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## Impacts of Human activities on the MacroBenthic Assemblage of a Stream in the Niger Delta, Nigeria

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### Abstract

The aim of this study was to assess the impact of human activities on the benthic macro-invertebrates assemblage of the Isiokpo stream in the Niger Delta, Nigeria. Samples were collected in duplicates from three different sites along the stream (upstream, midstream and downstream). Sample collection was done on a monthly basis for six months (December 2016 - May 2017) covering dry and wet season periods. Thirty six samples were collected, sorted and identified to the lowest taxonomic level possible yielding a total of 120 organisms. Abundance in percentage was in the order Insecta > Crustacea > Oligochaeta with poor distribution across study sites. Species richness and diversity were most and least at sites 1 and 2 respectively while species evenness and dominance were almost stable across study sites. Site 3 had the highest number of organisms followed by site 1 and the least was at site 2 with significant difference ( $p < 0.05$ ) observed between sites. Visible human influence around site 2 was largely responsible for the low abundance observed there. Temporal trend showed variation in the abundance of insects and crustaceans while those of oligochaets had relative stability suggesting differential response of the said organisms to the influence of both anthropogenic activities, seasonal and environmental variables. Cluster analysis of Bray-Curtis similarity after fourth root transformation had the most similarity (above 70%) between site 1A and 3B and least similarity between site 2A and 2B which highlights the poor similarity between site 2 and others sites. Findings from this study concluded that human activities impacted negatively on the benthic macroinvertebrate assemblage of the Isiokpo stream which could further affect the biodiversity of the area. This study provides baseline information for the study area and other inland streams in the Niger Delta in terms of inland water/stream monitoring and management.

**Keywords:** Macroinvertebrates, Anthropogenic Impacts, Inland Streams, Niger Delta, Nigeria

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### Introduction

One of the greatest environmental challenges of this century is to sustain natural biological structure and functional attributes of aquatic ecosystems, rivers in particular [1]. This goal requires that we know the condition of these dynamic systems and how they are being affected by specific factors and forces [2]. Effective management of riverine ecosystems requires the assessment and evaluation of river condition, using surveys and other direct measures, to determine the anthropogenic impacts on ecosystem structure and function [3]. Habitat alteration is a major factor contributing to biodiversity loss at the global scale [4-6]. The effects of human disturbances have been particularly serious in freshwater ecosystems [7-9]. Freshwaters make up a vital aspect of the inland water ecosystem. Monitoring of freshwater systems initially focused on chemical indicators, bacteria, algae, fungi and protozoa. A new type of monitoring involves different groups of organisms (macroinvertebrates, macrophytes) and stream conditions associated with them [10]. Sediment dwelling invertebrates provide numerous critical ecosystem services in freshwater [11,12] yet economic valuation of associated ecosystem function is rarely measured other than in shell fisheries production [13,14]. Benthic biologists are beginning to determine how the loss of freshwater species affect freshwater water ecosystem functioning [15] however, these experiments have primarily focused on small scale, short term studies of relatively few species [16]. Vulnerability of ecosystem is increasing because of the elimination of many freshwater habitats and accelerated extinction of key species [17,18]. Hynes [19] observed that the aquatic animals, which live on, in or near the substratum of running waters, include the nematodes, annelids, insects, crustaceans and mollusk and these organisms basically form part of the aquatic food chain. The non motile and limited motility nature of these organisms makes them useful meters to measure the environment. Biological assemblages are the central focus of many assessment and monitoring programs, as they provide a direct measure of biological condition relative to biological integrity—a stated objective

