Assessment of the Ethical, Social and Health Acceptability Perceptions of Water Reuse for Potable Purposes in Windhoek

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ABSTRACT

This paper summarizes the human and engineering dimensions of water reuse including ethical, health and social aspects in Windhoek. A survey was carried out through a structured questionnaire on various stakeholders to investigate the water quality assurance, control and publicity that should accompany water reuse for potable use. The questionnaire examined existing links between both direct and indirect water reuse sources and sustainable water management in the Upper Swakop Basin within which Windhoek falls. In view of diminishing fresh water that is threatened by water pollution the paper also examined the existence of integrated urban water planning to control and curb water pollution of the downstream freshwater Swakoppoort dam supplying the city of Windhoek. Slightly above half (53.5%) of the respondents were willing to drink water treated and certified reclaimed water to keep alive; 16.9% would resort to drinking bottled water and 28.2% would buy a filter and put it on the tap. Greater than 60% of respondents had trust and assurances of the safety of certified recycled water from the NGWRP water reuse plant. Nearly half (43.5%) of the general respondents wished there could be public bill boards sharing information of the product water quality. The involvement of all stakeholders affecting or affected by activities related to the direct or indirect water reuse for drinking is required to improve the water quality sources of recycled water and the routes of exposure. Proper effective awareness and educational programmes should be aimed at reducing discharge of hazardous chemicals from households. Communities should be educated to refrain from carelessly dumping point and non-point sources of water pollution. By tracing recycled water and fresh water systems from source, water pollution risks can be minimised.

Key Words: Water reuse; Windhoek; ethical issues; health; socio-cultural, quality assurance

INTRODUCTION

Water reuse is recycled water that is separated and highly treated so that it can be used again. Generally, water reuse for thermal cooling, industrial use, irrigation of recreational parks and other purposes has been popular worldwide, but water reuse for drinking has not been widely accepted as indicated by Environmental Protection Authority in Western Australia (Authority, Environmental Protection [EPA], 2005). Chen, Ngo, and Guo, (2013) stated that the observation is the same globally. Driven by the growing climatic-change-induced water stress and scarcity, as well as chronic imbalance between available fresh water resources and demand (Abdel-Dayem et al., 2011), many countries worldwide are looking into direct and indirect water reuse strategies that also have the benefits of controlling pollution to water reservoirs that are downstream.

Water reuse can be unplanned or planned. Unplanned potable reuse is where raw water withdrawals for drinking are made downstream of a wastewater outfall. Unplanned, indirect potable reuse is widespread, for example in the United Kingdom, United States of America and Australia (Williams, 1997). Planned potable reuse typical example is in Singapore's so called NEWater, meeting 30% of the country's needs (Biswas & Kirchherr, 2012). However, the first potable direct reuse plant in the world was established in Goreangab, Windhoek, as far back as 1968 (Murni et al., 2003; Law, 2005). Some countries like the United States and Australia experienced consumer resistance to water reuse for drinking. A survey carried out in 2010 indicated that only 36 % of respondents in Australia would consider drinking directly reclaimed water (Biswas & Kirchherr, 2012) while 15% would not even wash their cars with it. A survey carried out in the United States and Israel (Friedler & Lahav, 2006; Biswas & Kirchherr, 2012; Abdel-Dayem et al., 2011) showed that the respondents' resistance were based on health and social related concerns.

Fresh water resources are scarce in Namibia and water reuse for potable purpose was adopted as a sustainable way to enhance water security within the USB where demand, especially in and around Windhoek, has outgrown the available fresh water sources. The city relies on both surface water, groundwater and water from WINGOC water reuse plant. However, the raw water source for the water reuse plant is constrained by deteriorating water quality. WINGOC preferred to abstract raw water for its plant from the final filtrate coming from the Gammams Wastewater Treatment Plant that also has seasonal variations in water quality. Even though water reuse for drinking in Windhoek is long established, no study could be found as of the time this study was started on the public perceptions of this water reuse for potable purposes.

