

## Economic Analysis of Heavy Metals Pollution on Soil, River and Rice Production in Nigeria

Ezekiel, Ayinde Alani

Department of Agricultural Economics,  
Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria.

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### Abstract

Toxic metals (Cadmium, lead, copper and arsenic) study was carried out in soil, river and on rice production in Surulere Local Government of Oyo State. A group of soil and river sediment was mineralized with atomic absorption spectrophotometer analysis, the sediment samples was processed for texture analysis. The study also determined the levels of some heavy metals (Cd, Cr, As, Pb and Hg) in locally produced rice samples from the study area. Five rice samples were obtained from Agbonni, Iresadu, Oko, Iresapa and Ilajue. Results revealed that lead (Pb) ranged from 0.411 – 0.635 mg/kg in the samples. It was showed that the physico-chemical characteristics, the pH are from 7.0 – 9.0. Two kinds of textures were identified: loamy and loamy/sandy soil. Heavy metals identified from Arawo Lake rose from 0.02 to 11.0 mg/L for lead and 6.35 to 9.30 for arsenic. In soil, copper showed low concentrations in all the sites, while cadmium was below detectable limits. The levels of metal contamination and distribution were analyzed using geoaccumulation index and pollution load factor. The metal index analysis indicated high enrichment of the metals (especially Pb and Cr) which reflected anthropogenic effects of contamination attributable to several sources. This study made it clear that there is need to be more involved in environmental management to heavy metal hazard which could be turn to soil acidity and detrimental to the aquatic organism, in order to contributes to maximum food security of the country.

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**Keywords:** economic, heavy metals, pollution, soil, river, rice, spectrophotometer, production

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### INTRODUCTION

It has been tested and confirmed that metals can affect productivity in the soils and ecological geochemistry as it limit nutrients and toxic inhibitors. The biogeochemical cycling of metals is now a great subject of interest that calls for serious research. With the rapid Industrialization and economic development heavy metals are continuing to be introduced to soils and coastal ecology via several pathways including fertilization, irrigation, rivers, runoff, atmospheric deposition, and point sources where metals are produced as a result of metal mining, refining, and refinishing by products (Okoye 1991). Rice is one major staple grown in Nigeria. It has earned itself an important position of a commonly consumed staple by the national populace. Nigeria local rice with indigenous name (Ofada) is prone to disease and it has been examined that Ofada rice can be contaminated by heavy metals such as Cd, Cr, As, Hg and Pb (Imolehin et al., 2000). Previous studies have shown heavy metal contamination of food; such as rice containing lead, ranged from 0.00-61.17mg/kg and other food and fruit crops in Nigeria.

Cadmium and other heavy metals are discharged by factories and mines into rivers thence into irrigation channels, where they wind up in rice plants. The rice

makes its way to markets and restaurants, and rice husks are fed to animals raised for consumption. (Orisakwe et al., 2012). Soils are usually regarded as the ultimate sink for heavy metals discharge into the environment and sediments can be sensitive indicators for monitoring contaminants. (Otitolaju 2002). Prokaryotic microbes play a critical role in riveric Fe cycling. They contain most of the biogenic Fe in offshore waters and are responsible for a large portion of the Iron uptake by the plankton community. Surface populations of heterotrophic species assimilate more than 50% of the dissolved Fe and thus compete directly with phytoplankton for this limiting resource. In oligotrophic tropical and subtropical waters, photosynthetic bacteria become more important in Fe cycling as the number or unicellular cyano-bacteria increases and the nitrogen fixing Trichodesmium, which contains most of the biogenic Fe in the mixed layer, become abundant (Awofolu et al., 2005)

At present, our understanding of Fe biogeochemistry is incomplete because the process of control dissolved and particulate Fe concentration in the rivers will be known from laboratory studies that mimic natural conditions with varying degrees of success.

### SIGNIFICANCE OF THE STUDY

This study is aimed at analyzing and investigating the effects of the heavy metals, anthropogenic activities, biogeochemical reactions and geological structure on the soil, river and rice production in Nigeria in order to understand the nature of pollution; the health risk that arise from such parameters. Heavy metals are high pollutants because of their relative high toxicity and persistent nature in the environment, this can lead to soil and river pollution, and it can affect agricultural productivity, particularly rice production. This paper address issues on national capacity building strategy in conservation and natural resources management (NCBSNRM).

### OBJECTIVE OF THE STUDY

The broad objective of this study is to examine the economic analysis of heavy metals Pollution on Soil, River, Rice Production and safety of rice consumption of public health and toxicological importance.

