# Trace Metals Correlation Trends between: Water and Fish; Sediment and Fish in Qua Iboe River, Oruk Anam, Nigeria

**Abstract:**
Environment and its components is an aspect in environmental management that attracts greater attention of researches as it relates to human life. Components of environment refer to the biotic and the abiotic components including their kinds, levels, interactions among them leading to the state of the environment In unpolluted, environment, contaminants levels are within background levels but in a polluted environment, contaminants exist in elevated levels. In this research, trace metals (Cadmiun, Chromium, Nickel, Copper, Vanadium, Lead, and Tin) in water, fish and sediment samples from Qua Iboe River, Oruk Anam, Nigeria were determined using atomic absorption spectrometer. The results revealed variable levels of the investigated parameters in the samples. There was significant positive correlation between the studied trace metals in water, fish and sediment in both seasons. Correlation of the trace metals between water and fish as well as sediment and fish also revealed positive correlation in both wet and dry seasons. Between water and fish, significant positive relationship exist between Cadmium in water and that in fish (r =.957, P< 0.01), Chromium in water and that in fish (r =.997, P<0.01) and between sediment and fish, positive correlation exist between Cadmium in sediment and that in fish (r =.971, P<0.01), Chromium in sediment and that in fish (r =.988, P, 0.01) and so on. It could be concluded therefore that all the trace metals studied showed positive correlation within and between samples analysed. From the results, routine monitoring of the trace metals in the studied river is strongly advocated for sustainability of the ecosystem for use by the present without compromising the standard for future generations.

**Keywords:** Metals, river, sediment, fish, analysis, correlation, ASS, statistical

## 1. Introduction

Water is a basic need in life. This includes plants and animal's lives. The role of water in living things cannot be overemphasized. Extinction of some species of aquatic organisms may result if the pollution levels of the water body can no longer support lives of aquatic organisms. Water quality parameters are given prime consideration in the assessment of pollution status of the ecosystem. ''The quality of any water sample depends significantly on the levels of water quality parameters and contaminants it contains. Levels of contaminants or pollutants in aquatic environments vary from one water body to another depending on certain factors such as natural and anthropogenic prevalent in them. Although pollution occurs naturally, it is the anthropogenic activities that create more problems'' [5, 13, 18].

''Some humans do not understand that contamination or pollution status of their environment is significantly caused by them as a result of their pollution induced activities. Such activities include agriculture, fishing, boating, drilling of all types, transportation, road construction, swam reclamation, establishment of numerous upstream and downstream industries and a host of other activities carried out by man aimed at solving his social and economic problems. This is a reflection of the correlation between anthropogenic activities and impacts on humans and the environment. Higher levels of anthropogenic activities in the environment correlate withgreater the impacts on environment, biotic and abiotic components. It should be noted that the state of environmental pollution correlates correspondingly to health conditions of living resources of the area'' [3, 10, 13]. In heavily industrialised areas, theeffects of all such activities within the area may be immediately apparent on humans, plants and even objects within the environment. Effects may include corrosion of building roofs, car roofs, and corrosion of steel pipes, among others as a result of acid rain. Human health may be adversely affected to a level that may even result in abandonment of the environment depending on the level of pollution. This shows that there are interactions between biotic and the abiotic components of the environment'' [8, 9. 19].

‘‘In aquatic ecosystems, there are some kinds of relationships between levels of chemical elements in the river water and sediment lying under as well as aquatic biota such as fish that lives in the water. Correlations exist in levels of chemical elements between water and sediment; sediment and fish as well as water and fish including aquatic plants through accumulation'' [8, 15, 17]. There is also acorrelation between levels of these chemicals in fish and humans who consume the fish. This may depend on factors such asexposure frequency, exposure duration, body weight, age among other factors. It should be noted therefore that the levels of contamination or pollution in any environment are proportional to the levels of anthropogenic activities among other factors. ‘‘Sediment is considered a sink for many chemical elements including trace metals. In many cases, researchers have revealed that the concentrations of elements in sediment and plants can even be greater than the overlying water. Trace metals are metals in extremely small quantities that are present in plants and animals cells and tissues. Results of researches reveal that a greater percentage of trace metals load in aquatic environment is held unto particulate matter while some are embedded in sedimentas a result of anthropogenic activities''[6, 10, 15]. Distribution of trace metals in sediment in a highly populated area can also provide historic records levels anthropogenic impacts on the aquatic environment. ‘‘Studies on the sediment cores over the years have been extensively used as pollution records in many countries of the world. Results of sediment core studies can be used to establish principally impacts of anthropogenic and on depositional environment. It is therefore understood that elevated levels of trace metals in sediments can be ascribed to land-based and aquatic activities among others'' [7, 10, 11].

