RELATIONSHIPS BETWEEN WATER PHYSICO-CHEMICAL PARAMETERS AND BENTHIC MACRO INVERTEBRATES OF THE MIDDLE REACHES OF ORASHI RIVER, NIGER DELTA

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ABSTRACT

Orashi River is one of the major rivers that drain the River Niger through the Niger Delta into the Atlantic Ocean. The relationship between the physio-chemical properties of the river water and benthic macro invertebrates were studied between October 2017 and September 2018. Monthly samples of the river surface water and macro invertebrates were collected at five sampling stations using standard methods. Means and standard deviation of the water parameters were determined and correlated with the macro benthos to determine their relationship.Oligochaeta was represented by 9 species; Crustacea had 3 species while 2 species were identified under Insecta. Temperature (^{0}C) ranged between 27 ^{0}C and 29.4^{0}C. Conductivity fluctuated between 18 – 48.4µS/cm and pH was from 6.10 – 7.96. Salinity and turbidity ranged between and 0 – 0.02 and 8.50 – 107.7 NTU respectively. Total dissolved Solids (TDS) was from10 – 25.18 mg/L, Biological oxygen demand (BOD) 6.01 – 7.88 mg/l, Chloride 1.05 – 6.42mg/l, total alkalinity 3 – 9 mg/l and total hardness 2.29 – 9.93 mg/l. Nitrate, sulphate, Chromium, Iron and Zinc were between 0.05 – 0.95 mg/l, 2.10 – 10.31 mg/l, 0.003 – 0.08 mg/l, 1.542-4.966mg/l and 0.003-0.338 respectively. Correlation between macro benthos was positive with sulphate and DO but negative with Zinc, turbidity and BOD.There is need for effective monitoring of the river system to be able to detect environmental changes that could be corrected for a sustainable ecosystem.

Key words: positive, macro benthos, species, stations, water

INTRODUCTION

Orashi River is known to share similar natural features and environment characteristics with many other flood plain river systems in the central Niger Delta. The nutrient load of the river system is rich and provides good habitat for a biodiversity of species (Seiyaboh, *et al*, 2016). The area is rich in aquatic plants distribution that provides special biotic structural components in a fluvial ecosystem. The aquatic vegetation of Orashi River, though not utilized directly as food items by fish and other benthic communities (except aquatic mammals), has various ecological values for fish and other aquatic dwellers. The values include provision of refuge, shade, good environment for spawning and support for aquatic vertebrates and invertebrates, and as dietary requirement for fish. The aquatic flora of Orashi River has a high diversity profile due mainly to the presence of many amphibious plants, most of which are located on the emergent bank of the river.

The aquatic floating and submerged plants of the study area are restricted to few species such as *Nymphaea lotus* (water lilies), *Salvinia hastate* (water fern), *Pistia stratiotes* (water lotus), *Echhornia crassipes* (water hyacinth), *Azolla nilotica*, *Ceratophylum demersum* and the rooted herbs, shrubs, grasses and sedges. The effect of dry season condition around the study area was so obvious that it resulted to formation of large component of decaying vegetation, which was restricted to the dried-up littoral margins.

Water is essential natural resource abundant on the surface of the earth that exists in three states: solid, liquid and gaseous (Strahler & Strahler 1984) and occur as both surface and underground water bodies. The most common natural fresh water bodies are the fresh waters of the swamps, ponds, lakes, streams, rivers etc. Natural fresh water bodies have the ability to support life and the ability to dissolve substances naturally than every other liquid and often contain nutrients that living organisms need for survival (Clegg, 1974).

Plants and animals need good water quality for development, growth and productivity. The study of the physical and chemical characteristics of water is important since it may directly affect the quality and sustainability for use and productivity of aquatic organisms (Moses**,** 1982**).** Physical and Chemical characteristics of water determines the species composition, distribution and abundance of organisms of any water body (Atobatele & Ugwumba, 2008).This study is hence aimed at assessing the relationships between water physico-chemical parameters and benthic macro invertebrates.