#### The specific objectives are to:

- (i) identify the socio-economic characteristics of rice farmers in the study area.
- (ii) examine dissolved and particulate Metal, Iron, Zinc etc. concentration in the Soil and river.
- (iii) identify water resource quality for irrigation agriculture and aquatic animals.
- (iv) contrast to studies of river carbon and nitrogen dynamics where organisms have been shown to play a central role.

#### Detailed Field Survey

(i) Documentation of various negative and positive effects of apparent trace metals that can affect soil, river and rice production as limiting nutrients and toxic inhibitors as a result of the biogeochemical cycling of trace metals in the soil and river; if any, is being made of them for sporting agriculture, recreation etc.

(ii) Sample and analyze, where necessary, water and soil for heavy metals and non metals.

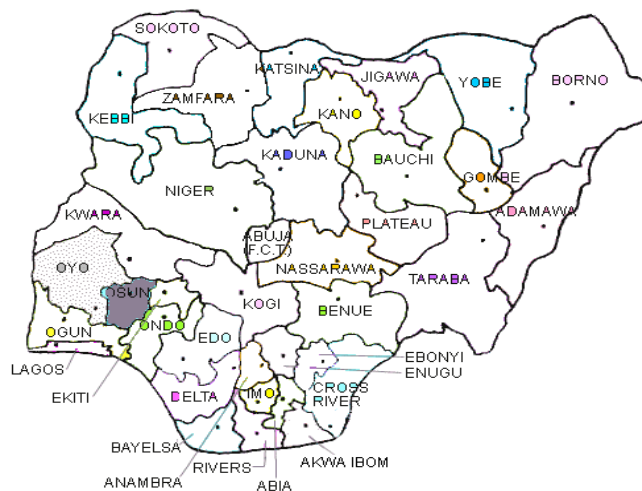
(iii) In situ physical parameters measurements e.g. soil, Surface water, pH, surface and groundwater depth and water column.

### MATERIALS AND METHODS

**Study Area:** The study was carried out in Surulere Local Government Area, Oyo State, Nigeria. This state is an inland state in South-Western Nigeria with its capital at Ibadan. It is bounded in the North by Kwara state, in the East by Osun State, in the South by Ogun state and in the West partly by the Republic of Benin. It was formed in 1976 from the former Western State, and originally included Osun State, which was split off in 1991. Oyo state is homogenous, mainly inhabited by the

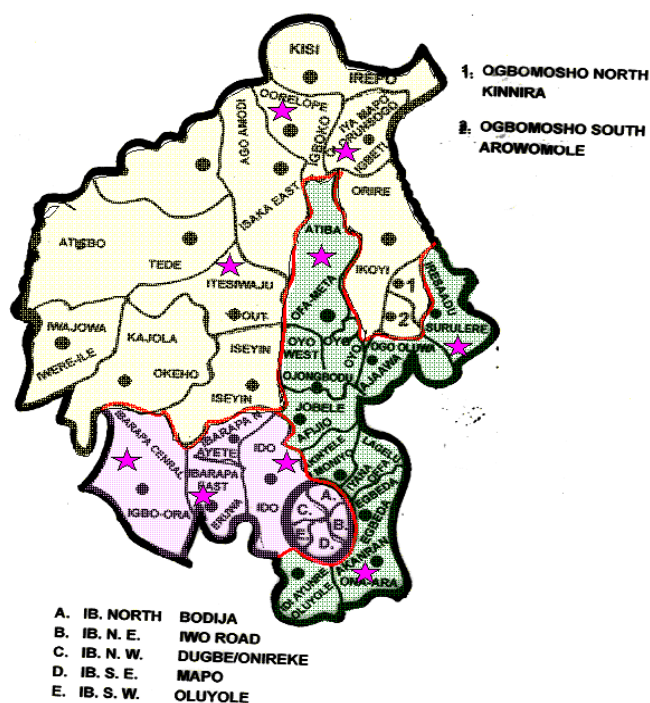
Yoruba ethnic (Wikipedia, 2013). The indigenes mainly comprise the Oyo State, the Ibadan and Ibarapa, all belonging to Yoruba family and speaking the same Yoruba language. The state consists of thirty three (33) Local Governments Areas with a total population of 6,617,720 inhabitants (Census, 2006). The capital, Ibadan is reported to be the largest city in Africa, South of Sahara other notable cities and towns in Oyo State include Oyo, Ogbomosho, Iresaapa, Iresaadu, Iseyin, Kisi, Okeho, Saki, Eruwa, Lanlate, Awe and Igbo Ora. The climate in the state favours the cultivation of crops like maize, yam, cassava, millet, rice, plantain, cocoa tree, palm tree and cashew. Oyo State is located within longitude 8° and latitude 3° 28'E with annual rainfall of 1247mm (Wikipedia, 2013).