METHODS

The study was based on a mixed design incorporating quantitative and qualitative cross-sectional studies of Windhoek residents' perceptions on the social, ethical and health issues of water reuse. The population of the study was all the about a 1000 residents of Windhoek involved and informed in the water sector. From the informed public, a purposive sample of 100 residents (about 10% sample) were selected and investigated as a preliminary explorative study. The respondents were sampled over a period of one month in 2013, based on either acquiring or having acquired tertiary education and having a water profession background (UNAM students, MAWF, NamWater, Municipality of Windhoek and WINGOC employees). Some respondents were general workers from Katutura Suburb, one of the low income suburbs in Windhoek. Another 15 respondents considered to be key stakeholders were sampled from those involved in the processing, management and regulating of water reuse in Windhoek (MAWF, Municipality of Windhoek and WINGOC senior technical employees)

Based on literature on previously conducted surveys elsewhere (Hurlimann, 2008; Ogilvie, Ogilvie & Company, 2010; Vedachalam & Mancl, 2010), the public views and perceptions on water reuse for drinking were collected using self-administered structured questionnaires. This questionnaire captured demographic information, the respondent's water resources

knowledge of the USB, familiarity with water reuse terminology, water reuse purposes and their acceptability, degree of trustworthiness, confidence in water treatment and reuse agencies in Windhoek. The questionnaire given to the informed / literate respondents also inquired on water reuse quality assurance publicity and public participation and governance areas.
The second questionnaire to key stakeholders involved in the production and water process quality assessment of the recycled water for drinking, captured the standards, the independence of water quality results, acceptance and ethical issues, quality of the raw water sources for the water reuse plant, confidentiality and public water governance issues. The administered questions were mixed (open –ended, close ended).

The two sets of questionnaires were pilot tested with a work colleague. The questionnaires were given respectfully by approaching face-to-face willing/volunteering respondents. The permission of the respondents and the purpose of the spontaneous questionnaire process were first requested. Some responded requesting to hand in the questionnaire at a later stage. For the survey carried out to the informed public, a set of 100 questionnaires on perceptions of water reuse were issued and 86 people (86% response rate) responded. Another set of 15 semi-structured questionnaires that guided interviews were administered to key informants involved in the production and water process quality assessment of the recycled water for drinking. Telephonic and email appointments were made with the key informants / stakeholders. From both questionnaires the returned surveys were reviewed by checking completeness and call backs were done where necessary to validate the responses. Upon completion of the survey the responses were transcribed into electronic coded format.

The quantitative data were analysed using descriptive summary statistics in the form of frequency tables and charts. Data entry, cleaning and analysis were carried out using SPSS and MS Excel. Qualitative responses were organised into emerging patterns and themes which were then summarised. To improve the validity and reliability, the questionnaires were pre-tested on colleagues and pilot tested in Windhoek. The results of the pilot test survey were used to modify the research instruments as necessary. For the key informants the semi structured interview format was adopted to ensure that the same subject or scope was maintained at each questionnaire administered.

RESULTS AND DISCUSSION

Demography

Of the 100 respondents to the questionnaire with 86% response rate, 61.3% were male and 38.7% were female. Most of the respondents (52%) were young (aged 18-34); with 37.3% in the 35-54 age group and the remaining 10.7% were above 55 years of age. The majority of respondents were blacks (81.1%), followed by whites (13.5%), coloureds (4.1%) and others (1.3%). Most of the respondents had achieved tertiary education level (89.3%). The sample comprised of professionals (64.9%), university students (20.3%), while the remaining were general workers and others (14.8%). The majority of the respondents earned more than N$

5,000 per month (79.3%) and came from households with more than three family members (84%). Although 88% of the respondents knew that the Municipality of Windhoek supplies them with drinking water, 30.1% did not know the source of this water and only 26.1% knew that one of the drinking water sources was NGWRP reclamation plant. About 67% of the respondents were familiar with the concept of water reuse. Given the semi-aridity of Namibia, 78.9% of the respondents saw the need to purify water from waste water treatment plants for the purpose of drinking.

