

Assessment Of Physico-Chemical Property Of Water Samples From Port Harcourt, Bonny And Opobo Coastal Areas For Sustainable Coastal Tourism Development In Rivers State, Nigeria.

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Abstract: The study evaluated some physico-chemical properties of water samples from Port Harcourt, Bonny and Opobo to determine the safety of water from the areas for sustainable coastal tourism development in Rivers State, Nigeria. Three water samples were collected with three sterilized plastic containers with a capacity of 25cl which were subjected to laboratory tests to know their constituents. The parameters tested were appearance, temperature, colour, turbidity, conductivity, PH, alkalinity, lead (Pb), Chromium (Cr), Cadmium (Cd), Ammonia, BODs and Dissolved Oxygen. The results of the water samples were compared with World Health Organization (WHO) water quality standard and the Nigeria National Water Quality standard to determine the safety of the water for human consumption and tourism development. The study revealed that Port Harcourt site has more prospects for tourism development more than Opobo study site because the Ph, alkalinity and BODs levels were lower than that of Opobo making the water safer except that the amount of dissolved oxygen was a little high in Opobo and turbidity was not detected in Opobo. The study revealed that Bonny water was very dense in appearance, dark brown in colour, highly turbid, basic and with mean concentration of the heavy metals – Lead, chromium and cadmium higher than the recommended World Health Organization (WHO) water quality standard and the Nigeria National Water Quality standard and therefore not safe for drinking and swimming. Treated portable water should be provided for the people of Port Harcourt, Opobo and Bonny especially people from Bonny area and development of tourism in the state to save the people and tourists from imminent danger of fecal contaminants and toxic substances.

Keywords: Water samples, Coastal tourism, Rivers State, Tourists, Tourism development, water quality standard and World Health Organization Standard.

Introduction

Water is an essential element for sustenance of life. According to WHO and UNICEF (2010) water is essential for human existence and its importance for individual health and well-being of a nation cannot be underestimated. Many people in developing countries do not have access to safe and clean drinking water. This situation can lead to so many health problems. Consumption of water contaminated by disease causing pathogens or toxic chemicals can cause health problems such as cancer, diarrhea, cholera, typhoid, dysentery and skin diseases. The impact of heavy metals on the environment is a concern to the government regulatory agencies and the public (Tiller, 1992). The concern is the contamination of water resources by potentially toxic metals from coastal areas of Rivers State. Drinking water is defined as having acceptable quality in terms of its physical and chemical bacteriological parameters so that it can be safely used for drinking and cooking (WHO, 2004). In assessing the quality of drinking water, consumers rely principally upon their senses.

Microbial, chemical and physical constituents of water may affect the appearance odour or taste of the water and the consumer will evaluate the quality and acceptability of the water on the basis of these criteria (WHO, 2004). Consumer perception and acceptability of drinking water quality depends on user sense of taste, odour and appearance (Sheat, 1992, and Doria 2010). Taste and odour can originate from various natural chemical contaminants, biological sources, microbial activity, corrosion or water treatment (WHO, 2004). Colour, cloudiness particulate matter and visible organisms can also contribute to unacceptability of water sources. These factors can vary from each community and are dependent on local conditions and characteristics. Turbidity is the most important problem for aesthetic value of water quality. Although, it does not necessarily adversely affect human health but it can protect micro organisms from disinfectant effects. Stimulate bacteria growth and indicate problems with treatment processes (WHO, 2004). For effective disinfection, median turbidity should be below 0.1 NTU; although turbidity of less than 5 NTU is usually acceptable by consumers (WHO, 2004). pH is another important operational water quality parameter. The pH that is within typical ranges has no direct impact on consumers (WHO (2007). Low pH levels can enhance erosive characteristics resulting in contamination of drinking water and adverse effects on its taste and appearance. High pH levels can lead to calcium carbonate deposition. Therefore, careful consideration of pH is necessary to ensure satisfactory water disinfection with chlorine which requires pH to be less than 8 (WHO, 2004). Electrical conductivity (EC) is a measure of the total ionic activity of solution cadmium metal is water quality parameter. Cadmium is released to the environment in waste water and diffuse pollution is caused by contamination from fertilizers and local air pollution. The WHO International Standards recommended a maximum

