



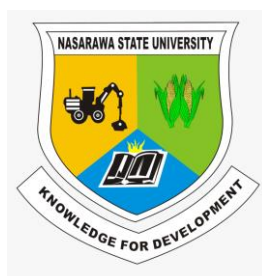
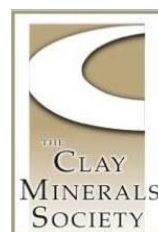
## ABSTRACT BOOK

**2<sup>nd</sup> International Students Conference on Medical Geology and  
Environmental Health-Africa Edition  
(ISCMGEH-Africa)**

**29 November – 1 December 2022**

**Compiled By:**  
*Prof. A. S. Olatunji*  
*Olayemi Opeyemi*  
*Oyaniran Opeoluwa*

## SPONSORS



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## **Brief History of the ISCMGEH**

### **Background**

A consortium of Senior Academics and Researchers in Medical Geology, Environmental Geochemistry and Health came together in 2021 to put together an international virtual platform for students (undergrads and postgrads) to showcase their research findings in environmental geochemistry and health and medical geology. The First edition of the Conference was held virtually on 18-20 October 2021 for the Latin Americas. Fifteen students participated with more than 100 attendees. These student researchers examined the impacts of the environment from both natural and anthropogenic influences on human, animal, and plant health. These are increasingly important fields of study that will help minimize adverse impacts of both modern industrial society and the natural environment on living organisms. The conference received institutional support from several International scientific and governmental organizations. The 2022 edition is devoted to the Africa Continent.

The advantage of this mode of conference is that it requires very little funding to organise, and it removed the financial burden on students as they do not need to travel to participate in an international scientific event. The students also do not pay any registration fees to participate in the conference.

This series of virtual conferences is designed to provide students with several benefits including:

- Providing students with a convenient opportunity to showcase their research
- Offering a comfortable venue to practice writing and speaking English, essential skills for professional development
- Allowing students, faculty, and others to learn of complimentary research being conducted within their region and to foster future collaborations
- Receiving constructive feedback on their research projects from knowledgeable attendees
- Fostering networking with other students and with established researchers in the region
- Providing tangible encouragement and awards for outstanding student research projects
- Posting their abstracts on several accessible, respected organizational platforms for web visibility
- Free one-year memberships in cooperating organizations

We acknowledge the support received from our numerous partners and sponsors as well as the huge enthusiasm of the students throughout the African continent and the diaspora for making this second edition a huge success. And believe that the future Conferences would be more successful.

**Prof Bob Finkelman**

**Prof Akinade Olatunji**

*For the 2022 ISCMGEH-Africa Planning Committee*

## ORGANISING COMMITTEES

### Advisory Committee:

1	Prof. Bob Finkelman	University of Texas, Dallas, USA
2	Prof. Nelly MANÑY	University of the Republic (Facultad de Química-Gral.), Flores 2124 Montevideo CP 11800, Uruguay
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4	Dr Christian Hartmann	IRD (Institut de Recherche pour le Développement) FRANCE
5	Dr Iosif Volfson	Russia Geological Society, RUSSIA
6	Prof. Imasiku Anayawa Nyambe	University of Zambia, ZAMBIA
7	Prof. Benjamin Mapani	Namibia University of Science and Technology, NAMIBIA
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11	Prof. Theo Davies	

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3	Prof. Odipo Osano	University of Eldoret, Kenya
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9	Dr Tesleem Kolawole	Osun State University, Nigeria
10	Dr Olubukola AFOLABI	Department of Geology, Afe Babalola University, Ado-Ekiti, Nigeria
11	Dr Jerry Olajide-Kayode	Osun State University, Nigeria
12	Dr Maryam Abduls-Salam	The Polytechnic, Ibadan, Nigeria/Monash University,
13	Dr Akinbile Victoria	University of Ibadan, Nigeria
14	Dr Bimbo Famuyiwa	Moshood Abiola Polytechnic, Abeokuta, Nigeria
15	Dr Nghargbu K'tso	Nasarawa State University Keffi
16	Dr. Ikabongo Mukumbuta	University of Zambia
17	Dr Nosiku Munyinda	University of Zambia
18	Chukwudi Nwoko	Nnamdi Azikiwe University, Nigeria/Kent State University, USA

### **Contact and Sponsorship**

1	Prof. Bob Finkelman	University of Texas, USA
2	Prof A. S. Olatunji	University of Ibadan, Nigeria

### **Conference Secretariat**

1	Prof A. S. Olatunji	Conference Chair & President SEGH
2	Olayemi Opeyemi	Conference Secretary
3	Oyaniran Opeoluwa	Conference Co-Secretary

## **SCHEDULE OF PRESENTATIONS**

Time	Tuesday 29 November 2022	Wednesday 30 November 2022	Thursday 1st December 2022
11:30-12:00	<b>OPENING CEREMONY</b>	<b>PLATFORM OPENS</b>	
12:00-12:05		<b>Keynote Talk 4 - Prof. Beneah D. O. Odhiambo</b> The Place of Geobotany in Geology	<b>Keynote Talk 5: Dr Kanneh Wadinga Fomba:</b> Indicators for Health Effects of Particulate Matter: Oxidative Potential
12:05-12:10			
12:10-12:15			
12:15-12:20			
12:20-12:30			
12:30-12:35	<b>Keynote Talk 1 - Prof. Imasiku A. Nyambe:</b> Environmental Impact of Copper and Lead Mining to Water, Agricultural Plants and Human Health in Zambia: Revisited		
12:35-12:40		<b>Shulamite O. Taiwo; Abiodun M. Odukoya and Michael J. Watts</b> The Concentration and Health Risk Assessment of Nitrate in Groundwater of Lagos, Southwest Nigeria	<b>Adamu Suleiman; Rifkatu Nghargbu, and Irena Ponikowska</b> Medicine, Geology, and Economics: The Synergy for Development and Environmental Safety
12:40-12:45		<b>Mbouemboue Nsangou Moussa Ahmed</b> Investigation of Pollution of Shallow Aquifer Waters by the Dumpsite in Douala City, Cameroon Using ERT Geophysical Method and Geochemical Water Test	<b>Eze Uchenna, Iliya Auta, and K'tso Nghargbu Balneo-geology</b> A tool for enhancing Balneotherapy & Balneotechnology
12:45-12:50		<b>Miranda Mboringong; Hyeladi Dibal; Uriah Lar and Edafetano Ashano</b> Evaluation of the Impact of Pollution Point sources (solid waste Dumpsites) on the Soils and Hand dug wells in Jos, Bukuru, Rayfield Areas, Northcentral Nigeria	<b>Marianne, E. A., Dibal, H.U., Isa, C. L., Lucius I., Zunnan, G and Carol, L</b> Contribution of Toxic Trace Elements in Earth Materials to the Prevalence of Kidney Diseases in Parts of Northeast and Northwest Nigeria
12:50-12:55		<b>Mustapha, S.O.; Olajide-Kayode, J.O. Olatunji, A.S. and Okunlola, O.A.</b> Impact of Artisanal Gold Mining on Soil Quality and Miners in Parts of the Proterozoic Ilesha Schist Belt, Southwestern Nigeria	<b>Sonia Shailong., Isah Okpanachi and Hyeladi Dibal</b> Mineral Source(s) of Fluoride in Groundwater of Kaltungo and Environs, North-eastern Nigeria
12:55-1:00	<b>Emmanuel Arhin; Amina W. Bukari; Raymond Kazapoe</b>	<b>Mubarak Abubakar; Maruf Abiola Agbaje and Idris Ahmad Sambo</b>	<b>Bilkisu Nafama, K'tso Nghargbu and Rifkatu Nghargbu</b>



