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APPLICATION OF HAZARD QUOTIENT (HQ) FOR MEASURING POTENTIAL HEALTH RISK OF SURFACE WATER USERS IN DOUGLAS CREEK

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ABSTRACT: *This study presents the application of hazard quotient (HQ) for measuring potential health risk of upstream and downstream surface water users in Douglas Creek in Qua Iboe Terminal in Ibeno L.G.A. Akwa Ibom State, Nigeria. For calculating the HQ, 12 parameters, namely, Temperature, Turbidity, Dissolved Oxygen (DO), TDS, TSS, Nitrate, Cu, Ni, Pb, Cr, Cl and EC were considered. The HQ for temperature was 1.2 and 1.3, turbidity was 39.2 and 44.8, DO was 2.7 and 2.5, EC was 11.7 and 12.5, TDS was 14 and 15, TSS was 26 and 30.1, nitrate was 1 and 0.9, Cl was 17.3 and 19.8, Pb was 6.8 and 7.3, Cr recorded same as 0.02, nickel was 6.9 and 9.8 and Cu recorded same as 0.1 at the upstream and downstream surface water in Douglas Creek. The HQ of temperature, turbidity, DO, EC, TDS, TSS, Cl, Pb, and nickel in water samples were all greater than unity and thus posed a potential health risk for human oral consumption. The present study revealed that upstream and downstream surface water in Douglas Creek poses a health risk to surface water resource users due to surface water contamination with gas flaring. Regular monitoring of upstream and downstream in Douglas Creek is recommended as well as research by biomedical experts to reveal the rigorous adverse impacts that physio-chemical contamination of surface water might induce in humans, particularly among individuals in vulnerable populations. Also, the local authorities should be made aware of such health risks and provide potable water facilities either by treating the water or by finding alternative sources for drinking.*

KEYWORDS: Downstream, upstream, health risk, surface water, hazard quotient.

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INTRODUCTION

Surface water from streams, rivers, lakes, canals and reservoirs is exposed to pollution due to anthropogenic activities. Surface water quality is governed by compound anthropogenic activities and natural processes (Javie *et al*., 1998; Ravichandran, 2003), namely weathering erosion, hydrological features, climate change, precipitation, industrial activities, agricultural land use, sewage discharge, and human exploitation of water resources (Malvi *et al.*, 2005). Indiscriminate waste disposal, which is a common practice in Nigerian cities, has major negative consequences on water and human health (Usoh *et al.,* 2023) and lack of appropriate water conservation measures has led to contamination of surface water bodies (Ahuchaogu *et al.,* 2022). Nta *et al.* (2017) noted that various forms of waste generated have destroyed most surface water bodies and aquatic lives causing human death. Surface water pollution affects crop yield negatively and high crop production depends mainly on quality water, soil and conducive climate (Usoh *et al.*, 2017). Widespread deterioration in water quality of inland aquatic systems has been reported due to the rapid development of industries, agriculture, and urban sprawl (Vie *et al*., 2009). The need for water in the lives of organisms can never be demoralized by its supportive role; it is one of the most important compounds that strongly influences life. The quality of surface water however is a function of natural and anthropogenic activities in the area. Regular monitoring of surface water is necessary to assess its potential impact on the health of surface water users.

Human health risk assessment has been defined by the United States Environmental Protection Agency as the process of estimating the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future. Health risk assessment involves identifying the potential of a risk source to introduce risk agents into the environment, estimating the amount of risk agents that come into contact with the human-environment boundaries and quantifying the health consequence of exposure (Ma *et al*., 2007). To fulfill the health risk assessment, generally, four steps must be followed: hazard identification, dose-response assessment, exposure assessment and risk characterization (Momot 8 Synzynys, 2005). Health risk assessment has drawn a lot of attention from many scientists across the world, and many assessments relating to drinking purpose and human health have been reported. Human health risk assessment is an effective approach to determine health risk levels posed by various contaminants (Wu *et al.*, 2010). This method has been applied to assess the potential adverse health effects of exposure to contaminated water (Wu *et al*., 2010; Hartley *et al*., 1999; Kavcar *et al*., 2009; Sun *et al*., 2007; Chanpiwat *et al*., 2014; Xu *et al*., 2014; Celebi *et al*., 2014; Nta *et al*., 2020). Ingestion is considered to be the primary route of exposure to chemical contaminants in drinking water. In the present study, considering the gravity of the situation, hazard quotient was used to assess the potential health risk of surface water users in Douglas Greek, Qua Iboe Terminal, Ibeno Local Government Area, Akwa Ibom State, Nigeria, for the purpose of communicating information on water quality trends to the general public or concerned authorities like policymakers.

