TOWARDS POLLUTION REDUCTION IN PERI-URBAN WATER SUPPLY: A CASE STUDY OF ASHANTI REGION IN GHANA

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ABSTRACT

The paper looks at a prevailing problem in providing water and sanitation in developing countries. The number of people in developing countries relying upon untreated groundwater supplies for drinking purposes is rising. Increasing concurrently with the development of groundwater resources is the provision of on-site sanitation facilities. The study assessed the pollution levels of contamination associated with on-site sanitation in forty-five groundwater supplies. Seven hand-dug wells recorded high levels of faecal coliform. Field measurements showed that nearby pit latrines were the courses of polluting these wells.

INTRODUCTION

The development of groundwater resources for potable use has increased substantially over the last decade in developing countries. In Ghana, most rural and some peri-urban dwellers now rely on untreated groundwater sources for domestic purposes. This increased popularity of groundwater has resulted from the fact that this resource is characterised by certain features that make it attractive as a source of potable water supply (Quist et at, 1988). Firstly, this is because aquifers underlie geographically large areas of the country, and these can commonly be tapped at shallow depth near the water demand centres. Secondly, water stored in aquifers is for the most part protected naturally from evaporation, and well yields are in most cases adequate, offering water-supply security in regions that are prone to protracted drought, such as in the northern parts of Ghana. Thirdly, with adequate aquifer protection, groundwater has excellent microbiological and chemical quality and it therefore requires minimal or no treatment. Lastly, the capital cost of groundwater development as opposed to conventional methods is relatively modest and the resource lends itself to flexible development (Dapaah-Siakwan and Gyau-Boakye, 2000).

Increasing concurrently with groundwater resources development is the provision of on-site sanitation facilities. Sanitation provision is of great importance in any community. However, the choice of sanitation technology depends on economic, technical and social issues. Generally, in those communities where groundwater is used for domestic purposes, on-site sanitation happens to be the choice of excreta disposal. There is therefore a growing concern that the wide spread use of on-site sanitation systems will cause subsurface migration of contamination, ultimately resulting in diseases transmission and environmental degradation. There is therefore a need to understand and establish a correlation between on-site sanitation and contamination of groundwater sources.

METHODOLOGY

The methodology included the following steps.

Survey of sanitary conditions

Visual inspection of the water points, sanitation systems and their immediate environs was conducted in each selected community. Distances between the various sanitation systems and the water points were measured. Their relative positions by deviation were noted. This was done with the assistance of the WATSAN committee members.

Sampling of water

(a) The samples were collected, stored and transported in suitable containers: well cleaned 500 ml plastic bottles for physico-chemical analyses and sterilized plain glass bottles for bacteriological analyses.
(b) Care was taken during sampling to prevent contamination of samples. All samples were collected by the use of hand-pumps fitted on the hand-dug wells and boreholes. The spout of hand-pumps were cleaned and sterilized with flame before sampling (Dugbartey, 2001).

Water sample analysis

Analyses of water samples were carried out within twenty-four hours of collection. Samples were analysed for the following parameters: faecal coliform, nitrate, and chloride

EFFECT OF DISTANCE FROM POLLUTION SOURCE ON POLLUTION LEVELS

Available literature (ARGOSS, 2001) maintains that increased lateral separation between pollution source and groundwater supply reduces the risk of faecal pollution. Hence the farther a groundwater supply is from the pollution source the less the risk of pollution. This study looked at the concentration of selected contaminants in relation to the distances between the groundwater supplies and the on-site sanitation systems. The contaminants analysed were faecal coliform, nitrate, and chloride because they are key indicators of the presence of faecal pollution. Research of the effect of soil type on contaminant level is presently underway.

The distances of the hand-dug wells from the closest on-site sanitation systems are shown in Table 1.

Table 1: Distances of hand-dug wells from on-site sanitation systems

Well Identification	Distance (m)
Wioso Hand pump No. 1	25
Oyoko Mission Pump No. 2	46
Adagya No. 1	49
Bimma No. 2	230
Odurokrom Hand pump No. 2	250
Bimma No. 1	330
Abotanso	343

The distances between the nearest pollution sources and the ground water supplies in relation to pollution levels are shown in Fig. 1. The levels of faecal coliform were highest in the wells at Wioso and Oyoko Mission at distances 25m and 46m respectively from on-site sanitation. The well at Adagya 1, which was 49m away from a pit latrine, was however, less polluted than the well at Abotanso, which was 343m away from a pit latrine. The distance between the groundwater supply system and the pit latrine was 330m at Bimma 1, but it showed more faecal pollution than Adagya 1, Bimma 2 and Odurokrom with lateral separations of 49m, 230m,and respectively.