	Trace Elements in Tailings: Understanding their Implications when the Tailings are used as Construction Materials	Heavy Metal Concentration in Determination of Water Quality and their Potential Risk for Human Health	Medical geochemistry, balneotherapy, and economic diversification
1:00-1:05	<b>Chukwuebuka Emeh; Benedicta Ozobialu; Chukwudi Ebenezer Nwoko; and Ejike Augustine Okoye</b> Environment-Human Bioaccumulation of Lead Resulting from Artisanal Lead-Zinc Mining Activities	<b>Osmond I., Nwali; Charles and C., Ugbor</b> Hydrogeochemical Facies Classification and Irrigation Water Quality Assessment of Water System in Okigwe South-eastern Nigeria	<b>Somtochukwul Azi and Chinenye Onyeabor</b> Assessment of Bioavailable Heavy Metals in Enyingba – Abakaliki Mine District, Nigeria; Health Implications
1:05-1:10	<b>Emmanuel Arhin; Pearl A. Ndo and Musah, S. Zango</b> Hotspots Analysis of Trace Elements in Areas Affected by Illegal Mining Activities: A case study at Mpatoam, Amansie West District, Ghana	<b>Q &amp; A SESSION III</b>	<b>Daniel John</b> The impacts of Climate Change on human health in Potiskum Area of Yobe state
1:10-1:15	<b>Temitope O. Adedayo; Abiodun M. Odukoya; and Michael J. Watts</b> Ecological and Health Risk Assessment of Potentially Toxic Elements (PTEs) in the soil of Artisanal Gold mine sites, Niger, North Central Nigeria		<b>Misheck Lesa Chundu, Imasiku A. Nyambe, Banda Kawawa</b> Effects of Land-Use Change on Ecosystem Services and the Future Scenario of the Bangweulu Wetlands, Zambia: A Remote Sensing Approach
1:15-1:20	<b>Rafiu Jimoh</b> Soil Geochemistry Assessment Around an Active Agricultural Land in Part of Minna, Northcentral Nigeria		<b>Q &amp; A SESSION IV</b>
1:20-1:25	<b>Zungukanji Nachilongo; Yoshitaka Uchida. , Ikabongo Mukumbuta and Jones Yengwe</b> Evaluating the potential of Cynodon dactylon and Imperata cylindrica for phytoremediation in lead contaminated soils of Kabwe		
1:25-1:30			
1:30-1:35		<b>Chileshe T. Kaoma; Nosiku Munyinda and Ntazana Sinyangwe</b>	

		Heavy Metal analysis in fish in selected Surface Water Bodies and Potential Health Effects in humans in Central Province, Zambia	<b>CLOSING CEREMONY</b>
1:35-1:40	<b>Keynote Talk 2 - Dr Geoff Plumlee:</b>  Medical geology: transdisciplinary science to understand the linkages between the earth, environment, disasters, and the health of humans and other organisms	<b>Julie Bwoga</b> Effects of Stocking Density and Seasonality on Digenean Trematode and Monogenean Infections in Nile Tilapia ( <i>Oreochromis niloticus</i> , Linnaeus 1758) reared In Cages in Uhanya Beach in Lake Victoria, Kenya	
1:40-1:45		<b>T.A. Laniyan, O.M. Morakinyo and K.C. Akindulureni</b> Microbial Diversity and Risk Assessment of Bioaerosols from Selected Dumpsites in Southwest, Nigeria	
1:40-1:50		<b>Peters, Michael Kwame</b> Spatial Analysis and Elemental Distribution of Trace Elements in Environmental Media Around Artisanal and Small-Scale Gold Mining Areas and their Implications on Environmental Health	
1:50-1:55		<b>Eleanor N. Jator</b> Environmental Pollution by Microplastics and Public Health Risks in Abuja Nigeria	
1:55-2:00		<b>Q &amp; A SESSION I</b>	<b>Ridwan, A.M; Dibal, H.U; Daspan, R. I.</b> GIS Mapping of Potentially Harmful Elements in Farm soils, Farm products and Mine Ponds located in areas devastated by Tin and Columbite Mining around the Jos – Bukuru and Barikin Ladi Tin Fields
2:00-2:05	<b>Muyaka Kamamba, Imasiku Nyambe and Kawawa Banda</b> Forest-Water Nexus with special interest in Evapotranspiration: A Remote Sensing-based approach		
2:05-2:10	<b>Keynote Talk 3: Prof Lynda Williams</b>  The Biogeochemistry of Wound Infections Treated with Natural Antibacterial Clays	<b>Q &amp; A SESSION IV</b>	
2:10-2:15			
2:15-2:20			
2:20-2:25			
2:25-2:30			