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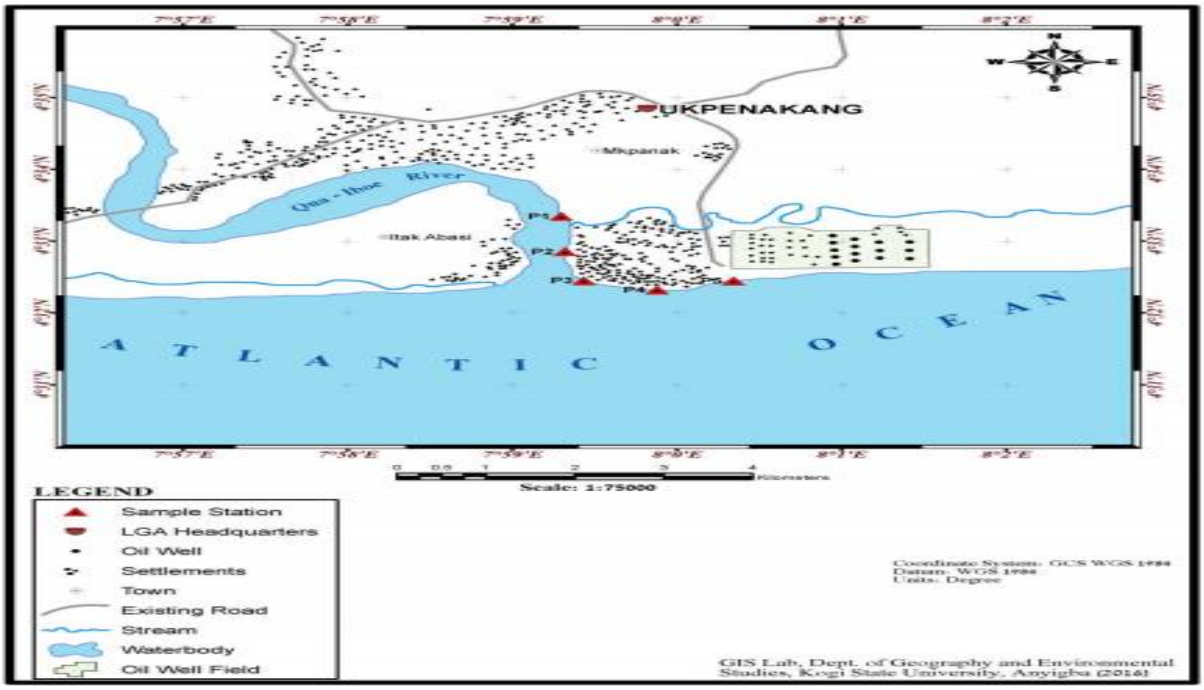
MATERIALS AND METHODS

Study Site

The area under study was Douglas Creek, Qua Iboe Terminal, Ibeno Local Government Area of Akwa Ibom State, Nigeria. It lies on the eastern side of Qua Iboe River between latitudes 4.300 and 4.450N and longitude 7.300 and 8.000E (Figure 1). Ibono is one of the largest



fishing settlements on the Nigerian coast (Andem *et al.*, 2013).

Figure 1: Map of Qua Iboe River Showing the Sample Stations

Surface Characteristics

Surface Water Sample Collection

The materials and equipment that were used in collecting the water samples upstream and downstream were chosen based on the physico-chemical parameters to be examined. To ensure that the samples were representative of upstream and downstream water information, sample collection equipment was strictly in line with USEPA (1992a) and UNEP/WHO (1996). One litre capacity containers were used to collect the water samples for laboratory analyses.

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Parameters Analyzed

The parameters chosen for this study were: temperature (°C), electrical conductivity EC, turbidity, TDS, TSS, dissolved oxygen (DO), chloride (Cl), nitrate, lead (Pb), copper, chromium and nickel.

Analytical Techniques and Laboratory Analysis

The chosen methods of analyses for the examination of all parameters in upstream and downstream water samples were in line with American Public Health Association (APHA, 2005) standard recommendation. The samples were examined for the chosen physical, chemical and heavy metal parameters.

Risk Assessment On Human Health

Exposure of human beings to physicochemicals could occur via three main pathways: direct ingestion, inhalation through mouth and nose, and dermal absorption through exposure to the skin. However, the ingestion pathway is the most significant for drinking water (Miguel *et al.*, 2007; USEPA, 2004).