General Acceptance

There were average levels of acceptance to use reclaimed water for certain uses. For household purposes acceptability levels were swimming pools (47%), washing cars (69%), lawn and garden watering (70%), toilet flushing (71%), and fisheries (51%). With regard to environmental restoration (wetland enhancement) the acceptance of water reuse was (56%). For municipal uses, acceptance levels were as follows: maintaining fountains (62%), swimming pools (51%), recreational (56%), flushing waste water pipes (74%) and fire fighting (73%). With regard to industrial and commercial uses, water reuse acceptability levels were as follows: car washes (66%), dust control (68%), mixing concrete (63%), and cooling power plants (68%). For landscape irrigation purposes the acceptability levels were: irrigation of school grounds (66%), public parks (69%), golf courses (69%), and industrial parks (69%). For agricultural irrigation, water reuse acceptability levels were: irrigation of commercial nurseries (65%), non-food crops (66%) and food crops (65%). The results for the respective acceptance of water reuse for different kinds of activities are given in Figure 1.

Willingness to use reclaimed water for specific purposes

The willingness to use the reclaimed water in whole or blended with treated water from freshwater sources were rated (from 0 to 10, with 0 being totally unwilling and 10 being totally willing) for different water uses as shown in Figure 2. The least popular willingness to use the wholly reclaimed water was for drinking (mean rating 5.53, standard deviation 3.91).

