QUALITY ASSESSMENT OF BOREHOLE WATER IN NIGERIA

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ABSTRACT

Water is a valuable resource to man. It has in recent years become one of the major themes of environmental, economic and social debates. Boreholes represent a major source of potable water supply for most urban and rural areas in Nigeria. Considering its continued proliferation, it becomes necessary to examine its water quality assessment and health implications. Some experts believe that the water from these boreholes is polluted as they are not adequately treated before consumption. This study employed the bibliographical approach, wherein it analyzed relevant literature. The analysis showed that there is no borehole water in any environment in Nigeria that is automatically safe, as the cost implications of getting a completely safe borehole is not within the reach of an average Nigerian. This reaffirms the need for a continued effort at investigating the quality of borehole water nationwide in order to ascertain the nature of water being consumed by the people. The study recommends water quality assessments which employ mathematical models and statistical techniques such as water quality index. This is because it was observed that most previous studies did not employ it. Water quality index does not only describe the behavior of the water quality indicators, it also allows for estimates and of future scenarios. Such analysis can be of great importance in the management of water resource, as well as in the formulation and implementation of national and state water policies.

KEYWORDS: Borehole, Water quality, Policy, Nigeria, Pollution

INTRODUCTION

Globally safe drinking water is of concern because of its importance to humans and other life forms (Mukherjee, Sundberg, Sikdar & Schutt, 2022). It is now certain that poor water quality results in poor health and low productivity which invariably limits poverty alleviation and economic recovery in any region, as the cost implications of getting quality water is increasingly getting beyond the reach of an average Nigerian. There is water, water everywhere but no water to drink is a well known adage. People are not only dying for water, they are also dying of it (Duru, 2009; Yuri, Adriano & Lutiane, 2022).

High incidence of communicable diseases that reduce vitality and economic productivity are often linked to low access to safe drinking water and sanitation. Disease from unsafe water and lack of basic sanitation kill more people every year than all forms of violence, including war (World Health Organization (WHO), 2004). Children are the most vulnerable group affected as a result of their bodies not being matured and strong enough to resist attack due to diarrhea, dysentery and other water related ailments. The dangers of neglect to this important issue is causing death of over 530 children every day due to water borne diseases in Nigeria (Ochekpe, 2012). This is like three airplane loads of children crashing everyday in Nigeria. Further, a startling statistics by WHO (2012) and United Nations International Children Education Fund (UNICEF) (2012) indicate that about 1.4 million children die every year from diarrhea caused by unclean water and poor sanitation and about 4000 children die in a day which is equivalent to one child every 20 seconds. This is as a result of the inability of the masses to foot the cost of quality clean water. This is a human tragedy attributable to an entirely preventable public health crisis that calls for global effort in terms of quality and quantity as well as making the cost of assessing clean water within the reach of everyone. All these facts apart, it is known that water has measurable constituents such as physico-chemical and bacteriological properties to varying degrees. The quantities and the levels of toxicity in the growing numbers of boreholes in Nigeria do not seem to be sufficiently known. This raises the issue of the quality of water from boreholes and their wholesomeness for human consumption.

According to United Nations (2022) poor water quality constrains improvement in standard of living, food security and attainment of the Sustainable Development Goal (SDGs). In different parts of Nigeria, the situation is quite pathetic. Effort by governments in the past decades to improve the water situation has not yielded the expected results. Government has neither spent time nor invested enough to alleviate this

pathetic situation. The quality of most water sources are affected by frequent use of pit latrines in rural communities of Nigeria and some urban centers; without any consideration for factors such as soil type, topography and geology. Indiscriminate dumping of waste on land does not help matters either.