MATERIALS AND METHODS

The study was conducted along the middle reaches of Orashi River, at the eastern section of the lower Niger Delta between October 2017 and September 2018. The study area lies between longitude 6^0 26' 32.5" to 6^0 30' 05.0" E and latitude 5^0 26'32.5" to 5^0 08' 24.6" N (figure1). The sampling points were OdiekeUgbobi station 1, Odiobor station 2, Mbiama station 3, Akinima station 4 and Oshiobele, station 5.

Fig. 1: Map of Niger Delta showing the middle riches of Orashi River

The field sample collection lasted for twelve months to cover both dry and wet seasons. Samples were collected once each month, between the hours of 8.00 am and 12 noon at points where human activities does not interfere with sample quality.
DO, turbidity, pH, conductivity and temperature were measured in-situ in the field using Extech water checker Model DO: 700 and Model Turb: 400.
Biochemical oxygen demand (BOD) was analyzed using the BOD test adapted from APHA (1998). Nitrate measurement was by Brucine Method while Total hardness was determined by EDTA titrimetric method of (APHA, 1998).Chloride and sulphate were determined by the Argentometric titration and turbidimetric methods respectively (APHA-AWWAWEF,1998).Phosphate determination was by the stannous chloride method (APHA-WE,1998). Total Hydrocarbon Content (THC) was determined with standardized spectrophotometer.
Total Alkalinity**:** The ions such as bicarbonate, carbonate, and hydroxide present in water were analyzed through hydrolysis of solutes. Cadmium, Chromium, Lead, Iron and Zinc were determined using an Atomic Absorption Spectrophotometer (AAS) as described in APHA, (1998).
Statistical analysis was conducted to determine the mean and standard deviation. Multiple linear correlation analysis was carried out on the water parameters and benthos, in order to verify if there is any significant relationship.

RESULTS AND DISCUSSION

Correlation of benthos with surface water physicochemical parameters of the middle reaches of Orashi River between October 2017 and September 2018 is presented in Tables 3 and 4. Analysis indicates a negative relationship between Crustaceans represented by *Macrobrachium vollenhovenii*, *Macrobrachium macrobrachion* and *Macrobrachium felicinum* and Temperature. This finding confirms those of Marioghae(1982), who reported that *Macrobrachium vollenhovenii*, *Macrobrachium macrobrachion* and *Macrobrachium felicinum* were found in water temperature of between 27^0C- 29.4^0C.
Positive correlation of Oligochaeta with temperature in the dry and wet seasons shows that Oligocheta (Table 1) can strive well in temperature range of between 27^0C- 29.4^0C except*, Eiseniellate tetraedra, Ophidonais serpentina, Dero obtusa and Paranais sp.* Insecta(Table 1) on the contrary cannot tolerate the temperature range except *Chironomus ablabiesmyia* in the wet season. The positive correlation during the wet season could be due to a reduction in human activities in the study area as the degree or condition of heat or coldness of a substance affects object or body of living organisms at a given time or place (Lucinda & Martin, 1999).

Table 1: Macro benthos of the middle reaches of Orashi River (October 2017 – September 2018)

Species	Family	Sub-class/Class
Lumbricilus sp *Eiseniellate tetraedra*	Lumbricidae	Oligochaeta
Chaetogaster diatropus *Dero obtusa* *Ophidonais serpentina* *Nais sp.* *Paranais sp* *Stylaria lacustris* *Uncinais uncinata*	Naididae ” ” ” ” ” ”	
Chironomus ablabiesmyia *Nepa cinerea*	Chironomidae Nepidae	Insecta
Macrobrachium felicinum *Macrobrachium macrobrachion* *Macrobrachium volenhoveni*	Penaeidae ”	Crustacea

Difference in the reports could be due to the anthropogenic activities in the study area that has led to migration of the crustaceans (Powell, 1982).There was positive correlation of Crustaceans with pH and Total Alkalinity which could be attributed to the pH range (6.10-7.96) that falls within the range from 6.0-8.5 suitable for aquatic life (Tucker & D'Abramo, 2008) and Total Alkalinity 3-9 that falls (Table 2) within the acceptable value (Seiyaboh *et al.,* 2016).