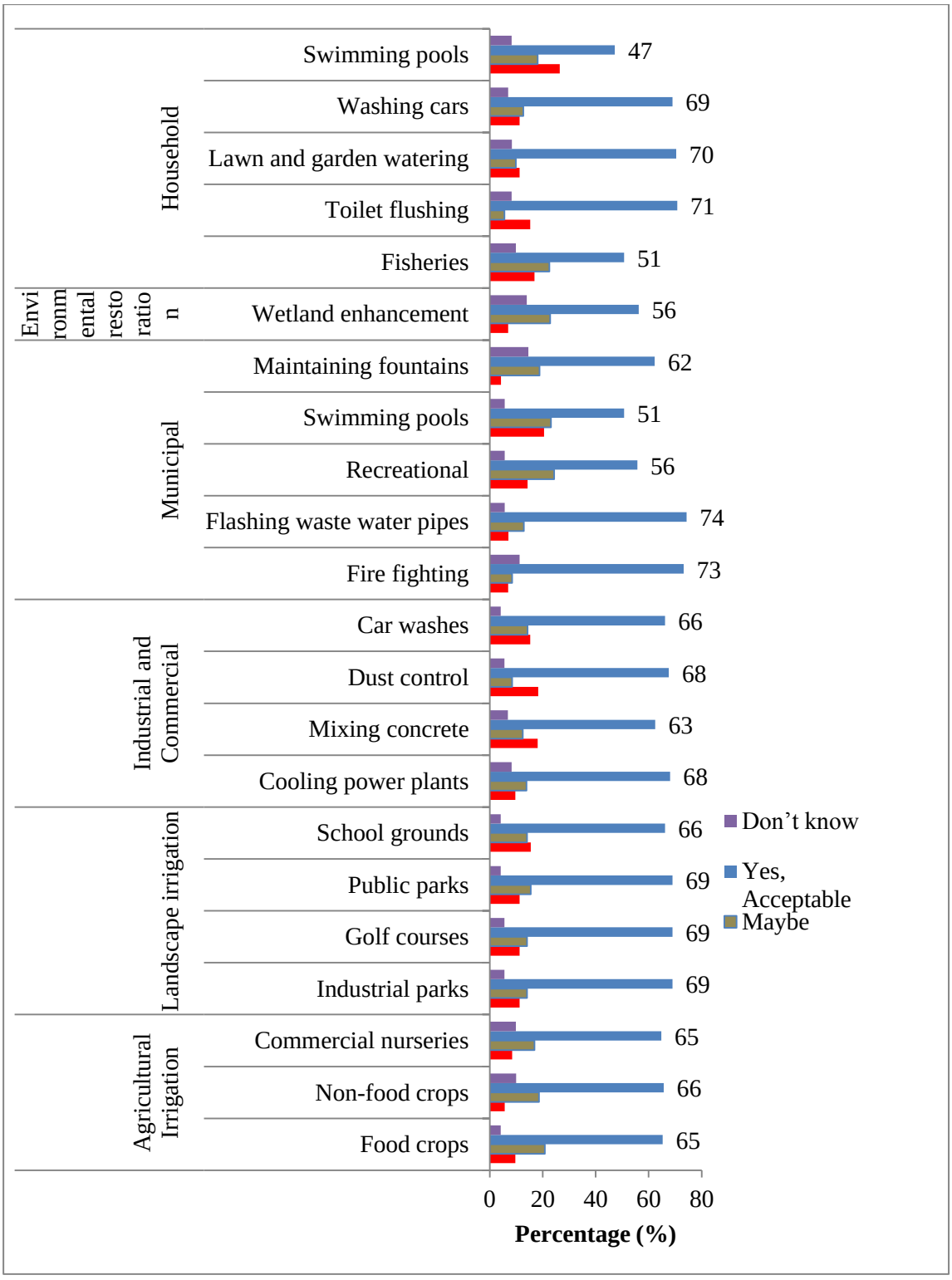

Figure 1Acceptability of purified water from sewerage treatment plants for various uses.

However, the respondents were slightly more willing to drink the reclaimed water if it were blended with treated water from groundwater and dams (mean 5.73, standard deviation 3.5). The highest willingness ratings for reclaimed water use were for irrigation of vegetables (mean 7.87, standard deviation 2.92) and lawns (mean 7.54, standard deviation 3.29). The respondents also did not mind using it as drinking water for pets and showering (mean 7.38,

standard deviation 3.27) though they showed less enthusiasm for using it for cooking (mean 6.49, standard deviation 3.76).