Borehole systems are the fastest growing sources of potable water now in Nigeria (Ume & Chukwuemeka, 2009), and in other climes (Makonjo & Calford, 2022). According to Forester, Chiton, Moench, Cardy and Schiffler (2000) over 400 million rural people in Sub – Saharan Africa are sustained by groundwater because it is probably the only realistic water supply option. However, some researchers have indicated that there are significant alterations in land use pattern and improper disposal of industrial effluents which are affecting groundwater, especially its quality (Mackey, 1990). The scenario just described raises the question of whether the water from boreholes nationwide is comparable to WHO standard guidelines in terms of health implication of using the water for drinking and domestic purposes.

Public concern on the issue of poor water quality due to doubtful potable quality water has been consistently expressed daily through the media, awareness seminars, workshops and symposia. In addition, the attention of policy makers has been drawn over the years to the potential dangers which lack of potable water and, indeed, unavailability of good quality water can portend as witnessed by the rampant outbreak of diseases. The cost effect of these diseases, its control and prevention cannot be overemphasized. The danger it poses to health and environment inclusive is great. As a result, national policies and programmes as well as international agencies projects and similar interventions have been made to address the issue in most parts of the country. Imo State Water Agency for instance should have developed its policy intervention measure with respect to the use of water from boreholes and the financial implications of the effects of the control of any outbreak of diseases in Imo State. Whether such policy(s) exist is one issue and whether the risks probable from the use of such water have been articulated and made known to the people is another.

The problem associated with supply of water through the borehole system in Imo state and other States of Nigeria have, of necessity, occupied the attention of Federal, State and International Agencies such as UNICEF, Jimmy Carter Foundation and Local authorities (Onyenechere, 2009). The cost of preventing any outbreak of these water borne diseases is far much less than its cure. Research work concerned basically with investigating the

challenges of private borehole waters as a source of water supply for the people is worthy and pertinent. This is because in the midst of abundant water resources, many communities provide water infrastructures through self-help and the result is that many private boreholes have been sunk across Nigeria with little or no control measures where such boreholes are sited. The inhabitants in turn consume, as no fault of theirs, suspected poor quality water from these private water sources that may be detrimental to their health.

In some cases, the natural geochemistry of an area gives rise to properties due to presence of certain undesirable toxic elements which affect the quality of borehole water especially as there may not be enough finance to improve the quality of such water. Since the quality of some borehole water is in doubt due to the presence of odour, colour, bacteriological contamination and undesirable chemical elements, researchers are keen to know the quality of borehole water in different parts of Nigeria so as to highlight the financial involvement and the implication of using it for domestic purpose more so as boreholes are more predominant than other artificial sources of water.

Therefore, it is obvious that borehole has taken a centre stage as a major drinking water source in Nigeria and the cost of sinking a borehole is not within reach. It no longer plays complimentary role to pipe borne water in Nigerian cities, because there is an upsurge in the construction of more boreholes. Given the growing demand for borehole water as an alternative, this paper hopes to examine the issue of borehole water quality taking cognizance of the cost implications of water borne diseases, caused by the consumption of poor quality water in Nigeria. It intends to do this using a bibliographical approach by analyzing relevant literature.

WATER QUALITY POLICY AND STANDARDS

Generally, quality policy presents the overall intentions and directions of the project related to quality as formally expressed by the top management principles in the ISO 5667-5: 1991 as a basis for the establishment of quality policy for drinking – water. Quality policy provides a framework for the setting of quality objectives. In other words, it has to be maintained that their objectives have to be consistent with the quality policy to achieve a standard. Thus, the quality objective should be measurable and the method of measurement defines quality objectives as follows:

(i) To achieve and maintain firm certification, achieving over 95 percent consumer satisfaction.

(ii) Tracking and qualifying the reason for failed water standard.

(iii) Quantifying the cost (health hazards) associated with water projects sub-system for quality related problems and resolution.

(iv) Certification of laboratory works adopted.

