ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

Microbial Quality of Borehole water and prevalence of water-related diseases in Selected Settlements in the Coastal Area of Ondo-State, Nigeria

O. Terebo, A.A. Soyingbe, O. Olayinka, O. *Bamgbose

Department of Environmental Health, College of HealthTechnology, Akure, Ondo state, Nigeria.
Department of Environmental Health Sciences, Ogun State College of Health Technology, Ilese-Ijebu
Department of Environmental Mgt & Toxicology, Federal University of Agriculture, Abeokuta, Ogun state
Department of Environmental Mgt & Toxicology, Federal University of Agriculture, Abeokuta, Ogun state

ABSTRACT: Shortage of potable water in coastal areas of Ondo State has brought about high dependence on borehole waters as a reliable resource for meeting rural water demands. This study assessed the microbial quality of 264 borehole water samples of selected settlements covering 33 locations divided into four districts (identified as I, II, III & IV) between 2013 and 2015. Microbial results showed that Districts I and II had the highest TBC (CFU/100 ml) for both seasons with 1.53±0.11 and 1.47±0.39 in rainy season and 2.54±1.24 and 2.86±0.91 in dry season. Total coliform count (TCC) in CFU/100 ml was lowest in District I in wet season (0.38±0.08) compared to 2.27±0.68, 2.53±0.52 and 2.59±0.59 recorded for districts II, III and IV respectively. Confirmation of microbial contamination was the isolation of eight genera of bacteria from these borehole samples: *Klebsiella sp, Bacillus sp, Stapylococcus aureus, Enterobacter sp, Micrococcus lactis, Salmonella sp, Pseudomonas sp.* and *streptococcuspneumonia*. Results from question showed that typhoid fever (58.8%) was most prevalent followed by diarrhoea (21%). Epidemiological records from hospital confirmed prevalence of typhoid fever with a decreasing trend from 2010 (52.08%) to 2014 (36.99%), though still representing the major illness in the study area. The study concluded that most of the boreholes were contaminated and hence, the need to put in place facilities to supply potable water. This would reduce outbreak of water related diseases among the inhabitants of the coastal areas of Ondo State.

KEYWORDS: Epidemiological study, borehole water, coliforms, pollution, water related disease.

I. INTRODUCTION

Potable water is not only necessary for man but for plants and animals as well for their survival. Water-borne diseases represent a major burden on human health worldwide. Water-borne diseases are caused by ingestion of contaminated water from pathogens contained in human or animal excreta. Africa population suffers markedly from water-borne infections due to lack of safe and sanitary water supply and disposal. Microbial contamination of water is a major problem for human health, and has led to some major waterborne disease outbreaks [1,2]. Both drinking and recreational water can be highly susceptible to microbial contaminants, with pathogens frequently observed in surface and groundwater [3,4]. More than a billion people in the developing world, most of them in Africa lack safe drinking water; an amenity taken for granted in developed world [5]. The failure to satisfy this basic human need has led to substantial, unnecessary and preventable human suffering and diseases [6]. In coastal area, potable water supplies remain a sheer illusion in most settlements of the oil producing areas of Nigeria. Shallow wells mostly less than 3 meters deep are dug few meters away from river/creek banks, thus relying on natural sand filtration of the river/creek water for purification. High population density in the coastal areas along with lack of proper drainage systems and excreta disposal methods in the sandy soils are some factors directly affecting the shallow aquifer, and hence, directly on human health [7,8]. Inadequate sanitation and persistent faecal contamination of water sources is responsible for diarrhoea disease in developing countries [9,10].

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

In other to prevent epidemic of some communicable diseases among the inhabitants of this area, there is need to protect water sources for sustainable use.

II. MATERIALS AND METHODS

A. Description of the Study Area

The study areas comprise mainly selected communities in Ilaje and Ese-odo Local Government Areas of Ondo state, Nigeria. Ondo State comprises of eighteen (18) Local Government Areas. Ilaje Local Government consists of over four hundred settlements covering an area of 3,000 square kilometres [11]. This area constitutes one of the major oil producing areas in the state and part of the Niger Delta region of Nigeria. The estimated population of Ilaje LGA is about 254,235 according to Population Census of 2006. However, Ese-odo LGA has a landed area of 762km^2 with a population of 154,978 [12]. It lies between longitudes 2’24 to 3’24 and latitudes 6’22 to 6’42. The mean annual total rainfall is >2000mm with a mean monthly temperature of 28-29^{0}C [11].

