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TOWARDS THE MILLENNIUM DEVELOPMENT GOALS

Effect of sanitation system on groundwater

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POLLUTION OF GROUNDWATER from different sources by waste matters as a result of human activities constitute one of the most difficult and complex problem in groundwater management. Implementation deficiencies of existing laws make protection of groundwater sources from domestic sanitation systems unsafe. The effluent infiltrates the ground and sooner or later percolates to aquifers. Thus, the performance of pit latrine and soak-away depends primarily on the ability of the soils and rocks in which pits are excavated to accept and purify the effluent (Catherine, 1989). The only way of knowing whether domestic sanitation practices (i.e. pit latrine, soak-away, unlined gutter, refuse dump) are potential groundwater (especially shallow groundwater) pollution hazard and consequently a health hazard is by monitoring the environmental effect of the systems. The study took place in Mando, a developing area along Lagos Road, Kaduna , for shallow groundwater quality surveillance. Due to frequent pipe-borne water shortage, most of the inhabitants in the study area are compelled to solemnly rely on shallow groundwater for abstraction. This paper discussed shallow well monitoring to find out :

1) Whether existing sanitation systems are polluting the selected hand dug wells water supply sources .
2) The nature of pollution hazard in terms of microbiological (coliform) and some physicochemical parameters.
3) The lateral distance from possible soak-away / pit latrine to the shallow well.
4) The static water level of selected shallow groundwater sources.
5) Recommend possible solution to the problems regarding groundwater contamination .

Sampling/analysis

Confidence in groundwater data depends on a thorough comprehension of how the process that operate during the entire sampling procedure (Reiley and Gibs, 1993). As the most common means of gathering groundwater data monitoring wells provide access to the groundwater and allow collection of samples, as well as physicochemical/bacteriological tests (Martin-Hayden, 1999). Samples that met requirements of the statistical sampling programme were obtained and handled in such a way that they do not deteriorate before reaching the laboratory. The samples were asceptically collected in sterilized plastic containers throughout the monitoring period. Multiple samples from each established sampling point were collected at every sampling operation. The sampling points were sited based on:

- Prevalent mode of sanitation activities,
- Shallow groundwater usage and
- Possible complaints from consumers.

A total of twelve (12) sampling locations were monitored within the period of April -October, 1999. Samples were analysed by adopting methods that provides the information required (APHA-AWWA -WEF,1992)

Results and discussion

Obviously, the properties and nature of waste matter discharged into a body of water would influence the quality of the water by altering its original nature. Human health can be affected and quality of the environment becomes degraded. The strength of the polluting substances and the rate of seepage to the groundwater can influence concentration of contaminant in the water body . Pathogens of faecal origin represent one of the greatest potential threat to safety of water supplies, but in most developed countries this hazard have been controlled with considerable success (Packham, 1993). Being a health hazard, nitrate is equally of major concern. Normally ammonia nitrogen is biologically oxidized to nitrate and then flushed into the ground serving as potential of groundwater pollution (Sorg, 1978). Serious and occasionally fatal effects in infants (below 1 year) have occurred following the ingestion of untreated well water containing nitrate concentrations greater than 20mg/l (CWQC, 1972). Generally, peak values of sanitation pollution indicators (i.e. coliform and nitrate) obtained in August might be due to high intensity rainfall coupled with loss in soil retention capability as a result of saturation , leading possible loss in matric forces . Hand dug wells closer to pit latrine/soak-away have higher nitrate and coliform contents (sample code A1, A4, A3, B4, A2 etc.). 42% of the monitored wells met lateral distance guideline level of 50ft (table 1) recommended by WHO as minimum distance from potential source of domestic waste (pit latrine/soak-away). 17% of the monitored wells have acceptable drinking water quality in relation to sanitation pollution indicators throughout the monitored period. Inhabitants in B4 are not completely using the well for drinking because of bad organic taste possibly due to the very poor quality as a result of sanitation systems .

Table 1. Lateral distance from soak-away/pit latrine

Sample Code	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Lateral Distance(ft)	54& 6	30	28	25	57	48	49	20	55&33	43	51	68

Nitrate: Fig. 1 and table 2 show the concentration of nitrate is in the range of 11-98mg/l throughout the period of monitoring. Only B1 & C4 of the monitored wells have met guideline level of 20mg/l nitrate concentration recommended by WHO. Very high nitrate concentration in the range of 59-98mg/l monitored in A1, might be as a result of soak-away contamination from neighbourhood with lateral distance of 6ft (Table 1). Whereas nitrate contamination in the range of 30-50mg/l in B2 might have reinforcement from the refuse dump.