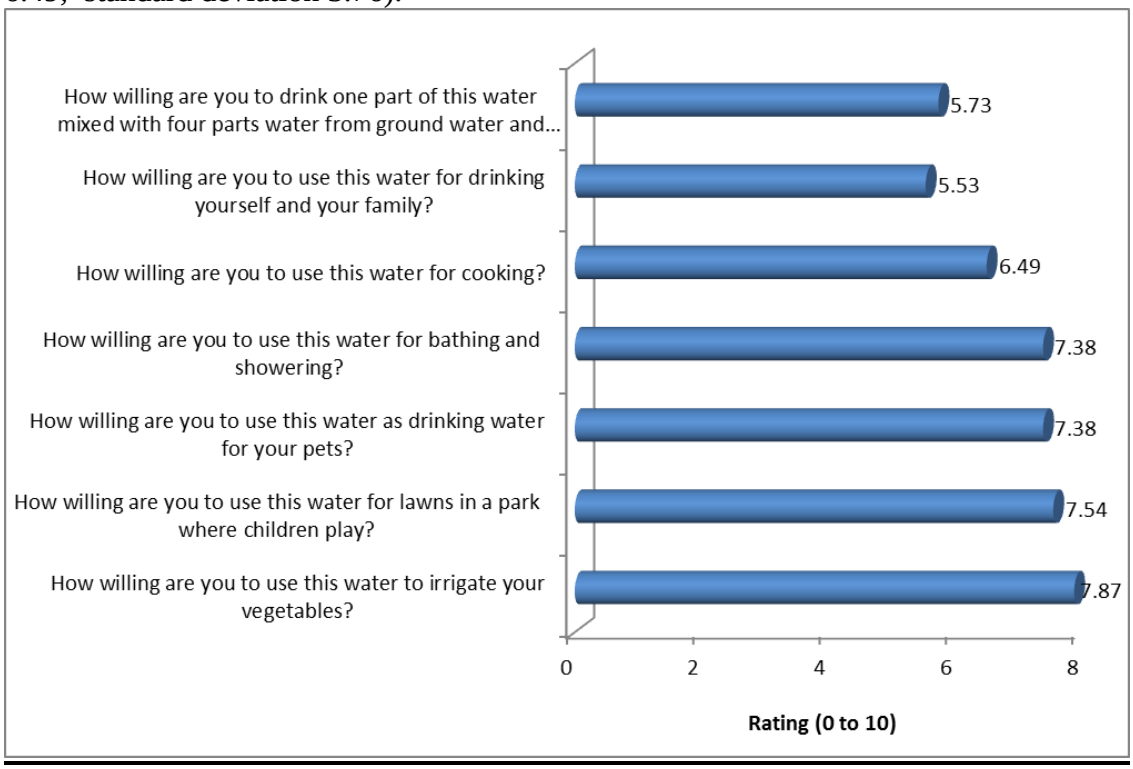

Figure 2 Willingness rating (0 to 10) for Water Reuse for Specific Purposes

Attitude to drinking recycled water if there was no other alternative

Only 53.5% of the respondents indicated that they would only drink recycled certified water to stay alive if they had no choice and 16.9% would resort to buying bottled water, while 28.2% indicated that they would fit additional tap filters to further clean the water (Figure 3).

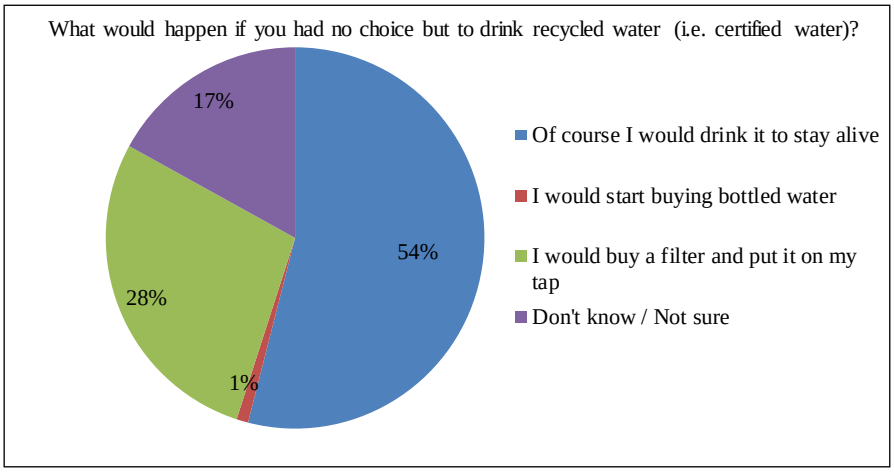

Figure 3 Respondents' Attitude to drinking recycled water if there was no other alternative.

Respondents' Trust in WINGOC's Quality Control Measures

There was a general trust (60%) in the knowledge of WINGOC's professionals in using the technology and meeting water quality requirements. The results are presented in Figure 4. Irrespective of scientific and engineering water quality assurance considerations, the respondents' perceptions on acceptance of drinking water from a water reuse plant, were

largely influenced by the lack of publicity of the daily water quality information on the water reuse (52.2%); prejudicial beliefs and fears (21.7%); visual imagery/ disgusting factor (17.4%) and to a lesser extent, historical or anecdotal information (8.7%). A high proportion (80%) of the respondents believed that increased local participation and ownership by all stakeholders in the management of the water resources will not only raise awareness and improve the stewardship about the fresh water resources but this could increase the level of acceptance of recycled water. Lahnsteiner and Lempert (2007) also concluded that the Windhoek public may accept such initiatives if properly informed, despite initial health and aesthetic concerns.

