Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.18, 2015

Assessment of Heavy Metal Concentrations of Selected Fin and Shell Fish from Ogoniland

Adata A. Jumbo Wegwu M.O. Belonwu D.C. Okerenta B.M.
Faculty of Chemical Science, Department of Biochemistry, University of Port Harcourt.
P.M.B 5323, Rivers State. Nigeria.

Abstract
Heavy metals in selected fin and shell fishes from Bodo and Kaa in Ogoniland were studied. Heavy metals concentrations were determined by Atomic absorption spectroscopy. There were detectable levels of heavy metals in samples from both test site (Bodo) and control site (Kaa). The concentrations of all heavy metals for samples were significantly lower at $p<0.05$ for samples from Kaa than samples from Bodo. Some of the heavy metals detected in samples were above the maximum permissible limits as recommended by the International Atomic Energy Agency (IAEA), United Nations Environment Program (UNEP) and Federal Environmental Protection Agency (FEPA) for heavy metals in fish. These findings suggest that the study sites were contaminated with heavy metals. This indicates that the consumption of fishes from the study areas would lead to severe health risks.
Keywords: Fin fish, Shell fish, and Heavy metals.

INTRODUTION

Heavy metals contamination is typically through the use and application of biosludge, contaminated animal manure and artificial fertilizers (USDA, 2012). As trace elements, some heavy metals are essential to maintain the body's mechanisms, but when present in excess, they bio-accumulate and become toxic because of their non-biodegradable nature (Demirezen and Ahmet, 2006). Heavy metals are considered the most important constituents of pollution from the aquatic environment and the sea due to toxicity and accumulation by marine organisms, such as fish (Emami *et. al.,* 2005). Plants can also accumulate heavy metals in their tissues in concentrations above the permitted levels which are considered to represent a threat to the life of humans, and animals feeding on these crops and may lead to contamination of food chain (Adnan *et al*, 2010; Patil *et. al.*, 2012). Fish is widely consumed in many parts of the world because it has high protein content, low saturated fat and also contains calcium, phosphorus, iron, trace elements like copper and a fair proportion of the B-vitamins known to support good health (Tucker, 2007). Fish accumulate toxic chemicals such as heavy metals directly from water and diet, and contaminant residues may ultimately reach concentrations hundreds or thousands of times above those measured in the water, sediment and food (Nkpaa *et. al.,* 2013; Osman *et. al.,* 2007; Goodwin *et. al.,* 2003; Labonne *et. al.,* 2001), thus, they are considered good indicators for heavy metal contamination in aquatic systems (Burger *et. al.,* 2002). According to Atuanya *et al.,* (2012), the concentration of heavy metals varies with variation in fish species. Also, the concentrations of these elements in the fish could be related primarily to their feeding habit (Farkas *et. al.,* 2003), differences in ecological needs, swimming behavior and the metabolic activities among the fishes, as reported by Canli and Atli, 2003.

As human population, urbanization and industrialization continues to expand, emission of heavy metals into the environment and their hazards on human life are of great concern, as people may be exposed to potentially harmful chemical, physical and biological agents in the air, food, water or soil. Their presence in aquatic ecosystems, mainly due to anthropogenic influences has far-reaching implications directly to the biota and indirectly to man (Hussain *et. al.,* 2013; Carpenter *et. al.* 1998).

MATERIALS AND METHODS

Reagents

All reagents used were of analytical standard

Study Sites

The study sites Bodo (test) and Kaa (control) are located in Ogoniland of Rivers State, with a population of close to 832000, and land area covering 1000km^2.

Collection of test samples

Fresh samples of selected fin and shell fish were collected from Bodo and Kaa Rivers of Gokana and Khana local government areas of Rivers State, Nigeria. At each site, 10 individual fishes of similar size for each species were collected. The identification of fish samples was done in the of the Department of Fisheries, Faculty of Agricultural Science, University of Port Harcourt. Collected samples were cleaned and wrapped in aluminium foil plates, and cooled in an ice chest, before transportation to the laboratory

Sample Preparation

Fresh fish samples were brought into the laboratory, washed under tap water and drained to enable the fish to be

weighed in the electronic balance. The weighed fish samples were then spread on the racks in the hot air drying oven, set at 70^{o}C for 18hour. The fish was then removed from the oven and ground to powder using a silimic mortar and pestle.