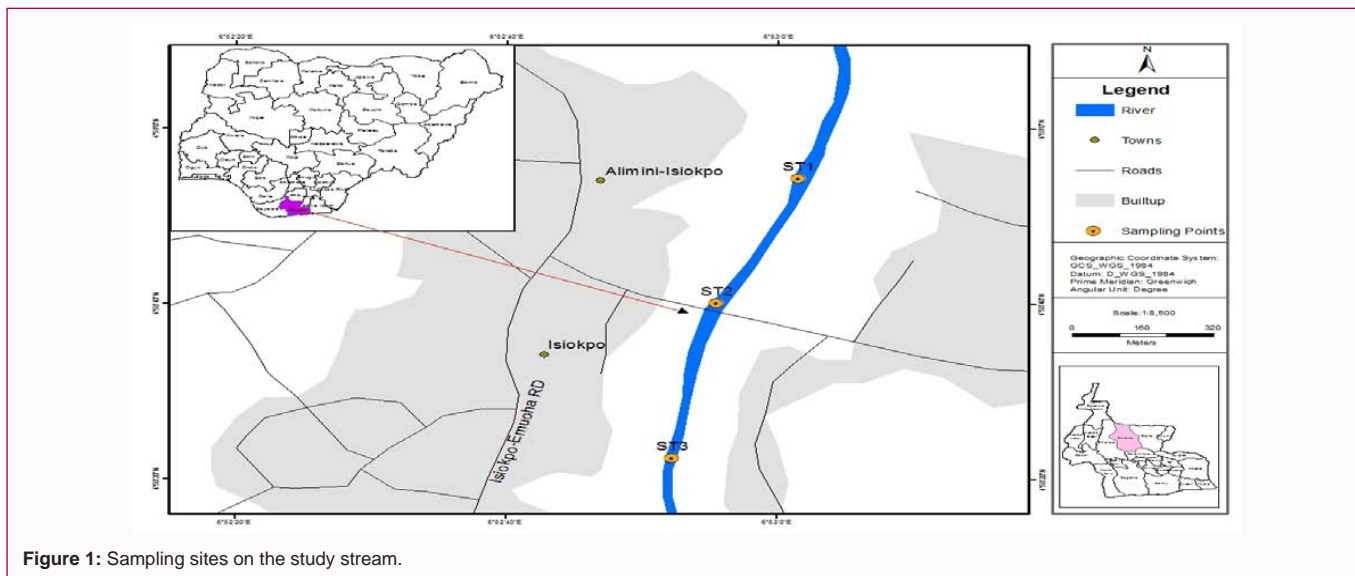


Figure 1: Sampling sites on the study stream.

of, for example, the Clean Water Act of 1972 (33 U.S.C. § 1251 et seq) and the Water Framework Directive of the European Union (2000/60/EG, Abl. L 327 of 22.12.2000), in addition, contribute to narrative water quality standards [20]. Thus, are helpful in examining site-specific impacts [17]. Changes in the environment will be reflected in variations in the species assemblage, both spatially and temporally [22]. This had also been ascertained by [23] that biota integrate the effects of multiple stressors in space and time partly due to the fact that they have different life cycles (short-lived and long-lived ones) and are also easy to identify to the lowest possible taxonomic level. Rosenberg and Resh [23] further stated that macroinvertebrate taxa vary in their tolerance to different stressors, providing information for interpreting cumulative stressor impacts through community assemblage structure. Monitoring of streams and rivers systems physically, chemically or biologically establish patterns that indicate deterioration in such aquatic systems. Studies have been done in the Niger Delta to assess the distribution, composition and abundance of macroinvertebrates in streams [24-26]. Benthic studies of the Isiokpo stream was not found in literature rather an assessment of the impact of crude oil spill on fish was reported in the area [27]. This study aimed to assess the impact of human activities on the macrobenthic assemblage of the Isiokpo stream in the Niger Delta of Nigeria. Findings of this study would be a basis for further studies in the area and also be useful in the management of inland streams and rivers in the Niger Delta region.

**Materials and Methods**

**Study site**

The study site is the Isiokpo stream (Oriobojo) in Ikwere Local Government Area of Rivers State. The area is located within the Niger Delta region of Nigeria (Figure 1). The stream has a unidirectional flow and surrounded by riparian vegetation. The stream serves for various domestic activities such as fishing, drinking, bathing, laundry, washing of vehicles, motorbikes and mini abattoir activities. For the purpose of this study three sites were established along the stream. ST1 upstream with minimal bathing, laundry and waste dumping, ST2 with a bridge crossing and major activities such as bathing, vehicle of washing, laundry, market and abattoir activities and ST3 with no visible human influence but more of vegetations.