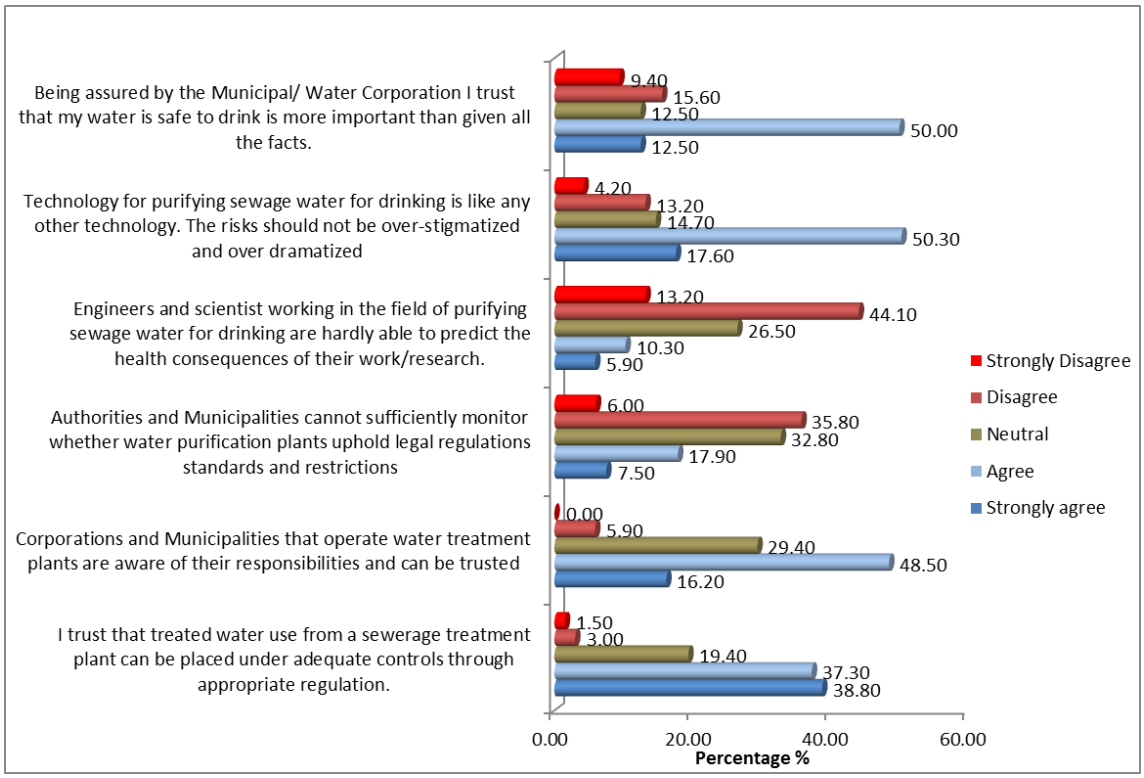

Figure 4 Trusting the Service Provider's Quality Control

The NGWRP and Windhoek Municipality have special health standards that formed the Private Management Agreement between them. These standards, however, are not well articulated in the Water Resources Management Act (2013). The water quality compliance, control and monitoring is carried out by NGWRP and/or Windhoek Municipality in accordance with the Private Management Agreement. Some parameters, like emerging endocrine disrupters, are not regularly checked because of lack of water quality laboratories in Windhoek to determine these parameters. The ability of NGWRP to individually check and monitor in real time, the suspected health endocrine disrupting compounds require sophisticated equipment and expertise and are costly. The endocrine disrupting compounds include those from personal care products, garden products, flavouring, total oestrogens (hormones) pharmaceuticals, nutrients and salts whose analytical tests according to the responses, can only be done outside Namibia. Julies et al. (2013) emphasised that Namibian samples to determine the presence of these special parameters, for instance, on Cytotoxicity and Immunotoxicity, where Lactate dehydrogenase (LDH) is measured with a chromogenic LDH assay kit, it is done in Europe and South African laboratories on intermittent basis.

