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RESEARCH ARTICLE

WATER QUALITY OF HIGH POPULATION DENSITYAREAS AT THE NATIONAL UNIVERSITY OF LESOTHO`S MAIN CAMPUS AND NEIGHBOURING MANONYANE COMMUNITY

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ABSTRACT

Given the importance of potable and safe water supplies for human consumption and, especially, given the vulnerability of such supplies where there exist high population densities, this study,from September 2014 to April 2015, assessed the water supplies at the National University of Lesotho and environs, for their potability.Water samples were obtained from different sources on campus, including stand pipes (taps) and tanks across the campus. Samples were also collected from sources that included springs, open wells and boreholes in the neigbouringManonyane community. These samples were analysed for Coliform and E. coli, together with physico-chemical parameters; pH, total dissolved solids (TDS) and residual chlorine. A structured questionnaire was also designed and administered, to get people's views concerning their perception of and experiences with the water sources.The water was generally of acceptable quality. TDS concentrations satisfied the WHO standards (below 1000 mg/l), being of excellent quality (<300 mg/l). Residual chlorine was generally below detection limit, pointing to a probable contamination linked to the health problems users reported. Fecal coliforms and E. coli were generally very low, except for one source. A mixed perception of the qualities of the water sources was obtained, but, generally, 60% rated the water qualities as satisfactory, good and very good. Users also reported experiences that compromised their health in one way or the other, due to continuous use of the water sources. Following the study, interventions were made in the community to address the problems identified. These ranged from community education to printing and distributing flyers on health education.

INTRODUCTION

Given the importance of safe drinking water [Nieuwenhuijsen, 2003; Aiyuk, 2016] and, as water continuously gets scarcer globally [Verstraete, 1994; Hoekstra, 1998sa; Hoekstra, 1998b; Aiyuk, 2003; Aiyuk, 2004; Aiyuk et al., 2004], the availability of potable water has become a daunting problem. This is especially so in developing countries, where, coupled with sanitation conditions that leave a lot to be desired, water resources have become threatened. Indeed, in recent years, a 'water crisis' has announced itself in most, if not all, countries on planet earth [Aiyuk, 2004; Aiyuk et al., 2013]. The rising demands made on water have influenced not just its supply and subsequent availability in terms of quantity, but rather also, and to a great extent, its quality. Good quality water could be abundant today, and 'tomorrow', it turns out to be very scarce, due to factors like population density, climate change, attitude, fixture maintenance schedules, cross contamination, etc., especially where sanitation levels are poor.

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Many of the consequences of using water rendered objectionable by pollutants and hence labeled non potable, are well known. Within such a context, apart from direct environmental consequences, human or public health is particularly at risk. Anthropogenic pollution [Aonghusa, 2012] has made eminent the need for sustainable water resources management. Water is known to have direct economic and social implications in any given society, and hence it is primordial to embark on a sustainable water resources management, if the many global change syndromes and the undesirable consequences, usually traceable to a water/wastewater cause, are to be alleviated. Also, the intensification of activities over a small land area can mount substantial pressures on available water resources and fixtures, leading to undesirable pollution. It is with this background that a study was carried out from September 2014 to April 2015, to assess the state of the water used on the main campus of the National University of Lesotho (NUL), together with the prevailing sanitation conditions. The campus is located in the Roma valley of Lesotho. The university campus is fairly small, and supports over 10000 students and over 400 staff. Also, as the presence of the university has influenced substantially the neighbouringManonyane community that also harbours a large

number of student homes and other activities, this study extended to this area. The main aim of the research was to monitor and assess water quality on NUL main campus and surrounding Manonyane community, in the context of:

- checking microbial quality
- checking physico-chemical quality
- addressing environmental (pollution control) and public health issues in relation to the above findings, through education and other means

MATERIALS AND METHODS

A situational analysis of sanitation conditions both on and off campus was carried out over a period of 1 year, looking at particularly solid and liquid waste management trends. Water samples were obtained from different sources on campus including stand pipes (taps), a borehole and tanks across campus. Samples were also be collected in the Manonyane community, from sources that included springs andstand pipes. The sampling sites are shown in Table 1. Coliform and E. coli analyses were done (MPN), together with physico-chemical ones (pH, total dissolves solids (TDS) and residual chlorine). The parameters were analyzed according to standard methods [APHA, 1992], and/or other techniques. Laboratory analyses were done in the laboratories of the Faculty of Health Sciences, using Faculty equipments, leaving the project with only chemicals and few other consumables to purchase. A structured questionnaire was also designed, to get people's views concerning their perception of water and sanitation (WATSAN) in their areas, and problems they might be encountering vis-a-vis their environments. The questionnaire wasself-administered and consultations were made with some respondents, where clarification was requested. The respondents were50 (28 students, 15 staff and 7 Manonyane residents). Respondents were carefully selected to reflect the heterogeneity of the on-campus population and also that of the outside community.