2:30-2:35			
2:35-2:40	<b>Olatunji, A.S; Olayemi, S.O; Adanike, M.F and Oyaniran, O.O.</b> Assessment of Metal Contents in Roadside Soils and Dusts of Offa, Nigeria		
2:40-2:45	<b>Vanessa U. Oparaugo; Tesleem O. Kolawole and Jerry O. Olajide-Kayode</b> Impact of Urbanisation on Soil Quality: Case study of Pb concentration in Osogbo Metropolis, Nigeria		
2:45-2:50	<b>Kavevaza Kaputuaza</b> Study on the harmful effects of Heavy metals on environmental health and food production in Namibia		
2:50-2:55	<b>Odukoya, A.M; Uzoewulu, G.A.; Akanbi, O.S. and Adeyemi M.O.</b> Contamination assessment of Potentially Toxic Elements in indoor dust within the University of Lagos, southwest Nigeria		
2:55-3:00	<b>Moses Mulenga and Ikabongo Mukumbuta</b> Effects of Chicken Manure and Chicken Manure-Derived Biochar on the Bioavailability and Concentration of Lead (Pb) in two Brassica Vegetables		
3:00-3:05	<b>Rhoda Kabaso; Jones Yengwe; Ikabongo Mukumbuta and Yoshitaka Uchida</b> The Effects of Biochar on Chemical Fractionation of Lead and Uptake by Lemon Grass in Heavy Metal Polluted Soils of Kabwe, Zambia		
3:05-3:10		<b>Q &amp; A SESSION II</b>	
3:10-3:15			
3:15-3:20			
3:20-3:25			

**Please Note that all time is in Central West African time**

## **KEYNOTE SPEAKER ABSTRACTS**

## **ENVIRONMENTAL IMPACT OF COPPER AND LEAD MINING TO WATER, AGRICULTURAL PLANTS AND HUMAN HEALTH IN ZAMBIA: REVISITED**

Imasiku Anayawa Nyambe  
Geology Department and UNZA IWRM Centre, School of Mines, University of Zambia, Box 32379,  
Lusaka, Zambia

### **ABSTRACT**

Mining has been known to fuel the socio-economic development of many countries, for example in Zambia, large-scale copper-cobalt mining developed in the 1930s and have continued to be in existence since that time. This has supported the social and economic development of the country accounting for about 93% of all of Zambia's foreign exchange earnings in 1991, and up to 80% in 2016. Copper production surpassed tonnages of over 600,000 tonnes between 1964 and 1980 and climbed to over 800,000 tonnes from 2011 to 2021.

A century of mining meant that the mining companies had to have licenses to discharge waste into the environment. Having these huge copper tonnages as well as open-cast operations, mining has created 1.899 million tonnes of overburden, covering an area of about 206,465ha, approximately 77 million tonnes of waste rock amounting to an area of 388 ha, 40 million tonnes of slag in an area of 279 ha, 791 million tonnes of tailings in an area of 9,562ha; with a total of 216,257ha occupying land for other purposes based on 2005 data. These have negatively impacted the environment and the ecosystem resulting in chemical pollution of water resources and agricultural plants in the Copperbelt region. Cobalt (Co), copper (Cu), manganese (Mn), selenium (Se), sulphates (SO<sub>4</sub>), calcium (Ca) and magnesium (Mg) markedly exceeding the permissible values for surface waters in the European Union. Limits for cadmium (cd), nickel (Ni) and zinc (Zn) and lead (Pb) also exceed the standards. Processing facilities consisting mainly of crushers, concentrators, smelters and refineries produce tailings that feed into tailing impoundments providing dust fallout on dry sections of the impounded areas affecting plant life, whereas their dams leak, discharging a pulp rich in iron (fe) and other heavy metals. The pH of waste waters from ore dressing plants employing chemical technologies fluctuated between 2.04 and 3.62 when insufficiently limed. The contents of Cu in these precipitates vary between 800 and 2,500 ppm, Co between 780 and 1,900 ppm, arsenic (As) between 2.7 up to 350 ppm, and Pb between 14 and 270 ppm. The contents of toxic elements in stream sediments reach 1,296 ppm arsenic, 3,660 ppm cobalt, 1,257 ppm chromium, 65,460 ppm copper, 6.47 ppm mercury, 48 ppm molybdenum, 360 ppm nickel, 1,370 ppm lead, 3,590 ppm zinc and 2.1 % sulphur total.

In agricultural plants, high concentration in roots and leaves have been noted in cassava roots and leaves for both arsenic and copper greater than 5 ppm and 200 ppm respectively growing near smelter plants mainly and tailing impoundments. Consumption of foods that grow up in polluted sites can be a health risk to humans and in Kabwe, Central Province of Zambia, where lead mining closed in 1994 after almost 100 years of mining, this has been a serious problem because blood lead levels particularly in children are above the reference level of 5.5 µg/dL to as much as above 50 ug/dl in some children. In contaminated soils, the lead can be above 20,000 pm and in some plants as much as 35ppm.

In conclusion and recommendation, there should be application of soil amendments to immobilize lead, copper and arsenic in the soil such as compost, animals' manure, biochar, and phosphate fertilizers before planting, and mix in the topsoil – to reduce lead, copper and arsenic levels in the edible plant parts and improve crop growth. In Kabwe, complete covering with clean topsoil the source area is recommended. Thorough washing of vegetables before cooking such as cassava leaves and other vegetables as lead, copper and arsenic containing dust particles accumulate on the vegetables whilst in the field. Thorough washing of vegetables before cooking has been shown to significantly reduce the concentration in cooked food as a simple, very effective practice that also promotes general hygiene. Therefore monitoring, maintaining standards and public awareness are strongly recommended as government is still finding a way of dealing with these environmental issues.

**Keywords:** mining impacts, water resources, agricultural plants, human health and environment

## **MEDICAL GEOLOGY: TRANSDISCIPLINARY SCIENCE TO UNDERSTAND THE LINKAGES BETWEEN THE EARTH, ENVIRONMENT, DISASTERS, AND THE HEALTH OF HUMANS AND OTHER ORGANISMS**

Geoff Plumlee, PhD  
Chief Scientist of the US Geological Survey

Medical geology is a vital part of [transdisciplinary science](#) that works to understand how the interactions between humans, the earth, the environment, disasters, and other living organisms affect health. It is the crucial geoscience component of an approach variously called [Environmental Health](#), [GeoHealth](#), and [One Health](#). Scientists from many earth and physical science disciplines contribute to these transdisciplinary efforts, such as geologists, geochemists, geophysicists, natural hazards scientists, analytical chemists, geospatial data analysts, and remote sensing specialists. We work in full cooperation with partners from many other science disciplines such as biology, microbiology, ecology, wildlife health, statistics, data science, information technology, public health, toxicology, epidemiology, biomedicine, engineering, economics, and risk communication. This presentation will use examples from Africa and elsewhere around the world to illustrate the foundational role that medical geology can play in advancing our understanding of human health within the complex earth system.