However, 75.7% of the respondents saw the need to institute a board of experts to certify the product water over and above the regular water quality control checks by Windhoek Municipality. It is interesting to note that the public respondents would like this board to include representatives of the public media and other multi-sectorial stakeholders (Figure 5). According to the expert responses (key stakeholders), the product water quality from NGWRP is compliant 96% of the time. NGWRP reuse plant has been ISO 9001 certified since 2008. However, information on the results of product water can only be accessed with confidentiality undertakings. There are no billboards and no websites where these results can be accessed notwithstanding this lack of easy access to information, there are water quality barriers built into the NGWRP plant, which include physical, organo-leptic, and pathogenic (bacteriological and viral) barriers. This multi-barrier approach processes include the following: Powdered Activated Carbon (PAC) dosing; pre-oxidation and pre-ozonation; flash mixing; enhanced coagulation and flocculation; dissolved air floatation (DAF); dual media rapid gravity sand filtration; ozonation; biologically activated carbon (BAC) filtration; granular activated carbon (GAC) filtration; ultra-filtration; chlorination disinfection and stabilization (Lahnsteiner & Lempert 2007). The five barriers ensure that the reuse water achieve the DOC values of < 1 mg/L.

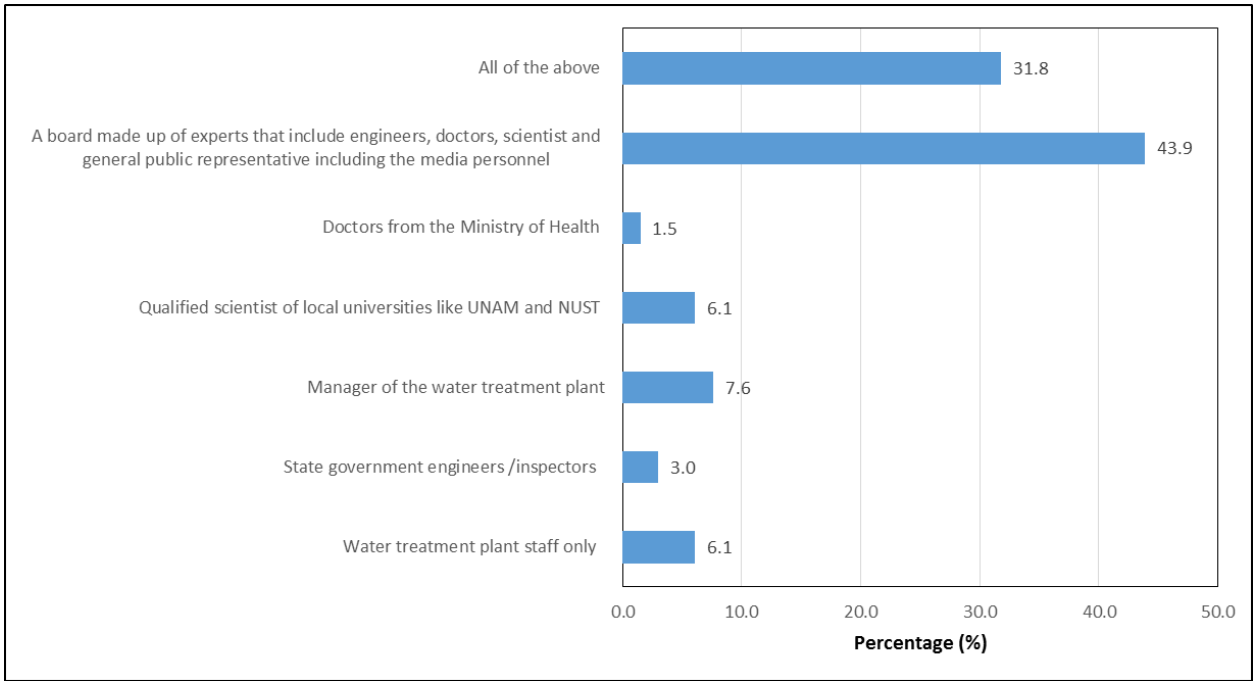

Figure 5 Opinions on Certification of Drinking Water Treated from Sewage Water

The quality of raw water source that feeds the plant is from Gammams domestic wastewater treatment plant and varies seasonally. The improvement of the raw water quality from Gammams wastewater treatment plant would result in less water reuse plant stoppage and disruptions. The feeling of key stakeholders on the Goreangab Dam reservoir being abandoned since 2009 as a raw water source due to deteriorated water quality was that this source should be continued as a raw water source by improving the management of the upstream catchment of the Upper Swakop Basin. Chapter 5 outlined initiatives to continuously make use of Goreangab Dam and prevent its raw water quality from continuously deteriorating. The key stakeholders indicated that blending the product water

from the water reuse plant with treated water from other sources improves the water quality, marketability and acceptance of the water. The key stakeholders perceived no harm in use of unblended reuse water and highly recommended it for drinking. However, due to operational and contractual obligations they indicated that blending is necessary. They also indicated that the yearly blending ratio of the treated water supplied to Windhoek could be increased and the blended water is distributed across the city except the Northern Industrial area. The fears of the key stakeholders on the quality assurance of the treated water included quality reduction due to poor maintenance of the reuse plant, possibility of WINGOC prioritising commercial interest in producing water from the plant at the expense of quality and health issues (Friedler & Lahav, 2006; Biswas, 2012; Abdel–Dayen et al., 2011). They however, did not consider the "yuck factor" perceptions as an issue given the water scarcity in Windhoek.