The Federal Government of Nigeria through the Federal Ministry of Water Resource (FMWR) has earlier formulated a National Water Quality Policy in 2008 which was re-invigorated in 2013, (Ochekpe, 2013). The move was to perfect the creation of Department of Water Quality Control and Sanitation from the defunct Department of Water Supply, Quality Control and Inspectorate. The essence of the move is three folds namely:

(i) To focus on improvement of sanitation and hygiene development and service delivery to meet national and global target for the water sub-sector.

(ii) To position the country on track to meet the Development Goals' targets.

(iii) To derive optimal benefit in safe water supply.

For clarity the new department is made up of divisions and units namely; Water Quality Control Division, Water Sanitation Technology division, and Monitoring and Evaluation units. The policy recognized the inputs of professionals and key players from other areas such as environment, health, housing and urban development, Standard Organization of Nigeria (SON), WHO, UNICEF, relevant non-governmental organizations, etc. The aim of the National Water Policy (NWP) is to set minimum standard on water during procurement, abstraction, treatment, distribution, storage, etc., with a view of ensuring quality, safety and sustainability of water at all times.

Water quality policy arose from the existing conditions of water source which require perfections from contamination as highlighted by United National Organization (UNO, 2012)

However the Federal Government of Nigeria's national water supply policy has the following as its aims:

1. Provision of potable water to all Nigerians by the year 2020.

2. Increase of supply to 120 liters per capita per day in urban area and 60 liters per capita per day in peripheral urban and rural areas by the year 2020.

3. Increase in the capacity of Local State and Federal government to assist communities to establish basic water supply facilities that the communities themselves can maintain with the possible support of the private sector.

4. Assistance to all rural communities to obtain basic water supply facilities', with priority being given those rural communities that (a) have each a population of 150 or more (b) are prepared to provide at least 5 percent of the capital cost in cash or kind, and (c) are ready to meet all the operational and maintenance cost for the facilities.

5. Increase in the capacity of the private sector at the local level to construct high quality hand-day wells, boreholes and improved latrines and to repair faulty water supply equipment.

6. Supplementation of the National Primary Health care programme by promoting better health practices, focusing water, good hygiene, diarrhea control and proper excreta disposal.

Thus, the development of the rural areas and indeed every part of Nigeria cannot be achieved without an effective water supply policy that can be sustained. According to Duru (2009), in a developing country like Nigeria, people are not only dying for water, they also dying of it. Therefore, the problem of quality and quantity of potable water for consumption are the crux of the matter, and people should as of right have access to it, as it has no alternative and the cost should be supplemented by the government. Improved water supply that meets with quality and quantity has a major effect on reducing water – based diseases (Ike – Obioha & Ikwuegbu, 2009).

In Nigeria, the National water supply policy admits that water supply is grossly inadequate in some states and aims at an improvement of the present level of 32 liter per capita per day for the rural areas which is far below the WHO standard of 70 and 130 liters for rural and urban area respectively (Ezeh, 2009). Water quality depends on the local geology and eco-system, as well as human uses such as sewage dispersion, industrial pollution, and management of other water uses. In the setting up of standards, Government and its agencies make political and technical / scientific decisions about how water will be used. Thus, different uses raise different concerns and therefore different standards are considered. In like manner, the parameters for water quality are determined by the intended use. In assessing water quality for human consumption, there are certain key components to be considered.

In countries where economic and human resources are limited, short and medium-term targets are established for national drinking – water standards,

water – quality surveillance and quality control programmes so that the most significant risks to human health are controlled first. The most common and widespread health risk associated with drinking – water is its microbiological contamination, the consequences of which are so serious that its control and financial involvement ought to always be of paramount importance. Thus, microbiological; quality is regarded as a priority. However, this is often difficult to be achieved in the short or medium term. Consequently, it is necessary to ensure that priority is given to water source that presents the greatest public health risk. Drinking water standards or regulations are necessary to ensure that accepted, standardized, reliable and accurate analytical methods are used by all agencies and laboratories.