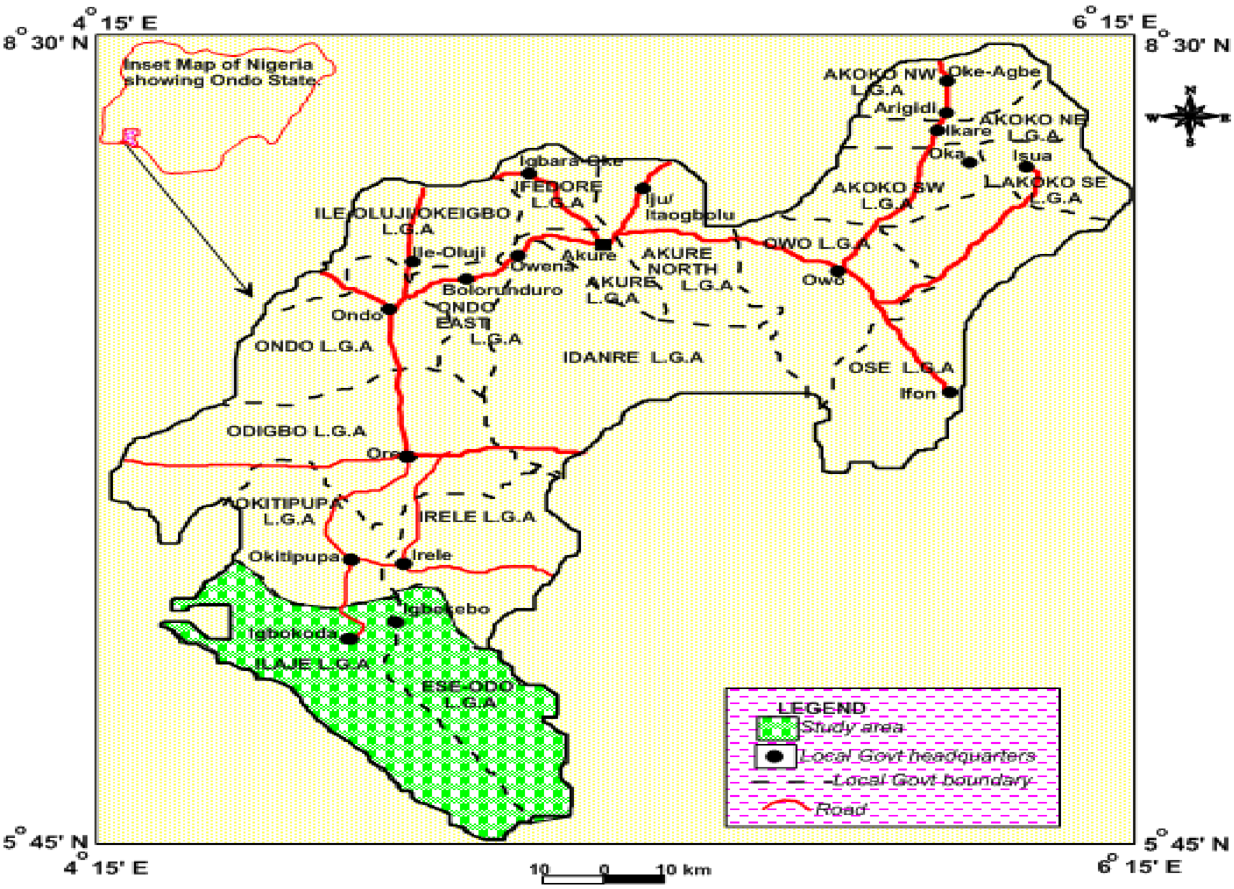

Fig1: Map of Ondo State showing the study areas

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

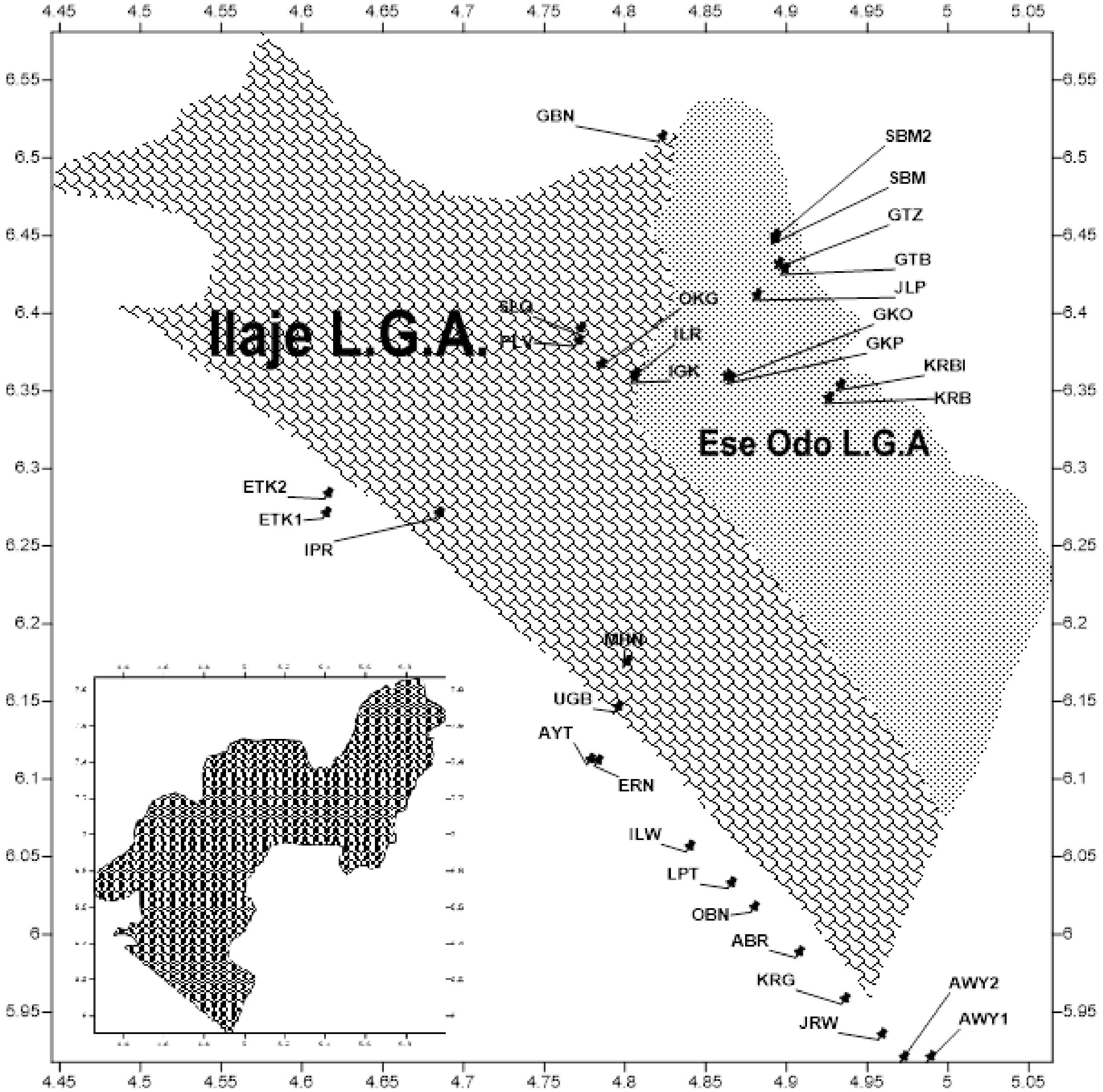

Fig 2: The digitised map of all sampling points in the coastal area of Ondo State

B. Sample Collection and Treatment

Samples were taken at interval from thirty boreholes in the two study areas. Sampling was conducted on the functional boreholes only in each of the selected settlement. Attempts were made so that the sampled boreholes are widely spread over the wards in the selected communities to give a clear representation of water quality status in the areas. Thirty

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

borehole points of various geographic locations was used for the study using a Global Positioning System (GPS) device. Sampling was carried out on the thirty borehole points within the selected communities of the coastal area which are grouped into districts I, II and III. Samples were taken thrice in each season of dry and rainy of 2014 and 2015 respectively. Again, samples were taken from three different urban water supply schemes (water works) which include Owena-Ondo, Owena-Ilesa and Alagbaka-Akure as district 1 to serve as control. A total of two hundred and sixty-four samples were taken for rainy and dry seasons respectively in all the communities of the stud

C. Quality Assurance Procedure

Special precautions for quality assurance during the study were considered a priority. All reagents were of analytical grade and water samples for bacteriological analysis were collected in McCartney bottles for preservation. Samples were taken to a sterile, air-tight vial bottle that was kept in refrigerator at temperature below 4^0C prior for microbiological analysis. Sampling was randomly taken from each of the selected settlements. Samples were subjected to laboratory analyses using standard methods [13]. All glasswares were thoroughly washed with detergent and rinsed with water, air dried and later sterilized in the autoclave at 121°C for 15minutes. Inoculating loop was flamed to red, while laboratory benches and inoculating chamber were swabbed with cotton wool moistened in 70% ethanol.