Table 2: Seasonal range, mean, and standard deviation in surface water parameters of the middle reaches of Orashi River (October 2017 – September 2018)

Parameter	Dry Range, Mean ±SD	Wet Range, Mean ±SD
Temp (^{O}C)	27-29.4 28.12±0.64^{a}	27-29.3 27.58±0.43^{b}
pH	6.1-7.92 7.04±0.58^{a}	6.2-7.96 7.26±0.38^{b}
Sal (psu)	0.01-0.02 0.01±0.00^{a}	0.01-0.02 0.01±0.00^{b}
Cond.(µS/cm)	22.8-36.8 31.76±3.03^{a}	18-48.8 24.66±7.15^{b}
TDS (mg/l)	12.3-19.5 15.94±1.98^{a}	10-25.18 13.13±3.3^{b}
Turb (Ntu)	8.5-39.1 25.61±5.89^{a}	10.6-107.7 35.62±19.41^{b}
DO(mg/l)	6-7.86 7.06±0.6^{a}	6.02-7.88 6.81±0.49^{b}

Parameter	Dry Range, Mean ±SD	Wet Range, Mean ±SD
BOD (mg/l)	2.06-21.18 2.87±2.72 [a]	2.04-3.98 2.91±0.66 [a]
THC (mg/l)	0-3.82 0.35±0.9 [a]	0-4.3 0.71±1.22 [a]
T.alk (mg/l)	3-9 4.2±1.85 [a]	3-9 4.4±1.82 [a]
Cl (mg/l)	1.76-6.42 3.24±0.9 [a]	1.05-2.92 1.72±0.46 [b]
T.Hards (mg/l)	2.29-5.9 3.96±0.91 [a]	3.53-9.93 5.45±1.59 [b]
NO_3(mg/l)	0.1-0.95 0.5±0.22 [a]	0.05-0.65 0.33±0.12 [b]
SO_4(mg/l)	2.1-7.51 4.21±1.45 [a]	2.55-10.31 4.93±1.85 [b]
Cd(mg/l)	0-0 NA	0-0 NA
Cr(mg/l)	0.003-0.053 0.02±0.02 [a]	0.051-0.08 0.07±0.01 [b]
Fe(mg/l)	1.542-4.966 3.45±0.52 [a]	2.205-3.989 3.39±0.4 [a]
Zn (mg/l)	0.017-0.322 0.11±0.09 [a]	0.003-0.338 0.05±0.04 [b]

Means with different superscripts a, b, c, d in the same column are significantly different at p=0.05 (Tukey HSD)

Correlation of Oligocheta and Insecta with pH was positive except *Lumbricillus sp* and *Chaetogaster diatropus* could be due to dilution of the river water by the seasons that year not conducive for *Lumbricillus sp* and *Chaetogaster diatropus* during the dry season.Oligocheta and Insecta negative correlation with Total Alkalinity could be attributed to the volume of water discharged into the river during the wet season.

Negative correlation of Oligocheta, Insecta and Crustacean in the study with electrical conductivity could be caused by the low range of EC (18 – 48.8µS/cm) reported which is against 50-1,500 µS/cm recorded by Izonfuo & Bariweni (2001) for most freshwater in Nigeria. The positive correlation of *Nepa cinerea* (Insecta) with Electrical conductivity during the dry season could be attributed to seasonal variation of conductivity in surface water in Niger Delta (George, 2008).