‘‘Researches reveal that fish and marine products contain certain chemical elements which can be essential to human life at low concentrations. These chemical elements can become toxic at elevated concentrations as a result of accumulation. The levels of these chemical elements in water and sediment beyond thenaturallevel reflect similarlevels of anthropogenic activities within the ecosystem'' [1, 2, 7]. ‘‘A similar trend holds for fish, in an unpolluted environment, fish normally carry natural burden of trace metals but in heavily polluted areas the burden goes beyond natural levels. ‘‘Analysis of some metals such as Fe, Zn, Cu, Mn, Cd and Pb in water, fish and sediment in northern Delta Lakerswas carried out in both wet and dry seasons. Findings showed a positive correlation of the metals between the water and fish as well as between the sediment and fish in both seasons'' [14, 15]. Asimilar correlation of metals was also reported between water and fish as well as between sediment and fish from Atabong river and Cross River estuary, Niger Delta, Nigeria[12, 19]. ‘‘Accumulation levels of some trace metalsin fish from Issiet river, Nigeria during wet and dry seasons were investigated. Findings showed that accumulation levels in fish exceeded the levels of the metals in water and indicated bioaccumulation in fish and no significant differences of the metals between the dry and wet season''[13].It is worthy of note that impacts of land-activities on river water also have corresponding impacts on the sediment lying underneath and the fish that live in the river'' [3, 12, 19].

## 2. Methodology

### Study Area

The study area is Qua Iboe River (QIR) flowing through Akwa Ibom State in Nigeria. As presented in Figure 1, it is located between latitude 04$^{o}$ 28'31.0'N and 07$^{o}$10'12.4'N and longitude 06$^{o}$ 52'50.5'E of Greenwich Meridian. It flows through Inen Nsai, Umani, Ikot Okoro, Nung Ikot and Ibesit in Oruk Anam into Ibagwa in Abak.