D. Statistical Analysis

Inferential statistics were used for analyses of the data generated. Analysis of variance (ANOVA) and Pearson correlation were performed on the data using SPSS 20.0 for significant variations and inter-element relationships. Results were presented as the mean ± standard error. Correlation Analysis was done using SAS [14]

III. RESULTS AND DISCUSSION

Table 1: Seasonal variation in mean values of TBC and TCC in borehole waters in the coastal areas of Ondo State

	TBC (CFU/100ml)		TCC (CFU/100ml)	
Districts	**Rainy**	**Dry**	**Rainy**	**Dry**
I	1.523±0.11	2.453±1.24	0.383±0.38	0.970±0.07
II	1.475±0.39	2.861±0.91	2.275±0.68	2.673±0.59
III	2.690±0.74	2.070±0.52	2.530±0,52	2.390±0.44
IV	2.450±0.48	3.387±0.83	2.591±0.59	3.019±0.63
Mean±SE	**2.136±0.29[a]**	**2.783±0.42[a]**	**2.280±0.33[a]**	**2.556±0.31[a]**

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

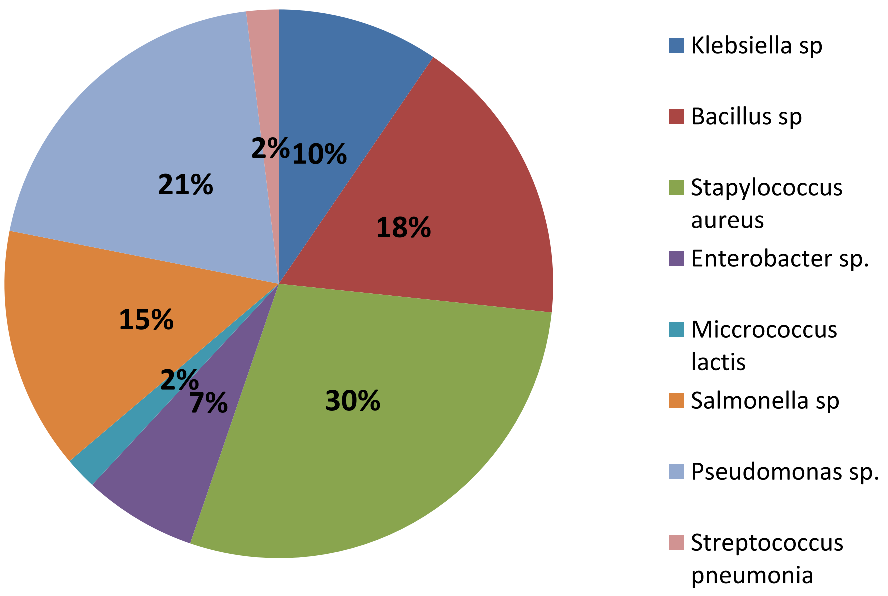

Figure 3: Percentage Occurrence of Bacterial Isolated from the Borehole Samples

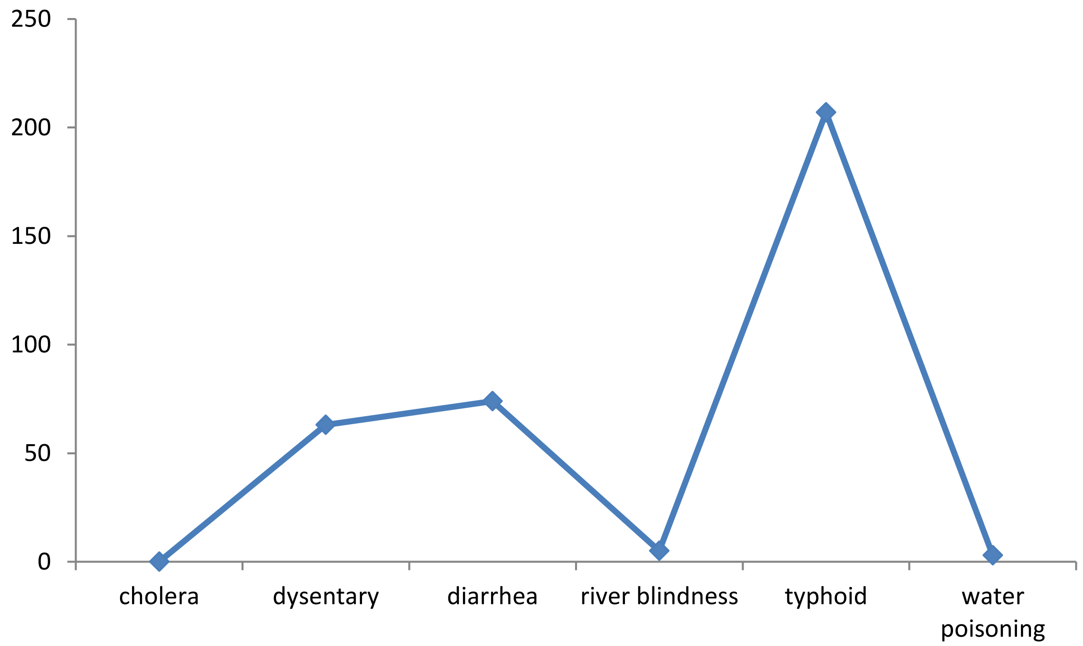

Figure 4: Types and magnitude of illnesses in the study area.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 9, Issue 6 , June 2022