Correlation of Crustaceans and insects with TDS was positive during the dry seasons but negative during the wet seasons. The negative estimate could be due to the rains, which diluted totality of all the dissolved substances from organic and inorganic materials present in the water below the level of concentration suitable for the crustaceans. Similarly, Oligocheta correlation with TDS was negative in both dry and wet seasons, suggesting that the organisms will find it difficult to survive in TDS range of 10.0-25.8mg/l (Table 2).

Crustaceans,Oligocheta and Insecta correlation was negative with turbidity, indicating that turbidity range of 8.50 – 107.7Ntu was not suitable for macro benthos in middle reaches of

Orashi River. This could be caused by a change in the amount of particle materials held in suspension within the water system (such as silt, clay, organic matter, plankton and other inorganic materials) as a result of erosion resulting, wind action, surface water run-offs, algal bloom and human activities, depending on water source, type and seasonality.

Table 3: Dry season correlations of benthos and surface water physicochemical parameters of the middle reached of Orashi River (Oct.2017-Sept.2018)

	Lum.sp	E.tetra	O.serp	C.diatr	Derop	Naissp	Parana	Stylari	Uncina	C.abla	Nepac	M.voll	M.mac	M.feli	TEMP	pH	Ec	TDS	TURB	DO	BOD	THC	T.ALK	Cl	T.HAR	NO3	SO4	Fe	Zn
Lum.sp	1																												
E.tetrahydra	-.945*	1																											
O.serpentina	-.967**	.989**	1																										
C.diatrophus	0.703	-0.83	-0.75	1																									
Deropbtusa	-.975**	.922*	.963**	-0.58	1																								
Naissp	-0.75	0.682	0.706	-0.38	0.815	1																							
Paranaissp	-.902*	.992**	.977**	-0.82	.894*	0.65	1																						
Stylarialacustris	-0.55	0.35	0.404	-0.04	0.605	.889*	0.281	1																					
Uncinaisuncinata	-0.22	-0.05	0.063	0.453	0.329	0.583	-0.1	0.853	1																				
C.ablabiesmyia	-.895*	.989**	.965**	-0.85	.881*	0.685	.995**	0.316	-0.1	1																			
Nepacinerea	-0.13	-0.06	0.006	0.114	0.038	-0.39	-0.13	-0.19	0.046	-0.2	1																		
M.vollenhovenii	-.912*	.918*	.920*	-0.67	.936*	.914*	.900*	0.658	0.267	.920*	-0.28	1																	
M.macrobrachion	-0.85	.962**	.954*	-0.77	0.857	0.57	.988**	0.178	-0.16	.972**	-0.12	0.844	1																
M.felicinum	-.936*	.977**	.983**	-0.72	.956*	0.792	.975**	0.475	0.111	.974**	-0.17	.966**	.950*	1															
TEMP	0.558	-0.69	-0.67	0.698	-0.49	0.045	-0.72	0.387	0.581	-0.67	-0.32	-0.36	-0.77	-0.57	1														
pH	-.901*	0.794	0.874	-0.38	.934*	0.62	0.763	0.487	0.373	0.718	0.337	0.75	0.754	0.82	-0.53	1													
Ec	0.192	-0.11	-0.11	-0.04	-0.27	-0.77	-0.07	-0.85	-0.67	-0.15	0.626	-0.48	0.021	-0.25	-0.63	-0.03	1												
TDS	-0.37	0.338	0.414	-0.1	0.372	-0.2	0.347	-0.3	-0.14	0.254	0.726	0.055	0.427	0.274	-0.74	0.637	0.723	1											
TURB	0.511	-0.43	-0.44	0.232	-0.57	-.937*	-0.39	-.915*	-0.63	-0.45	0.538	-0.75	-0.29	-0.56	-0.35	-0.33	.941*	0.518	1										
DO	-0.04	0.126	0.198	0.158	0.143	-0.28	0.205	-0.45	-0.2	0.115	0.295	-0.08	0.345	0.141	-0.55	0.368	0.635	0.808	0.54	1									
BOD	0.69	-0.59	-0.58	0.658	-0.53	-0.17	-0.5	-0.12	0.112	-0.49	-0.63	-0.38	-0.43	-0.44	0.603	-0.57	-0.28	-0.47	-0.02	0.107	1								
THC	-0.22	0.295	0.222	-0.64	0.026	-0.38	0.266	-0.52	-0.72	0.253	0.492	-0.05	0.255	0.083	-0.71	0.058	0.674	0.403	0.506	0.023	-0.75	1							
T.ALK	-.943*	0.85	.894*	-0.5	.975**	.910*	0.808	0.766	0.487	0.81	-0.04	.946*	0.746	.909*	-0.29	.879*	-0.46	0.199	-0.72	-0.03	-0.47	-0.11	1						
Cl	.885*	-0.8	-.884*	0.369	-.940*	-0.64	-0.79	-0.48	-0.37	-0.74	-0.25	-0.77	-0.79	-0.85	0.532	-.993**	0.058	-0.62	0.346	-0.42	0.48	0.01	-.881*	1					
T.HARDS	-0.82	0.69	0.748	-0.3	.886*	.959**	0.644	.899*	0.681	0.655	-0.13	.885*	0.574	0.794	-0.03	0.784	-0.65	0.03	-0.84	-0.14	-0.29	-0.35	.963**	-0.79	1				
NO3	.891*	-0.82	-0.83	0.596	-.895*	-.954*	-0.77	-0.81	-0.43	-0.81	0.213	-.962**	-0.68	-0.87	0.175	-0.71	0.61	0.062	0.842	0.291	0.442	0.091	-.956*	0.708	-.935*	1			
SO4	-.953*	0.874	.908*	-0.66	.900*	0.537	0.823	0.37	0.125	0.794	0.404	0.748	0.785	0.823	-0.68	.918*	0.074	0.592	-0.26	0.175	-0.83	0.405	0.829	-.881*	0.67	-0.73	1		
Fe	0.476	-0.43	-0.42	0.546	-0.31	0.183	-0.37	0.248	0.36	-0.33	-0.76	-0.11	-0.35	-0.25	0.739	-0.44	-0.63	-0.67	-0.4	-0.16	.922*	-.883*	-0.19	0.357	0.032	0.108	-0.69	1	
Zn	.953*	-.928*	-.972**	0.606	-.966**	-0.64	-.914*	-0.39	-0.16	-.880*	-0.18	-0.84	-.906*	-.930*	0.679	-.958*	0.011	-0.58	0.336	-0.34	0.595	-0.19	-.885*	.962**	-0.74	0.76	-.941*	0.47	1