Nigeria Standard for Drinking Water Quality (NSDWQ) was established to ensure the protection of the consumers and speed up the process of upgrading non-protected water systems and improving the management of all drinking – water systems in Nigeria. It is based on general principles of preventive, integrated and collaborative muti-agency approach. Since water quality issue is health related issue, Federal Ministry of Health in collaboration with the Standards Organization of Nigeria with a technical committee of key stakeholders gave birth to NSDWQ.

The underlying principle is the effective protection of public health against water related diseases that require preventive, integrated management approach. They include:

- The protection of drinking water from catchments and source until it is used by consumers.
- A collaborative multi-agency approach that involves all agencies that have some responsibility in the management of water quality.
- Water quality standard that is comprehensive, realistic and implementable within the resources of the implementing agencies
- The development of procedures and requirements that ensure good water quality management in order to meet the maximum allowable limits. These procedures also protect the environment.
- An independent surveillance agency with strong enforcement authority and functions decentralized to Local Government Level.
- An effective drinking – water quality data management systems to enable generation of data for development of coherent public health – centered policies and practices.

QUALITY OF BOREHOLE WATER AND CASE STUDIES

Since drinking water quality is a relative term that relates the composition of water with effects of natural processes and human activities; the status of quality of water supplied these days to the people is becoming a source of concern and worry to many consumers. Quality of water depends on the location of the sources and the state of the environment. According to Mishra (2005), all biological reactions occur in water and it is the integrated system of biological metabolic reactions in an aqueous solution that is essential for the maintenance of life. Deterioration of drinking water quality therefore arises from the introduction of chemical compounds and other extraneous into the water supply system through leaks and cross connections. Following the increase of industrialization on one hand and rapid increase of population on the other which is not marched by an increase in the financial involvement, the desire for good quality water has increased in exponential proportion. This is worsened when it is considered that the remaining part of the water is heartily polluted by industrials waste, sewage and wide range synthetic chemicals. Rainfall is one of the factors according to Napacho and Manyele (2010) that affects water quality as it can wash dissolved nutrients into the water-shed and increase organic carbon level, depress alkalinity level and stimulate corrosion. Similarly, dry season results in proportionally high level of dissolved minerals or nutrients in a particular water source. Pollution that involves enormous finance to control is a major problem in Nigeria.

The problem of chemicals and mismanaged waste especially treatment and disposal of solid and liquid wastes are the major contributors to urban environmental pollution. As a result, fresh water which is supposed to be a precious and limited vital resource that requires protection, conserved and used wisely by man is devastated leading to drinking water contamination. This renders it unsuitable or dangerous as regards food, human and animal health, industry, agriculture, fishing or leisure pursuits (Obodo, 2009). According to this author, the seriousness of this situation is hinged on the ground that by the end of this century, the waters of the world may be lifeless as long as people fail to decontaminate waste dumped into lakes, rivers and stream. This waste may reach an astonishing level of 600 percent in Nigeria. Over 2 billion people of the world's population have suffered from disease related to drinking polluted water and the financial involvement in the control of such diseases is better imagined. In the same vein, more than 250 million new cases of water borne diseases are reported each year, resulting in more than 10 million deaths and nearly 75 percent of these diseases cases occur in tropical areas (Obodo, 2009).

From the foregoing, improper waste management, unscientific sewage waste disposal and carelessness by industries may deteriorate borehole water quality in Nigeria. As previously stated, the quality of drinking water plays an important role in maintaining sound health and is imperative to monitor the water quality that is supplied from boreholes to the people for drinking. According to Oke and Aladejena (2012) borehole water is one of the major sources of water for human activities mainly for consumption, agricultural and industrial uses. It is no longer news but a common experience that pipe-borne water in most cities is in short Supply while Rivers and streams are often outreach to the inhabitants, and where available, may dry up during the dry season. This compels people to depend mainly on borehole waters and hand – dug wells which are cheaper alternative for potable supply.