*Dr. Geoff Plumlee has been the USGS Chief Scientist since January 2019. In this role, he provides strategic scientific vision and counsel to the USGS Director and other executive leaders on inter- and transdisciplinary USGS science research priorities, activities, capabilities, and partnerships. From May 2016 to early 2020, Geoff was the USGS Associate Director for Environmental Health, where he led USGS research at the intersection of the environment and health. Geoff brought to these executive leadership positions 33 years of research and science leadership experience with the USGS, where, as a geologist and environmental geochemist, he helped carry out and lead many research projects on the linkages between mineral resources, the environment, disasters, and human health. Geoff holds a Bachelor of Science in Geology from the University of New Mexico and a Doctorate in Geochemistry from Harvard University, 1989. See his staff profile page at <https://www.usgs.gov/staff-profiles/geoffrey-plumlee> .*

## **THE BIOGEOCHEMISTRY OF WOUND INFECTIONS TREATED WITH NATURAL ANTIBACTERIAL CLAYS**

Lynda B. Williams

Arizona State University, School of Earth & Space Exploration, Tempe, AZ 85287-1404

In this talk I will review what we have learned about what makes certain clays antibacterial, and how they even successfully kill drug-resistant bacteria *in vitro*. However, *in vivo* testing has not been as successful due to complexation of Fe<sup>2+</sup> with biomolecules in wound fluids. Evidence suggests that competition with nano mineral precipitation in the wound interferes with the antibacterial mechanism. Methods to circumvent the precipitation of antibacterial reactants are needed.

## **THE PLACE OF GEOBOTANY IN GEOLOGY**

Beneah D. O. Odhiambo\*

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### **ABSTRACT**

This paper demonstrates the Place of Geobotany in Geology by first giving a brief reflective perception on the use of plants in geology; and then defines the term geobotany and underscores its economic and strategic importance in geology. Thirdly, the entry levels at which plants are used for general geological mapping (regional geobotany), and for specific identification of mineral deposits (indicator or target geobotany) are presented. How mineral uptake influences the spectral reflectance characteristics of plants (spectral geobotany) is presented in the fourth section of the chapter. Field geobotanical and biogeochemical techniques, including how to sample and treat plants for use as geological material are presented in the last part of the paper. In each of the sections experiences and data gathered around the chromite, fluorite and Pb-Zn mineral deposits in Kenya have been extensively used to underscore the place and usefulness of geobotany to geological studies.

**Keywords:** Geobotany, Remote Sensing, element concentrations.



## **INDICATORS FOR HEALTH EFFECTS OF PARTICULATE MATTER: OXIDATIVE POTENTIAL**

Khanneh Wadinga Fomba, Eduardo José dos Santos Souza, Nabil Deabji, Hartmut Herrmann  
Leibniz Institute for Tropospheric Research, Atmospheric Chemistry Department, Permoserstr.  
15, 04318 Leipzig, Germany

### **ABSTRACT**

Long-term and short-term exposures to ambient particulate matter (PM) have been associated with increased rates of morbidity and mortality. However, the mechanisms of these health effects are not yet well understood. PM mass has often been used as a metric to quantify air quality standards and their impact on health outcomes, however, not all PM components are linked with adverse effects indicating the limitation of PM mass as a metric for determining particle toxicity. Studies have shown that certain PM components can cause oxidative stress, which is one of the major mechanisms responsible for aerosol health effects. Such components e.g., transition metals, brown carbon, organic aerosols especially quinones, usually called PM-redox-catalysts (PRC), can catalyze redox reactions within the body and exacerbate the formation of reactive oxygen species (ROS). Higher ROS concentrations over the body's antioxidant capacity may lead to cell damage and respiratory illnesses. The ability of aerosol particles to produce ROS called its oxidative potential (OP), can be measured using several acellular methods, such as ascorbic acid (AA), dithiothreitol (DTT), electron spin resonance, and glutathione assays. Contradictory associations to health endpoints such as Asthma, lung cancer, and pulmonary diseases have been observed with these assays, however, the mechanisms responsible for these differences are still not understood. In this study possible mechanisms that may explain these differences are highlighted. Investigations of PRC on AA OP assays ( $OP^{AA}$ ) and  $OP^{AA-SELF}$  (assay with higher antioxidant content) show that, depending on the chemical interactions between the PRC, the OP value can vary up to about 50% (e.g., 2.37 to 2.79  $\text{nmol min}^{-1}$ , for interactions between Cu & Zn in  $OP^{AA}$ , and 1.09 to 1.43  $\text{nmol min}^{-1}$  in  $OP^{AA-SELF}$ ). These antagonistic and synergistic effects seem to be stronger for OP assays with higher antioxidants (e.g.,  $OP^{AA-SELF}$ ) and those with lower antioxidants ( $OP^{AA}$ ), respectively. Investigations of PM samples from two African cities (Praia, Cabo Verde, and Fez, Morocco) influenced by mineral dust and anthropogenic emissions, respectively, further highlight the impact of the PRC such as quinones, and transition metals on the OP. Besides OP assays, cell-based assays where PM extracts are incubated with human cells are also used to predict PM toxicity. Such assays have shown the pro-inflammatory effects of PM under the influence of chemical species such as Fe, Al, organics, and microorganisms. The combination of these assays provides new insights into the prediction of the toxicity of inhaled aerosol particles.

