A comparative study of elements relationship in sediment of Anambra Drainage Basin in wet and dry season and its sustainable management

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Abstract. This research is aimed at examining geo-chemistry of stream sediment in the Anambra Drainage Basin. Twelve sediment samples were collected using sediment grab from the six sub basins and analyzed for 21 parameters in the wet and dry season. The selected 21 parameters are -clay, silt, fine sand, coarse sand, pH/H$_2$O, KCL, carbon, organic matter, nitrates, sodium, potassium, calcium, magnesium, cation exchange capacity, base saturation, aluminum, hydrogen, phosphorus, manganese, zinc and iron. There was a significant relationship ($r>=.661$, $p<0.05$) between variables-base saturation and potassium chloride; organic matter and carbon; nitrates and clay; hydrogen and pH/H$_2$O; fine sand and clay; manganese and fine sand; hydrogen and potassium chloride; manganese and CEC; coarse sand and silt; calcium and fine sand together with manganese and coarse sand. The sources of sediment were from natural and artificial origin. The basin requires management to ensure its sustainability.

Keywords: sediment, drainage basin, sources of deposition, management

1. Introduction

Sediments ranging from consolidated to non-consolidated have generated a lot of research interest mainly because sediments are resources [1][2] facilitates landscape and soil development [3] important in maintaining the morphodynamics of river beds, tidal channels, inter-tidal flats, marsh plains[4][5] provide record histories of river pollution[6][7]. They provide useful data for managing problems and in water resource planning and development [8] and also offers a background for the development of sediment guideline and standard [9]. Sediment considered in this paper are those found in river basin. Thus, a river basin comprises the non-human attributes of a drainage system supporting different ecological units where entrainment and deposition of sediment occurs [10] leading to the re-sculpturing of the landscape [11]. Sediment transported in a drainage basin are resources[1][2] and a number of variables determine the volume of sediment transported by a river: cross-section of the channel and flow velocity [12] intensity and duration of rainfall [13][14][15] relief and type of soil [16][17] prevailing earth surface processes[18] land use and human interventions [19][20][21]–cum-velocity of the river transport [22]e.t.c.

Sediments in a drainage basin are laden with elements which could be detrimental to health and aquatics. [23] disclosed that Ghaghara river in India, is loaded with trace elements. In same vein,
evidence shows that the downstream segment of Tembi river in China is concentrated with trace elements [24] and such can lead to toxicity and bio accumulation [25]. Such elements in drainage basins are emanating from socio economic activities and runoff processes [26] together with fluvio-geomorphic processes [27]. In addition to the above, the assemblage of minerals in sediment due to deposition process provides an avalanche of history of the pollution in the depositional environment [28]. Thus, sediments are important for record purposes. It is therefore necessary to ascertain the elemental status of Anambra drainage and the relationship in the elements occurring in the basin.

Given that sediments are resources and the drainage basin under study is located within sedimentary rock formation geographically positioned in the humid tropical region where there is intense surficial geomorphic processes orchestrating from the fluvial processes [27], the nexus of this research is designed to analyze elemental composition in the Anambra drainage basin during rainy and dry season. Thus, this present study will also provide insight on sediment composition and such knowledge will go a long way in unraveling the geo-chemistry of sediments. Against the above background, this study will be an effective tool in the formulation of basin management policies and improving understanding of textural character of the sediment since there is a pronounced fluvio-geomorphic processes operating within the basin surrounding [27]. This is because sediments originate mostly from soil erosion, runoff activities, anthropogenic and non-anthropogenic activities that present day environmental geo-hazards thrive on [29] [30] [31]. This study is set out to unravel the sediment composition of Anambra drainage basin in order to bridge the existing academic gap.

2. Study Area

Anambra drainage basin is located on longitude and latitude grid of 6°00’N to 7°30’N and 7°00’E to 7°30’E (Fig. 1) covering some parts of Enugu, Anambra and Kogi state in Nigeria underlain by sedimentary formation of different geologic age (Fig. 2). In terms of topography, the basin is situated in a low land (0-200 meters) within the western flank while the eastern section has traces of highland and is heavily degraded by erosion [32]. The nature of soil within the basin is ferralitic, hydromorphic, lithosols and juvenile soils [32] which originated from deposited sediment materials. Climatically, the basin is positioned in the humid tropics with two seasons-wet and dry. Its temperature is usually 30°C in the dry season while it drops to 22°C wet season [33] [34]. Anambra basin is supporting a robust biogeography though man’s quest for survival and urbanization is leading to depletion of vegetation resources within the basin [35].