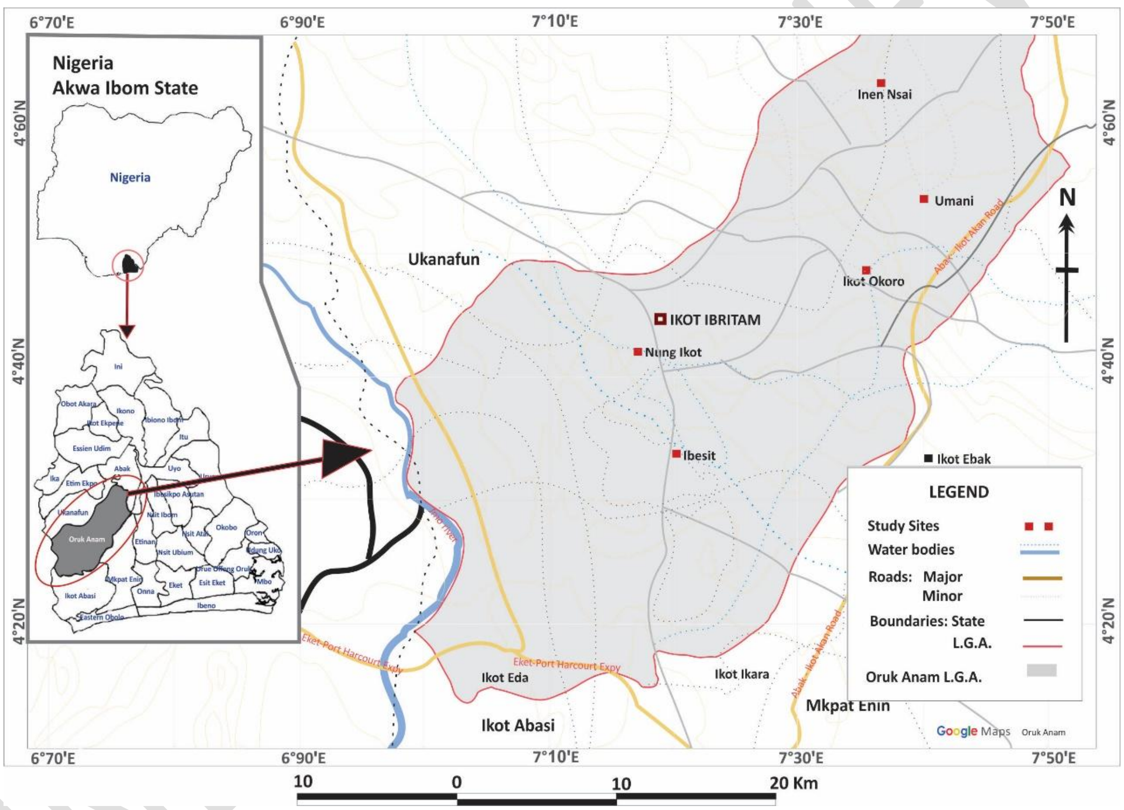


**Figure 1: Map of study area**

### 2.1 Sampling, Preservation and Treatment:

Samples preservation is a vital step in any analysis. It is a measure taken to prevent reduction or loss of components of interest from the samples once the samples are removed from their natural sources. A good preservation method maintains the integrity of the samples and guarantees the validity of the result [4, 16].

#### 2.1.1 Water Samples

The bottles for water sample collection were properly prepared before sampling. In the field, the bottles were pre-rinsed several times with water from the different sampling locations. Water samples were collected using pre- rinsed 1-litre (1L) polyethylene bottles by dipping each mouth of the container against the flow direction to avoid trapping air bubbles in the bottle [13, 19]. Water samples for dissolved oxygen determination were fixed on site with 2 mL of Winkler solutions 1 and 11 using separate dropping pipettes for each respectively. The samples for trace metals analysis were collected with $HNO_3$ pre-rinsed (1L) polyethylene containers and 5 mL of concentrated nitric acid ($HNO_3$) to a pH < 2 was added to maintain the oxidation state of the metals and to reduce microbial action. Samples collected were properly labeled noting the sampling locations, date and hour of sampling as well as sample temperature. The samples collected were immediately placed in an ice box and transported to the laboratory for analysis.

#### 2.1.2 Sediment Samples

Sediment samples were collected alongside water samples using Eckman grab sediment sampler at five different points around each sampling location and thoroughly mixed to form a composite bulk sediment sample. The sediment samples collected were stored in polyethylene bags and labeled properly to indicate sampling locations, date and time of collection'' [12, 16, 18] The samples were placed in an ice box and transported to the laboratory for analysis. ``Prior to analysis, sediment samples from each study site were first air-dried on reaching the laboratory and later placed in porcelain oven-dried crucibles and at a temperature of 105$^{o}$C for 24 hours to remove moisture. The dried samples were then ground into a homogeneous mixture with the help of a porcelain mortar and pestle and sieved through 2 mm mesh screen to remove coarse materials. Each of the finely dried sediment (20 g) was kept in an air-tight plastic bottle prior to digestion.

#### 2.1.3 Fish Samples

``Fish samples were collected from the five sampling locations with the help of local fishermen using local fishing traps (Ikpa) set adjacent to the sampling locations at dusk and inspected at dawn. Five medium sized fish samples were obtained and placed in a locally made aquarium and transported immediately to thelaboratory for analysis. Beforeanalysis, the fish samples were washed with distilled water to remove loosely held particles before they were gutted and decapitated usinga stainless steel kitchen knife. The decapitated fish samples were filleted on both sides, placed in a porcelain crucible and dried in an oven'' [4, 5, 16, 18]. The dried muscles were homogenised using mortar and pestle. The resultant homogenised fish samples were stored in a welllabeled plastic bag prior to digestion.

### 2.2 Digestion of Samples and Analysis

#### 2.2.1 Sediment Samples

``Each of the finely homogenised sediment samples (2.0 g) was digested in a mixture of nitric acid ($HNO_3$) and hydrochloric acid in the ratio of 3:2 in a silica beaker and refluxed in a hot sand bath for 1 hour. The resultant solutions were transferred to an evaporating dish after refluxing where they were heated gently on a hotplate and left to evaporate to near dryness. They were leached with 5 mL of 2% nitric acid and the undigested portion of the sediment was filtered off using acid-washed filter paper'' [16, 17]. The filtrate was put in a volumetric flask and made up to 100 mL with distilled water. The digested samples were aspirated into atomic absorption spectrometer.

#### 2.2.2 Fish Samples

In the analysis of fish, the finely homogenised fish samples (2.0 g) of each were put in a crucible and burned in a furnace until it turned to ash. The ash was leached with 5 mL of 6 M HCl in a volumetric flask and made up to 50 mL using distilled water. The digested samples were prepared in triplicate and analysed using anatomic absorption spectrometer.