According to Akinbile and Yusuf (2011), the quality of borehole water is generally based on the various physical and chemical parameters linked to weathering activities from surrounding rocks and anthropogenic activities. The main factors that influence the deterioration of water quality are agricultural wastes, domestic and municipal sewages, commercial and industrial wastes. These include organic and inorganic materials, salts, nutrients, heavy metals, radioactive waste, pesticides, pathogens, oil and heat. According to Ademoroti (1966), other sources and types of contaminants include highways salt, fertilizers spread across the land surfaces.

In the course of water passage though the ground, water dissolves minerals in rocks, collects suspended particulate matter, particularly those of organic as well as pathogenic micro-organism from faecal matters (Onuh & Isaac, 2009). In some other areas, water source are shared with the animals making the water dirty and contaminated. Naturally, borehole water is generally clear, colorless with little or on suspended matter, free from very minute organisms which cause diseases. The slow filtration action of the water flow through the ground offers benefit to the purity and chemical quality of the water. Also, the lack of oxygen and nutrients in the ground water renders it unfavorable to the environment for the growth and multiplication of the organisms. Certain minerals of heavy metals have been classified as toxic, and they are Zinc, Manganese, Nickel and Copper but they act as micro – nutrients at lower concentrations. According to Eriyamremin, Asagba, Akpobone and Ojieburu (2005), the health risk due to heavy metal contamination of water through soil has been reported.

Ground water pollution occur when leachate or pollutants percolate through the soil down to the phreatic surface. On reaching the ground water, the pathway of the contaminants is that of ground water flow and the influencing factors are those of cover deposit permeability, depth of impermeable layers and hydraulic head gradient in the aquifer. According to Eja (2002), the depth of penetration in the aquifer is dependent on the distance from the nearest ground water divide and from the nearest drainage channel, the pollutants introduced by human activities either from point source (those from farming practice, the application of agrochemicals and the use of sewage sludge as fertilizers) and non-point sources.

A source of water is considered bacteriological potable if it does not contain any micro organism that may be pathogenic to man (Geldreich, 1999). The routine monitoring for these pathogenic microorganisms which cause gastro-intestinal disease such as cholera, typhoid and dysentery are impractical and expensive. Researchers therefore need to be satisfied with the evidence of the presence of pathogens by testing for indicator organism such as coli form microorganism. Table 1 shows a population range of bacterial isolates obtained from the boreholes in Ekosin, Benin City Nigeria in a study by Solomon, Frederick and Basil (2006).

Consequent upon this, some scholars suggested that there is need to consider reliable indictors that could assess both the physical and chemical constituents of water thereby monitoring both drinking water operation and performance. In the overall, the quality and quantity of available water have implication on the health status of a community. This is in conformity with the work of Nnodu (2008) which stated that over 50,000 people die daily due to water borne diseases and about 2.3 billion people worldwide have mortality and morbidity associated with water related ailment. Thus, the presence of such contaminants in the borehole water awakens the recommendation of many more of such studies.

Table1: Population Range of Bacterial Isolates From The Sampled Borehole In Ekosin.

Borehole	Heterotrophic bacterial x 10 cfu /ml	Potential human pathogenic bacterial x 10 cfu/ml	Coliform mpn/100ml	E.coil mpn/100 ml	Streptococcus faecalis mpn/100ml	Clostridium Performing ns mpn/100l
1.	2.0-2.8	0-1.8	0-4	0	0	0
2.	1.5-2.1	0-1.5	0-7	0-4	0	0
3.	2.2-3.1	1.0-1.9	0-9	0-4	0-3	0
4.	1.0-2.0	0-1.3	0-3	0	0	0
5.	2.4-30	0-1.6	0-7	0-4	0	0

Source: Solomon et al. (2006).