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allowable concentration of 0.01mg/litre (WHO, 2003S). The kidney is the main target organ for cadmium toxicity. Ammonia is an important operational water quality parameter. Ammonia in water is an indication of possible bacterial sewage and animal waster pollution (WHO, 2003B). Ammonia in the environment originates from metabolic agricultural and industrial processes and from disinfection with chloramines. The maximum allowable concentration recommended by World Health Organization was 0.5mg/l (WHO, 1984; FEPA, 1991). Chromium is another heavy metal that has health implication. The liver is the main target organ for chromium toxicity. The WHO International Standards for drinking water recommended a maximum allowable concentration of 0.05mg/l for chromium based on health concern. As a practical measure, 0.05mg/l is considered to be unlikely to give rise to significant health risks (WHO, 2003c). Lead is a compound which can adversely affect human health. Lead is a general toxicant that accumulates in the skeleton. It is toxic to both the central and peripheral nervous systems, inducing neurological and behavioral effects. Apart from its carcinogenic effects, it has been observed that lead has a deficit effects on the intelligent quotient of children who were exposed to it. The upper concentration limit recommended by WHO International Standards for drinking water was 0.1mg/litre (WHO, 2003d). For the reason of morbidity and motility associated with the lack of access to safe drinking water and poor hygiene practices in developing countries like Nigeria which have adversely affected the economic vitality and future of the country. Also, the importance of access to safe, clean and acceptable drinking water has become crucial for tourism development in Rivers State. The study was aimed at assessing some physico-chemical properties of water samples from port Harcourt, Bonny and Opobo for sustainable coastal tourism development of Rivers State, Nigeria,

Methodology

The researcher collected water samples with separate containers from the three study sites (locations) for laboratory analysis. The three water samples were collected with three sterilized empty Ragolis water plastic containers with a capacity of 25cl. The water samples from three different sites of the study area were subjected to laboratory tests to know their constituents. The parameters tested were appearance, temperature, colour, turbidity, conductivity, PH, alkalinity, Pb, Chromium (Cr), Cadmium (Cd), Ammonia, BODs and Dissolved Oxygen. The World Health Organization (WHO) water quality standard and the Nigeria National Water Quality standard were used to compare the results of the three water samples from the three study sites. This critical examination of the results with WHO water quality standard and Nigeria National water quality standard enabled the researcher to determine if the water in the study area would be safe or hazardous to tourists and tourism staff for drinking, swimming and bathing should the area be developed for tourism.

RESULTS AND DISCUSSION

Table 1 shows the mean values of the physico-chemical parameters of water samples from three study sites – Port Harcourt, Bonny and Opobo compared with WHO (1984)