Risk characterization for this study was quantified by potential non carcinogenic risks, reflected by the hazard quotient (HQ). The (HQ) is calculated using the following equation (Kavcar *et al*., 2009; USEPA 1992):

Hazard Quotient (HQ) = [Exposure Concentration/Reference Concentration (RFC)] (1)

where:

Exposure Concentration: Per unit amount of a chemical or other hazardous substances representing a health risk in an environment in mg/l or ppm.

Reference Concentration (RFC): An estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Its unit is also in mg/l or ppm. RFC values employed in this study were obtained from NSDWQ (2007) and WHO (2011).

Health risk assessment of the toxicants was interpreted based on the values of HQ. A hazard quotient less than or equal to 1 indicates that adverse effects are not likely to occur, and thus can be considered to have a negligible hazard. If the hazard quotient is greater than 1, the adverse health effects are possible.

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RESULTS AND DISCUSSIONS

Table 1 presents the summary of health risk assessment for exposure to upstream and downstream surface water in Douglas Greek.

The hazard quotient of temperatures in upstream and downstream surfaces in Douglas Creek were 1.2 and 1.3; these are greater than unity. The same applies to turbidity for upstream and downstream surfaces with hazard quotients of 39.2 and 44.8 respectively. Thus, the hazard quotients were greater than unity, which poses a health risk to surface water users. Turbidity has no direct health impact but can harbor microorganisms protecting them from disinfection and can entrap heavy metals and biocides. This can bring problems in the water treatment process and can also be a potential risk of pathogens in treated water (NSDWQ, 2007).

Dissolved oxygen had a hazard quotient of 2.7 and 2.5 for upstream and downstream surface water samples in Douglas Creek. This poses a great risk or hazard since it is greater than unity. Dissolved oxygen concentrations indicate whether aerobic or anaerobic conditions exist in the surface and therefore provide useful information to assess the potential for biodegradation or biotransformation of chemicals of potential concern.

Hazard quotient values for EC were 11.7 and 12.2, TDS values were 14 and 15, TSS values were 26 and 30.1, and Cl values were 17.3 and 19.8. These calculated hazard quotients were greater than unity, which makes them pose health risk to upstream and downstream surface water users in Douglas Creek.

Pb had hazard quotient values of 6.8 and 7.3 for upstream and downstream surface water in Douglas Creek. Thus, from the results of this study, Pb poses a high risk of contamination for human health exposure to surface water users. Pb may cause cancer, interfere with vitamin D metabolism, affect mental development in infants, and be toxic to the central and peripheral nervous systems on the health status of local surface and groundwater resource users in the host communities, as reported by NSDWQ (2007). It may also cause anemia, brain damage, anorexia, mental deficiency, vomiting and even death in human beings (Maddock & Taylor, 1977; Bulut & Baysal, 2006), and is toxic even at lower concentrations.

The hazard quotient values for Cr in the upstream and downstream surface water in Douglas Creek were the same (0.02) and Cu also recorded the same as 0.1 at the two sampling points. These pose no risk of contamination for surface water resource users.

Nickel recorded 6.9 and 9.8 in the upstream and downstream surface water in Douglas Creek. Nitrate recorded 1 and 0.9 at the upstream and downstream sampling points in Douglas Creek.

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Table 1: Health Risk Assessment for Exposure to Upstream and Downstream Surface Water in Douglas Creek

S/N	Parameters	Upstream Surface Water	Downstream Surface Water
1.	Temperature	1.2	1.3
2.	Turbidity	39.2	44.8
3.	Dissolved oxygen	2.7	2.5
4.	EC	11.7	12.5
5.	TDS	14	15
6.	TSS	26	30.1
7.	Nitrate	1	0.9
8.	Cl	17.3	19.8
9.	Pb	6.8	7.3
10.	Cr	0.02	0.02
11.	Ni	6.9	9.8
12.	Cu	0.1	0.1

CONCLUSION

Downstream and upstream surface water samples at Douglas Creek were studied. The results revealed that the hazard quotient values for temperature, turbidity, DO, EC, TDS, TSS, Cl, Pb, and nickel were above unity. This means that human health risk exposure is high due to the consumption of water from both the downstream and upstream at the Creek. This confirms that downstream and upstream surface water at Douglas Creek are contaminated by gas flaring activities in the area. The results of this study can be used beneficially and applied to monitoring and educating the local surface water users who normally drink the surface water directly. In order to reduce or minimize more risk, the local authorities should be made aware of such possible health risks and provide potable water facilities either by treating the water or finding alternative sources for drinking. Continuous monitoring and further studies of the area are also recommended to ascertain long-term effects.

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