#### Preparation of Blank Samples

A blank sample was prepared alongside allthe reagents used for sample digestion.

### 2.3 Quality Control and Assurance

The implementation of laboratory quality assurance and quality laboratory methods, including the use of standard operating procedures, calibrations with standards, analysis of reagent blanks and analysis of replicates guaranteed the quality of the analytical data. Each sample was analysed in triplicates. All chemicals and reagents used in the study were of analytical grade. Standard solutions prepared were performed under aclean laboratory environment. All samples were digested alongside blanks. Quantification of the metallic contents of digested samples and blanks was carried out with the Unicam 939/935 Atomic Absorption Spectrophotometer which was pre-calibrated using certified standard.

### 2.4 Statistical Analysis:

The generated data were processed using the Statistical Package for Social Sciences (SPSS). Relationships between the analysed trace metals, mean concentrations in water, sediment and fish from all sampling sites were investigated using Person's correlation coefficient, r, at $P<0.05$ and 0.01 significant levels.

## 3. Results and Discussion

Results of theanalysis of trace metals in water, fish and sediment samples from Qua Iboe River, Oruk Anam, Nigeria were presented in Tables 1, 2 and 3 respectively. Results in Table 4 presented correlation analysis of the trace metals within fish. Results in Tables 5 and 6 presented correlation analysis of the trace metals between water and fish while Tables 7 and 8 presented correlation analysis of the trace metals between sediment and fish samples for both seasons.

The levels of the trace metals studied in water samples from the five sampling locations in both seasons were as presented in Table 1.

**Table 1: Levels (mg/L) of trace metals in surface water of Qua Iboe River for wet and dry seasons**

| Trace Metals | | Cd | Cr | Ni | Cu | V | Pb | Sn |
|---|---|---|---|---|---|---|---|---|
| IN | Wet | 0.02±0.01 | 0.01±0.01 | 0.01±0.01 | 0.02±0.01 | 0.01±0.01 | 0.00±0.00 | 0.02±0.01 |
| | Dry | 0.03±0.01 | 0.01±0.01 | 0.02±0.01 | 0.03±0.01 | 0.02±0.01 | 0.00±0.00 | 0.00±0.01 |
| UM | Wet | 0.02±0.01 | 0.01±0.01 | 0.02±0.01 | 0.05±0.01 | 0.02±0.01 | 0.00±0.00 | 0.01±0.01 |
| | Dry | 0.04±0.01 | 0.0±0.01 | 0.03±0.01 | 0.07±0.01 | 0.03±0.01 | 0.00±0.00 | 0.02±0.01 |
| IO | Wet | 0.04±0.00 | 0.03±0.01 | 0.03±0.00 | 0.07±0.01 | 0.0 ±0.00 | 0.00±0.00 | 0.02±0.00 |
| | Dry | 0.06±0.01 | 0.04±0.01 | 0.01±0.01 | 0.08±0.01 | 0.04±0.01 | 0.01±0.00 | 0.02±0.01 |
| NI | Wet | 0.05±0.01 | 0.07±0.01 | 0.02±0.01 | 0.08±0.01 | 0.03±0.01 | 0.00±0.01 | 0.02±0.01 |
| | Dry | 0.07±0.00 | 0.08±0.00 | 0.04±0.01 | 0.10±0.00 | 0.04±0.01 | 0.01±0.00 | 0.03±0.00 |
| IB | Wet | 0.05±0.01 | 0.06±0.01 | 0.03±0.01 | 0.08±0.01 | 0.03±0.01 | 0.01±0.01 | 0.02±0.01 |
| | Dry | 0.08±0.00 | 0.09±0.00 | 0.04±0.00 | 0.10±0.01 | 0.04±0.01 | 0.01±0.00 | 0.03±0.01 |

IN = Inen Nsai, UM = Umani, IO = Ikot Okoro, NI = Nung Ikot, IB = Ibesit, STD = Standard deviation.

Statistical analysis of the results indicated that the levels of the trace metals in water samples in most cases increased from Inen Nsai sampling location (upstream) to Ibesit location (downstream). Moreover, in some cases, the levels of the trace metals were higher in dry season than wet season reflecting concentration and dilution effects in dry and wet season respectively.

Results of analysis of trace metals in sediment samples from the sampling locations are presented in Table 2.