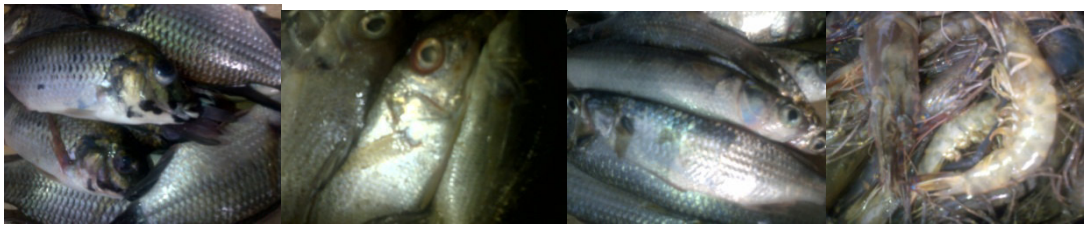

Figure 1 Tilapia sompat grunt mullet shrimps

Determination of heavy metal levels

Two grams of the fish samples were weighed into porcelain crucibles and placed in the muffle furnace which was then set at 550^{o}C for ashing. At the end of the 18hours, the furnace was switched off and allowed to cool to room temperature. The ash was then retrieved from the furnace. 3mls of conc. Nitric acid ($HNO_{3)}$ was added and with the use of a glass rod, the ashes were made to go into solution. This was diluted further with about 15mls of distilled water.