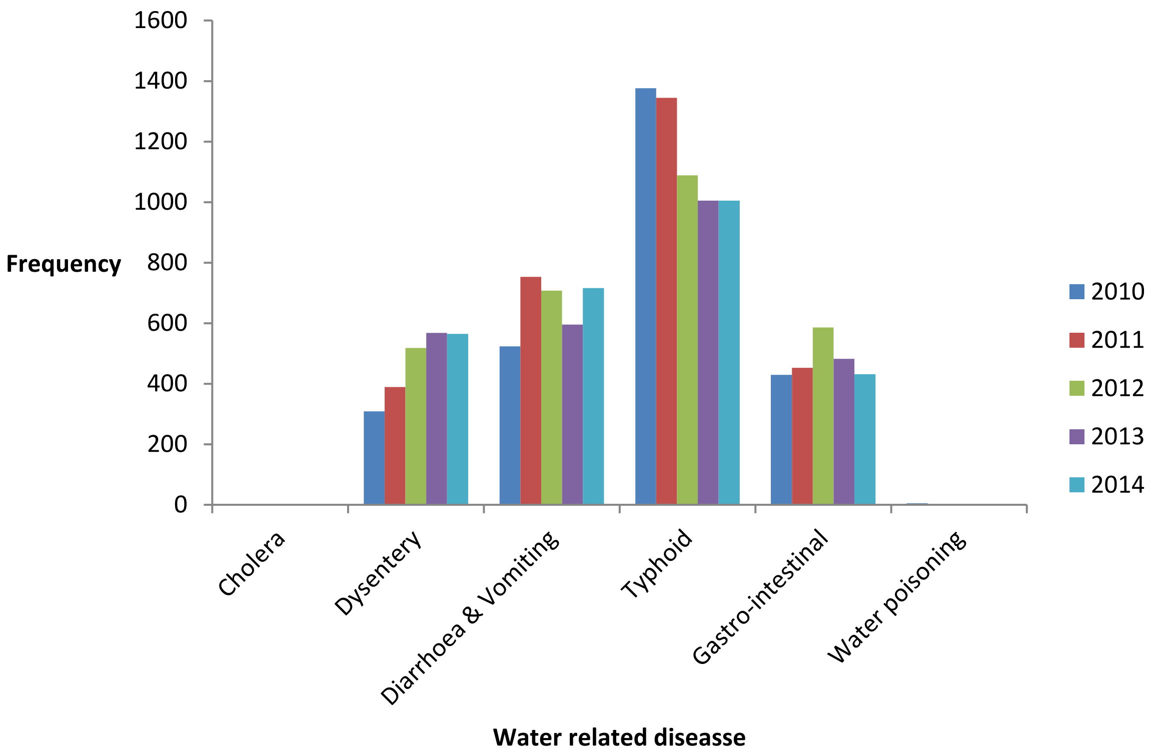

Figure 5: Water related diseases in the Coastal Districts of Ondo State

E. Seasonal mean values of Total Bacteria and Coliform Counts in borehole waters in the coastal areas of Ondo State

The mean values of the microbial counts (TBC and TCC) of the borehole water in the coastal areas on the basis of districts and for both the dry and rainy seasons. A total of thirty-three (33) communities were sampled and the means of the parameters in respect of TBC were 2.14±0.29 CFU/100ml and 2.78±0.42 CFU/100ml for rainy and dry seasons respectively. Similarly, TCC recorded mean values of 2.28±0.33CFU/100ml and 2.56±0.31CFU/100ml for rainy and dry seasons respectively. For dry season, the mean values of microbial load were observed being lowerin rainy season than values obtained in dry season in all the communities for both TBC and TCC.
Reporting on district basis, Districts III and IV had the highest TBC 2.69±0.74 CFU/100ml and 2.45±0.48 CFU/100ml followed by Districts I and then II in the rainy season. These counts were higher in dry season in Districts IV (3.39±0.83 CFU/100ml) and II (2.86±0.921 CFU/100ml). That of District III fell to 2.070±0.52 CFU/100ml in this same season. TCC was lowest in District I in rainy season (0.383±0.38 CFU/100ml) compared to 2.275±0.68 CFU/100ml, 2.530±0.52 CFU/100ml and 2.591±0.59 CFU/100ml recorded for other districts; II, III and IV respectively. It was highest in District IV (3.019±0.63 CFU/100ml) followed by District II (2.673±0.59 CFU/100ml), District III (2.390±0.44 CFU/100ml) and District I (0.970±0.07 CFU/100ml) in dry season. On a comparative basis, study showed that no seasonal variation existed ($p>0.05$) between the TBCs and TCCs for both the rainy and dry seasons in the study area. The results further showed that season positively influenced the TBC and TCC in all the districts except in District III where the influence was negat

F. Microbial estimation of borehole water sample

The percentage occurrence of bacterial in the study illustrates the resident and transient strain found in borehole samples according to figure 7. *Staphylococcus aureus*, *Bacillus* sp. and *Pseudomonas aeruginosa*, were the predominant

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 9, Issue 6 , June 2022

organisms with (30%), (18%) and (21%) respectively, Klebsiella sp. (10%), Salmonella sp. (10%), and *Enterobacteraerogenes and others* (5%).