3. Materials and Method

In the rainy season, 12 sediment samples were collected between July 2013 and another 12 sediment samples was collected in the dry season-March 2014 in the six sub basins mapped out in the Anambra drainage basin at different stations as depicted in table 1 and figure 3. The geo chemistry of the samples was analyzed in the laboratory within 24 hours of collection to avoid the alteration in chemistry. Metals and non-metals were determined in the laboratory using the [36] [37][38] [39] and [40] after which the result of the analyses was subjected to correlation analysis.
FIG.1: THE ANAMBRA DRAINAGE BASIN IN SOUTH EASTERN NIGERIA
FIG.3: THE SAMPLED SUB BASIN
Table 1: Location Coordinates of the Sampled Stations

| Location   | Latitude          | Longitude         | Description |
|------------|-------------------|-------------------|-------------|
| Ogugu      | 7°4'32.931"N      | 7°14'38.855"E    | X3          |
| Adumafo    | 7°13'34.84"N      | 7°16'35.095"E    | X2          |
| Ogeaji     | 7°19'38.399"N     | 7°30'28.158"E    | X1          |
| Ogurugu    | 6°57'41.356"N     | 7°3'46.612"E     | X4          |
| Ukpoopkara | 6°53'6.971"N      | 6°55'9.985"E     | X7          |
| Nkpologu   | 6°54'43.005"N     | 7°20'59.867"E    | X5          |
| Akukwa     | 6°32'3.368"N      | 6°59'34.757"E    | X8          |
| Otuocha    | 6°20'8.951"N      | 6°50'32.922"E    | X12         |
| Enugu_Agbo | 6°6'44.493"N      | 7°18'11.535"E    | X10         |
| Maku       | 6°10'3.537"N      | 7°26'36.602"E    | X9          |
| Igga       | 6°27'15.509"N     | 7°14'2.55"E      | X11         |
| Umulokpa   | 6°41'40.016"N     | 7°20'46.299"E    | X6          |

4 Results and Discussion

4.1 Geo-Chemistry of Anambra River Basin.

Table 2, contain result of geo-chemical sediment composition levels within the drainage basin for the rainy season and dry season. Variations were noticed in the sampled parameters further depicted in the line graphs presented in figures 4a, 4b and 4c. This strengthens the fact that there are indications of variation in the composition levels of the sampled parameters in the rainy and dry seasons.

FIG. 4a. Variation in the Water, KCL (potassium chloride), C(carbon), N(nitrates), Na(sodium), CEC(Cation Exchange Capacity), and K(potassium) Composition Level of River Sediment in the Rainy and Dry Season.