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

The positive correlation of the macro benthos with DO could be due to the convenient range of DO (6.01-7.88) recorded during the study period which agrees with Andem *et al*(2012) that aquatic life cannot survive below DO of 4mg/l.

Negative macro benthos correlation with BOD throughout the study period could be attributed to the high range (2.06-3.97) recorded. BOD level of 1.0 to 2 mg/l is clean, 3.0 mg/l is fairly clean, and 5.0 mg/l is doubtful whereas, value of 10.0 mg/l and above, is highly polluted and bad (Chindah, *et al.,* 1991). Levels below 2.04 mg/l is considered reasonable safe for macro benthos.

Table 4: Wets season correlations of benthos and surface water physicochemical parameters of the middle reached of Orashi River (Oct.2017-Sept.2018)

	Lum.sp	E.tetra	O.serp	C.diat	Derop	Naissp	Parana	Stylari	Uncina	C.abla	Nepac	M.voll	M.mac	M.feli	TEMP	pH	SAL	Ec	TDS	TURB	DO	BOD	THC	T.ALK	Cl	T.HAR	NO3	SO4	Cr	Fe	Zn
Lum.sp	1																														
E.tetrahydra	.922**	1																													
O.serpentina	0.746	.829*	1																												
C.diatrophus	.876**	.922**	0.715	1																											
Deropbtusa	.962**	.954**	.850*	.892**	1																										
Naissp	.895**	.948**	.914**	.829*	.973**	1																									
Paranaissp	.960**	.945**	0.665	.948**	.931**	.851*	1																								
Stylarialacustris	.992**	.949**	0.741	.924**	.966**	.900**	.985**	1																							
Uncinaisuncinata	.912**	.967**	.859*	.859*	.975**	.991**	.893**	.925**	1																						
C.ablabiesmyia	.834*	.952**	.925**	.896**	.933**	.956**	.846*	.865*	.944**	1																					
Nepacinerea	0.183	-0.07	-0.42	0.169	0.014	-0.17	0.228	0.186	-0.08	-0.24	1																				
M.vollenhovenii	0.338	0.173	-0.26	0.42	0.205	0.029	0.449	0.374	0.13	0.01	.943**	1																			
M.macrobrachion	0.517	0.289	-0.13	0.452	0.363	0.186	0.56	0.523	0.277	0.093	.922**	.949**	1																		
M.felicinum	0.613	0.438	-0.06	0.526	0.457	0.278	0.687	0.626	0.374	0.208	0.749	.839*	.921**	1																	
TEMP	0.368	0.574	0.525	0.239	0.433	0.579	0.348	0.368	0.583	0.508	-0.59	-0.44	-0.3	-0.07	1																
pH	0.456	0.127	0.129	0.29	0.345	0.16	0.353	0.404	0.138	0.11	0.536	0.433	0.556	0.494	-0.55	1															