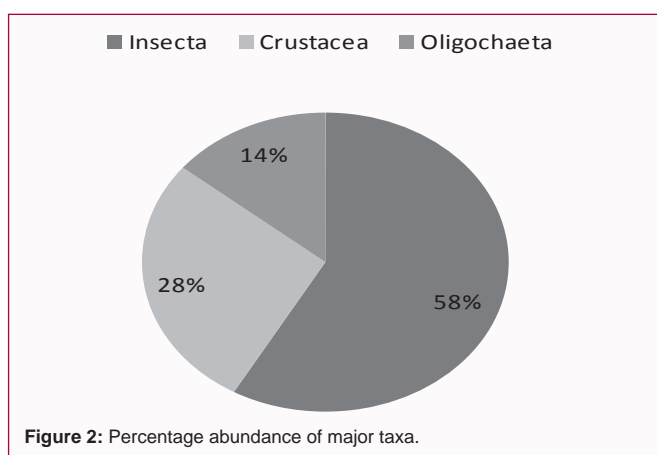


Figure 2: Percentage abundance of major taxa.

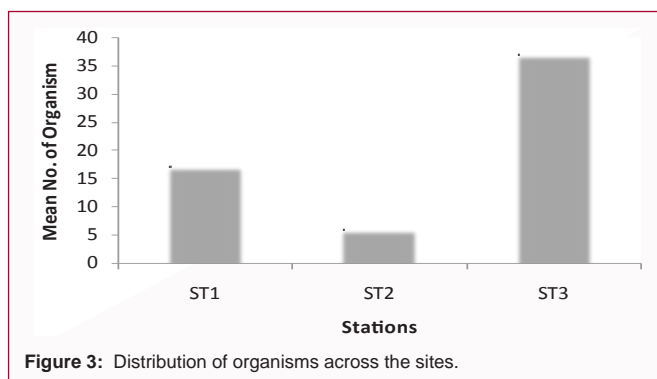


Figure 3: Distribution of organisms across the sites.

**Sample collection and analysis**

Samples were collected for a period of six months (December 2016 to May 2017). Sediment samples were collected in duplicate per site with an Ekman grab (15 by 15 cm) and emptied into a plastic bucket. The sediment samples were washed through a 0.5 mm sieve to obtain the benthic macro-fauna. The material retained by the sieve was placed in a container and preserved with 5% formalin water mixture and stained in Rose Bengal to facilitate sorting in the laboratory. Aliquots of the sample were taken onto a white tray with water for sorting using a pair of forceps and a magnifying hand lens. The organisms were collected and preserved in small bottles containing

70% ethanol. The contents were later identified to the lowest possible taxonomic level using appropriate keys. Only the heads of organisms were counted, since the individuals were sometimes fragmented.

### Data analysis

Ms Excel was used for plotting charts and analysis of variance between sites, while PRIMER 6 was used for both univariate (species richness, species evenness, Shannon Weiner diversity and species dominance indices) and multivariate (cluster) analysis of data. Cluster analysis was done using Bray-Curtis similarity after fourth root transformation of data.

## Results

The macrobenthic faunal composition and abundance of the study area was quite poor. Table 4.1 shows absence (-) and presence (+) of the organisms found in the study area. Total of 120 organisms were enumerated with three major groups identified. The insecta had the highest percentage abundance (58%) followed by the Oligochaeta (28%) and the Crustacea (14%) as seen in Figure 2. Number of organisms distributed across study sites indicated station 3 had more benthic fauna compared to sites 1 and 2 (Figure 3).

Temporal trends (Figure 4) showed a reduction in the abundance of organisms towards the month of May as the rainy season sets in particularly, with regards to the abundance of the insects and the crustaceans. The Oligochaets however, showed relative stability across study period. Analysis of variance showed significant difference ( $p < 0.05$ ) between sites examined in terms of the abundance of organism observed. Univariate diversity indices (Figure 5) shows that species were richer and more diverse at site 1 followed by site 3.