RESULTS AND DISCUSSION

Figure 1 presents the Total Dissolves Solids (TDS) values over the study period. As can be seen from the plot, all TDS values fell within recommended ranges for palatability [WHO, 2011].

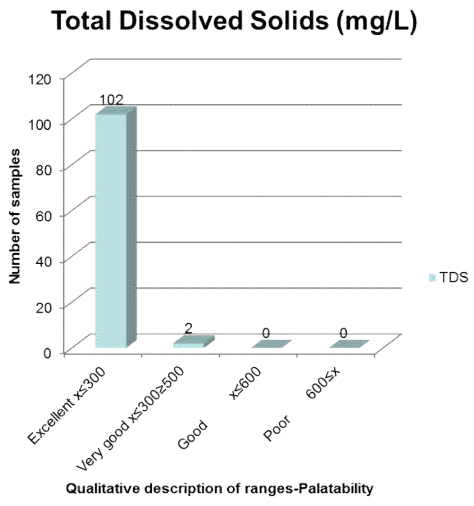

Figure 1. TDS concentrations over the study period

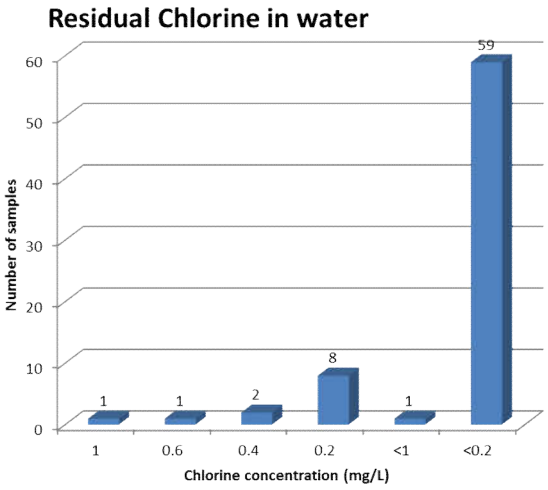

Figure 2. Residual chlorine concentrations over the study period.

The water was found to be of acceptable quality (below 1000 mg/l TDS). 81.9% of the samples had residual chlorine below detection limit (<0.2 mg/l), pointing to a high probability of no chlorine at the point of use and thus presenting a possibility of risk on the users. So, the chlorine level is a possible explanation of health problems in users, in spite of the water being treated [UNESCO, 1993]. There could also be contamination of water between the source and the point of use [Wright, 2004]. Figure 3 highlights the microbiological content of the water in the study area, over the study period, in terms of Total coliform (TC) concentrations. 90.1% of the samples had MPN values of <2.2 cfuper 100ml, indicating that the water was safe for consumption. MPN of 2.2 cfu/100ml was detected at the Mafikeng gravity fed system, and an MPN value higher than 16cfu/100ml was detected at the Hata-butle semi-protected spring, indicating pollution and non potability of the source. The spring is down-gradient in a drainage basin and was possibly polluted by run-offs [Nkwocha et al., 2011; Nartey, 2012; Nartey, 2012].

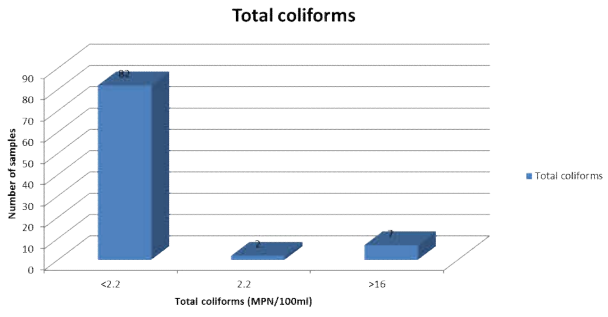

Figure 3. Total coluiform concentrations over the study period

A solid waste disposal area is also upstream of the sorce, increasing the likelihood of pollution [Tchobanoglous, 1991]. For all the samples analysed, no E. coli was detected, pointing to a contention that there was no faecal contamination of the water source. Only 2% of the respondents perceived the quality as very good, while 6% saw it as good. 8% of the respondents perceived the quality as very poor and 32% saw it as poor. Perceptions of water quality can be influenced by many factors that includeorganoleptic properties (mainly flavor), perception of risk and previous experience.