Source: Fieldwork 2013-2014
| Parameter | Ankpa Upstream | Ankpa Downstream | Obele Upstream | Obele Downstream | Adada Upstream | Adada Downstream | Oji Upstream | Oji Downstream | Manu Upstream | Manu Downstream | Ezu Upstream | Ezu Downstream |
|-----------|----------------|------------------|---------------|------------------|----------------|------------------|-------------|--------------|--------------|----------------|-------------|----------------|
|           | R/S | D/S | R/S | D/S | R/S | D/S | R/S | D/S | R/S | D/S | R/S | D/S |
| clay      | 4   | 6   | 4   | 6   | 4   | 6   | 4   | 6   | 12  | 6   | 8   | 6   |
| silt      | 18  | 6   | 14  | 12  | 18  | 6   | 14  | 12  | 16  | 16  | 18  | 24  |
| fine S    | 12  | 66  | 12  | 66  | 12  | 66  | 12  | 66  | 12  | 66  | 12  | 66  |
| coarse S  | 72  | 86  | 78  | 75  | 64  | 70  | 64  | 70  | 77  | 77  | 60  | 80  |
| Fe2O3     | 1.7 | 1.5 | 1.9 | 1.9 | 1.9 | 2.0 | 1.8 | 2.0 | 2.1 | 2.1 | 1.8 | 2.1 |
| KCL       | 1.5 | 1.5 | 1.8 | 1.8 | 1.8 | 1.9 | 1.5 | 1.6 | 2.1 | 2.1 | 1.7 | 1.8 |
| C         | 1.18 | 0.22 | 0.73 | 0.19 | 0.09 | 0.04 | 0.41 | 0.22 | 0.14 | 0.14 | 1.68 | 1.08 |
| OM        | 2.04 | 0.38 | 1.25 | 0.32 | 0.16 | 0.06 | 0.71 | 0.38 | 0.71 | 0.52 | 0.24 | 0.27 |
| N         | 0.02 | 0.04 | 0.02 | 0.04 | 0.01 | 0.05 | 0.01 | 0.02 | 0.01 | 0.04 | 0.03 | 0.05 |
| Na+       | 1.7 | 2.8 | 1.8 | 2.4 | 1.9 | 2.8 | 2.1 | 2.2 | 1.8 | 2.8 | 1.7 | 2.4 |
| K+        | 1.8 | 3.5 | 2.3 | 3.5 | 1.9 | 3.5 | 1.9 | 3.5 | 1.8 | 3.5 | 1.8 | 2.8 |
| Ca2+      | 1.8 | 6.9 | 9.2 | 8.8 | 9.2 | 1.8 | 9.2 | 1.2 | 9.2 | 8.8 | 9.2 | 1.8 |
| Mg2+      | 9.2 | 6.9 | 8.6 | 6.9 | 5.1 | 4.7 | 2.3 | 2.2 | 5.9 | 1.3 | 2.3 | 1.2 |
| CEC       | 1.8 | 1.7 | 1.9 | 1.7 | 1.9 | 2.2 | 2.1 | 2.1 | 2.1 | 1.9 | 2.4 | 2.1 |
| Basis S   | 14.3 | 73.04 | 12.39 | 80.71 | 20.17 | 51.61 | 10.64 | 64.7 | 18.68 | 9.0 | 9.56 | 58.21 |
| Ar        | 1.6 | 0.4 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| H         | 2.0 | 1.8 | 0.8 | 0.4 | 2.2 | 1.8 | 2.2 | 2.2 | 2.2 | 1.8 | 5.1 | 3.4 |
| P         | 1.7 | 1.7 | 2.2 | 1.6 | 6.3 | 6.2 | 6.2 | 6.2 | 6.2 | 5.1 | 6.2 | 5.1 |
| Mn        | 1.8 | 1.8 | 5.1 | 9.1 | 2.2 | 2.1 | 1.8 | 1.8 | 4.7 | 4.7 | 7.9 | 5.8 |
| Zn        | 0.5 | 9.0 | 0.5 | 9.6 | 0.0 | 1.3 | 0.7 | 9.0 | 0.7 | 9.0 | 1.9 | 2.7 |
| Fe3+      | 1.2 | 5.2 | 1.2 | 1.4 | 8.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.5 | 8.1 | 1.1 |

RS = Rainy season; DS = Dry season
Source: Fieldwork 2013-2014
FIG. 4b. Differences in the Composition Level of Clay, Fine sand, Silt, Coarse sand, Magnesium, Base saturation and Zinc in the River Sediment in the Rainy and Dry Season.

Source: Fieldwork 2013-2014
Fig. 4c. The Deviations in the Composition Level of Calcium, Aluminum, Hydrogen, Phosphate, Manganese and Iron in the River Sediment during Rainy and Dry Seasons.

Source: Fieldwork 2013-2014
4.2 Correlation Co-efficient of the Sediment Geo-Chemical Analysis

The correlation co-efficient for rainy and dry season sediment samples (Table 3), of the result of the analyzed sediment parameters was applied to explain the degree of relationship or association that exists between the variables. It revealed to us variables that occurred dependent or independent of the other.