Macrobenthic cluster analysis of Bray-Curtis similarity after fourth root transformation showed stations 1A and 3B were most similar (above 70% similarity), followed by stations 3A and 1B (Figure 6). Station 2 A & B showed highest dissimilarity (<20%) compared to other stations examined.

## Discussion

The abundance and composition of macrobenthic fauna of the Isiokpo stream was poor. Results showed the characteristic dominance of the insects followed by the oligochaetes and the crustaceans. In a study of an inland river/stream in the Niger Delta [22] recorded the dominance of insects but had higher number of total organisms (803) compared to the current study. In another study of an inland brackish creek, [28] found the dominance of polychaetes with 96% while oligochaetes and crustaceans had 2% and 1% respectively. In this study, distribution of the organisms across the study sites indicated that site 2 had the least number of organisms strongly linked to the human activities there. Almeida et al [29] had reported higher total abundance in a regulated stream compared to low abundance in disturbed tributaries. Washing of motorbikes, bathing and laundry activities could lead to environmental disturbances and habitat fragmentation capable of negative effects on the benthic community structure. Site 3 downstream of the disturbed area had the highest number of benthic macrofauna, followed by site 1 upstream of the disturbed area while site 2 had the least number of organisms during the study. The finding of this study disagreed with those of [1] who found that ecological conditions reduced from up-to downstream which was better revealed by biotic than abiotic indices. The reason is that site 2 had most anthropogenic activity which impacted more on the benthic abundance and composition followed by site 1. The

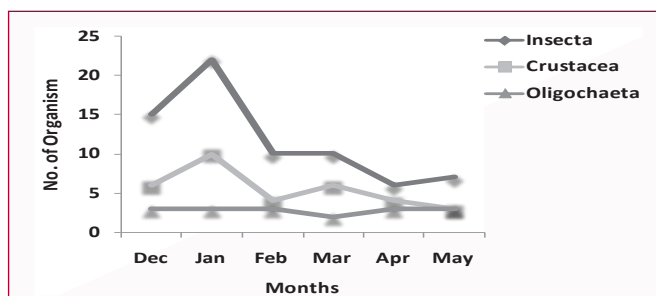


Figure 4: Number of organisms across study period.

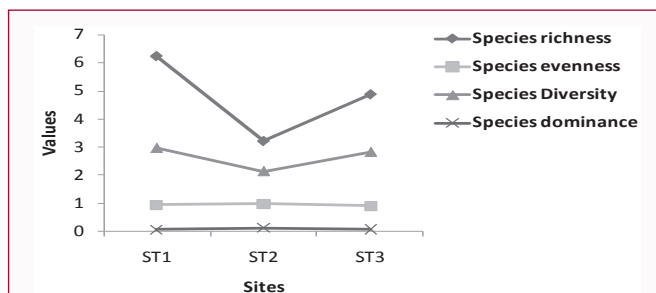


Figure 5: Univariate diversity indices of organisms.

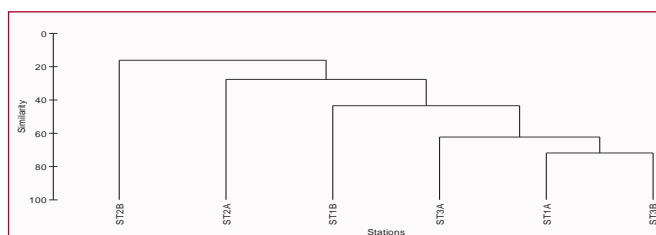


Figure 6: Cluster analysis of macrobenthic fauna using study sites.