Nitrate and Chloride

Relations between Chloride levels in water supplies and distance are shown in Fig. 2, while Fig. 3 shows the relation between Nitrate and distance. The trend for concentration of the three contaminants is similar: the highest at Wioso, followed by Oyoko Mission and then Bimma 1.

The study shows that the pollution levels in groundwater sources depend on distance between the groundwater supplies and the pit latrines. Because the latrines and groundwater supplies are located in different communities with varying soil types, it is likely that the low levels of contaminant levels in Adagya 1, Bimma 2 and Odurokrom may be due to the soil types. The second speculation is that there may be ingress of faecal coliform into the well through the openings.

ARRANGEMENT OF ON-SITE SANITATION SYSTEMS & GROUNDWATER SOURCES

In Ghana residential areas usually share common walls. Due to lack of sewerage and water supply systems in new residential areas, the residents tend to depend on groundwater resources for their water supply, and on-site sanitation for disposal of excreta. There is no law governing the arrangement of on-site sanitation and groundwater tapping points in a private compound. This may be a major source of health risks as these two technologies are usually developed hand-in-hand. In some arrangements, there is only a wall separating a hand-dug well in one compound from an on-site sanitation system in another. Interviewing a few residents of a suburb in Kumasi revealed that even the psychological effect of the closeness of the two necessities of peri-urban and rural residences is so conflicting that some have ceased using their hand-dug wells as a source of their water supply.

There is therefore the need to increase the lateral separation between pollution source (on-site sanitation) and groundwater supply to reduce the risk of faecal pollution. It is therefore necessary that town planning agencies should enforce this ideal phenomenon as shown in Fig. 4. The proposed arrangement demands that within the same compound, the longest distance possible should be provided between hand-dug wells and on-site sanitation. Also, houses having common walls should concentrate the development of on-site sanitation at the corner of their shared fence walls, while hand-dug wells are place at the diagonal as shown in Fig. 4.

CONCLUSIONS

On–site sanitation is a major potential source of pollution of ground water source. The study has shown that distance has a tremendous effect on pollution level in groundwater sources. Therefore appropriate measures should be taken to reduce this impact on the health of those who depend on these conflicting necessities of life. Future studies will seek to establish the relationship between soil type, rate of water movement in soil, and the level of contamination in groundwater sources. This would aid in the selection of the appropriate distance between on-site facility and groundwater source for a particular soil type to contribute to the reduction of the negative impact of on-site sanitation on groundwater source.

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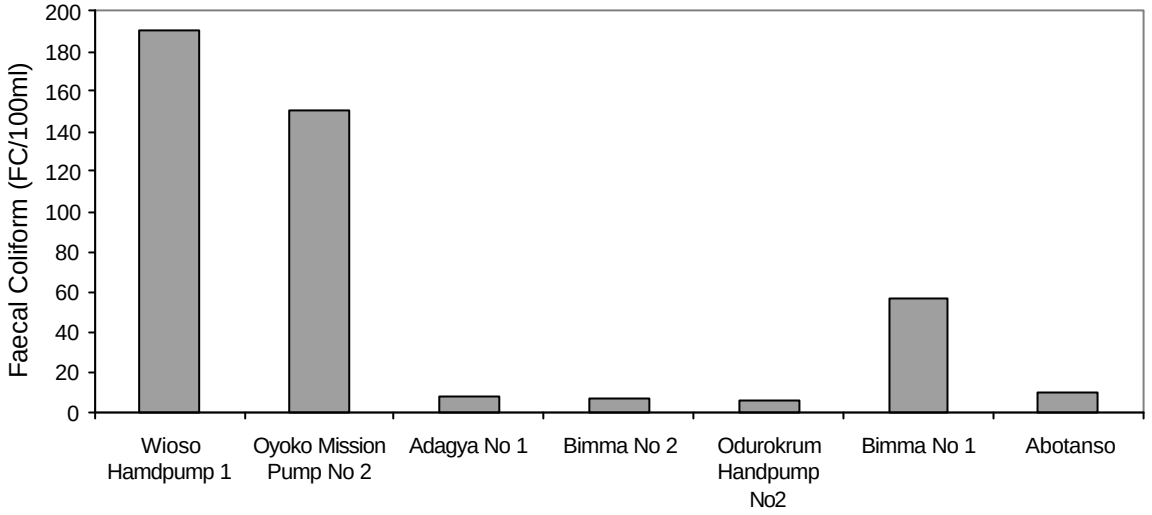

