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## **Extended Abstracts**

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title: **The development of a groundwater quality index for the Niger Delta Region, Nigeria**

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## INTRODUCTION

The Niger Delta region is the most important place in Nigeria from economic view point due to the enormous oil and gas reserves. The area suffers from water scarcity and pollution problem. Groundwater in the area is used for drinking, domestic, agricultural and industrial purposes. Hence there is the need to develop an index for assessing the quality of groundwater in the area. The index is intended to simplify the reporting of complex and technical water quality data (CCME 2001) rather than assessment conducted on a variable-by-variable or benchmark-by-benchmark basis which is very tasking (Rosemond et al., 2009).

## STUDY AREA

The study area is situated between latitude 4°00' and 6°00' North and longitude 5°30' and 8°30' East. The climate of the area is tropical with wet and dry seasons. The maximum temperature range from 34 to 43°C and the relative humidity ranges between 60 to 96%. The delta receives between 2073 and 4366mm of rainfall annually (Akpokodje, 1987). Three lithostratigraphic units underlie the study area. These include the Benin (coarse grained gravelly loose sands with intercalations of clays and shales), Agbada (sands, sandstones and shales) and Akata (shales with minor intercalations of sandstones and siltstones) Formations (Short and Stauble, 1967).

## DATA ANALYSIS

The groundwater quality index (GWQI) utilizes six parameters including static water level (SWL), total dissolved solids (TDS), pH, chloride (Cl), sulphate (SO<sub>4</sub>) and nitrate (NO<sub>3</sub>). These parameters highlighted mainly the natural and anthropogenic sources of pollution.

The median (med) values from 43 sites were computed for each variable and were as follows: SWL=1.25m, TDS=77.44mg/l, pH=6.45, Cl=81.50mg/l, SO<sub>4</sub>=8.00mg/l and NO<sub>3</sub>=0.50. The raw data (fd) for 43 sites were then compared with the median values and scored as one (fd > med) or zero (fd < med). However, for static water level, the reverse was the case as one was assigned if the SWL at a particular site was less than the median value and vice versa. Since the deeper the SWL, the less vulnerable the groundwater is to pollution. These scores were summed for all six variables and divided by the number of variables as follows:

$$\Sigma = \frac{SWL_{score} + TDS_{score} + pH_{score} + Cl_{score} + SO_{4score} + NO_{3score}}{6}$$

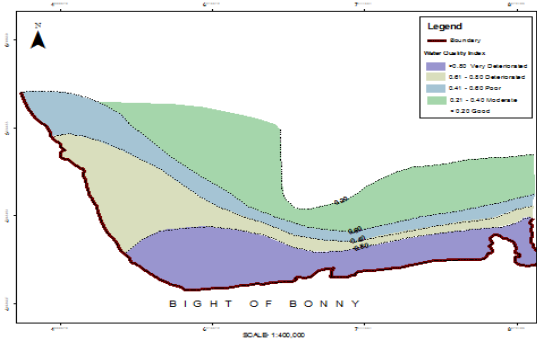
This resulted in an index value ranging from zero to one for each sampling site. An index value of zero indicated that a site has good quality water, while a score of one indicated a site that had poor water quality.

## RESULTS

Table 1 presents the quality class interval used in assessing the quality of groundwater in the area while table 2 and figure 1 includes details of water quality for the Niger Delta area.

**Table 1.** Classes used to assessed the quality of groundwater for the study area

Class	Index value	Remarks
I	0.80-1.00	Very deteriorated
II	0.61-0.80	Deteriorated
III	0.41-0.60	Poor
IV	0.21-0.40	Moderate
V	0.00-0.20	Good



**Figure 1.** Groundwater quality index map for the Niger Delta.

The correlation between different ion is presented in table 3.

Groundwater quality index values show that in the study area, five sites representing about 12% of all the sites were very deteriorated, eight sites (19%) were deteriorated, fifteen sites (34%) were of poor quality, ten (23%) were of moderate quality and the remaining five sites had good water quality. Correlation analysis shows that the chloride, sulphate and water level are the major variables controlling the index and in turn the deterioration of groundwater (Table 3).