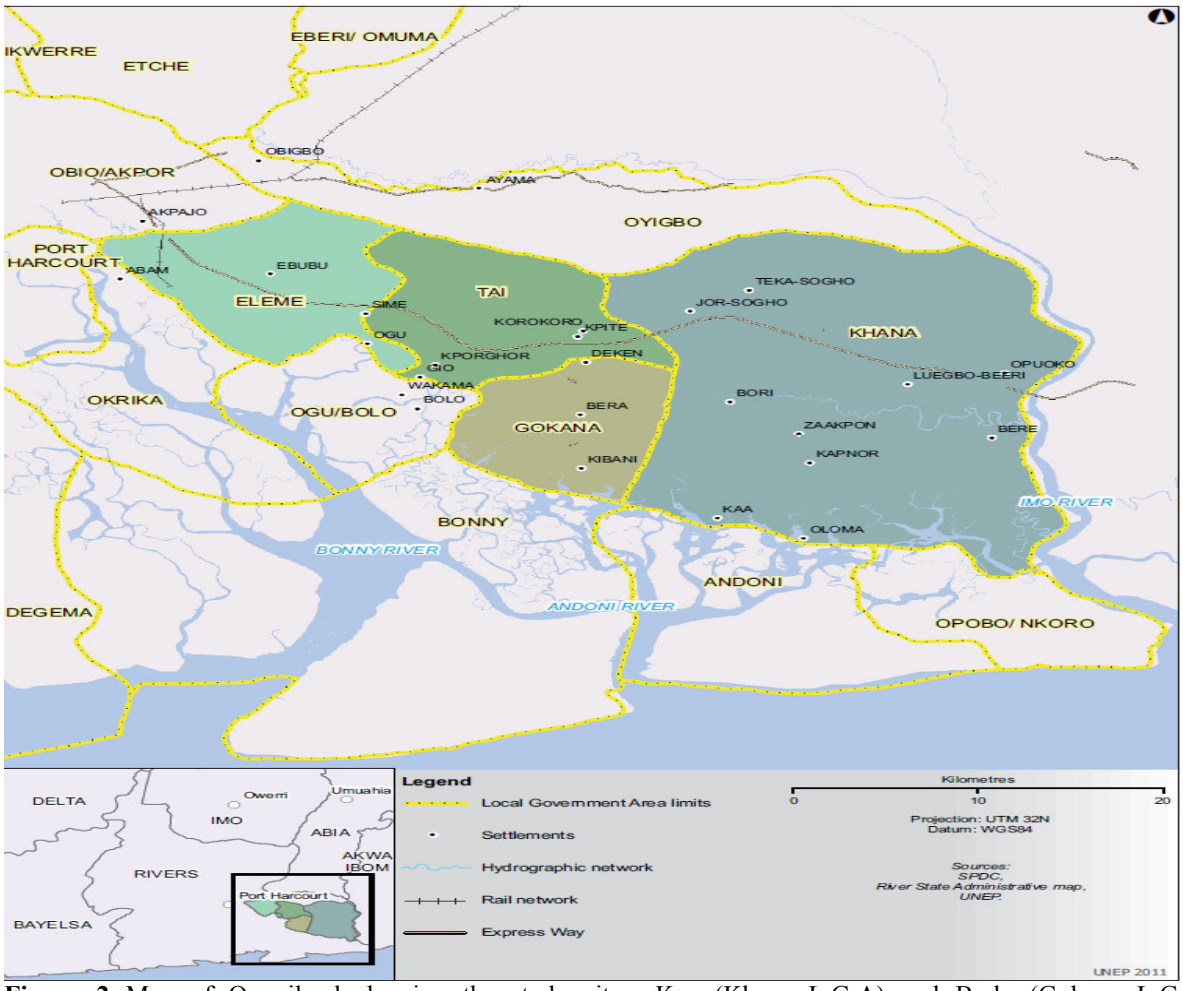

Figure 2 Map of Ogoniland showing the study sites; Kaa (Khana L.G.A) and Bodo (Gokana L.G.A) (UNEP,2011)

The ash mixture was filtered into 100ml volumetric flasks and made up to the mark with extra distilled water. The ashed and filtered samples were then transferred into plastic 120ml bottles and sent for atomic absorption spectroscopic analysis.

Atomic Absorption Spectroscopy (AAS) Analysis

For each of the metals, atomic absorption spectroscopy was calibrated using metal standard (Cr –

357.90nm, Cd – 228.80nm, Pb -283.30nm, Zn – 213.9nm, Mn – 279.50nm, Fe – nm). The extract was aspirated directly into the atomic absorption spectroscopy machine.

Atomic Absorption Spectroscopy Conditions

The atomic absorption spectroscopy (AAS) was GBC Avanta pm ver 2.02 Avanta. The carrier gas was acetylene and air: 70psi. In order to analyze the sample for its atomic constituents, it had to be atomized. The atomizers were flame and electro thermal (graphite tube) atomizers. The atoms were then irradiated by optical radiation. The radiation source could be an element-specific line radiation source or a continuum radiation source. The radiation then passed through a monochromator in order to separate the element-specific radiation from any other radiation emitted by the radiation source, which was finally measured by a detector.

RESULTS

Table 1 Heavy metals concentration (mean ± S.E.M, mg/Kg.) in fin and shell fish from study sites[Bodo (test site) and Kaa (control site)].

HEAVY METAL	TILAPIA KAA	BODO	SHRIMPS KAA	BODO	MULLET KAA	BODO	SOMPAT GRUNT KAA	BODO
Cr	0.02±.006^a	0.20±.006^b	0.02±.006^a	0.34±.015^b	0.03±.006^a	0.24±.015^b	0.02±.006^a	0.28±.006^b
Cd	0.02±.006^a	0.04±.006^b	0.01±.000^a	0.04±.006^b	0.01±.000^a	0.05±.006^b	0.02±.006^a	0.05±.006^b
Zn	0.33±.032^a	0.62±.142^b	0.35±.006^a	0.67±.006^b	0.32±.012^a	0.50±.006^a	0.30±.010^a	0.55±.010^a
Pb	0.01±.000^a	0.04±.006^b	0.01±.000^a	0.04±.006^b	0.02±.006^a	0.04±.007^a	0.03±.006^a	0.07±.006^b
Mn	0.10±.006^a	0.18±.012^b	0.12±.021^a	0.23±.006^b	0.14±.010^a	0.18±.006^a	0.13±.006^a	0.16±.017^a

Values are expressed as mean ± standard error of mean (S.E.M) of three replicates, (n=3). Values with different superscript (a,b) in the same row are significantly different at the 0.05 levels ($p< 0.05$)

To assess the potential health risk of heavy metals to humans contamination of heavy metals in fish were compared to the permissible limits recommended by UNEP (UNEP, 1985), FEPA (FEPA, 1991) or IAEA (Wyse *et. al*., 2003).