SAL	-0.25	0.037	0.169	-0.27	-0.11	0.088	-0.25	-0.24	0.062	0.086	-.844*	-.763*	-0.74	-0.56	.781*	-.829*	1														
Ec	-0.5	-0.61	-0.62	-0.62	-0.51	-0.57	-0.5	-0.52	-0.58	-0.61	0.028	-0.11	-0.1	9E-04	-0.35	0.168	-0	1													
TDS	-0.42	-0.56	-0.58	-0.56	-0.44	-0.52	-0.43	-0.45	-0.53	-0.56	0.076	-0.06	-0.03	0.072	-0.37	0.259	-0.07	.995**	1												
TURB	-0.57	-0.6	-0.49	-0.38	-0.6	-0.69	-0.49	-0.55	-0.72	-0.5	0.007	-0.08	-0.25	-0.22	-0.68	0.214	-0.27	0.546	0.542	1											
DO	0.449	0.222	0.057	0.389	0.276	0.074	0.452	0.432	0.082	0.127	0.458	0.447	0.506	0.602	-0.4	.807*	-0.71	0.098	0.182	0.399	1										
BOD	-.772*	-0.66	-0.56	-0.57	-0.67	-0.58	-0.71	-0.74	-0.56	-0.56	0.031	-0.04	-0.24	-0.47	-0.31	-0.53	0.168	0.142	0.065	0.118	-0.72	1									
THC	-0.25	-0.02	0.435	-0.18	-0.02	0.182	-0.33	-0.25	0.09	0.217	-.843*	-.828*	-.842*	-.876**	0.385	-0.51	0.683	-0.2	-0.25	-0.16	-0.7	0.312	1								
T.ALK	0.178	-0.17	-0.11	-0.16	0.024	-0.12	0.014	0.085	-0.16	-0.24	0.317	0.105	0.294	0.313	-0.38	.825*	-0.53	0.472	0.538	0.283	0.689	-0.52	-0.45	1							
Cl	.879**	.911**	.804*	0.703	.915**	.938**	.825*	.867*	.939**	.848*	-0.21	-0.03	0.183	0.37	0.722	0.12	0.212	-0.39	-0.34	-0.71	0.11	-0.7	0.071	0.009	1						
T.HARDS	-0.19	-0.35	-0.71	-0.19	-0.36	-0.54	-0.07	-0.17	-0.47	-0.51	0.594	0.543	0.487	0.583	-0.5	0.347	-0.48	0.614	0.642	0.557	0.586	-0.1	-.845*	0.444	-0.39	1					
NO3	0.273	0.347	0.681	0.243	0.43	0.576	0.138	0.252	0.514	0.505	-0.35	-0.33	-0.26	-0.43	0.334	-0.14	0.241	-0.6	-0.61	-0.62	-0.52	0.131	0.717	-0.32	0.382	-.951**	1				
SO4	0.062	-0.12	-0.54	-0.01	-0.12	-0.32	0.158	0.067	-0.24	-0.32	0.625	0.607	0.616	0.752	-0.36	0.44	-0.49	0.541	0.587	0.373	0.666	-0.3	-.909**	0.508	-0.13	.964**	-.894**	1			
Cr	0.376	0.149	-0.14	0.063	0.242	0.099	0.338	0.33	0.137	-0.04	0.357	0.317	0.514	0.709	0.032	0.53	-0.26	0.537	0.598	-0.03	0.554	-0.58	-0.65	0.699	0.351	0.618	-0.53	.775*	1		
Fe	0.108	-0.2	-0.42	-0.11	-0.08	-0.28	0.081	0.062	-0.25	-0.35	0.576	0.445	0.548	0.63	-0.45	0.707	-0.59	0.604	0.666	0.379	.755*	-0.43	-.804*	.842*	-0.1	.839*	-0.72	.891**	.848*	1	
Zn	-0.5	-0.38	0.137	-0.52	-0.37	-0.22	-0.62	-0.54	-0.33	-0.17	-.822*	-.938**	-.943**	-.938**	0.115	-0.31	0.551	0.155	0.104	0.291	-0.4	0.204	.822*	-0.04	-0.24	-0.5	0.334	-0.62	-0.46	-0.41	1