Coliform: Fig. 2 and Table 3 show the monitored coliform content is in the range of 3-95 total coliform/100ml in the sampled wells. Only B1 & C4 of the monitored wells have met the acceptable level of 10 total coliform/100ml recommended by WHO, while B3 & C3 met the guideline mainly during April-June of the monitored periods. The very high coliform count of 59-95/100ml in A1, might be from neighbourhood soak-away contamination (table 1). Whereas coliform count in the range 15-47/100ml in B2 might have contribution from the refuse dump.

Other Parameters : There is irregular change of pH in the range of 6.4-8.0 monitored throughout the period . A range of 2-173NTU turbidity have been obtained throughout the monitoring program. Lower values of turbidity obtained in some dug wells during April-May period might be due to lack of side erosion within the wells (possibly as a result of greater cohesion) and vice versa especially in August. The very high value of 173NTU in August of sampling point A4 may not be far from the side erosion that lead collapse of affected portion of the well. There might be reinforcement to turbidity values from users due to turbulence prior to collection of samples. Electrical conductivity ranged from 39-887:S/cm. Some wells have higher values in April-July, this might be due to dilution from rainfall during August-October. There are however some wells which have higher values especially in August possibly due to more salt intrusion as a result of higher dissolution of high intensity rainfall. The static water level ranged between 1.5-6.4m and might be a function of rate of abstraction; population in household and period of season in the study area.

Conclusion

Results of the analyses suggests, the significance of drinking water monitoring for the case study area. The nitrate and coliform (sanitation activities indicators) analyses of water samples from the hand dug wells signifies that, most of wells might be contaminated due to their closeness to pit latrines/soak-away. The sanitation activities indicators might have been derived as a result of seepage from pit latrines/ soak-away, however unlined drainage systems and refuse dump might have equally contributed. General peak values of sanitation pollution indicators obtained in August might be due to high intensity rainfall that lead to possible loss of matric forces . Since, a good location of wells form the basis

Table 2. Nitrate Concentration (mg/L)

LOC. CODE	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT	MEAN	STDEV	COEFVAR
A1	70.3	67.7	71.8	74.6	98	97	59	76.91	14.88	0.19
A2	20	28.9	29.6	32.1	49.1	41	32.5	33.31	9.32	0.28
A3	59	59.3	60	61.8	74.6	70.3	35.1	60.01	12.54	0.21
A4	58.1	58.7	62	70.3	89.2	87	60	69.33	13.47	0.19
B1	18.2	20	21.5	20	22	21.6	16.8	20.01	1.93	0.10
B2	30	25	34.2	36.5	50	49.1	34.6	37.06	9.33	0.25
B3	29.8	27.6	30	31.4	36.7	32.5	28.4	30.91	3.04	0.10
B4	36.9	30.5	34.2	38	54	48.2	36.7	39.79	8.28	0.21
C1	46.7	45.4	48.6	51.6	63.8	41	28.4	46.50	10.71	0.23
C2	23.4	23.9	26.5	27	40	38.9	41	31.53	8.02	0.25
C3	20	18.5	22.1	24.8	30.7	27.6	26.2	24.27	4.33	0.18
C4	11	12.3	15.8	18.2	20	16.5	12.9	15.24	3.30	0.22

Table 3 Coliform Content (T.C./100mL)

LOC. CODE	APR	MAY	JUN	JUL	AUG	SEPT	OCT	MEAN	STDEV	COEFVAR
A1	59	56	79	84	95	92	68	76.14	15.51	0.20
A2	10	14	20	20	27	38	31	22.86	9.77	0.43
A3	54	50	63	66	88	84	45	64.29	16.52	0.26
A4	46	44	68	78	90	85	70	68.71	17.95	0.26
B1	7	7	6	8	10	10	5	7.57	1.90	0.25
B2	22	20	28	32	47	45	15	29.86	12.32	0.41
B3	10	9	9	11	19	21	10	12.71	5.06	0.40
B4	40	38	49	50	68	61	45	50.14	10.92	0.22
C1	20	20	21	25	45	31	23	26.43	9.05	0.34
C2	18	14	17	19	34	28	17	21.00	7.21	0.34
C3	9	9	10	11	16	12	10	11.00	2.45	0.22
C4	4	4	5	6	9	8	3	5.57	2.23	0.40

for water quality control, sanitation officers, town planners and residents have significant role to play in protecting risk of groundwater contamination by sanitation systems. Inhabitants of sample area A1 were advised to discuss with neighbour A2 for possible relocation of his soak-away to appropriate location. Whereas, those in C1 were also advised to condemn or relocate the pit latrine that has lateral distance of 33ft to their hand dug well.