implication of this is that curtailment and control of human activities around sites 1 and 2 would lead to tremendous improvement in macrobenthic assemblage as evidenced in site 3 downstream of the disturbed zone. This however, accords with the findings of [22] who reported impact of human activities on the benthic assemblages of an inland river in the Niger Delta. In relation to the sites examined obvious variations were observed in species richness and diversity compared to evenness and dominance. Most species richness and diversity were recorded at site 1 and the least at site 2. Species evenness and dominance did not vary much across sites suggesting the ability of the sites to restore faster if further perturbations are halted. Dauer *et al.* [30] noted that contaminated sediments pose a multitude of stress on benthic communities that collectively lead to reduced biomass and species richness and to dominance by shallow-dwelling opportunistic taxa [31]. The abundance of oligochaetes in the study area was lowest but relatively stable across study months compared to those of crustaceans and insects in that order. This corroborates the finding of [32] who recorded only 2% of oligochaetes in another study of macrobenthic invertebrates in the Niger Delta. The current study showed that oligochaete population had minimal temporal fluctuation while the crustaceans and insects had more temporal variations. The oligochaetes are more of infaunal dwellers than the crustaceans and the insects and therefore, could have responded differently to environmental variables and perturbations leading to their relative stability in abundance. Considering that most inland streams in the Niger Delta are strongly influenced by seasons (wet and dry seasons) with higher volumes of water during the wet season

**Table 4.1:** Shows absence (-) and presence (+) of the organisms found in the study area.

	ST1A	ST1B	ST2A	ST2B	ST3A	ST3B
Chironomid larva	-	+	-	-	+	+
Chaoborus larva	+	-	+	-	+	+
Shrimps	+	-	-	-	+	+
Tubifex sp	+	-	-	-	+	+
Chironomid larva	+	+	-	-	+	+
Chaoborus larva	+	-	-	-	+	+
Shrimps	-	+	-	-	+	+
Tubifex sp	+	+	-	-	-	+
Chironomid larva	+	+	+	+	-	-
Chaoborus larva	+	-	-	+	-	+
Shrimps	-	+	-	-	+	-
Tubifex sp	-	+	-	-	+	+
Chironomid larva	+	-	-	-	+	+
Chaoborus larva	-	-	+	-	+	-
Shrimps	+	-	-	-	+	+
Tubifex sp	+	-	-	-	+	-
Chironomid larva	-	+	+	-	-	+
Chaoborus larva	+	-	+	-	-	-
Shrimps	+	+	-	-	+	+
Tubifex sp	-	+	+	-	+	-
Chironomid larva	-	+	-	-	+	-
Chaoborus larva	+	-	-	+	-	+
Shrimps	+	-	-	-	+	+
Tubifex sp	+	-	+	-	-	+

and vice versa. Seasonal impact was more on crustaceans and insect populations than the oligochaets in the study area. The Isiokpo stream and by extension other inland streams in the Niger Delta are highly impacted by human activities. This undoubtedly leads to biodiversity loss as observed in this study. Gichana et al. [33] reported the need for protection of riparian zones and treatment of sewerage wastes before release into the environment in order to protect aquatic biota. The benthic fauna play a key role in ecosystem services particularly along the food chain. Cumulative disturbance from anthropogenic activities has serious negative consequences that lead to ecosystem disruptions and eventual collapse. Such negative consequences directly and indirectly affect man that naturally depends on the environment for livelihood.

## Conclusion

The Isiokpo stream just like other inland streams in the Niger Delta provides ecosystem services and livelihood for local and community dwellers. The current study has shown a deteriorating and impacted environment evidenced by the poor abundance, composition, distribution and diversity of macrobenthic fauna of the study area. This is attributed to the increased human activities on the stream with negative consequences on the biotic strata of the aquatic system. The insects, crustaceans and oligochaets were the only three groups of benthic macro-invertebrates observed of course, in low abundance across the study sites, particularly at site 2. The implication of this is that fish population in the stream would be affected as most fish at that trophic level depend on these benthic

organisms, this would ultimately lead to poor fish yield for fishers in the area. This study serves as a baseline for further studies in the area and provides information for the management and improvement of the Isiokpo stream and by extension other inland streams/ecosystems in the Niger Delta.

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