All the species collected from study sites contained the elements analyzed for (chromium, cadmium, lead, zinc and manganese) in detectable amounts. The result of the study showed that the mean heavy metals concentration occurred in the following increasing order: Tilapia Pb<Cr,Cd<Mg<Cr<Zn for samples from Kaa and Pb,Cd<Mn<Cr<Zn for samples from Bodo, Mullet Cd<Pb<Cr<Mn<Zn for samples from Kaa and Pb<Cd<Mn<Cr<Zn for samples from Bodo, Sompat grunt Cr,Cd<Pb<Mn<Zn for samples from Kaa and Cd<Pb<Mn<Cr<Zn for samples from Bodo and shrimps Pb,Cd<Cr<Mn<Zn for samples from Kaa and Pb,Cd<Mn<Cr<zn for samples from Bodo. This shows that the concentration of zinc is highest for all samples; from Kaa and Bodo however, it was not above the FAO maximum permissible limit. **Table 1** shows the mean concentrations of heavy metals analyzed for in Tilapia, Mullet Sompat grunt and Shrimps from the study sites. In tilapia, zinc measured the highest in tilapia collected from Bodo, and lead measured the lowest for tilapia collected from Kaa. The mean concentrations of all the heavy metals analyzed for in samples collected from test and control sites were below the UNEP, IAEA and FEPA maximum permissible limits of heavy metals in fish, as reported by Ekeanyanwu *et. al.,* 2011, except the mean concentration of chromium in Tilapia collected from Bodo, which was lower than the IAEA maximum permissible limit of 0.73, but higher than the FEPA maximum permissible limit of <0.10. In mullet, zinc measured the highest mean concentration for mullet collected from Bodo, and cadmium measured the lowest for mullet collected from Kaa. The mean concentrations of all the heavy metals analyzed for in the samples collected from Kaa were all below the FEPA, IAEA and FAO maximum permissible limits for heavy metals in fish, as reported by Ekeanyanwu *et. al*., 2011. However, for the samples collected from Bodo, the mean concentration of chromium was below the IAEA maximum permissible limit, but above the FEPA maximum permissible limits, for chromium in fish, and the mean concentration of cadmium was below the IAEA and UNEP maximum permissible limits, but within the FEPA permissible level. The mean concentrations of zinc, manganese and lead for samples collected from Bodo were all below the FEPA, UNEP and IAEA maximum permissible limits for heavy metals in fish (UNEP, 1985; Wyse *et. al.,* 2003; FEPA, 1991). In Sompat grunt, zinc measured the highest, for sompat grunt collected from Bodo, while chromium and cadmium measured the lowest, for sompat grunt collected from Kaa. The mean concentrations of all the heavy metals analyzed for samples collected from Kaa were all below the FEPA, IAEA and UNEP maximum permissible limits for heavy metals in fish, as reported by Ekeanyanwu *et.al.,* 2011. However, for the samples collected from Bodo, only the mean concentrations of zinc, lead and manganese were below the FEPA, IAEA and UNEP maximum permissible limits for heavy metals in fish. The mean concentration of cadmium for

samples collected from Bodo was below the UNEP and IAEA maximum permissible limits of 0.30 and 0.18 respectively, but within the FEPA permissible limits of 0.05, and the mean concentration of chromium for samples collected from Bodo were below IAEA maximum permissible limits of 0.73, but above FEPA maximum permissible limits of <0.10, for heavy metals in fish. In shrimps, zinc measured the highest, for shimps collected from Bodo, and cadmium measured the lowest, for shrimps collected from Kaa. The mean concentrations for heavy metals analyzed for in samples from Kaa and Bodo were all below FEPA, UNEP and IAEA maximum permissible limits for heavy metals concentration in fish, as reported by Ekeanyanwu *et. al*., 2011, except for the mean concentration of chromium in shrimps collected from Bodo, which was below IAEA maximum permissible limit, but higher than FEPA maximum permissible limit of heavy metals in fish.

DISCUSSION

It is important to note that the pH of a water body influences the concentration of many metals by altering their availability and toxicity. Virtually all metals can produce toxicity when ingested in excessive quantities, but there are some which are particularly important, because they are either pervasive or produce toxicity as complexes or "ligands" with organic compounds. When in complexes with these metals, the biological molecules lose their ability to function properly, and result in malfunction / death of affected cell.