References

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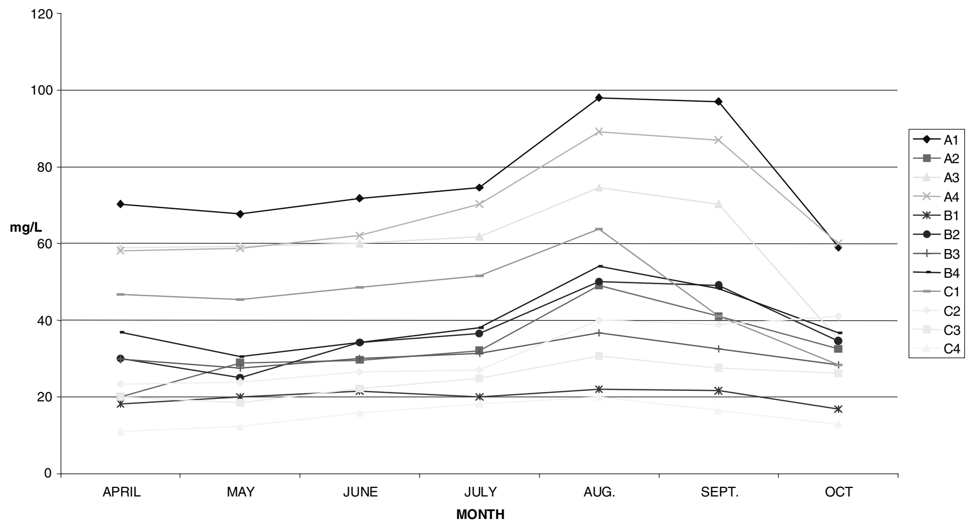
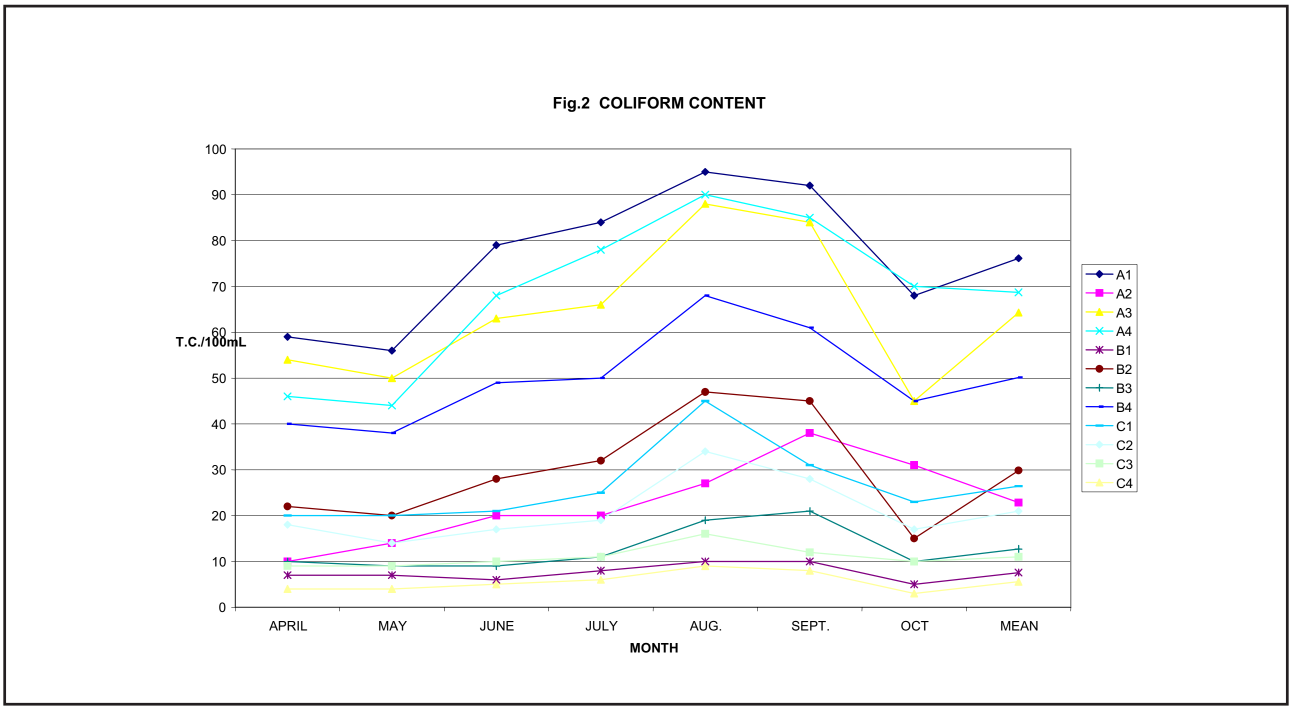
Fig. 1 NITRATE CONCENTRATION





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