Table 1. Details of sampling sites

	Site	Number of samples	Water abstraction method	Supplier
ON-CAMPUS	Staff residences	3	Stand pipes	Water and sewerage company (WASCO)
	Student hostels	3	Stand pipes/Reservoirs	WASCO
	Catholic student hostel	1	Borehole	Self
	Mafikeng	1	Gravity-fed system	Community
OFF-CAMPUS	Ha Scout	1	Stand pipe	WASCO
	HataButle	2	Borehole and spring	Community
	St. Joseph's hospital	2	Stand pipes	WASCO

Indeed, more than half of the respondents (52%) perceived the quality as satisfactory. 92% of the respondents used water piped by WASCO, the Water and Sewerage Company of Lesotho. Therefore, the general quality of the water in the study area, in terms of perception of the users, could be described as acceptable during the study period.

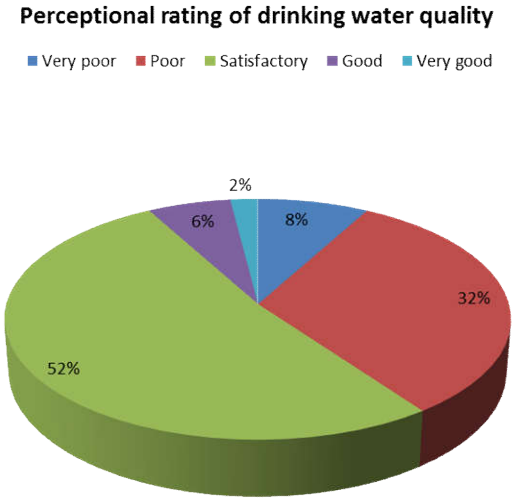

Figure 4. Pie chart showing perception of water quality for drinking

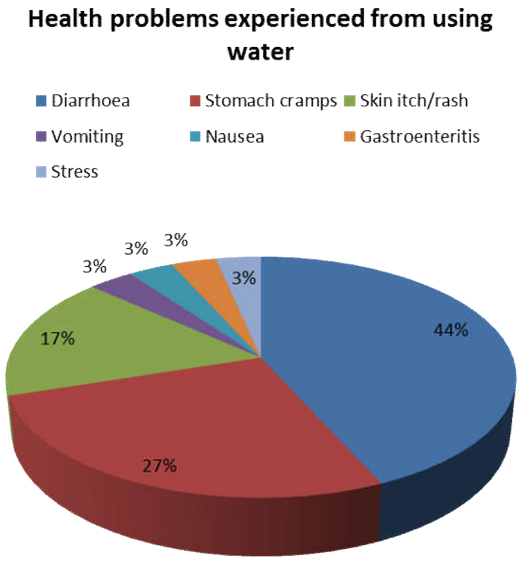

Figure 5. Pie chart of health problems linked to water use by users

Figure 5 gives a distribution of health problems experienced from using the water in the study area for drinking. 44% of the respondents had experienced diarrhea, 27% had experienced stomach cramps, 17% had experienced skin itch and/or rash.

The itch and rash condition had been previously reported [Sekar, 2011], but, it was not clear in their study, whether the itch and rash symptoms arose from using the water for bathing or coming in contact with it, as the authors reported in their studies. A small percentage (9%) of respondents had also experienced conditions that ranged from vomiting to nausea to gastroenteritis. Overall, there were more water users who had not experienced problems associated with the water use (on- and off- campus) , than those who had health problems. However, more cases with health problems had obtained their water from a source on campus. Actually,the on-campus water supply fixtures of the university are quite old and there could be a possibility of cross-contamination [UNESCO, 1993].

At the end of the study and following an assessment of all the results, a community intervention was made to mitigate the negative impacts found. Amongst these, a community meeting was held with landlords of private student accomodations, to inform them of the findings and advise on remedial measures, through health education on water and sanitation. This was also the case with the Hata-butle community members who were using the semi-protected spring that showed high TC values, and they also received health education on water and sanitation, an important drive towards pollution control [USEPA, 1998]. In addition, a meeting was held with the local environmental health officer on improvement of water quality surveillance and infrastructure. Again, the findings of the research were disseminated to the Manonyane community council, and educational pamphletswere developed and printed for the general public, both in English and the local language.

Coclusion

From this study, the on-campus water supply was found to be generally of good quality. Off-campus water sources in the Manonyane community were of good quality, except for the unprotected spring. The survey showed a general satisfaction with the perception of water quality by members of the study area, although a mixed perception of the qualities of the water sources was obtained.There could be a causal relationship between continued use of the water resources and health problems. The intervention made following the study are expected to bring positive change and alleviate many of the problems faced by users in the study area, due to the use of the water supplies.

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Author Contributions: Professor S. Aiyuk was the Grant holder and was the general producer and editor of the manuscript. Mrs. T. Siimane wrote the Materials and Methods

section and also parts of the discussion. Ms. R. Hlabanaddi the parameter analyses and produced the graphics.

Conflicts of Interest: The authors declare no conflict of interest.

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