**Table 2: Levels (mg/kg) of trace metals in sediment of Qua Iboe River for wet and dry seasons**

| Trace Metals | | Cd | Cr | Ni | Cu | V | Pb | Sn |
|---|---|---|---|---|---|---|---|---|
| IN | Wet | 0.02±0.01 | 0.02±0.01 | 0.02±0.01 | 0.05±0.01 | 0.03±0.01 | 0.01±0.01 | 0.02±0.01 |
| | Dry | 0.03±0.01 | 0.03±0.01 | 0.03±0.01 | 0.06±0.01 | 0.03±0.01 | 0.01±0.01 | 0.02±0.01 |
| UM | Wet | 0.06±0.01 | 0.04±0.00 | 0.04±0.01 | 0.07±0.01 | 0.04±0.01 | 0.01±0.01 | 0.04±0.01 |
| | Dry | 0.10±0.08 | 0.15±0.01 | 0.05±0.01 | 0.08±0.00 | 0.05±0.00 | 0.02±0.01 | 0.05±0.01 |
| IO | Wet | 0.08±0.01 | 0.05±0.01 | 0.07±0.01 | 0.11±0.01 | 0.06±0.01 | 0.03±0.01 | 0.05±0.00 |
| | Dry | 0.13±0.01 | 0.11±0.00 | 0.10±0.00 | 0.21±0.01 | 0.07±0.01 | 0.03±0.00 | 0.08±0.00 |
| NI | Wet | 0.10±0.01 | 0.11±0.01 | 0.08±0.01 | 0.15±0.01 | 0.06±0.01 | 0.03±0.01 | 0.07±0.01 |
| | Dry | 0.21±0.01 | 0.20±0.00 | 0.10±0.00 | 0.17±0.00 | 0.08±0.00 | 0.03±0.00 | 0.08±0.00 |
| IB | Wet | 0.10±0.01 | 0.11±0.01 | 0.08±0.01 | 0.15±0.01 | 0.03±0.01 | 0.03±0.01 | 0.07±0.01 |
| | Dry | 0.21±0.01 | 0.21±0.00 | 0.17±0.00 | 0.18±0.01 | 0.08±0.01 | 0.03±0.00 | 0.08±0.01 |

IN = Inen Nsai, UM = Umani, IO = Ikot Okoro, NI = Nung Ikot, IB = Ibesit, STD = Standard deviation.

Results of analysis of the trace metals in sediment samples from the five sampling locations showed the trend of increase from upstream to downstream. Higher levels of trace metals were recorded in dry season than wet season as applicable to the analysis of water samples.

Results of trace metals analysis in fish samples from the sampling locations are presented in Table 3.

**Table 3: Levels (mg/kg) of trace metals in fish for wet and dry seasons**

| **Trace Metals** | | **Cd** | **Cr** | **Ni** | **Cu** | **V** | **Pb** | **Sn** |
|---|---|---|---|---|---|---|---|---|
| IN | Wet | 0.06±0.01 | 0.87±0.02 | 0.06±0.01 | 0.06±0.01 | 0.23±0.01 | 0.01±0.01 | 0.21±0.01 |
| | Dry | 0.09±0.01 | 0.74±0.01 | 0.48±0.01 | 0.33±0.01 | 0.33±0.01 | 0.02±0.01 | 0.26±0.01 |
| UM | Wet | 0.07±0.00 | 0.78±0.01 | 0.08±0.01 | 0.23±0.01 | 0.12±0.01 | 0.23±0.01 | 0.27±0.01 |
| | Dry | 0.30±0.00 | 0.5±0.01 | 0.07±0.01 | 0.50±0.01 | 0.32±0.01 | 0.23±0.00 | 0.29±0.01 |
| IO | Wet | 0.48±0.01 | 0.8±0.01 | 0.03±0.01 | 0.41±0.01 | 0.45 ±0.01 | 0.31±0.01 | 0.37±0.01 |
| | Dry | 0.30±0.01 | 0.53±0.01 | 0.04±0.01 | 0.51±0.01 | 0.04±0.01 | 0.41±0.00 | 0.38±0.01 |
| NI | Wet | 0.48±0.01 | 0.56±0.01 | 0.03±0.01 | 0.61±0.01 | 0.33±0.01 | 0.43±0.01 | 0.41±0.01 |
| | Dry | 0.51±0.01 | 0.67±0.01 | 0.03±0.01 | 0.51±0.01 | 0.4 ±0.01 | 0.45±0.01 | 0.51±0.01 |
| IB | Wet | 0.58±0.01 | 0.87±0.01 | 0.03±0.01 | 0.44±0.01 | 0.6 ±0.01 | 0.45±0.00 | 0.56±0.01 |
| | Dry | 0.53±0.01 | 0.71±0.01 | 0.03±0.01 | 0.50±0.01 | 0.4 ±0.01 | 0.45±0.01 | 0.40 ±0.01 |

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IN = Inen Nsai, UM = Umani, IO = Ikot Okoro, NI = Nung Ikot, IB = Ibesit, STD = Standard deviation.