Fig. 1 Effect of Distance on Faecal Coliform Concentration in Wells

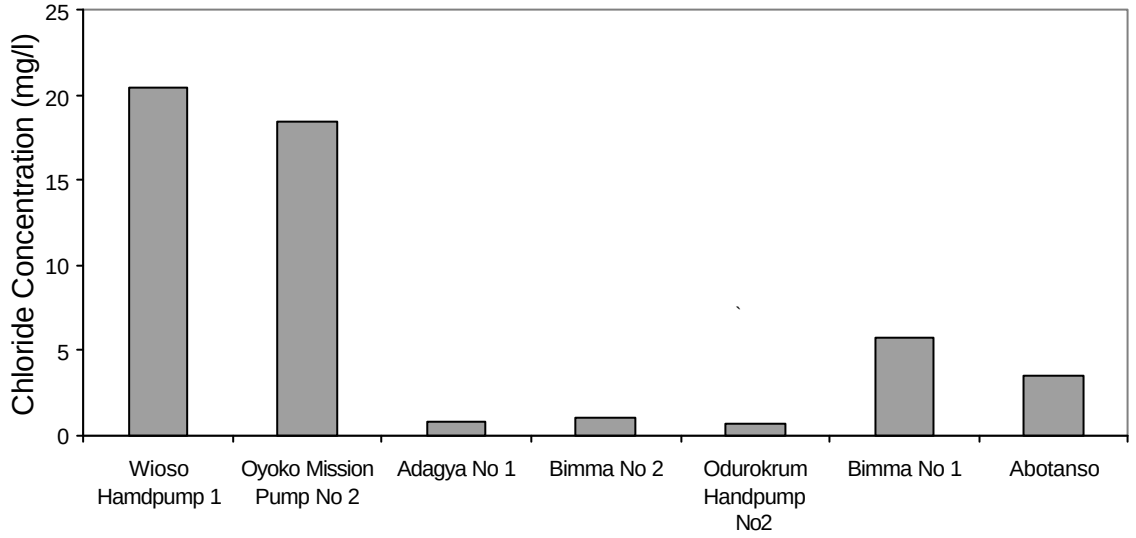

Fig. 2 Effect of Distance on Chloride Concentration in Wells

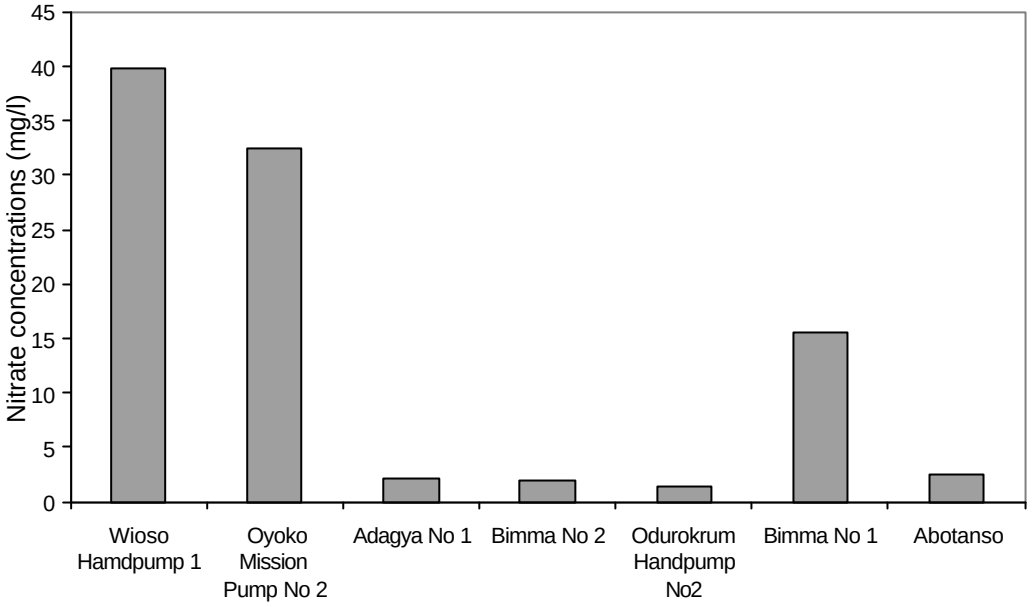