The study area lies in the rainforest zone of Nigeria and this has made about 80% of the inhabitants to engage in agriculture. There are two distinct seasons, rainy and dry season. The rainy season starts in Oyo State during the first week of March and lasts till the Month of October, while the dry season lasts November – March, all things being equal. The low rainfall is marked by the period of August break in August. Mean temperature varies from daily minimum of 25°C to a daily maximum of 35°C. Humidity is quite high in Oyo State. Relative humidity in the State is around 70 percent with a minimum of about 60 percent in the evening and a maximum of around 80 percent in the morning, (Wikipedia, 2013). The people in the study area engaged in the farming enterprises that degrade the land the more. The farming practices notable among them are those that involve slash and burn, deforestation, farming on a slopping land at the expense of future production.



**Source:** World atlas travel

Figure 1: Map of Nigeria showing Oyo State where the study areas are located



Source: Website of Oyo state government

Figure 2: Map of Oyo State showing the selected Local Government Areas

### METHOD OF DATA COLLECTION

Data for this study were obtained in year 2013, from a sample survey of Surulere Local Government areas, Oyo State, Nigeria. Primary data were collected using well-structured questionnaire and interview schedule.

**Collection and Treatment of Samples:** Rice samples were collected from different market locations from Iresaadu, Iresaapa, Oko, Iajue, and Agbonni into different labeled polyethylene bags. The samples were washed with deionized water and spread on clean bagco bags to allow the water to drain off. The sample were packed into labelled brown envelopes and dried in the Gallenkhamp oven at a temperature of 62°C for 3days. After drying, the samples were pulverized into fine powdery form. The rice samples were sieved using 2 mm sieve to obtain very fine particles. Drying continued until all the wet samples reached a constant weight. Ten gram (10g) of dried samples each was weighed into digestion flasks, 4ml perchloric acid and 8ml nitric acid were added to the respective flasks. The digestion flasks were then put on a hot plate set to 100°C (gradually increased) until the samples were all digested. After digestion the digested samples were diluted with distilled water appropriately in the range of standards which are prepared from stock standard solution of the metal. Heavy metal concentrations in the samples were

measured using a Perkin Elmer AS 3100 flame atomic absorption spectrophotometer facility in the Laboratory.

**Statistical Analysis:** Descriptive statistics tools such as Percentage, Covariance, Means, standard deviations, Regression Model and Pollution Index were used to analyze the data collected.

### METHOD OF DATA ANALYSIS

Pollution index is a powerful tool for ecological geochemistry analysis. The commonly used pollution indices by heavy metals in soils and waters classified as two types of single index and integrated index in an algorithm point of view. Four single indices of contamination factor (or concentration factor), ecological risk factor, and index of geo-accumulation was illustrated, and reference values for analysis of single indices were distinguished into background levels and threshold pollution values. Eight integrated indices were divided into two groups. One group was suitable for the normal distribution single indices including the sum, average, weighted average, vector modulus, and numerous pollution indices and the other for log-normal distribution including the product, root or product, and weight power product pollution indices. Using background level as reference values five contamination classes were divided and the terminologies were suggested for the single and integrated indices to unifying the analysis results. Software of EGAPI was developed in a single document interface to analyze the four single and eight integrated indices by heavy metals to analyze the quality of soils and coastal ecological geochemistry pollution indices by heavy metals of Cu, Pb, and Zn in soils and coastal ecology.

### SOURCE OF INFORMATION

The major sources of information were primary and secondary data.

### RESULT AND DISCUSSION

Table 1: Lead concentrations in locally produced rice samples from the study area

| Identify               | Study Area | Mean (mg/kg) | Mean (µg/kg) |
|------------------------|------------|--------------|--------------|
| Adui rice              | Iresaadu   | ND           | ND           |
| Ofada rice             | Iresaapa   | 0.610±0.002  | 510±2        |
| Oko rice               | Oko        | 0.21H0.002   | 311±2        |
| Jue (par boiled)       | Iajue      | 0.248± 0.002 | 348±2        |
| Agbonni meal rice      | Agbonni    | 0.602±0.002  | 502±2        |
| Agbonni, raw           | Agbonni    | 0.634±0.001  | 525±1        |
| ordinary rice          |            |              |              |
| Yido rice              | Oko        | ND           | ND           |
| Adui rice (par boiled) | Iresaadu   | 0.307±0.003  | 408±3        |
| Mean of all samples    |            | 0.327        |              |