The results of fish analysis in most cases indicated higher levels of the trace metals in downstream than wet season. The results also revealed higher levels in dry than wet season.

**Table 4: Correlation between trace metals in fish**

| | Cd | Cr | Ni | Cu | V | Pb | Sn |
|---|---|---|---|---|---|---|---|
| **Cd** | 1 | | | | | | |
| **Cr** | .934** | 1 | | | | | |
| **Ni** | .929** | .864** | 1 | | | | |
| **Cu** | .971** | .841** | .879** | 1 | | | |
| **V** | .791** | .820** | .543** | .776** | 1 | | |
| **Pb** | .982** | .927** | .879** | .950** | .826** | 1 | |
| **Sn** | .983** | .939** | .881** | .941** | .827** | .987** | 1 |

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

Results in wet season showed that Cd had significant positive relationship with Cr (r = .934, p<0.01), Ni (r = .929, p<0.01), Cu (r = .971, p<0.01), V (r = .791, p<0.01), Pb (r = .982, p<0.01) and between Pb and Sn, a significant positive correlation was established at (r = .987, p<0.01). Also Cu showed a significant positive correlation with V (r = .543, p<0.01), Pb (r = .879, p<0.01) and Sn (r = .881, p<0.01) while Pb showed a positive relationship with Sn at (r = .987, p<0.01) as reported in Table 4. The same trend of positive correlation was also recorded in dry season. The results indicated that as the concentration of Cd in fish increased, there were corresponding increases in concentrations of other trace metals in the fish. Similar positive correlation pattern of the investigated trace metals in water and sediment was observed for both wet and dry seasons. This result was consistent with the results reported by [13,15, 19].

**Table 5: Correlation between trace metals in water and fish for wet season**

| | | Fish | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Ni | Cu | V | Pb | Sn |
| | Cd | .957** | .948** | .890** | .884** | .781** | .963** | .972** |
| **Water** | Cr | .922** | .997** | .839** | .824** | .836** | .923** | .939** |
| | Ni | .911** | .782** | .865** | .904** | .669** | .894** | .906** |
| | Cu | .978** | .854** | .900** | .995** | .761** | .961** | .955** |
| | V | .948** | .849** | .837** | .941** | .787** | .945** | .963** |
| | Pb | .949** | .929** | .869** | .906** | .835** | .927** | .941** |
| | Sn | .476* | .410* | .409* | .526** | .433* | .371 | .390 |

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

**Table 6: Correlation between trace metals in water and fish for dry season**

| | | Fish | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Ni | Cu | V | Pb | Sn |
| **Water** | Cd | .978** | .985** | .899** | .916** | .726** | .957** | .982** |
| | Cr | .910** | .987** | .764** | .835** | .758** | .947** | .930** |
| | Ni | .953** | .890** | .833** | .953** | .884** | .963** | .933** |
| | Cu | .972** | .883** | .868** | .984** | .868** | .964** | .940** |
| | V | .935** | .800** | .870** | .959** | .844** | .902** | .908** |
| | Pb | .945** | .872** | .902** | .927** | .741** | .931** | .959** |
| | Sn | .867** | .854** | .808** | .799** | .674** | .844** | .908** |

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

Results in Table 5 show correlation of trace metals in water and fish during wet Season. The results revealed that there was a significant positive relationship between Cd in water and that in fish (r = .957, p<0.01), Cr in water and fish (r = .997, p<0.01), Ni in water and fish (r = .865, p<0.01), Cu in water and fish (r = .995, p<0.01), V in water and fish (r = .787, p<0.01). The relationship between Sn in water and fish was significant at (r = .390, p>0.05). Results in Table 6 shows the results of correlation of trace metals between water and fish during dry season and followed the same pattern as observed during wet season. The results indicated that for both seasons, there was a significant positive relationship between concentrations of trace metals in water and metals in fish. Metals analysis in water and sediment from Issiet river, Uruan, Nigeria indicated a similar results [13]. That implies that for both seasons, as the concentrations of trace metals in water increased significantly, there were corresponding significant increases in the concentrations of the metals in fish.