**Table 2.** Summary of GWQI values and quality of groundwater in the area.

N <sup>o</sup>	Location	North	East	Index values	Remarks
1	OL	4° 27.055	7° 11.085	0.67	Deteriorated
2	OW	4° 28.035	7° 11.933	0.88	Very deteriorated
3	UP-1	5° 40.000	5° 34.005	0.39	Moderate
4	AG-1	5° 20.010	7° 05.090	0.50	Poor
5	BR-1	4° 18.000	6° 15.000	0.78	Deteriorated
6	OG-1	4° 58.006	5° 51.000	0.50	Poor
7	TD-1	4° 32.000	5° 52.001	0.83	Very deteriorated
8	OO-1	5° 26.009	6° 37.000	0.56	Poor
9	AK-1	5° 36.070	6° 40.003	0.25	Moderate
10	KW-1	5° 39.070	6° 30.003	0.44	Poor
11	EB-1	5° 28.011	6° 43.003	0.58	Poor
12	OB-1	4° 35.000	6° 14.004	0.39	Moderate
13	CK	4° 50.000	5° 40.000	0.67	Deteriorated
14	OS-1	5° 06.001	6° 30.004	0.67	Deteriorated
15	OS-2	5° 05.008	6° 30.377	0.42	Poor
16	RU	4° 06.440	6° 46.991	0.17	Good
17	MG	4° 57.526	6° 48.816	0.33	Moderate
18	IG	4° 57.373	7° 00.804	0.33	Moderate
19	EN	4° 53.568	7° 01.921	0.50	Poor
20	KK	4° 51.348	7° 09.637	0.33	Moderate
21	AF-1	4° 51.117	7° 11.593	0.25	Moderate
22	BE-1	5° 22.007	5° 13.000	0.57	Poor
23	IK-1	4° 34.119	7° 32.794	0.94	Very deteriorated
24	SC-1	4° 34.60	8° 10.96	0.72	Deteriorated
25	IWC	4° 34.070	7° 58.313	0.39	Moderate
26	IWA	4° 33.095	7° 57.493	0.11	Good
27	OKU	4° 33.439	7° 56.492	1.00	Very deteriorated
28	OKE	4° 32.869	7° 59.089	0.33	Moderate
29	IY	4° 32.398	7° 59.100	0.67	Deteriorated
30	IWO	4° 32.087	7° 55.029	0.83	Very deteriorated
31	ATQ	4° 32.097	7° 50.021	0.67	Deteriorated
32	NT	4° 32.137	7° 51.288	0.50	Poor
33	AK	4° 31.657	7° 51.760	0.17	Good
34	ATE	4° 31.852	7° 47.466	0.50	Poor
35	IKO	4° 31.381	7° 45.251	0.50	Poor
36	OKP	4° 33.405	8° 16.958	0.17	Good
37	ITA	4° 32.545	8° 17.124	0.17	Good
38	LOC	4° 32.746	8° 17.024	0.67	Deteriorated
39	TOM-1	4° 34.806	8° 11.324	0.50	Poor
40	TOM-2	4° 34.842	8° 12.204	0.50	Poor
41	TOM-3	4° 36.442	8° 11.024	0.33	Moderate
42	OSU	5° 37.000	5° 47.003	0.50	Poor
43	IB-1	4° 53.562	7° 08.269	0.41	Poor

**Table 3.** Correlation matrix between GWQI value and some parameters.

	GWQI	SWL	TDS	pH	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>
GWQI	1.000						
SWL	-0.372	1.000					
TDS	0.085	-0.135	1.000				
pH	-0.001	0.407	0.175	1.000			
Cl <sup>-</sup>	0.351	-0.264	0.621	0.013	1.000		
SO <sub>4</sub> <sup>2-</sup>	0.308	-0.272	0.265	0.212	0.271	1.000	
NO <sub>3</sub> <sup>-</sup>	-0.022	0.439	-0.172	0.325	0.061	-0.215	1.000

## SUMMARY

Overall, the Niger Delta region show generally poor or deteoriated water quality in most cases (65%) in coastal regions and moderate or good water quality (35%) in inland areas. Variations in water quality between sites reflects variation in chloride and sulphate concentrations, however many sites throughout the area display effects of static water levels. This has implications for the communities, suggesting that many sites within the Niger Delta do not have access to suitable water for to meet their daily needs.

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