Reducing shallow–well contamination in Uganda

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Abstract: The water quality monitoring in SE Uganda showed that shallow groundwaters commonly exhibit levels of the coliform bacteria and nitrate concentration determined in the WHO health guidelines. Therefore, the main causes of groundwater contamination were investigated. The results indicated that the scoop wells represent a potential contamination source of adjacent shallow wells.

Keywords: groundwater, contamination, monitoring, Uganda

Introduction

Despite an abundance of surface water in Uganda (18 % of the land area), the predominantly rural (>70 %) population relies almost exclusively on groundwater for a portable water supply. This dependence arises from the more widespread occurrence, superior quality and reduced susceptibility to contamination of groundwater supplies compared to surface water resources. As a result, provision of safe water to rural communities in Uganda has depended primarily upon the construction of wells and protection of spring discharges. This paper depicts a case study taken in east and central Uganda. Particular attention has recently been directed at developing the shallow-well aquifer since the formation is less costly to develop and recent study has found it to be more productive than the deeper, bedrock aquifer.

However, monitoring of water quality in south eastern Uganda, a region of intense shallow–well development, shows that within months of installation, shallow groundwater commonly exhibit levels of coliform bacteria and nitrate exceeding W.H.O health guidelines.
Human and livestock waste excreted in pit latrines, over land or in open-pit wells, called "scoop wells" may contain worms, protozoa, bacteria and viruses that if consumed, can lead to the contraction of hepatitis, typhoid, cholera and a variety of diarrhea diseases. Wells and springs harvesting shallow groundwater are generally protected from these pathogens by a granular soil matrix which both filters bacteria, protozoa and worms due to their relatively large diameter (>0.5 μm) in relation to the aquifer material, and adsorbs smaller viruses (0.07 μm to 0.7 μm) on account of their strong, negative surface charge. Despite this cleansing capacity, the presence of coliform group of bacteria in groundwater indicates that faecal contamination has occurred.

Scientific paper

Wells construction commonly occurs near scoop wells and swamps, because the presence of a shallow water table in these areas inhibits the formation of duricrusts, which are impenetrable to hand drilling, and virtually guarantees water will be found. However, with an average depth to water of just 2.6 m, the length and time (in some case as little as 2 weeks) during which the granular medium is able to remove surface wastes before they enter the groundwater system, is limited. Pumping tests achieved an average, steady state drawn down of 4.5 m using a mean pumping rate of 12 l/minute, a value that is similar to the capacity of most hand pumps. Consequently, steep hydraulic gradients can develop between shallow wells and the sources of pollutants (scoop wells and swamps).

The biological and chemical quality of water from 10 shallow wells in Mukono District was evaluated at the beginning of the first rainy season in April 2000 and three months later during the short dry season in July. Site selection depended upon the presence of an adjacent scoop well which was also analyzed in July 2000, for its biological and chemical quality. Results of the biological tests are presented in the table below. Only total coliform counts were considered since false, positive readings for faecal coliforms have been observed in tropical environments using standard methods.

RESULTS AND DISCUSSION

All of the scoop wells exhibit several faecal contaminations with total coliform counts well in excess of 100 per 100 ml. As such, they constitute a potential source of contamination to adjacent shallow wells. Significantly, at the three sites where the scoop wells declined dramatically and in two instances fell to within acceptable levels (L10 count/100 ml; W.H.O, 1985).

A the remaining seven sites with an operation scoop well, six shallow wells show unacceptably high coliform counts ranging from 12 to 97 per 100 ml. At four of these sites, total coliform counts have risen since initial testing in April. With respect to nitrate levels, the average concentration in the seven shallow wells having an adjacent scoop well is considerably higher (11 mg/L) than the average amount recorded in sixty shallow wells at the time of construction (1.0 mg/L).

Both the total coliform and nitrate date show deterioration of shallow-well, water quality in the presence of a polluted shallow-well. No apparent relationship exists, however, between the magnitude of contamination and the distance separating scoop wells from shallow wells. Although inconclusive, the total coliform and nitrate evidence strongly implies nearly scoop wells are a key threat to shallow-well water quality. Delineation of a safe distance between shallow wells and point sources of faecal contamination such as scoop wells and pit latrines is necessary in order to ensure the sustainability of this portable water supply.

Conclusion

The practice of siting shallow wells in the vicinity of existing scoop wells has been identified as a probable source of faecal contamination to shallow wells in Mukono District of South Eastern Uganda. Simulations of groundwater flow in the shallow aquifer indicate that a wellhead protection area of 60 m between wells and contaminant sources such as scoop wells, pit latrines and swamps is required to ensure the sustainability of this vital, potable source of water to rural communities.

The impact of site variations such as the hydraulic gradient (local shape), as well as the rate and duration of well pumping which are critical for effective planning and surveying of groundwater development activities, have been evaluated. Continued monitoring of shallow groundwater quality is necessary in order to evaluate whether the suggested minimum separation (60 m) between wells and contaminant sources, known as wellhead protection area, is adequate.