**Keywords :** Ambient particulate matter, oxidative stress, redox-catalyst, pro-inflammatory

## **STUDENT PRESENTER ABSTRACTS**

## **IMPACT OF ARTISANAL GOLD MINING ON SOIL QUALITY AND MINERS IN PARTS OF THE PROTEROZOIC ILESHA SCHIST BELT, SOUTHWESTERN NIGERIA**

Mustapha, S.O.<sup>1,2\*</sup>, Olajide-Kayode, J.O.<sup>1,3</sup>, Olatunji, A.S.<sup>4</sup> and Okunlola, O.A.<sup>4</sup>

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### **ABSTRACT**

Osu and Itagunmodi areas of southwestern Nigeria have a long history of artisanal gold mining, which is done with crude tools and equipment. The lack of safety regulations or precautions during mining activities poses adverse environmental effects not only on the environmental media but also the health of miners and residents around mining sites. This study evaluates the quality of soils around three Artisanal Gold Mine (AGM) pits within this area and assesses potential impact on the health of both artisanal miners and residents. Thirty-nine soil samples were obtained along horizontal profiles around AGM pits at Orogo, Amuta and Itagunmodi, with three control samples obtained in areas outside the mining areas. The samples were analysed for Potentially Toxic Elements (PTEs) such as Mo, Cu, Pb, Zn, Ag, Co, As, Cd and Hg, using Inductively Coupled Plasma-Mass Spectrometry technique sequel to aqua regia digestion. Calculated Enrichment Factor showed the soils of Orogo area had moderate enrichment of Co and Cu with extremely high enrichment of As, Ag and Hg, while Amuta and Itagunmodi had extremely high enrichment of Ag and Hg. Geoaccumulation Index and Contamination Factor calculations indicated moderate contamination of Cu and Co, with very high contamination of As in Orogo area, while all three AGM sites were very highly contaminated with Ag and Hg. Contamination degree and pollution indices for Orogo (1233.48; 694), Amuta (844.42; 463) and Itagunmodi (584.52; 289) confirmed that all three sites were very highly contaminated and severely polluted. Health Quotient (HQ) of dermal contact calculated for miners, adults and children showed no likely adverse effect of Ag and Hg in all three pits for miners, while Health Indices (HI) revealed that miners are more likely to experience adverse effect of Hg exposure if mining continues (Orogo 0.75; Amuta 0.39; Itagunmodi 0.36). The significant pollution and possible adverse health effects especially on the miners are a cause for concern, as prolonged contact with these soils can lead to long term effects including cancer, and damage to liver, kidney, heart, blood vessels and thyroid.

**Keywords:** Artisanal Gold Mining, considerable contamination, mercury enrichment, miners, Hazard Quotient.

## **TRACE ELEMENTS IN TAILINGS: UNDERSTANDING THEIR IMPLICATIONS WHEN THE TAILINGS ARE USED AS CONSTRUCTION MATERIALS**

Emmanuel Arhin<sup>1</sup>, **Amina W. Bukari**<sup>2</sup>, Raymond Kazapoe<sup>3</sup>  
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<sup>1</sup>University of Energy and Natural Resources, School of Geosciences, Department of Geological Sciences, P. O. Box 214, Sunyani, Bono Region, Ghana.

<sup>2</sup>Pan African University of Life and Earth Sciences, University of Ibadan, Ibadan, Nigeria.

<sup>3</sup>University for Development Studies, Department of Engineering Geology, Nyankpala, Ghana.

### **ABSTRACT**

The essentiality of elements to humans depends on exposure degree and the dosage rate. Utilising mined out materials for construction purposes requires ascertaining element concentration levels. This study aimed at establishing the elemental composition and concentrations of tailings material to assess its suitability as a construction material.

Forty (40) tailings dam materials at Kinross Gold Mining Limited (6°18'37" N 2°22'59" W) in the Western Region of Ghana were sampled for their elements distributions and concentrations using the Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) analytical method. Eleven (11) elements including As, Hg, Mo, Cd, Pb and Zn were analysed. Results were statistically analysed using Microsoft Excel.

All the elements analysed and compared with global background values in soils showed depletion except Mo which showed an enrichment factor of 49.1780. The calculated geo-accumulation index (Igeo) of all selected elements also showed no pollution with only Mo depicting moderate pollution with an Igeo value of 1.1876. Assessment of localized pollutions using Pollution Load Indices (PLI) calculated relative to the landscape locations showed  $PLI < 1$  with values between 0.0007 and 0.0724 making them perfect except for a sample with PLI of 1.5191. Cyanide (CN), used in metallurgical extraction also showed depletion in the analysed samples.

The results revealed that apart from Mo that appeared polluted in the area, all the other elements showed depletion when compared with the global background values. It was thus concluded that the polluted element identified by Igeo and PLI has no known detrimental effects on humans and therefore the tailings dam material could be used for all sorts of construction works and agricultural purposes as well.

**Keywords:** Mine tailings, global background values, pollution load index

## **ENVIRONMENT-HUMAN BIOACCUMULATION OF LEAD RESULTING FROM ARTISANAL LEAD-ZINC MINING ACTIVITIES**

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### **ABSTRACT**

The proliferation of shallow mine pits and indiscriminate dumping of mine tailings in the environment due to artisanal Lead-Zinc mining activities within the study area puts the immediate environment at risk of Lead toxicity. Considering the adverse effect of Lead toxicity on humans, it became imperative to evaluate the availability of Lead within the environment and to ascertain the potential pathway through which the contaminant can enter the human body.

For this reason, soil, plant, groundwater, surface water, and human blood samples were collected to determine the amount of Lead in the environment. The samples were collected within and beyond the mine catchment area in such a way to reflect lateral variation. Samples were chemically digested and thereafter subjected to spectroscopic analysis using the atomic absorption spectroscopy method for the plant, soil, and water samples, whereas inductive coupled plasma mass spectroscopy was employed for blood sample analysis. Biogeochemical and statistical analysis such as bioconcentration factor (BCF), bioaccumulation factor (BAF), and Pearson's correlation analysis were employed to determine the relation between the concentration of Lead in the physical environment and in the biological environment. All sample collection procedures and laboratory analysis followed the American Public Health Association (APHA) standards, whereas all the biogeochemical and statistical analysis was done with Microsoft Excel.

Results of the laboratory analysis revealed that the average Lead concentration in the environment was 0.49 mg/kg, 0.03 mg/kg, 0.04 mg/L, and 0.01 mg/L in soil, plant, surface water, and groundwater, respectively. The correlation coefficient of 0.9 between the Lead concentration in plant and soil, and an average bioconcentration factor of 0.20 was evidence of soil to plant transfer of Lead. Total environment-human bioaccumulation of Lead was 3.95 of which 48%, 37 %, and 15 % of it were contributed by ingestion of surface water, plants, and groundwater, respectively. The average concentration of Pb in the blood of the residents within the study area (0.36 mg/L) was above the normal permissible limit in human blood.

**Keywords:** Mine tailings, spectroscopic analysis, bioconcentration and bioaccumulation factors

## **HOTSPOTS ANALYSIS OF TRACE ELEMENTS IN AREAS AFFECTED BY ILLEGAL MINING ACTIVITIES: A CASE STUDY AT MPATOAM, AMANSIE WEST DISTRICT, GHANA**

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### **ABSTRACT**

Elements distribution and concentration levels in surface environments can reveal spatially, terrains enriched in disease-causing-elements and deficiency of essential elements. Both scenarios have health implications to humans. Mpatoam, a town in Ghana, has seen numerous illegal mining operations that will influence elements mobility and concentrations, which forms the focus for this study, to identify hotspots of trace elements.