standard. The mean water temperatures of the samples were 33°C, 39.7°C and 34°C for Port Harcourt, Bonny and Opobo respectively. The appearance of water samples from Port Harcourt and Opobo was clear while that of Bonny was very dense indicating the presence of many particles and sediments inside the water making it unwholesome and unsafe for drinking by tourists. The colour of water samples from Port Harcourt and Opobo were clear showing a sign of being clean water for drinking, while the water sample from Bonny was dark brown indicating a sign of bad water for tourists to consume. The turbidity indicates a sign of cloudiness caused by large number of individual particles that are invisible with the naked eyes. The turbidity of water sample from Port Harcourt was 0.001mg/l, Bonny was 146mg/l and Opobo was non-detectable, while WHO standard was 5. The mean turbidity of Port Harcourt and Opobo was less than the WHO standard which is an indication of good quality water, while the water sample from Bonny was highly turbid. In the conductivity of water which measures the ability of water to pass an electrical current due to presence of high concentration of salts and other chemicals that ionize in the solution, Port Harcourt has shown 0.001uscm⁻¹, Bonny (0.04uscm⁻¹) and Opobo (0.001uscm⁻¹). The water conductivity of Bonny was higher than Port Harcourt and Opobo indicating higher concentration of salts and other chemical ions. This also indicates that waters from Port Harcourt and Opobo were more salt free, ion-free or impurity free than the water from Bonny. The PH of water samples from Port Harcourt, Bonny and Opobo were 7.03, 80.87 and 7.11 respectively. The PH of waters from Port Harcourt and Opobo was within the maximum acceptable range of 6.5 and 7.5 of a normal good drinking water. The pH of water sample from Bonny is said to be basic or alkaline which has health implications. The mean BODs for Port Harcourt water sample was 1.67mg/l, Bonny water sample was 16.10mg/l and Opobo water sample was 1.75mg/l as against 6.0 for WHO standard. The Bonny water sample BODs was too high and deviated significantly from maximum permissible level of 6.0 mg/l for BOD for drinking purpose WHO (1984). This could be attributed to increased total suspended solids, high organic matter content of the river where the water was collected, sewage discharges, oil refining and petrochemicals, oil spills, industrial effluents dissolved solids, etc. when these pollutants gain access into the river, they will need a large amount of oxygen needed by aquatic organisms thereby using it up to the detriment of the aquatic organisms. The BODs of 1.67mg/l for PH and 1.75 for Opobo as against the 6.0 for WHO standard implies that the amount of pollutants that gain access into the rivers where the water samples were collected were significantly low. The implication is that the rivers in Port Harcourt were less polluted than that of Opobo while rivers from Bonny were highly polluted with heavy pollutants which gain access into them. The mean dissolved oxygen content recorded in this study was 3.50mg for Port Harcourt 2.73mg/l for Bonny and 3.76mg/l for Opobo was less than the recommended minimum standard of 5mg/l (WHO, 1984, FEPA. 1991) for drinking purpose. This deviation was more significant in Bonny more than Port Harcourt and thereafter Opobo. This shows that the water sample from Bonny contained large amount of dissolved oxygen followed by the sample from Port Harcourt. Water sample from Opobo appeared the best

amongst the three samples with 3.76mg/l dissolved oxygen content closer to 5m/l recommended minimum standard of WHO. The mean concentration of the heavy metals in the study sites – Port Harcourt, Bonny and Opobo is as follows (see table 4.9). The following heavy substances – lead (Pb) cadmium (Cd), Chromium (Cr) and Ammonia (NH) were non-detectable in water samples from both Port Harcourt and Opobo study sites. However, for lead (Pb): Bonny (0.0175mg/l) and WHO (0.1); for cadmium (Cd): Bonny (0.0193mg/l) and WHO (0.01); for chromium (Cr): Bonny (0.17mg/l) and WHO (0.05) and for Ammonia (NH): Bonny (1.16mg/l) and WHO (0.5). The table shows that the following parameters: PH, BODs, cadmium, chromium and Ammonia were higher than the recommended values for WHO standard except in lead (Pb). Considering that those metals are toxic substances. It can be seen that the water from Bonny study site is not suitable for human consumption and for swimming by tourists. However, it may be suitable for other purposes such as irrigation and industrial purposes but should not come in contact with food and skin becomes of its toxicity.

Table 1: Comparisons of Physico-chemical Parameters of water samples from Port Harcourt, Bonny and Opobo with WHO Standard.