Mean ± SD

ND = Not detectable

Table 2: Lead concentrations in locally produced rice samples according to their study area

| Study Area | Mean (mg/kg)      | Mean ( $\mu\text{g/kg}$ ) |
|------------|-------------------|---------------------------|
| IREAADU    | 0.356 $\pm$ 0.024 | 356 $\pm$ 2.40            |
| IREAAPA    | 0.474 $\pm$ 0.03  | 166 $\pm$ 1.60            |
| OKO        | 0.256 $\pm$ 0.016 | 464 $\pm$ 3.0             |
| ILAJUE     | 0.614 $\pm$ 0.012 | 613 $\pm$ 1.2             |

rice according to locations

Fig. 3: shows the mean values of lead from Iresaadu, Iresaapa, Oko, Ilajue and Agbonni. Samples from Agbonni had the least value of lead (0.17 mg/kg) while samples from Iresaadu had the highest value of lead (0.612mg/kg). Lead concentration in the samples from various study area ranged from 0.17mg/kg to 0.614mg/kg. The result also shows that the concentrations of the heavy metals: chromium, arsenic, cadmium and mercury could not be detected at less than 0.002 mg/kg in any of the samples. Results of this study have revealed that lead (Pb) is the predominant contaminant of locally produced rice from the study area as it was the only heavy metal found in the samples. The other heavy metals: cadmium (Cd), chromium (Cr), mercury (Hg) and arsenic (As) were not detectable at 0.002 mg/kg. Lead (Pb) concentration of the samples followed the sequence (Adui rice) > (Ofada) > (Oko) > (Jue) > (Agbonni meal rice) > (Agbonni raw) with lead (Pb) values of 0.624, 0.511, 0.103, 0.307, 0.236 and 0.410 mg/kg respectively. These values were found to be 86.2, 86.1, 86, 85, 82, and 81 % higher than the WHO/FAO (2002) provisional tolerable intake regulations (PTWI) of 0.036 mg/kg lead. These findings should create an open end for the incoming researchers to continue further research on this study and to enable government to assist local rice producer's increase their level of production.

In conclusion lead (Pb) is the primary heavy metal contaminant of locally produced rice in the study area. Its mean concentration in all the samples was found to be higher than the FAOAVHO (2002) recommended

limit of lead in cereals. Consumers of locally produced rice in the study area are at greater risk of lead (Pb) toxicity. The result of these are dangerous health effects of lead (Pb) toxicity which include cancer, decreased nervous function, weakness in fingers, wrists, or ankles; small increases in blood pressure; and anaemia, brain and kidney damage, death, pregnancy miscarriage, damage of reproductive organs for sperm production. Martin and Griswold (2009). Monitoring and systematic gathering of information on heavy metal levels in the environment are essential components of any pollution control system is well supported. It is essential for agricultural activities and other human activities that increase heavy metal contamination of food stuffs be controlled. Therefore, I recommend that the federal ministry of agriculture should take action on how to control heavy metal contamination of our locally produced food. Also, blood samples of individuals who consume this rice should be analysed for lead (Pb) toxicity and appropriate action taken by the federal ministry of health, I also suggest that further research be carried out to find out the exact factors that were responsible for heavy metal contamination of the samples for specific remedial actions to be taken.

#### CONTRIBUTION TO THE KNOWLEDGE

This study created an open end for the incoming research by making ways of determined presence of heavy metals in the soil, river and the negative effects on water organism and rice production.

#### REFERENCES

- Awofolu, O.R, Mbolekwa, Z. Mtshemia, V and Fatoki, O.S (2005). Levels of trace metals and sediment from Tyume River and its effects on an irrigated farmland. ISSN 0378-4738- Water SA, 31(1): 87-94.
- Otitoloju A.A (2002) Joint Action Toxicity of Heavy metals and their bioaccumulation by benthic animals in Lagos Lagoon, Ph.D Thesis University of Lagos.
- Okoye B.C (1991), Heavy metals and organisms in Lagos Lagoon, Int. J. Environment, 37: 285- 292.
- Imolehin, E.D. and A.C. Wada 2000. Meeting the rice production and consumption demands of Nigeria with improved technologies. International Rice Commission Newsletter, Vol. 49, FAO, Rome, pp. 23-41.
- Jones, Monty P., 1995. *The rice plant and its environment*. WARDA Training Guide 2. WARDA, Bouaké, pp. 27-30.
- Wikipedia (2013) [http:// en.m.wikipedia.org/wiki/rice](http://en.m.wikipedia.org/wiki/rice) section 14.