Twenty-five soil (25) samples were collected from alluvial plains and an elevated embankment. The samples were analyzed using X-Ray Fluorescence (XRF) for thirteen (13) trace elements (V, Cr, Ni, Cu, Zn, As, Rb, Sr, Zr, Nb, Mo, Ba and Pb). The interrelations among the elements in the samples were assessed using multivariate factor analysis and pollution levels assessed with three (3) indices.

Factor 1 (PCA1) represented As-group, and related to the underlying geology, suggesting that As and Cr toxicities have their sources linked to the geology, but their spread facilitated by mining activities. Comparison of the results with continental crustal averages showed toxicities of As, Cr, V, Zr, Ni and Mo from Contamination Factor (CF) and Pollution Load Indices (PLI). However, Cu, Zn, Pb, Rb, Sr, Ba and Nb were deficient. Geoaccumulation Index (I<sub>geo</sub>) for As indicated moderate pollution while 12 other elements were marked as unpolluted. Spatial maps for the transformed data indicated hotspots for As and Cr at all points with highest values from active points for As. Zn generally indicated cold spots.

Disease-causing elements based on the hotspots and coldspots of these elements in the area revealed effects on the health of the people, which calls for further investigation on water and food crops grown in the area.

**Keywords:** Disease causing elements, pollution hotspots, pollution load indices

## **ECOLOGICAL AND HEALTH RISK ASSESSMENT OF POTENTIALLY TOXIC ELEMENTS (PTES) IN THE SOIL OF ARTISANAL GOLD MINE SITES, NIGER, NORTH CENTRAL NIGERIA**

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### **ABSTRACT**

Globally the artisanal gold mining site is a possible source of pollution associated with PTEs. In the study area, mining and gold processing sites are adjacent to farmlands which pose risks not only to the environment but also the health of the populace. The purpose of the research was to determine the health risk of PTEs in the ore samples, agricultural soil, and mine wastes within the vicinity of artisanal gold mine and processing sites in Niger state, a north-central part of Nigeria. 33 samples were collected, and geochemical analysis were determined using Inductively Coupled Mass Spectrophotometry (ICPMS) method.

Nine PTEs were considered for the purpose of this study and follow the order As>Pb>Cu>Fe>Zn>Mn>U>Cr>Ni with values higher than upper crustal values in 93.94%, 90.91%, 78.79%, 60.61%, 60.61%, 45.45%, 42.42%, 15.15%, and 6.06% of the samples respectively. The soil samples can be classified as unpolluted to very high polluted (0.30 - 29.60) and low to very high risk (35.31 - 33034.85) based on Pollution Load Index and Potential Ecological Risk Index evaluation respectively. Average daily dose and hazard quotient (HQ) were calculated for adults and children in the study area and decreased in the following order: ADD<sub>dermal</sub> > ADD<sub>ingestion</sub> > ADD<sub>inhalation</sub>. The non-carcinogenic health risk index (HI) of PTEs calculated for children and adults in the study area varied between 3.4 - 467 and 0.6 - 69 respectively. Most of these values were higher than a considered safe level (= 1) and therefore showed that these PTEs posed a serious non-carcinogenic HI for both adults and children exposed to the soil in the study area.

The mining and processing areas in the study area poses a serious non carcinogenic and carcinogenic health risks to the populace especially the children and it is important to put in place appropriate remediation strategies to minimise the risks in the area.

**Keywords:** Mines wastes, agricultural soil, non-carcinogens

## **SOIL GEOCHEMISTRY ASSESSMENT AROUND AN ACTIVE AGRICULTURAL LAND IN PART OF MINNA, NORTHCENTRAL NIGERIA**

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### **ABSTRACT**

Minor and Major element in an agricultural field has been evaluated using the Energy Dispersive X-ray Fluorescence Method (EDXRF) in part of Minna, North central Nigeria. A total of Ten (10) distinctive soil samples were collected, bagged and later transported to the Energy Research Centre, Zaria for further analysis. The precise location of each of the soil sample Points were acquired by Garmin 72 Global Positioning system (GPS) system. The soil samples collected were assigned labeling S1 to S10 using the maker for proper identification. Correlation of soil samples results with the concentration of essential elements as described in literature were established and results showed that the mean concentration of the soil samples is 0.71 % for Magnesium which is lower than standard of 0.83 %. Magnesium concentration for samples 1, 2, 3, 4, 5, 6, 8, and 10 were found extremely low except for sample 7 and 9 with concentration value of 3.42% and 2.08%. However, calcium mean concentration of the soil samples was found higher than the mean as described by standard (2.2% >2.0%) while the calcium values in the soil were extremely low. This can affect the yield of the agricultural crops grown on the soils. The mean percentage of the Potassium is low compared with the standard described by (1.3 % < 1.8%). Manganese value for sample 10 is 1250 ppm and sample 6 is 3050ppm being the highest. The mean concentration calculated for major element was found to be in the magnitude K (2.17%)>Fe (1.60%)>Ca (1.30%)>Mg (0.71%) and minor element, Mn (895ppm)>Zn (176ppm)>Cu(155.86) respectively. The soil geochemical analysis shows a distinctive variation in concentration of element from one location to another. There are deficiencies analysed elements in the soil from the area and this can affect the growth and yield of the agricultural crops especially yam grown in the area.

**Keywords:** Energy Dispersive X-ray Fluorescence Method, Soil samples, Major and minor elements, Agricultural field



## **ASSESSMENT OF METAL CONTENTS AND THEIR ECOLOGICAL IMPLICATIONS IN ROADSIDE SOILS AND DUSTS OF OFFA, NORTHCENTRAL NIGERIA**

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### **ABSTRACT**

The geochemical mapping of soils and dusts of urban areas is essential for planning and assessment of impact of urbanization on the environmental media. An assessment of roadside soils and dusts of Offa Town in North Central, Nigeria was undertaken with a view to assessing their metal distribution and environmental implications.