| S/N | Parameters | Units | Port Harcourt | Bonny | Opobo | WHO |
|-----|------------------|--------------------|--------------------------|-------------------------|--------------------------|---------|
| 1 | Appearance | - | Clear | Very dense | Clear | - |
| 2 | Temperature | °C | 33°C | 39.7°C | 34.0°C | - |
| 3 | Colour | - | Colourless | Dark Brown | Colourless | - |
| 4 | Turbidity | NTU | 0.001 | 146 | ND | 5 |
| 5 | Conductivity | uscm ⁻¹ | 0.001 uscm ⁻¹ | 0.04 uscm ⁻¹ | 0.001 uscm ⁻¹ | - |
| 6 | PH | - | 7.03 | 8.87 | 7.11 | 6.5-7.5 |
| 7 | Alkalinity | mg/l | 0.004mg/l | 0.001mg/l | 0.005mg/l | - |
| 8 | Pb | mg/l | ND | 0.0175 mg/l | ND | 0.1 |
| 9 | Cr (chromium) | mg/l | ND | 0.17mg/l | ND | 0.05 |
| 10 | Cd (cadmium) | mg/l | ND | 0.0193 mg/l | ND | 0.01 |
| 11 | Ammonia | mg/l | ND | 1.16mg/l | ND | 0.5 |
| 12 | BODs | mg/l | 1.67mg/l | 16.10mg/l | 1.75mg/l | 6.0 |
| 13 | Dissolved oxygen | mg/l | 3.50mg/l | 2.73mg/l | 3.76mg/l | 5(m/l) |

Source: Field survey, 2013

KEY:

ND - Non-Detectable

The following parameters: Lead, Chromium, Cadmium, Ammonia were non-detectable from Port Harcourt and Opobo water samples. These water samples were clear and colourless. Also, BODs, PH parameters were less than the recommended WHO standard for Port Harcourt and Opobo; while turbidity was non-detectable for Opobo and

less than recommended value for WHO standard for Port Harcourt. This implies that the water samples from Port Harcourt and Opobo were safe and wholesome for human consumption, swimming and bathing for tourists. Table 2 displays the physical and chemical parameters of water samples from Bonny, Opobo and Port Harcourt with the National Standard for Drinking water quality (SON, 2014). The mean values of water temperature reveals 33°C for Port Harcourt, 39.7 °C for Bonny and 34.0 °C for Opobo while the National Standard is ambient (i.e. dependent on the atmosphere and the environment). This shows that water temperatures have no health implication. The water samples from Port Harcourt and Opobo were clear and colourless while the sample from Bonny was very dense and dark brown and the National Standard recommended a maximum permitted level of water value of 15. The water samples from Port Harcourt and Opobo have acceptable quality in terms of colour and appearance unlike the water sample from Bonny. The mean turbidity values were 0.001, 146 and non-detectable (ND) for Port Harcourt, Bonny and Opobo respectively, while the National Standard recommends 5 as the maximum permitted level for water turbidity. The turbidity values of water samples from Port Harcourt and Opobo were less than Port Harcourt and Opobo were less than the permitted level recommended by Stand Organisation of Nigeria as the National Standard. Also, the water sample from Bonny was highly turbid and differed significantly from the National Standard value. This level of turbidity makes it unacceptable for human consumption and therefore unsuitable for tourists' use. The mean values of water conductivity of water samples from Port Harcourt, Bonny and Opobo were 0.001us/cm, 0.04 us/cm and 0.001us/cm respectively, while the value recommended by SON as the maximum permitted level was 1000us/cm. The conductivity levels of water samples from the three study sites were for less than the National Standard value recommended by SON. This indicates that the concentration of salts and other chemicals that ionize in solutions were not high in the three water samples from the study sites in comparison with the National Standard recommendation. However, the water samples from Port Harcourt and Opobo were more salt free, ion-free or impurity free than the water sample from Bonny. It is important to note that the higher the conductivity of water, the higher the ability of the water to pass electricity current. The pH was 7.03 for Port Harcourt, 8.87 for Bonny and 7.11 for Opobo while the National Standard was $\geq 6.5 \leq 8.5$. The pH values of water samples from Port Harcourt and Opobo were within the recommended range of the National Standard. The PH value of the water sample from Bonny was little above the National Standard value. This implies that the PH of water from Opobo and Port Harcourt was acceptable for a good drinking water; but the water from Bonny was slightly alkaline which has health implication and unsuitable for consumption. The mean value of lead (Pb) showed non-detectable (ND) for water samples from Port Harcourt and Opobo and 0.0175mg/L for Bonny while the National Standard recommended value was 0.01mg/L. This indicates that Opobo and Port Harcourt waters were lead-free and no health implications on human concerning those issues connected to excess lead (Pb) in the body. On the other hand, the water from Bonny appears to be toxic, likely to cause cancer, have interference with Vitamin D