The results of bacteriological analysis revealed the poor condition of some of the borehole water sample in respects to the total viable bacteria recorded in this study. The mean values of TBC were (2.14±0.29 CFU/100 ml and 2.78±0.42 CFU/100ml) and TCC (2.28±0.33 CFU/100 ml and 2.56±0.31 CFU/100 ml) respectively. This result was at variance with Olal e.al [15] who found that Escherichia coli level in water were above the upper detection range for their standard water analysis techniques which was 1800 CFU/100-ml in the Maasailand region of the Kenyan Rift valley. Similarly, Itah et al. [16] also reported high faecal coliform in their study on bacteriological and rural water supplies in Calabar. This could explain the relatively high microbial counts observed in the water from these sources.

In this study, it is important to recall that all these boreholes water are used for drinking among others. This highlights the public health concerns for people who solely depend on this resource for living in this rural community. Presence of viable bacteria and coliform load in groundwater samples are unacceptable, though, most of the borehole water met physicochemical requirements. No Seasonal variation existed ($p>0.05$) between the TBCs and TCCs for both rainy and dry seasons in the coastal area of Ondo State. Districts III and IV had the highest TBC 2.69±0.74 and 2.45±0.48 followed by Districts I and then II in the rainy season. These counts were higher in dry season in Districts IV (3.39±0.83) and II (2.86±0.91). That of District III fell to 2.070±0.52 in this same season. TCC was lowest in District I in rainy season (0.383±0.38) compared to 2.275±0.68, 2.530±0.52 and 2.591±0.59 recorded for other districts; II, III and IV respectively. It was highest in District IV (3.019±0.63) followed by District II (2.673±0.59), District III (2.390±0.44) and District I (0.970±0.07) in dry season. The result further showed that season positively influenced the TBC and TCC in all the districts except in District III where the influence was negative. This study revealed the presence of viable bacteria and total coliform counts in the borehole water samples in both seasons. Anthropogenic activities in the vicinity of water collection sites as well as settlements lacking proper sanitation facilities might have contributed to the poor water quality of the different water sources, especially communities that had high coliform count [17]. However, studies showed that the presence of biodegradable organic matter in water are found to promote bacterial growth and may be related to the occurrence of coliform bacteria in distribution systems [18]. According to WHO [19], the microbiological potability standards for drinking water in most developed countries rely on the detection of total coli forms and E coli (faecal coli form) as markers for human pathogens.