4.2.1 Correlation Co-efficient of the Rainy Season Sediment Geo-Chemical Analysis

Pearson Correlation revealed a significant positive relationship between the following sediment physicochemical parameters, p < 0.05 (Table 4). We observed that between fine sand and clay, (r = .668, p = .018), fine sand and silt (r = .888, p < .001), the relationship in these variables were moderate and high respectively. Potassium chloride and pH / H2O exhibits a very strong/high association (r = .912, p < .001). In organic matter and Carbon, there was a perfect relationship (r = 1.000, p < .001) while Nitrates and clay showed very strong association (r = .805, p < .002). Cation Exchange Capacity and clay displayed a moderate level of relationship is noted, (r = .621, p = .031) while in Cation Exchange Capacity and Silt a high degree of inter correlation was noted (r = .800, p = .002). Very strong and positive relationship was noted in these variable as regards their co-efficient: Cation Exchange Capacity and fine sand, (r = .839, p = .001), Base Saturation and pH/H2O, (r = .706, p = .010), Base Saturation and potassium chloride (r = .749, p = .005), Base Saturation and potassium (r = .824, p = .001), Manganese and fine sand (r = .877, p < .001), Manganese and silt, (r = .831, p = .001), Hydrogen and pH/H2O (r = .725, p = .008), Iron and Zinc (r = .755, p = .005), but a positive moderate relationship exist between Hydrogen and potassium Chloride (r = .631, p = .028), Manganese and clay (r = .698, p = .012) together with Manganese and Cation Exchange Capacity (r = .642, p = .024). This implies that increase in one variable will bring about increase in the corresponding variable and vice versa. A negative correlation existed between coarse sand and clay,(r = -.756, p = .004), coarse sand and silt (r = -.904, p < .001) coarse sand – cum- fine sand (r = -.989, p < .001), Calcium and silt (r = -.91, p = .043), Calcium and fine sand (r = -.623, p = .030), Cation Exchange Capacity and coarse sand (r = -.850, p < .001), Manganese and coarse sand (r = -.897, p < .001) and between Manganese and Calcium (r = .661, p = .019). This implies that increase in one variable will decrease the other variable and vice versa. The relationship between other pairwise variables was not significant, p > 0.05.

4.2.2 Correlation Co-efficient of the Dry Season Sediment Geo-Chemical Analysis

Pearson Correlation revealed a significant positive relationship between the following sediment physicochemical parameters, p < 0.05 (Table 4). We noted a very strong relationship between silt and clay (r = .969, p < .001), potassium Chloride and pH / H2O (r = .866, p < .001). Organic Matter and Carbon revealed a perfect correlation (r = 1.000, p < .001). A moderate but positive relationship was noted in these variables: potassium and Sodium (r = .595, p = .041), Cation Exchange Capacity and Silt (r = .614, p = .034) together Base Saturation and Calcium (r = .697, p = .012). This implies that increase in one variable will bring about increase in the corresponding variable and vice versa. Negative relationship existed in Coarse sand and fine sand (r = -.822, p = .001) and between Magnesium and potassium (r = .679, p = .034). This implies that increase in one variable will decrease the other variable and vice versa. The relationship between other pairwise variables was not significant, p > 0.05.
Table: 3 Correlation Matrix of Physicochemical Parameters of Sediment in the Rainy Season