metabolism, as well as having the tendency to affect the mental development in infants. In other words, the water is hazardous to human health. The value of chromium (Cr) was non-detectable (ND) for Port Harcourt and Opobo; 0.17 mg/L for Bonny, and 0.05 mg/L for National Standard. Similarly, the water samples from Opobo and Port Harcourt indicated to be good and acceptable for human consumption. The waters from those two study sites were not hazardous when considering those health issues linked with chromium. In contrast, the water from Bonny was higher than the recommended National Standard value by Standard Organization of Nigeria. From the finding, it shows that water from the study site was hazardous for drinking thereby making it carcinogenic and likely to cause cancer. The table also shows that cadmium (cd) was non-detectable (ND) for Opobo and Port Harcourt, 0.0193mg/L for Bonny and 0.003mg/L for National Standard considering this having metal, the waters from Opobo and Port Harcourt have no health implication and is therefore good and acceptable as good for drinking. The mean value of cadmium (cd) was above the maximum permitted level recommended as National Standard value. The water is hazardous to human health. The level of the metal in the water from Bonny has the potential to damage the kidney; as cadmium is known to be toxic to the kidney. For Ammonia, there is no recommended maximum permitted level according to the National Standard for drinking water quality in Nigeria. However, this metal was not detected in the water sample from Bonny. The absence of Ammonia in the water samples from Opobo and Port Harcourt has no doubt made the water from these sites to be acceptable and preferable to the water from Bonny. The BOD's value was 1.67mg/L for Port Harcourt, 1.75mg/L for Opobo and 16.10 mg/L for Bonny. There is no recommended value according to the National Standard. BOD's is a parameter which indicates presence of suspended solids and organic matter content. The results revealed that the water from Bonny has a very high suspended solids and organic matter content more than Opobo; while Opobo has slightly more than the value of Port Harcourt. This shows that sewage discharges oil spills, industrial effluents, dissolved solids, etc have significantly more access into the rivers in Bonny than the rivers in Opobo and Port Harcourt. This indicates that rivers in Bonny were heavily polluted while rivers in Port Harcourt were less polluted. The mean value of dissolved oxygen for Port Harcourt was 3.5 mg/L; Opobo was 3.76 mg/L and Bonny was 2.73 mg/L. The mean value of dissolved oxygen was least in Bonny thereby making the water less acceptable, while the mean value of the dissolved oxygen was highest in Opobo thereby making it more acceptable.

Table 2: Comparisons of physical and chemical parameters of water samples from Bonny, Port Harcourt and Opobo with National standard for drinking water quality

| S/ No | Parameters | Units | Port Harcourt | Bonny | Opobo | National standard |
|-------|------------------|-------|---------------|------------|------------|-------------------|
| 1 | Appearance | - | Clear | Very dense | Clear | - |
| 2 | Temperature | °C | 33 °C | 39.7 °C | 34.0 °C | Ambient |
| 3 | Colour | TCU | Colourless | Dark brown | Colourless | 15 |
| 4 | Turbidity | NTU | 0.001 | 146 | ND | 5 |
| 5 | Conductivity | US/CM | 0.001us/cm | 0.04 | 0.001 | 1000 |
| 6 | PH | - | 7.03 | 8.87 | 7.11 | ≥6.5≥8.5 |
| 7 | Alkalinity | Mg/L | 0.004 | 0.001 | 0.005 | - |
| 8 | Pb | Mg/L | ND | 0.0175 | ND | 0.01 |
| 9 | Chromium | Mg/L | ND | 0.17 | ND | 0.05 |
| 10 | Cadmium | Mg/L | ND | 0.0193 | ND | 0.003 |
| 11 | Ammonia | Mg/L | ND | 1.16 | ND | - |
| 12 | BODs | Mg/L | 1.67 | 16.10 | 1.75 | - |
| 13 | Dissolved oxygen | Mg/L | 3.50 | 2.73 | 3.76 | - |

