
Fe (ppm)	0.311	0.637	0.084	0.3
$NO-_2$ (ppm)	<0.05			3
$NO-_3$ (ppm)	2.495	3.3	1.9	50

All the inhabitants were followed WHO recommendation, while constructing their wells and toilet pits (fig:2). (At least, there should be a 10 m distance between the latrine pit and well).

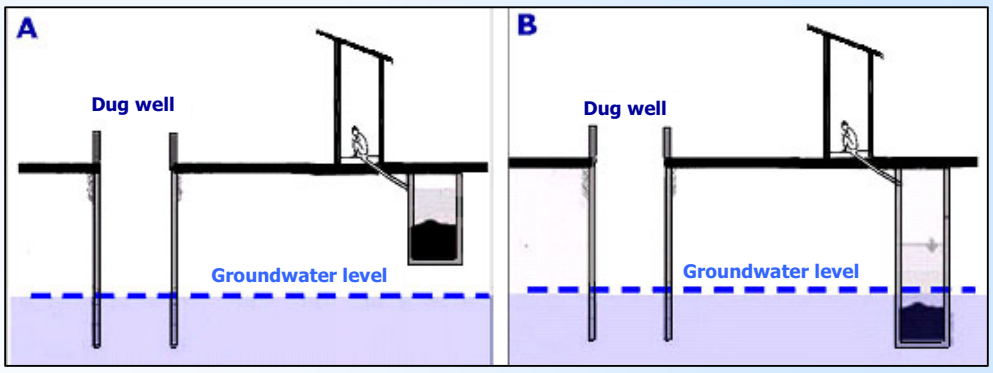


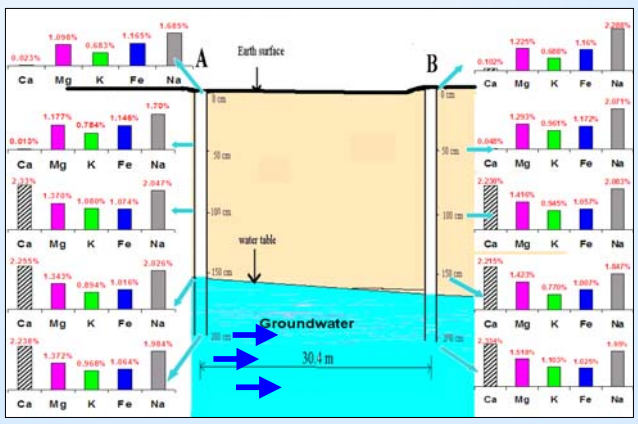
Fig. 2: Latrine pit above (A) and below (B) the groundwater level

Higher number of *E.Coli* are found in deeper toilet pits which are extended to saturated zone and also in the wells which are dug closer to shallow latrine pits (table 3).

Table 3. E coli count in the well water with different conditions

Comparing factor	Mean E Coli count (MPN/100ml)
Dug wells where with fish	47.12
Dug wells where without fish	48.20
Wells with water pump	19.18
Without water pump	53.66
Latrine pits below the groundwater table	56.65
Latrine pits within the unsaturated zone	12.98
constructed dug wells	35.27
Poor constructed wells	64.45

Calcium concentration in the soil is gradually increased with the depth of the auger hole compare to other chemical components in the soil due to calcified sand stone (fig: 3).



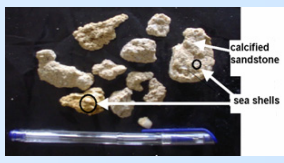


fig: 4: Calcified sand stone in the aquifer

Figure 3. Chemical component variations in the soil samples

Conclusions

Groundwater in Denipitiya area is contaminated with chemically as well as with biological components. Soil analysis reveled that calcified sandstone aquifer permeability contribute significant affect to contamination of bacterial pollution.