Physico-chemical parameters; Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Potential of Hydrogen (pH) of the samples were also determined for fifty (50) samples comprising roadside soils (30) and dusts (20). Some portions of the samples were obtained to undergo grain size analysis. The samples were air-dried, disaggregated and sieved to appropriate sizes for geochemical analysis. They were digested using Aqua regia and subsequently analysed using Inductively Coupled-Plasma Optical Emission Spectroscopy (ICP-OES) for elemental composition of the samples. Statistical and geochemical evaluation of the results were undertaken using Microsoft Excel and statistical software IBD-SPSS (version 20.0) to determine their elemental associations and quality of the environmental media. The obtained results were then used for the generation of geochemical maps using ArcGIS. Pollution indices including geo-accumulation index ( $I_{geo}$ ), contamination factor (CF), contamination degree (CD), pollution load index (PLI) was determined. Additionally, ecological risk to the studied environment was also assessed.

The grain size distribution showed that the obtained soil samples are predominantly silty in nature. The average pH (6.95) revealed slightly acidic conditions while EC and TDS ranged 42.4-3130.2  $\mu$ S/cm and 26.6-1998 mg/L, respectively. The selected elements (mg/Kg) were in the following ranges of concentration of all media: Cu 17.0-654.0; below detection limit (bdl)-1151.0; 22.0-2129.0; 7.0-97.0; 6.0-27.0; 422.0-1396.0; 8.0-733.0; 47.0-293.0; 30.0-266.0; and 65.0-583.0.

The high level of contamination in the study area appeared to be influenced by Pb and Zn concentrations. This contamination could be due to traffic and vehicular activities in the area. All of the selected elements aside from Pb were low risk metals from an ecological standpoint. However, a moderate level of risk is still considered to exist. The elemental concentrations in the study area have been contributed by a combination of both lithogenic and anthropogenic inputs

**Keywords:** Geochemical Mapping, Metal Distribution, Pollution Indices, Lithogenic inputs, Anthropogenic inputs

## **IMPACT OF URBANISATION ON SOIL QUALITY: CASE STUDY OF Pb CONCENTRATION IN OSOGBO METROPOLIS, NIGERIA**

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### **ABSTRACT**

Since becoming the capital of Osun state, Osogbo metropolis, like other large cities, has been undergoing urbanisation because of industrialization and population growth. These changes are often accompanied by contamination of environmental media from associated anthropogenic activities. This study assessed the concentration of Pb in soils of Osogbo metropolis relative to different land uses to evaluate the degree of contamination and determine the current state of soil quality in the area.

Sixty-four soil samples collected at high density residential/commercial area (RC, n=15), industrial area (IA, n=10), heavy traffic area (HT, n=15), farmland (FL, n=13), and solid waste landfill (LF, n=11) were air-dried, disaggregated and sieved to < 75-micron fraction. After aqua regia digestion, the samples were analysed by Inductively Coupled Plasma Emission Spectroscopy (ICP-ES). Results obtained were interpreted using descriptive statistical parameters while environmental indices (Metal Ratio, Index of Geoaccumulation [ $I_{geo}$ ], Contamination Factor [ $C_f$ ], and Ecological Risk Factor [Er]) were used to estimate the degree of soil pollution and the ecological risk for humans and biota.

The Pb concentration (ppm) in soils from high density residential/commercial areas ranged from 13.60 to 702 (average:  $120.9 \pm 173.36$ ); industrial areas, 23 to 1410 (average:  $218.20 \pm 423.43$ ); heavy traffic areas, 54 to 201.50 (average:  $108.01 \pm 40.32$ ); farmland, 12 to 47 (average:  $22.54 \pm 7.96$ ) while for solid waste landfills, 17 to 495 (average:  $91.82 \pm 146$ ).

It was observed that the mean concentration of Pb in soils taken from industrial soils were up to 17 times higher than the average crustal value of Pb. Furthermore, the mean Pb concentration in high density residential/commercial, heavy traffic areas, and solid waste landfills were approximately 10, 9, and 7 times higher than the Pb in the average crust, respectively. Farmland soils had as much as twice the concentration of the average background value of Pb. The results also revealed that the soils from the IA, RC and LF fell within the highest  $I_{geo}$  classes, with the upper values ranging from heavily-extremely to extremely contaminated. The highest recorded  $C_f$ , from IA fell in the very high contamination class ( $C_f \geq 6$ ) while farmland soils had the lowest  $C_f$  indicating low contamination status. All sampled sites exhibited low potential ecological risk with the least being from farmland soils (Er = 5.64) and the highest from industrial areas (Er = 54.33); indicating moderate potential ecological risk.

Overall, the quality of the urban soil in Osogbo is clearly deteriorating. However, further detailed investigations should be carried out, with a larger sampling size and inclusion of other media, to better evaluate the impact that urbanisation is having on the quality of the environment in Osogbo metropolis.

**Keywords:** Urbanisation; Index of Geoaccumulation; considerable ecological risk; Pollution index; Osogbo

## **STUDY ON THE DISTRIBUTION OF HEAVY METALS IN SOIL AND FOOD PRODUCED IN FARMS FROM THE TSUMEB AND OTAVI AREAS, NAMIBIA.**

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### **ABSTRACT**

Environmental problems have always been a concern to the environment and the people and Animals living in the environment. This study focuses on the harmful effects of heavy metals on food production and agriculture.

The Oshikoto region of Namibia's Tsumeb and Otavi areas served as the study's location. Assessing the concentration, distribution, and chemical movement of a few hazardous heavy metals in the soil and food produced was the main goal. Farm samples of the soil and food were gathered. Throughout a two-year span.

In Tsumeb, the mean concentration of heavy metals in soil samples over the study period varied from 0.8 mg/kg to 1513.72 mg/kg to 7.97 mg/kg to 1.21 mg/kg to 2.03 mg/kg to 13.18 mg/kg and 9.36 mg/kg, while in Otavi it varied from 0.41 mg/kg to 1082.9 mg/kg to 7.96 mg/kg to 0.53 mg/kg to 1.75 mg/kg to 7.82 mg/kg and 8.49 Over the course of the study period, the mean content of these hazardous metals in dietary samples varied from 5.8 mg/kg to 12.49 mg/kg to 0.68 mg/kg to 1.27 mg/kg to ND and ND from Tsumeb. While the concentration from Otavi ranged from 0.64 mg/kg; mg/kg; 62.3 mg/kg; 0.65 mg/kg; 0.61 mg/kg and 7.33 mg/kg 13.87 mg/kg 4.38 mg/kg for Cr, Mn, Hg, Ni, Cu, Zn and Pb respectively. Both soil and food samples contained substantial amounts of the analyzed elements. Metals accumulation Factor (AF) values greater than 1 were found in food samples of manganese, copper, nickel, and zinc, indicating chemical mobility of metals from labile metal components found in soil samples. The amounts of Manganese, Copper, Nickel, and Zinc discovered in dietary samples were found to be greater than permitted concentrations in food.