Some studies have already been carried out on borehole water in different parts of the world and in Nigeria to determine its suitability for drinking and other purposes over the years. Okonkwo, Eme and Sewift (2012) in an attempt to identify the effect of the dump site near and away from borehole water located at Rumuogwunama in Eneka of Obio-Akpor Local Government Area in Rivers State, Nigeria, proved that the averages results of the analysis were below the WHO standard, thus low for drinking water quality and industrial use. In order to achieve good drinking water, they recommended a treatment operation that will modify the pH and heavy metals identified. Thus, presence of dump sites are potential source of pollution to ground water possibly due to shallow depth of water – table and therefore confirmed that the dump sources as contraindication. This is in tandem with findings of other scholars who proven that rapid increase in pollution in large cities without adequate plan jeopardizes limited water resources (Okonkwo, 2014).

Similarly, studies conducted by Fasanwon, Ayeni and Lawal (2010) on a comparative study of borehole water quality from sedimentary terrain and basement complex in South – Western Nigeria indicate that the composition of a terrain has influence on the water quality, and the elemental composition vary with lithology and the water qualities in the two zone are suitable for consumption. It was however recorded that some samples from the sedimentary basin have slight iron content. On studies carried out by Alexander (2008) on the ground water quality in Mubi town in Mubi North Local Government Area of Adamawa State to examine the suitability or otherwise of their use of the ground water for drinking and domestic purposes, the analysis revealed that the water sample were slightly acidic and alkaline (pH 6.30 + 0.01 to 7.52 + 0.05). The conclusion was that these water samples were good for drinking and domestic uses. Iyasele and Idiata (2012) in their studies on determining the borehole water quality in Edo South

and Edo North areas of Edo State found the analysis o f the water to have pH, magnesium and iron on the average with values that exceed the limit for consumption, thus the water analysis of borehole water for Benin City area need mild treatment to become fit for drinking. The physico- chemical and microbial analysis of the water quality from the Edo North area shows a level that constitutes pollution.

In the work of Obot and Edi (2012), evaluation of the spatial variation to boreholes water quality with depth was carried out with sample from functioning borehole in Uyo Municipal, the state Capital of Akwa Ibom, located in the coastal plains sands formation of Nigeria. The results were compared with the Nigeria Standard for Drinking Water Quality (NSDWQ) using standard procedures. The percentage compatibility of the water quality with the standard varied with depths, giving a strong correlation (r=98 percent) between the depths of boreholes and their water qualities. They recommended that depth needs to be considered if quality compatibility has to be guaranteed in the coastal plains sands formation. Also, water quality authority should set a baseline depth range for standard compatibility quality assurance in the area considering ground water dynamics and the seepage of polluted run-off in the largely flat terrain of the territory. Summarily, heavy metals and possible pollutants of ground water decrease as the depth increases, that is, surface pollutants found it difficult to percolate very deep down into the ground water aquifer as the depth increases beyond certain threshold value.

In another development, Asuquo and Etim (2012) on their physiochemical and bacteriological studies of selected borehole water in Uyo metropolis in Akwa Ibom State got results that suggest that the borehole water studies are safe for drinking, laundry and other application but with continuous managing of the water quality of the borehole and proper chlorination of the water. In the studies by Onwughara, Ajiwe and Nnabuenyi (2013) on physico-chemical parameters of water from selected boreholes in Umuahia North Local Government Area, Abia State Nigeria, their analysis showed a range that lies within recommended standard except few that are above WHO permissible limit. The results indicated that the water sources were contaminated and unfit for human consumption. This, therefore, calls for appropriate treatment measures before the consumption of the waters from the sources by the populace to avoid long term accumulative health problems of the pollutants.

It is a general belief that ground water like borehole provides a significant proportion of rural dwellers in the developing countries with access to safe drinking water and this will continue to do so in the future. There are regions

where groundwater quality is not fit for human consumption due to high level of arsenic, fluoride, iron or nitrates, or contamination from human impact as poor sanitation or spill or Chemicals. In support of their views Solomon et al. (2006) in studying the bacteriological and Physico-chemical quality of some water borehole using five boreholes from Ekosodin, Benin City, Nigeria; observed two borehole that are fit for direct consumption, while three boreholes failed to meet the bacteriological standard for potable water.