| parameter | Clay | Silt | Fine Sand | Coarse Sand | H2O | KCl | C | OM | N | Na | K | Ca | Mg | CEC | Base S | Al | H | P | Zn | Mn |
|-----------|------|------|-----------|-------------|-----|-----|---|----|---|----|---|----|----|-----|--------|----|---|---|---|---|
| Silt      |      |  .544 |          |             |     |     |   |    |   |    |   |    |    |     |        |    |   |   |   |   |
| Fine Sand | .468 |      |          |             |     | .818|   |    |   |    |   |    |    |     |        |    |   |   |   |   |
| Coarse Sand | .756 | .904 | .989     |             |     |     |   |    |   |    |   |    |    |     |        |    |   |   |   |   |
| H2O       | .265 | .041 | .138 | 142        | .405|     |   |    |   |    |   |    |    |     |        |    |   |   |   |   |
| KCl       | .384 | .003 | .116 | 149 | 912 | .718| .797| .724| .863| .020|   |    |    |     |        |    |   |   |   |   |
| C         | .091 | .456 | .347 | .306 | .165| .058|   |    |   |    |   |    |    |     |        |    |   |   |   |   |
| OM        | .805 | .099 | .312 | .392 | .082| .278| .312| .315|   |    |   |    |    |     |        |    |   |   |   |   |
| N         | .002 | .759 | .323 | .208 | .801| .381| .323| .318|   |    |   |    |    |     |        |    |   |   |   |   |
| Na        | .146 | .042 | .038 | .049 | .449| .188| .539| .539| .477|   |    |   |    |    |     |        |    |   |   |   |   |
| K         | .551 | .897 | .903 | .882 | .143| .558| .071| .071| .117|   |    |   |    |    |     |        |    |   |   |   |   |
| Ca        | .227 | .236 | .138 | .182 | .411| .451| .196| .195| .502| .477| .441| .668| .571| .185| .141| .542| .543| .554| .096| .930| .043| .030| .064| .527| .172| .066| .096| .736| .992| .126| .826| .181| .224| .178| .198| .093| .113| .168| .168| .119| .011| .140| .526|
|       | CEC | Base S | Al | H | P | Zn | Mn | Fe |
|-------|-----|--------|----|---|---|----|----|----|
|       | .574 | .485   | .580 | .537 | .774 | .726 | .802 | .601 | .714 | .973 | .664 | .696 |
|       | .821 | .800*** | .839*** | .850 | .885 | .714 | .814 | .714 | .814 | .814 | .814 | .814 | .814 |
|       | .031 | .002    | .001 | .000 | .619 | .725 | .176 | .176 | .505 | .649 | .223 | .139 | .723 |
|       | -.286 | .034 | -.082 | .107 | .706 | .749** | -.066 | .067 | -.010 | .456 | .824** | -.537 | -.114 | -.275 |
|       | .367 | .917 | .800 | .740 | .010 | .005 | .838 | .835 | .975 | .136 | .001 | .072 | .724 | .388 |
|       | -.015 | .158 | -.277 | -.222 | -.359 | .290 | -.084 | .083 | -.106 | .005 | -.210 | -.067 | -.389 | .084 | -.351 |
|       | .963 | .623 | .363 | .488 | .252 | .360 | .796 | .798 | .744 | .888 | .512 | .836 | .211 | .796 | .264 |
|       | -.106 | .097 | -.078 | .066 | .725 | .631 | -.219 | -.217 | -.131 | .203 | -.001 | .027 | -.430 | -.009 | .281 | -.156 |
|       | .742 | .765 | .810 | .853 | .008 | .028 | .494 | .497 | .685 | .526 | .997 | .933 | .197 | .979 | .376 | .627 |
|       | -.202 | .213 | -.116 | .086 | .258 | .202 | .174 | .175 | -.347 | .114 | -.145 | .021 | .026 | .031 | .257 | -.294 | .462 |
|       | .530 | .507 | .720 | .790 | .418 | .528 | .588 | .586 | .270 | .725 | .652 | .949 | .937 | .924 | .420 | .426 | .130 |
|       | .317 | .048 | -.067 | -.019 | .288 | .249 | -.322 | -.322 | .238 | .128 | -.126 | .260 | -.030 | -.080 | .103 | -.358 | .305 | .096 |
|       | .316 | .883 | .837 | .952 | .365 | .435 | .307 | .307 | .456 | .692 | .695 | .414 | .950 | .805 | .755 | .253 | .336 | .768 |
|       | .898 | .831** | .877** | .897 | .023 | .071 | .199 | .198 | .436 | .169 | .143 | -.611 | -.444 | .642 | .216 | .143 | .073 | -.016 | .147 |
|       | .012 | .001 | .000 | .000 | .944 | .827 | .535 | .537 | .156 | .599 | .658 | .019 | .148 | .024 | .500 | .657 | .821 | .961 | .649 |
|       | .420 | .136 | -.044 | -.025 | -.122 | -.148 | -.517 | -.518 | .302 | -.002 | -.250 | .383 | .006 | .058 | -.326 | -.205 | .187 | -.100 | .755** | .069 |
|       | .174 | .673 | .892 | .938 | .708 | .646 | .085 | .084 | .360 | .994 | .433 | .219 | .984 | .858 | .301 | .522 | .560 | .758 | .005 | .831 |
Table 4: Correlation Matrix of Physicochemical Parameters of Sediment in the Dry Season