Obiri-Danso [20] investigated nine wells and boreholes in Kumasi Ghana and found that microbial indicator organisms were present in all the samples throughout the study irrespective of the time of sampling. Okotto [21] studied shallow wells in Kisumu, Kenya and Addis Ababa, Ethiopia and reported high diseases occasioned by number of times household suffered water-borne diseases in the study areas. In both cities all the sampled wells showed contamination greater than 200 TTC/100-ml. Kenya applies World Health Organization Standards for its drinking water, where a zero presence of coliforms in a 100 ml sample of drinking water is recommended WHO [22]

G. Water related diseases in the coastal Areas of Ondo State

The water related diseases in the coastal areas of Ondo State were represented in Figure 9. These included dysentery, diarrhoea and vomiting, typhoid, gastro-intestinal disorder and water poisoning. Cholera and water poisoning were not recorded between 2010-2014. There was slight increase in the incidence of dysentery in this part of the state and an irregular pattern of diarrhoea and vomiting cases. Meanwhile, gastro-intestinal disorder predominated in 2012 in the area. Among the water related diseases, typhoid fever was mostly recorded. Epidemiological data from hospital records confirmed the prevalence of typhoid fever with a decreasing trend from 2010 (52.08%) to 2014 (36.99%), though still representing the major illness in the study area.

The annual hospital data from communities' healthcare facilities over a period of five years between 2010 and 2014 indicated typhoid fever as the leading illness in all the districts of the study areas. For instance, in district III, typhoid fever was found to have incidence rate of 38.5%, 33.0%, 22.0%, 21% and 20% in 2010, 2011, 2012, 2013 and 2014 respectively of the total disease burden recorded in each community health care facility with cholera was non-exitent. Similarly, results from the health care centres also revealed that water related diseases in the coastal districts of Ondo State included dysentery, diarrhoea and vomiting, typhoid, gastro-intestinal disorder and water poisoning. Cholera and water poisoning were not recorded between 2010-2014. There was slight increase in the incidence of dysentery in this part of the state and an irregular pattern of diarrhoea and vomiting cases. Meanwhile, gastro-intestinal disorder predominated in 2012 in the area. Among the water related diseases, typhoid was mostly recorded. It was very high, both in 2010 and 2011 and came down but not as much as other diseases in the area between 2010-2014.

In contrast to this study, WHO verified 578 infectious disease outbreaks in 132 countries from July 1998 until August 2001 and cholera was the most frequent, with acute diarrhoea as the fourth [23]. However, the gradual decline in the incidence rate of typhoid fever as reported in this study could be as a result of sensitization and improved sanitation, personal hygiene and consciousness to protect water sources. The results from this study contrasted the work of Sow *et.al* [24] on the Senegal River basin in which water related disease patterns before and after the construction of Diama dam in Northern Senegal was studied.

IV. CONCLUSION

This study assessed the quality of 264 borehole water samples along with epidemiological studies of selected settlements covering 33 locations divided into four districts (identified as I, II, III & IV) between 2013 and 2015 in coastal areas of Ondo state. Microbial analysis showed higher contamination in dry than in rainy seasons. This study confirmed the presence of eight genera of bacteria in these boreholes: *Klebsiella sp, Bacillus sp, Stapylococcus aureus, Enterobacter sp, Micrococcus lactis, Salmonella sp, Pseudomonas sp.* and *streptococcuspneumonia*. Epidemiological data confirmed the prevalence of typhoid fever in the study area. In conclusion, the study concluded that most of these boreholes were contaminated and there is need to put in place facilities for potable water in order to prevent epidemic of some communicable diseases among the inhabitants of the coastal areas.

V. RECOMMENDATIONS

1. Water quality laboratories should be established in every to regularly test water from designated water points and ensure safe water for basic human needs.
2. The location of borehole should be far away from any contamination sources to prevent contaminated water through infiltration. Education of the public on personal hygiene should be enhanced and the need for water treatment to reduce the level of transmission of pathogenic microbes to humans. This should be stepped up to create commitment and positive attitudes towards the conservation and sustainable utilization of the water sources.
3. Establishment of continuous local community water quality monitoring program. Full inventory of the local community water sources and demand driven research and monitoring should be carried out annually to improve scientific information and knowledge based to determine their administrative area, type, status, values and threats. This will promote innovative planning and integrated approach towards the conservation and management of the local community water sources in selected settlements in the coastal area of Ondo state, South-western Nigeria.