The results show that lead and cadmium concentration were comparatively lower in comparison to the other elements tested in all the species. However, the presence, even in small amounts of lead and cadmium is threatening, because lead and cadmium belong to non-essential and toxic group of metals, which have no known function in biochemical processes, and are toxic even in low concentrations (Ozparlak *et. al.,* 2012). These results suggest that individuals consuming the samples from the study sites may be at risk of serious health hazards resulting from the accumulation of these heavy metals.

CONCLUSION

It can be concluded from the findings of this research that there is a significant pollution of the study sites with the presence of heavy metal pollutants in the test site (Kaa) and the control site (Bodo) studied, though, in much higher levels in the test site than the control site. The people of Ogoniland are exposed to significant health risks if they continue to consume the fish from these sites.

REFERENCES

Aberoumad, A. & Pourshafi, K. (2010). Chemical and proximate composition properties of different fish species obtained from Iran. *World Journal of Fish and Marine Sciences* Vol**.** 2 (3): 237-239.

Adnan, A. T., Ahmad, M. E., Muhammad, I., Khatak, M. and Khan, M. A. (2010). Evaluation of industrial and city effluent quality using physicochemical and biological parameters. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 9(5), pp 931-939.

Ali, M., Iqbal, F., Salam, A., Iram, S. & Athar, M. (2005). Comparative study of body composition of different fish species from brackish water pond. *International Journal of Environmental Science and Technology.* Vol. 2(3): 229-232.

Association of Official Analytical Chemists (AOAC). (2000). Official Methods of Analysis of the Association of Official Analytical Chemists, Vols. I & II, Association of Analytical Chemists, Arlington. 2000. 17th Edition.

Atuanya, E., Nwogu, N, and Akor, E. (2012). Effluent qualities of government and private abattoirs and their effects on Ikpoba River, Benin City, Edo State, Nigeria. Advances in Biological Research. Vol 6 (5): 196- 201

Ayeloja, A. A., George, F. O. A., Dauda, T. O., Jimoh, W. A. & Popoola M. A. (2013). Nutritional Comparison of Captured *Clarias Gariepinus* and *Oreochromis Niloticus. International Research Journal of Natural Sciences.* Vol.1 (1):9-13

Burger, J., Gaines, K..F., Shane, B. C., Stephens, W. L., Snodgrass, J., Dixon, C., McMahon, M., Shukla, S., Shukla, T., and Gochfeld, M. (2002). Metal levels in fish from the Savannah River: Potential hazards to fish and other receptors. Journal of Environmental Research. Vol **89** pp 85.

Canlı, M. and Atlı, G. (2003). The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environ. Pollut., Vol. 121**:** 129–136.

Carpenter, S. R., Caraco, N. F., Correl, D. L., Howarth, R.W., Sharpley, A. N. & Smith, W. H. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Journal of Applied Ecology*. Vol. 8(3):559-568.

Demirezen, D. and Ahmet, A. (2006). Heavy metal levels in vegetables in Turkey are within safe limits for Cu, Zn, Ni and exceeded for for Cd and Pb. *J. Food Qual*. 29:252-265

Dempson, I. B., Schwarz, C. J., Shears, M. & Furey, G. (2004). Comparative proximate body composition of Atlantic salmon with emphasis on Parr from fluvial and lacustrie habitats. *Journal of Fish Biology.* Vol.

64: 1257-1271

Ekeanyanwu, C. R., Ogbuinyi, C. A. & Etienajirhevwe, O. F. (2011). Trace Metals Disrtribution in Sediments and Water from Okumeshi River in Delta State, Nigeria. *Environmental Research Journal*. Vol. 5(1): 6-10.

Emami, K. F., Ghansari, M. and Abdollah, M. (2005). Heavy metals content of canned tuna fish. *Journal of Food Chem*. 93(2), 293-296.

Farkas, A., Salanki, J. and Specziar, A. (2003). Age- and Size- Specific Patterns of Heavy Metals in the Organs of Freshwater Fish *Abramis brama* L. Populating a Low- Contaminated Site," *Water Research*, 37 (5): 959–964.

Fawole, O. O., Yekeen, T. A., Adewoye, S. O., Ogundiran, M. A., Ajayi, O. E. & Nwaiya, M. N. (2013). Nutritional qualities and trace metals concentration of six fish species from Oba reservoir, Ogbomoso, Nigeria. *African Journal of Food Science.* Vol. 7(8): 246-252

Federal Environment Protection Agency (FEPA). (1991). Guidelines and standard for environmental pollution control in Nigeria. Federal Environment Protection Agency, Lagos.