Source: Field survey, 2013

KEY:

ND = Non – Detectable

BOD's =Biochemical oxygen demands

Therefore, looking at the parameters holistically, the waters from Port Harcourt and Opobo were neither toxic nor carcinogenic because the level of heavy metals present in them was less than the National Recommended value. The waters were clear and colourless. Also, their pH, conductivity and turbidity levels were lower than the National Standard values. The quality of water from Port Harcourt and Opobo study sites were suitable, acceptable and good for normal good drinking water. The waters were not hazardous but safe for drinking by tourists. In view of the above parameters used for the study, Opobo and Port Harcourt study sites are suitable sites and have prospect for tourism development. However, Port Harcourt site has more prospects for tourism development more than Opobo study site because its Ph, alkalinity and BODs levels were lower than that of Opobo except that the amount of dissolved oxygen was a little high in Opobo and turbidity was not detected in Opobo. The study revealed that Bonny water was very dense in appearance, dark brown in colour, highly turbid, basic and with mean concentration of the heavy metals – Lead, chromium and cadmium higher than the recommended National Standard. Also, the water has high concentration of ammonia and BOD's as well as being low in dissolved oxygen. This implies that Bonny water was hazardous and not safe for human consumption. The water was highly polluted with heavy metals that are toxic. The indication is that one of the challenges of developing tourism in Bonny is the poor quality of the water as a result of pollution. The water did not meet the recommended National Standard for drinking water quality in Nigeria.

CONCLUSION AND RECOMMENDATION

The study revealed that Bonny water was polluted with toxic substances. It was discovered that the pH, BODs, cadmium, chromium and Ammonia were higher than the recommended values for WHO except in lead (Pb) thereby polluting the water from Bonny and making it unsafe consumption. The study showed that Bonny water was very dense in appearance, dark brown in colour, highly turbid basic and with mean concentration of heavy metals-lead, chromium, and cadmium higher than the recommended National Standard. The water had higher concentration of ammonia and BOD's as well as being low in dissolved oxygen. This implies that Bonny water was hazardous and so not safe for human consumption. Hence, water pollution has been found as one of the major challenges confronting development of tourism in Bonny. The study has disclosed that lead, chromium, cadmium, ammonia were not detected from Port Harcourt and Opobo water samples. These water samples were clear and colourless with BODs and PH less than the recommended WHO. The turbidity was non-detectable for Opobo and less than recommended value for WHO standard in Port Harcourt. Also, the pH, conductivity and turbidity levels of water samples from Port Harcourt and Opobo were lower than the National Standard values. The water samples from Port Harcourt and Opobo were neither toxic nor carcinogenic because the level of heavy substance present in them was less than the National recommended value. This has shown that Port Harcourt and Opobo have brighter prospects for tourism development due to the wholesomeness and safety of water from those areas. It was discovered that water samples from Port Harcourt and Opobo were free from harmful bacteria yielded no growth after 48 hours of incubation at 37°C while water samples from Bonny revealed growth of moderate pseudomonas spp. after 48 hours of incubation. This has indicated faecal contamination of Bonny water thereby making it unsafe for drinking. Treated portable water should be provided for the people especially people from Bonny area to save them from imminent danger of consuming water polluted with faecal contaminants and toxic substances. Central urban sewage system should be established and effluent treatment facility integrated to tackle the increasing industrial effluent as a means of checking excessive pollution of rivers in the state. However, where central urban sewage treatment and disposable system is not possible septic tanks and soil absorption systems need to be developed and placed appropriately. Septic tank should be installed above water table and should not be close to drinking water supplies and water bodies in coastal areas.

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