Fig. 3 Effect of Distance on Nitrate Concentration in Wells

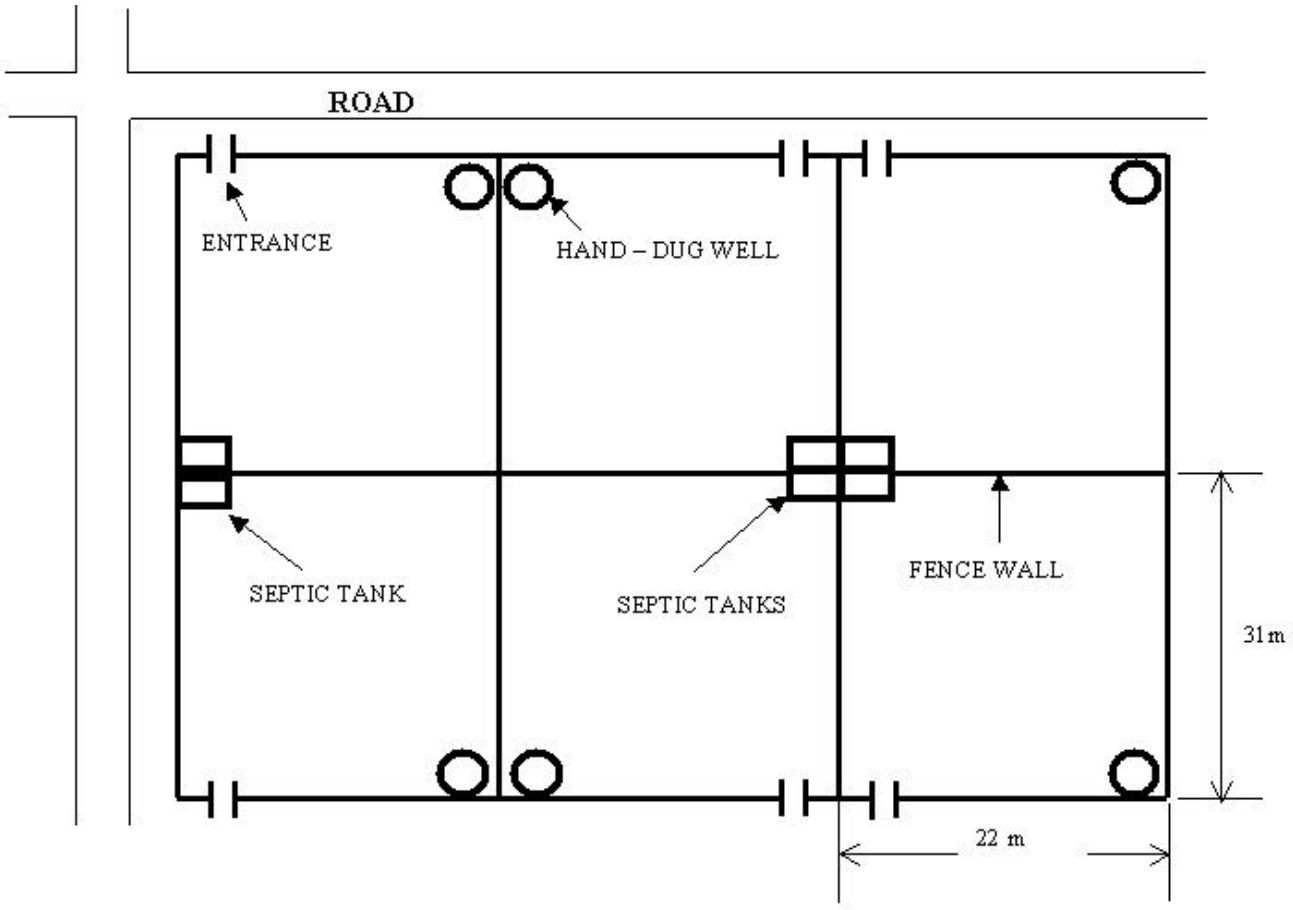

Fig 4. Proposed Layout of Septic Tanks and Hand-Dug Wells in Residential Areas