Goodwin, T. H., Young, A., Holmes, M., Old, G., Hewitt, N., Leeks, G., Packman, K. and Smith, B. (2003). *Science of the Total Environment*. 314, 475-494.

Hussain, A., Sulehria, A. Q. K., Ejaz, M. and Maqbool, A. (2013). Monthly Variations In Physicochemical Parameters Of A Flood Plain Reservoir On River Ravi Near Balloki Headworks (Pakistan). *Biologia Pakistan* Vol. 59 (2), 371-377 PK ISSN 0006 - 3096

Labonne, M., Basin, S., Othman, D. and Luck, J. (2001). *Chemical Geology Journal*. Vol. 181. Pp 1-4, 181-191.

Majid, A., Mokhlesi, A., Bastami, K. D., Khoshnood, R. & Eshaghi, N. (2011). Survey of some chemical compositions and Fatty Acids in cultured Common Carp (*Cyprinus carpio*) and Grass Carp (*Ctenopharyngodon idella*), Noshahr, Iran. *World Journal of Fish Marine Science.* Vol. 3:533-538.

Mazumder, M. S. A., Rahman, M. M., Ahmed, A. T. A., Begum, M. & Hossain, M. A. (2008). Proximate composition of some small indigenous fish species in Bangladesh. *International Journal of Sustainable Crop Production.* Vol.3(4):18-23.

Muraleedharan, V., Antony, K. P., Perigreen, P. A. & Gopakumar, K. (1996). Utilization of unconventional fish resources for surimi preparation. Proceedings of the second workshop on scientific results of FORV SAGAR. Sampada. Dept. of Ocean development. New Delhi, (India). Pp 539-543

Nkpaa, K. W., Wegwu , M. O. and Essien E. B. (2013). Heavy metals concentrations in four selected seafood from crude oil polluted waters of Ogoniland, Rivers State, Nigeria. *Archives of Applied Science Research*. 5 (4): 97-104

Osman, A., Wuertz, S., Mekkawy, I., Exner, H. and Kirschbaum, F. (2007). *Journal of Environmental Toxicology*. Vol**.** 22 (4) Pp 375-389.

Ozparlak, H., Arslan, G. & Arslan, E. (2012). Determination of some metals levels in muscle tissue of nine fish species from Beysehir Lake, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, Vol. 12: (761–770).

Palani, K. M., Ruba, A. A., Jeya, S. R. & Shanmugam, S. A. (2014). Proximate and Major Mineral Composition of 23 Medium Sized Marine Fin Fishes Landed in the Thoothukudi Coast of India. *Journal of Nutrition and Food Science.* Vol. 4 (1):7-14

Patil. P.N, Sawant. D.V, Deshmukh. R.N (2012). Physico-chemical parameters for testing of water – A review. *International journal of environmental sciences* vol 3, no 3, 2012. ISSN 0976 – 4402

Ravichandran, S., Kumaravel, K. & Pamela, F.E. (2011). Nutritive composition of some edible fin fishes. *International Journal of Zoology and Research.* Vol. 7(3): 241-251.

Tucker, B. W. (2007). Overview of current seafood nutritional issues: Formation of potentially toxic products, in Shahidi F, Jones Y, Kitts DD (Eds.), Seafood safety, processing and biotechnology. Technomic Publishing Co. Inc., Lancaster, PA(USA)

United Nations Environmental Programme (UNEP). (2011). Environmental Assessment of Ogoniland. Published by United Nations Environmental Programme, Nairobi, Kenya. Pp 7-49, 198- 225. ISBN: 978-92-807-3130-9

United Nations Environmental Programme (UNEP). (1985). Reference methods for marine pollution studies. Determination of Total Hg in Marine Sediments and Suspended Solids by Cold Vapour AAS. Vol 26.

United States department of Agriculture, Natural Resources Conservation Service, Petroleum an Heavy metals. Retrieved from www.nrcs.usda.gov

Wyse, E. J., Azemard, S. & Mora, S. J. (2003). Report on the World-wide Intercomparison Exercise for the Determination of Trace Elements and Methylmercury in Fish Homogenate IAEA-407, IAEA/AL/144 (IAEA/MEL/72), IAEA, Monaco.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar