Pergamon

PII: S0043-1354(96)00040-1

Wat. Res. Vol. 30, No. 9, pp. 2017–2026, 1996

0043-1354/96 $15.00 + 0.00

WELL WATER SURVEY IN TWO DISTRICTS OF CONAKRY (REPUBLIC OF GUINEA), AND COMPARISON WITH THE PIPED CITY WATER

YVES GÉLINAS[1]*, HAROLD RANDALL[2], LUCIE ROBIDOUX[1] and JEAN-PIERRE SCHMIT[1]

[1]Chemistry Department, Université du Québec à Montréal, C.P.8888, Succ. A, Montréal, Québec, Canada, H3C 3P8 and [2]UNICEF-Conakry, B.P. 222, Conakry, Republic of Guinea

(First received April 1995; accepted in revised form January 1996)

Abstract—Analyses of water from wide-diameter open wells were carried out in two districts of Conakry (Republic of Guinea) during the dry season of 1994 (April–May) to evaluate its bacteriological and physico-chemical quality and to compare well water to the piped city water. Widespread well water contamination for nitrate and fecal bacteria was found throughout both districts. The other common water-quality parameters, as well as total organic carbon and halogens, oils and greases of general use, and 34 inorganic elements were within the standard norms for safe drinking water. Chromium and, to a lesser extent, lead and mercury could become a threat to health if the situation worsens. Although thorough hydrogeological studies are needed to determine contaminant pathways, insufficient well maintenance appears to be the main factor contributing to the bacteriological contamination, while the nitrate contamination seems more closely linked to infiltration of organic contaminants from the soil surface. Piped city water was found to comply with WHO norms for drinking water and its use should be strongly encouraged to reduce the incidence of water-borne diseases. Copyright © 1996 Elsevier Science Ltd

Key words—bacteria, Conakry, contamination, fecal organisms, well water, nitrate, piped water supply, Republic of Guinea, sanitation, water quality

INTRODUCTION

In a vast majority of developing countries, fast growing populations combined with poor living conditions in rural areas have forced many people to migrate to cities in search of better living conditions. This has led to a dramatic expansion of most of the major cities throughout developing countries, mainly via the uncontrolled growth of slums or squatter settlements on their fringes (Khadam, 1988). This results in an increasing demand for water and an added pressure on the environment caused by insufficient facilities for the disposal of excreta, wastewater, household trash, and stormwater. The growing demand for urban water, the decreasing availability of quality surface sources, and the scarcity of economical resources has now placed much emphasis on groundwater exploitation as a drinking water supply and on unsewered sanitation systems. Unfortunately, under certain hydrogeological conditions (permeable soil and shallow aquifer), these low-cost technologies may be in conflict and may lead to an enhanced groundwater pollution threat (Lewis *et al.*, 1981).

The management of water quality in these areas is now of prime importance since most often, urban sewage is a dominant factor contributing to the contamination of groundwater (Kindler, 1992). Improvements in water supplies (quality and quantity) and sanitation facilities are believed to reduce the transmission of pathogens and thus improve children's growth rates and concomitantly reduce mortality rates (Esrey and Habicht, 1986; Blum and Feachem, 1983). It is therefore essential to look at all these problems in an integrated water management fashion (Geldof *et al.*, 1994; Egboka *et al.*, 1989), considering the multiple causes of disease and death. Studying merely those interventions feasible in water, sanitation, or urban projects alone often leads to mitigated results (Listorti, 1990).

The population of Conakry (Republic of Guinea) is expected to rise from around 830,000 in 1985 to more than 2 million inhabitants by the year 2000. While the availability of water for domestic use is not critical in many parts of the city, water quality is strongly influenced by the uncontrolled development of the suburban districts. Two of these districts, Bonfi and Hafia-Mosquée (Fig. 1) have been the focus of attention from UNICEF and the Guinean government over the past several years. In 1990, these districts were selected as primary study sites within a new urban development program (PADU) whose main objective is to improve the standards of living

*Author to whom all correspondence should be addressed.

of the population. Bonfi and Hafia-Mosquée are characterized by high-density population and a poorly developed basic infrastructure. The water distribution network is primitive, domestic sewage is left untreated, autonomous sanitation systems (septic tanks and dry pit latrines only) are often in need of repair or are not cleaned out regularly and there is no stormwater drainage system. There is a great lack of services: the removal of household refuse is irregular and the maintenance of the little infrastructure that exists is poor. This situation, further worsened by heavy rainfall (which averages 3000 mm from June to October), has induced a marked degradation in the quality of the urban environment and has intensified the stress imposed on natural water resources (Republic of Guinea, 1993).

Among the PADU concerns is the evaluation of the bacteriological and physico-chemical quality of the drinking water to assess the potential risks of propagation of the common water-borne diseases. Until recently, only groundwater drawn from traditional wells was available for drinking and domestic use. The poor condition of these traditional wells made contamination of the water highly probable and it was decided to modernize as many wells as possible by reconsolidating and lining with concrete their upper part, adding an adequate metal cover and a pulley, and constructing a wide concrete curb and an enclosure around the well. A plastic container or a rubber pouch fitted with a rope is used to draw the water from both the traditional and modernized wells. Until May 1994, 11 wells in Bonfi and 9 wells in Hafia-Mosquée had been modernized, and a total of about 60 more was planned before the end of 1995. In parallel, public faucets with drains were constructed at 7 locations in Bonfi and 4 locations in Hafia-Mosquée (17 planned) to provide piped city water collected from a dam located about 60 km northeast of Conakry, and from a deep borehole located about 30 km to the northeast. Families that can afford it are also connected to the piped-water system via a private faucet. The water from the piped-water system is of better quality and, ideally, it should be used at least for drinking by most of the population. Unfortunately, because of the many problems collecting bills, the Guinean water company and UNICEF have stopped any further public faucet construction. Thus, in Bonfi and Hafia-Mosquée, many families still rely on traditional or modernized wells for drinking water, and most of them use well water for their personal hygiene and the washing of clothes and dishes. This situation, further worsened by the inadequate disposal of excreta, increases the risk of widespread contamination by water-borne diseases.

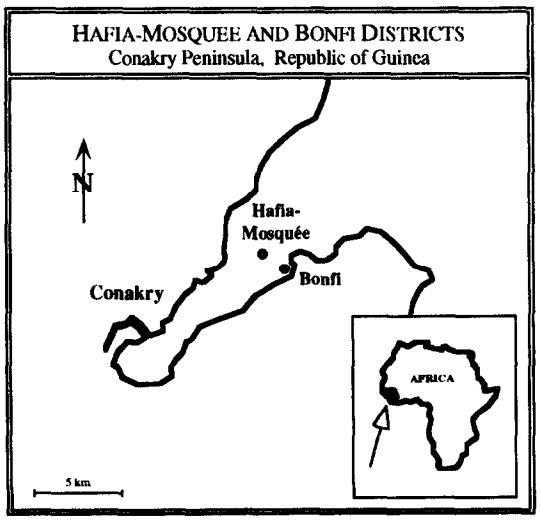

Fig. 1. Districts of Bonfi and Hafia-Mosquée, Conakry, Republic of Guinea.

The general objective of this work was to rapidly identify the most significant potential health problems associated with the use of well water in the Conakry peninsula for drinking and domestic purposes. Since no previous results have been published on that subject until now, this study could then serve as a guideline for further and thorough analyses. The specific objective of this work was to evaluate the bacteriological and physico-chemical quality of the three types of water sources available (piped-water system, modernized wells and traditional wells) and to determine the potential health risks to the population by way of a single analysis of the characteristics and potential contamination affecting the aquifer in that part of Conakry.

METHODS

Results presented in this paper reveal a "snapshot view" of the well water quality for a set of specific conditions. Only one sample per well has been collected at the end of the dry season and the observation area was limited to two districts of Conakry. All samples were collected during six sampling campaigns within a period of 2 weeks.

Study sites

Both districts are located about 10 km outside downtown Conakry on the Conakry peninsula (Fig. 1). Bonfi lies alongside the coast, while Hafia-Mosquée occupies the highest hill of the area at about 40 m above sea level. The Bonfi district is divided in four zones of equal surface area: Bonfi-Matam in the southwest end, then, going eastward, Bonfi-Centre, Lucia-Camara and Bonfi-Port at the extreme northeast end. Matam is less densely populated and there are only a few wells. The three other zones are characterized by numerous wells, high population density, and the presence of markets and refuse containers, a situation that resulted in a very degraded environment. The ground is sandy and permeable, and of the 232 wells dug, more than 150 are still in use. Among the 46 samples drawn from Bonfi, 5 were located in Bonfi-Matam (1 fountain (F), 2 modernized wells (MW) and 2 traditional wells (TW)), 12 in Bonfi-Centre (3 F, 3 MW and 6 TW), 19 in Lucia-Camara (2 F, 4 MW and 13 TW), and 10 in Bonfi-Port (2 F, 2 MW and 6 TW).

Hafia-Mosquée tops the highest hill of the Conakry peninsula, at an altitude between 25 and 40 m above sea-level. A huge municipal water tank is located at the summit in the center of the district, and the steep slopes in the vicinity of the tank preclude the construction of any type