CONCLUSION

Moderate public willingness exists in residents of Windhoek involved in the water sector to drink treated and certified reclaimed water reuse. From this survey conducted in 2013, slightly above half (53.5%) of the respondents were willing, if they had no choice, to drink water treated and certified reclaimed water to keep alive; 16.9% would resort to drinking bottled water and 28.2% would buy a filter and put it on the tap. Greater than 60% of respondents had trust and assurances of the safety of certified recycled water from the NGWRP water reuse plant. Public acceptance can be enhanced with improved public communication of the results of the product water from water reuse plant. Nearly half (43.5%) of the respondents wished there could be public bill boards (public media and websites) sharing information of the product water quality. The involvement of all stakeholders affecting or affected by activities related to the direct or indirect water reuse for drinking is required to improve the water quality sources of recycled water and the routes of exposure. Proper effective awareness and educational programmes should be aimed at reducing discharge of hazardous chemicals from households. Communities should be educated to refrain from carelessly dumping point and non-point sources of water pollution. By tracing recycled water and fresh water systems from source, water pollution risks can be minimised.

Even though performance contracts on water quality and health standards exist at NGWRP, proper legislation is required for water reuse for drinking. An independent board with appropriate knowledge and expertise that includes media and public representatives should carry out regular field audits of water quality to eliminate the health hazards and risks. In accordance with integrated water resources management principles, Upper Swakop Basin Committee should encourage appropriate utilisation of reclaimed water. Avenues to sustainably augment the fresh water resources with water reuse should also be promoted. It is also recommended that investigations on how different social groups accept water reuse for drinking in Windhoek can be undertaken in further studies.

Since the samples were purposive, the capacity to generalise to the wider population is limited but the findings give useful insights for further research. Further research could focus on the

probability sampling methods to confirm and compare the patterns of the responses revealed in this study.

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