Mustafa, Ibrahim, Harunayi and Abubakar (2013) in their studies on physico – chemical analysis of water samples carried out from wash borehole used for drinking purpose using multiple tube technique in Maiduguri Metropolis, Nigeria, got results that indicated that none of the samples complied with the bacteriological standard as the coliform count ranges between $6x10^3$ and $145x10^3$ MPN/ml. two borehole samples did not comply with the pH standard recommended by WHO, NAFDAC and NSWDWQ. It was equally discovered that the total dissolved solid of the water sample from one borehole exceeded the standard requirements. Following this, they suggested that awareness be created about the situation of the wash boreholes and necessity of treatment by consumers before it can be used for both drinking and domestic purpose.

In another development, work by Elinge, Yusuf, Jude, Peni and Owusu (2010) on physico-chemical and bacteriological analysis carried out on four borehole water samples collected around Aliero Community were done n Kebbi State, Nigeria. The concentration of the metallic ions differs being highly above the WHO desirable limit from some boreholes while others are similar within the desirable WHO limits. The bacteriological analyses however indicated the highest bacteria count in one borehole with $4.0x10^5$ ctu/cm3; while the total coliform, was 1320mpn/100ml in another. Thus, while others were not acceptable, some were safe for drinking and the tap water was safer compared to these borehole water samples due to the latter's pretreatment process.

Bello, Osho and Bello (2013) in their investigative studies on bacteriological and physico-chemical analysis of Borehole and well water sources in Ijebu – Ode in South Western Nigeria found from the samples (borehole and well waters) to contain isolates of Escherichia coli, Klebsiella Sp, Proteus Sp. Pseudomonas aeroginosa and Staphilococcus aureus, the total bacterial and coliform count varying in degrees. Although all borehole water samples investigated had zero faecal coilform count that of well water sample ranges from zero to $4.1x10^2$c cfu/ml. They concluded that not all borehole water are safe for consumption, and well waters were of poorer bacteriological qualities indicative of health risk to the inhabitants of the geographical location.

In the study carried out by Napacho and Manyale (2010) involving the analyses of the drinking water sources from tap water, river and well water (deep and shallow wells), on pH, Chlorine, nitrate and total hardness in Temeke District of Dares Salam, the tap water found to be of higher quality than other sources in term of chemical characteristics. The study equally revealed that the chemical parameters of water source did not meet the permissible WHO and Tanzania Bureau of Statistics (TBS) levels. Thus, it was recommended that drinking water source for domestic use should be protected from pollution sources, as the cost implications of controlling water borne diseases cannot be overemphasized.

CONCLUSION AND RECOMMENDATION

From literature so far, it is not known of any particular environment in Nigeria which can be said that water from its borehole is automatically safe. Nevertheless these studies are not sufficient nor are they all comprehensive. There is need for more borehole quality studies; temporally and spatially using more sophisticated statistical software's and mathematical indices such as the Water quality index (WQI). Water Quality index (WQI) is commonly used for the detection and evaluation of water pollution, and may be regarded as rating reflecting parameters (Tambekar, Hiruckar, Mule & Dongre, 2007). The concept of Water Quality Index (WQI) to represent gradation in water quality was initially proposed by Horton in the early 1970s and cited by Srinivas Rao and Nageswararao (2013) as basically a mathematical model for calculating a single value from multiple test results. According to Shankar and Balasubramaya (2008), it turns complex and scientific water quality data into information that is understandable and useable by the public. On this basis, Chanhan, Pawar and Lone (2010) referred to it as an important parameter for the assessment and management of ground water; it can also be a tool for the formulation and implementation of water policy and laws nationwide. The cost implications of these models should also be taking into cognizance.

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