| Parameter | Clay | Silt | Fine Sand | Coarse Sand | H2O | KCl | C | OM | N | Na | K | Ca | Mg | GeC | Base S | Al | H | P | Zn | Mn |
|-----------|------|------|-----------|-------------|-----|-----|---|----|---|----|---|----|----|-----|--------|----|---|---|----|----|
| Silt      | 0.969| 0.000|           |             |     |     |   |    |   |    |   |    |    |     |             |    |   |   |    |    |
| Fine Sand | -0.103| -0.167| 0.749 | 0.004      |     |     |   |    |   |    |   |    |    |     |             |    |   |   |    |    |
| Coarse Sand | -0.474| -0.422| -0.257| 0.503      | 0.119| 0.172| 0.001|     |   |    |   |    |    |     |             |    |   |   |    |    |
| H2O       | -0.484| -0.457| -0.257| 0.503      | 0.111| 0.135| 0.096|     |   |    |   |    |    |     |             |    |   |   |    |    |
| KCl       | -0.531| 0.513| -0.041| 0.339| 0.866*| 0.076| 0.988| 0.898| 0.000|     |    |    |    |     |             |    |   |   |    |    |
| C         | -0.029| 0.149| -0.231| 0.159| 0.142| 0.222| 0.644| 0.471| 0.621| 0.660| 0.488|     |    |    |             |    |   |   |    |    |
| OM        | -0.031| 0.147| -0.232| 0.162| 0.144| 0.224| 1.000| 0.849| 0.646| 0.665| 0.494| 0.000|     |    |             |    |   |   |    |    |
| N         | -0.024| 0.089| -0.006| 0.043| 0.166| 0.489| 0.166| 0.166| 0.166| 0.166| 0.166|     |    |    |             |    |   |   |    |    |
| Na        | -0.057| 0.075| -0.039| 0.075| -0.156| 0.204| -0.151| -0.154| -0.143| 0.860| 0.816| 0.904| 0.816| 0.629| 0.525| 0.640| 0.632| 0.660|     |    |   |   |    |    |
| K         | 0.135| 0.124| 0.261| -0.310| -0.308| -0.158| -0.169| -0.169| -0.211| -0.767| 0.867| 0.996|     |    |             |    |   |   |    |    |
| Ca        | -0.223| -0.205| -0.477| -0.309| -0.328| -0.292| -0.266| -0.262| -0.240| -0.058| 0.311|     |    |    |             |    |   |   |    |    |
| Mg        | -0.188| -0.254| -0.226| -0.071| 0.045| 0.083| -0.167| -0.169| -0.376| -0.211| -0.679| 0.002|     |    |             |    |   |   |    |    |
5. Sources of Sediment Depositions

There are many sources of sediment in a river basin. The following are a number of ways sediments are deposited into the drainage basin.

i. Sediments originate from the decay of organic life that is found within the basin. Such organic life includes leaves of plants, trunks of vegetation down to animals that dies and decays into the basin. Anambra drainage being located in the bushes of rural settlement is supporting a host of crops due to floodplain agricultural practice. During harvesting the river is used as a sink for the crop waste that are disposed which on event of decay and decomposition becomes a substrate. Thus, organic matter is a major source of sediment.

ii. The soil within the basin is another source of sediment. Mostly dominating the lithology of the basin is sandy. Sandy soils are easily washed away through runoff processes and it finds its way into the drainage channels. This is a major way through which sedimentation occurs in the basin because of low resistance to the force of detachment and entrainment.

iii. Several agricultural activities were noted along the Anambra drainage basin. This is because a good number of stream segments in the basin meander through rural areas. As a result, some of the...
inhabitants of the river environment cultivate food along the bank of the basin. The continuous farming on the bank exposes it to overbank processes and flooding. This leads to sedimentation of the basin.

iv. The deposition of varied wastes in the basin is one of the ways sediment flux in the basin is enhanced. Domestic waste and refuse are emptied into the basin indiscriminately and it ends up as sediments. Most of the inhabitants and basin occupants use the river basin as an appropriate recipient for all household and farm wastes.

6. Sustainable Management Strategies for the River sediment and the River Basin

i. It was noted that sediment are washed into the river through run off processes. To this end it is vital to construct water ways that will divert the run off instead of emptying sediment laden water into the drainage basin.

ii. Erosion is an ongoing process along the river bank. As a result it is important that cover crops be planted at the basin bank as a way of checking erosion and building up the stability of the soils, thereby minimizing down slope entrainment

iii. There is need for appropriate planning of the basin to ensure that it is not over exploited but can serve the next generation. This can be achieved through avoidance of unhealthy dumping of domestic waste and other refuse in to the basin, discouragement of deforestation on the basin together with upholding better land management practices. This is because dumping of wastes will expose the sediments to contamination and pollution and there by endangering the life of aquatics which it is a host to.

iv. In other to strengthen the management practices, the populace should be targeted for awareness program. In this manner the masses will be advised to desist from any activity that will compromise the viability of the basin as a nature’s gift to mankind.

7. Conclusion

The sediment is composed of metals and non –metals within the drainage basin. Elements composed in 'the sediment exhibited high relationship described as a positive relation while some manifested a negative or inverse relationship. Sediments originate from anthropogenic and non-anthropogenic sources. Anambra River needs effective and efficient management to avoid over loading of the elements.

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