**Table 7: Correlation between trace metals in sediment and fish for wet season**

| | | Fish | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Ni | Cu | V | Pb | Sn |
| **Sediment** | Cd | .971** | .873** | .841** | .981** | .842** | .976** | .971** |
| | Cr | .932** | .988** | .810** | .856** | .892** | .940** | .949** |
| | Ni | .982** | .868** | .944** | .980** | .699** | .956** | .955** |
| | Cu | .983** | .978** | .927** | .925** | .794** | .965** | .970** |
| | V | .986** | .888** | .945** | .976** | .726** | .965** | .961** |
| | Pb | .943** | .797** | .889** | .959** | .681** | .928** | .929** |
| | Sn | .988** | .898** | .889** | .989** | .813** | .977** | .975** |

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

**Table 8: Correlation between trace metals in sediment and fish for dry season**

| | | Fish | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cd | Cr | Ni | Cu | V | Pb | Sn |
| Sediment | Cd | .956** | .961** | .815** | .922** | .842** | .979** | .949** |
| | Cr | .929** | .991** | .862** | .830** | .605* | .913** | .954** |
| | Ni | .960** | .806** | .981** | .970** | .674** | .868** | .921** |
| | Cu | .909** | .736** | .983** | .917** | .551* | .789** | .870** |
| | V | .976** | .841** | .937** | .993** | .794** | .923** | .943** |
| | Pb | .934** | .781** | .864** | .979** | .852** | .908** | .888** |
| | Sn | .979** | .858** | .932** | .986** | .783** | .933** | .948** |

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

Results in Table 7 show correlation of trace metals in sediment and fish in both seasons and revealed that during wet season, there was a significant positive relationship between Cd in sediment and that in fish (r = .971, p<0.01), Cr in sediment and fish (r = .988, p<0.01), Ni in sediment and fish (r = .944, p<0.01), Cu in sediment and fish (r = .925, p<0.01), Pb in sediment and that of the fish (r = .928, p<0.01). Table 8 presented results of correlation analysis between trace metals in sediment with those in fish during dry season and revealed that there was a significant positive relationship between Cd in sediment and that in fish (r = .956, p<0.01), Cr in sediment and fish (r = .991, p<0.01), Ni in sediment and fish (r = .981, p<0.01), Cu in sediment and fish (r = .917, p<0.01), Pb in sediment and that of the fish (r = .908, p<0.01). The results also show that there were significant positive relationship between concentrations of metals in sediment and those in fish for both seasons. The results implied that in water and fish during wet season, there was a significant positive relationship between concentrations of metals in water and metals in sediment. The result was also in consistent with results of correlation analysis of trace metals reported for wet and dry seasons by [15, 19, 20]. This indicated that for both seasons, as the concentrations of trace metals in sediment increased significantly, there were corresponding significant increases in the concentrations of metals in fish.

## Conclusion

Correlation analysis revealed positive relationships between Cd with Cr, Ni, Cu, V and Pb in the water, sediment and fish in both the dry and wet seasons. There was also apositive relationship between the trace metals in water and fish as well as sediment and fish in both seasons. Concentrations of the trace metals obtained in water theduring dry season were higher than levels reported in wet theseason reflecting theconcentration and dilution effects of the metals in dry and wet seasons respectively. The results revealed that as the concentrations of the metals increased in water, there was also acorresponding increase in the concentrations of the metals in fish in both seasons. The results further revealed thecorrelation of the trace metals between sediment and fish in both seasons followed the same trend. It could be concluded therefore that significant positive correlations exist between levels of trace metals in the river and fish and also between sediment and fish. Hence, pollution control of fish and sediment by the government can best be achieved by pollution control of the river through regulatory framework of anthropogenic activities within and around aquatic ecosystem.

**References:**


1 Ahmad MK, Islam S, Rahman S, Haque MR, Islam MM. Heavy metals in water, sediment and some fisheries of Burriganga River, Bangladesh. *International Journal of Environmental Research.* 2010; 4(2): 26 - 32.

2 Akan JC, Abdulraham FI, Ochanya AE, Askira YK. Heavy metals in sediment from River Ngida Maiduguri Metropolis, Borno State. Nigeria. *Journal of Environment Chemistry and Ecotoxicology*. 2010;2(9): 131 - 140.