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

Macro benthos correlation with Total hydrocarbon was negative in wet season but positive in the dry season for crustaceans and insects. This might be as a result in reduction in "kpo-fire" (illegal crude oil refining) in the area. Hydrocarbons are compounds made up of hydrogen and carbon elements that could be separated into petroleum and natural gas (biologically degradable). The negative correlation could be due to toxicity of hydrocarbon as it is severe on most aquatic organisms even at very low exposure (Vandermeulem *et al*., 1985).

Correlation with Chloride was negative during the study period suggesting that Oligocheta, Insecta and Crustaceans cannot survive above 6.42mg/l CL concentration. The positive correlation recorded for Oligocheta wet season shows that the concentration was suitable for the macro benthos to survive at a maximum concentration of 2.92mg/l

Positive correlation recorded of macro benthos with Total Hardness indicates that the range of 2.29-9.6 was suitable for their survival. Negative correlation for Oligochetes in wet season might be due to seasonal variation of Total Hardness in the middle reaches of Orashi River.

Concentration of NO_3 from 0.05-0.95mg/l does not favour survival of the macro benthos, but favoured Oligochetes and insects only during the wet season. This might be as a result of the heavy water discharge into the river. Positive correlation suggests that Oligocheta, Insecta and Crustaceans can withstand levels of SO_4 from 2.1-10.31mg/l, except for Oligochetes in the wet season, which might be as a result of the heavy rains. The concentration of 0.003-0.338mg/l

Zn was negative correlation suggesting that the level of concentration does not support survival of Insects, Oligochetes and Crustaceans.

CONCLUSION

Correlation analysis between macro benthos and physio-chemical properties of the Orashi River studied indicates positive and negative correlation between classes and species with different water parameters from October 2017-September 2018.It is therefore pertinent for baseline studies and monitoring along the river system to detect environmental changes or alterations and be remedied to sustain the ecosystem goods and services.

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