REFERENCES

[1]. Moe, C. L. and Rheingans, R. D. 2006. Global challenges in water, sanitation and health. *Journal of Water and Health*, *4*(S1), 41-57.
[2]. O'Connor, D. R. 2002. Report of the Walkerton inquiry: Part two, a strategy for safe drinking water. *Toronto, Ontario: Ontario Ministry of the Attorney General, Queen's Printer for Ontario*.
[3]. Hancock, C. M., Rose, B. J. and Callahan, M. 1998. Crypto and Giardia in U.S. Groundwater. Journal of the American Water Works Association, 90(3): 58-61.
[4]. Lemarchand, V and Lebanon S 2003. Pathogens in portable and recreational waters. Journal of water and Health Tech 64 (4): 42-48
[5]. Kornfeld, I. 2010. Global Water Apartheid: From Revelation to Resolution, A.*Vanderbilt*
and Journal of Transnational Law , 43, 701.
[6]. Abdus-Salam, N., Adekola, F. A. and Apata, A. O. 2010. A physicochemical assessment of water quality of oil producing areas of Ilaje, Nigeria. *Advances in Natural and Applied Sciences*, *4*(3): 333-345
[7]. Schmoll, O., Howard, G., Chilton, J. and Chorus, I. 2013. Protecting groundwater for health: managing the quality of drinking-water sources.*Water Intelligence Online*, *12*, 9781780405810.
[8]. Yadav, R. K., Minhas, P. S. and Dagar, J. C. 2016. Potential of Wastewater Disposal Through Tree Plantations. In *Agroforestry for the Management of Waterlogged Saline Soils and Poor-Quality Waters* (pp. 163-179).Springer India.
[9]. Mara, D., Lane, J., Scott, B. and Trouba, D. 2010. Sanitation and health.*PLoS Medicine*, *7*(11), e1000363

[10]. Baldursson, S. and Karanis, P. 2011. Waterborne transmission of protozoan parasites: review of worldwide outbreaks–an update 2004–2010. *Water Research*, *45*(20), 6603-6614
[11]. Adeleke, M. L., Omogbemi, T. E. andOgunjobi, V. O. 2015. Value Chain Strategies in Fish Production for food Security in Nigeria: The Case of Selected Key Actors in Fish Production in Ondo State Coastal Areas. *International Journal of Innovative Research and Development|| ISSN 2278–0211*, *4*(13).
[12]. National Population Commission 2006.Census Population Figure.
[13]. APHA. 1998. Standard Method for the examination of Water and Wastewater.20th edition. Published jointly by American Public Health Association, American Water works Association and Water Environment Federation'. Washington, DC 2005-2605.
[14]. SAS. 1999.*www.ats.ucla.edu/stat/sas/library/sas anova_mf.htm*
[15]. Olal, B. A., Tsingalia, H. M. and Okeyo-Owuor, J. B. 2014. Assessment of microbiological contaminants in community water sources in lower Nyakach Division, Kisumu County, Kenya
[16]. Itah, A.Y., Etududo, S.M. and Enomfon, A. 1996. Bacteriological and chemical analysis of some rural water supplies in Calabar, Nigeria. *West African Journal of Biological and Applied Chemistry* 41:1-10
[17]. Nyenje, P. 2014. Fate and Transport of Nutrients in Groundwater and Surface Water in an Urban Slum Catchment Kampala, Uganda. TU Delft, Delft University of Technology.
18. Sancho, R. and Rockey, C. 2011. Developing a treatment water safety plan. *Drinking Water Quality Management from Catchment to Consumer: A Practical Guide for Utilities Based on Water Safety Plans*, 91.
19. WHO. 1993. Guidelines for drinking water quality; vol.1. Recommendations 2nd ed. Geneva, World Health Organisation 1993: 8-29, 173.
20. Obiri-Danso, K., Adjei, B., Stanley, K.N., Jones, K. 2009. Microbiological quality and metals in Wells and Borehole water in some peri-urban communities in Kumasi, Ghana. *African Journal of Environmental Science and Technology*, 3 (1) pp 55-66.
21. Okotto, L., Ayalew, M., Chenoweth, J., Malcolm, R., Pedley, S. and Mulugetta, Y. 2009. The establishment of legal frameworks for independentand small-scale water providers.
22. WHO. 2006. Guidelines for Drinking Water Quality: Incorporating 1st and 2nd Addlenda, Vol.1 Recommendations 3rd ed. Geneva.
23. WHO. 2002. World Health Report 2002. Reducing risks, promoting healthy life World Health Organization, Geneva.
24. Sow, S., De Vlas, S. J., Engels, D. and Gryseels, B. 2002. Water-related disease patterns before and after the sconstruction of the Diama dam in northern Senegal. *Annals of Tropical Medicine & Parasitology*,*96*(6), 575-586