3 Akpan NA, Udombeh RB, Mfon BU. Investigation of the Quality of Physicochemical Parameters in Water Samples from Qua Iboe River, Ikot Ekpene Stretch, Akwa Ibom State, Nigeria. *Asian Journal of Geological Research.* 2024a;7(1): 31–40.

4 Akpan NA, Udombeh RB, Ukpong MB, Iboroakam EU. Effects of Human Activities On Trace Metals in Qua Iboe River, Ikot Ekpene Stretch, Akwa Ibom State, Nigeria. *International Journal of Science Research Archive.* 2024b; 11(01): 2120-2128.

5 Akpan NA. Human Health Risk Assessment of Some Trace Metals through Fish Consumption from Qua Iboe River, Oruk Anam, Nigeria. *Asian Journal of Environment and Ecology*. 2024; 23(5): 19 – 29.

6 Alinnor I, Alagoa A. Trace Metals Distribution in Fish Sediment and Water Samples from Nkisa River Nigeria. *British Journal of Applied Science and Technology.* 2014;4 (20): 2901 - 2913.

7 Butu AW, Iguisi EO. Concentration of heavy metals in sediment of River Kubanni, Zaria, Nigeria. *Comprehensive Journal of Environment and Earth Science.* 2013; 3(1):14–25.

8 Chiara F, Livia VA, Monica M, Gilmo V. Spaciation of heavy metals at water sediment interface, *Environment quality.* 2013;10(02): 62 – 83.

9 Elkady AD, Sweet ST, Wade TL, Klein AG. Distribution and assessment of heavy metals in the aquatic environment of lake Manzala, Egypt. *Ecological Indicators,* 2015; 5(8): 445 – 457.

10 El-Zeiny M, El-Hamid H, El-Alfy M. Anthropogenic impacts on water quality of River Nile and marine Environment,Rosetta branch using geospatial analyses. *Journal of Environmental Science*. 2018; 47: 89 – 101.

11 Emara, M., Farag, K. S., Dawuh, A. A. and Fathi, M. Assessment of heavy metals concerntration in water and edible tissue of Nile tilapia (*Oreochromics nitoticus*)

from two fish farm irrigated with different water sources, Egypt. *International Journal of Environment.* 2015; 4(1): 121 – 150.

12 Etuk BA, Udiong DS, Akpakpan AE. Human Health Risk Assessment of Trace Metals in Water from Cross River Estuary, Niger Delta, Nigeria. *Asian Journal of Chemical Sciences.* 2020; 7(3):1-11

13 Ido UH, Akpan NA, Udombeh RB, Udoidiong OM. Bioaccumulation of Trace Metals in Fish From Issiet River, Uruan, Nigeria. *Science Journal of Analytical Chemistry*. 2023; 11(4):40 – 48.

14 OlabanjiIO and Oluyemi EA. Preliminary assessment of heavy metals pollution of Oba Reservior, Ile-Ife, South-West, Nigeria using *Mormyiousrume* and Tilapia.*Ife Journal of Science.* 2014; 16(1): 35 – 43.

15 Ubon UU, Ekwere IO, Ikpe EE, Obadimu C. Assessment of physicochemical properties and water quality index of borehole water in Mkpat Enin Local Government Area, *International Journal of Chemistry Studies*. 2021; 5(2):49-58.

16 Ubon UU, Ikpe EE, Ekwere IO, Uwanta EJ. Physicochemical and Polycyclic Aromatic Hydrocarbons (PAHs) Analysis in Soil and sediment from Vicinty of Ikot Akpaden, Akwa Ibom State, Nigeria. *Asian Journal of Biology*. 2023;19(1): 16-24.

17 Udosen ED. *Concepts in Environmental Chemistry Anikzo Global Ventures*. Nigeria. 2015; 421p.

18 Udosen ED. Enviro-chemical Pollutants: The Unwelcome yet Unavoidable Human companions, the 68th Inaugural Lecture, University of Uyo, University of press Ltd. 2019; 102p.

19Uwah EI, Edem EM, Udosen IE, Udosen ED, Udoidiong OM. Quantification of pollutant levels in water, sediment and winkles in Akani Obio Uruan River, Nigeria. *Science Journal of Analytical Chemistry.* 2020;8(2): 43-47.

20Uwah EI, Rapheal U, Okon RU, Essien DU, Udoidiong OM. Atomic absorption spectrophotometric determination of elements in water, fish and sediment of Atabong River, Nigeria. *Science of Journal of Analytical Chemistry.* 2021;9(4): 73-75.

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