**Keywords:** Heavy Metals, Environmental Health, Food Production and Agriculture.

## **CONTAMINATION ASSESSMENT OF POTENTIALLY TOXIC ELEMENTS IN INDOOR DUST WITHIN THE UNIVERSITY OF LAGOS, SOUTHWEST NIGERIA**

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### **ABSTRACT**

Pollution studies and health risks associated with exposure to Potentially Toxic Elements (PTEs) in dust samples from the different schools were investigated.

Nineteen indoor settled dust samples were collected from classrooms in four (4) different schools and were subjected to geochemical analysis using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Contamination and health risk indices including Geo-accumulation Index (Igeo), Contamination Factor (CF), Pollution Load Index (PLI), Hazard Quotient (HQ), Hazard Index (HI) were derived.

The PTE concentrations were in the order of Zn > Cu > Pb > Co > U > Cd and observed to be higher than average crustal values with exception of Co. Igeo values showed the dust was unpolluted with Co, U, and Cu but moderately to highly polluted with Cd, Zn, and Pb. CF values suggest that the degree of contamination is low for Co, moderate for U and Cu and high for Cd, Zn, and Pb. The PLI value ranged from 1.33 to 5.99 showing significant enrichment of PTEs in all the samples. The Hazard Quotient (HQ) showed that Pb in dust from SS6 and SS7 could have adverse effect on kids and adults via ingestion and dermal routes. Hazard Index (HI) in adults suggests significant Pb risk with values (avg. 1.12) > 1 in 63% of the samples.

Dust from the schools is moderately to highly polluted with Cd, Zn and Pb while only Pb and Cd can pose human health risk in the classrooms.

**Keywords :** Geoaccumulation Index, contamination degree, metal enrichment,

## EVALUATING THE POTENTIAL OF *CYNODON DACTYLON* AND *IMPERATA CYLINDRICA* FOR PHYTOREMEDIATION IN LEAD CONTAMINATED SOILS OF KABWE

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### ABSTRACT

Heavy metal contamination in Kabwe town particularly Pb contamination is of serious concern. Several phytoremediation measures with the aim to remediate Pb contamination have been used with a focus on the use of exotic grasses. However, very few Pb phytoremediation studies employing the potential use of native grasses in Kabwe have been done. Therefore, this study employed the use of native grasses *Cynodon dactylon* (couch grass) and *Imperata cylindrical* (cogon grass) for phytoremediation of lead contaminated soil.

A greenhouse pot study consisting of four grasses; couch, cogon, lemon, and vetiver, replicated four times in a Completely Randomized Design was carried out to evaluate their potential for phytoremediation of lead in contaminated soils. All grasses and soil samples were collected from Kabwe. Grasses and soil before planting and after harvest were analysed for Pb using wet acid digestion (plant Pb) and aqua regia (total soil Pb), DTPA (extractable soil Pb) respectively. The potential of the grasses for phytoextraction and phytostabilization was evaluated using the bioconcentration factor (BCF), translocation factor (TF) and bioaccumulation factor (BAF).

Results showed that cogon grass had the potential for phytoextraction (BAF and TF > 1) compared to lemon grass (TF, BAF and BCF > 1) an already established phytoextractor. Results further showed that couch grass can be used for phytostabilization (BCF > 1, TF and BAF < 1) compared to vetiver grass a phytostabilizer (TF < 1, BCF and BAF < 1).

**Keywords:** Completely randomized design, phytoextraction, phytostabilization

## EFFECTS OF CHICKEN MANURE AND CHICKEN MANURE -DERIVED BIOCHAR ON THE BIOAVAILABILITY AND CONCENTRATION OF LEAD (PB) IN TWO *BRASSICA* VEGETABLES

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### ABSTRACT

Lead (Pb) contamination has been widely reported in Kabwe town soils due to mining activities. The bioavailability and excessive amounts of Pb in soils are toxic to both plants and microorganisms. Manure and biochar have been reported to immobilize heavy metals in soil. This study thus evaluated the effects of chicken manure and chicken manure-derived biochar on the bioavailability of Pb in the soil and its uptake by plants in polluted garden soils of Kabwe.

Pots containing Pb contaminated soil with five treatments of manure and biochar in the following proportions: CT (un-amended polluted soil, control); 2% and 4% of CM (chicken manure); 2% of and 4% of CMB (chicken manure-derived biochar) were used in this study. The manure and biochar were applied as a percentage of total mass of soil in the pot. *Brassica napus* (rape) was planted and grown in the soils under greenhouse conditions for nine weeks. After harvesting the rape, *Brassica rapa* (Chinese cabbage) was planted in the same pots and grown for eight weeks. The planting of Chinese cabbage was done to ascertain the residual effects of the amendments. Soil pH and bioavailable Pb were measured six times during the experiment and after the harvest, Pb concentration in plant tissues was determined using Flame Atomic Absorption Spectroscopy (FAAS-Z series 2010).

Concentrations of bioavailable Pb were higher in the amended soils of 2 % and 4% CM ( $18.90 \pm 1.5$ ;  $21.18 \pm 2.3$  mg Pb/kg), 2% and 4% CMB ( $29.16 \pm 2.4$ ;  $41.15 \pm 2.6$  mg Pb/kg) compared to CT ( $18.36 \pm 1.6$  mg Pb/kg). Despite higher bioavailable Pb in the manure and biochar amended soils; the concentration of Pb in both rape and Chinese cabbage tissues was lower than that in un-amended polluted soil (CT). Concentration of Pb in rape from 2% and 4% CM were less than detection limit, 2 % and 4% CMB were  $12.79 \pm 2.49$  mg Pb/kg and  $8.4 \pm 0.20$  mg Pb/kg while concentration of Pb in rape from CT was  $35.13 \pm 13.72$  mg Pb/kg. In Chinese cabbage, all amendments had Pb concentrations in plant tissues less than detection limit while the value in CT was  $8.13 \pm 0.97$  mg Pb/kg.

The experiment showed that amendment application with increase in dose application results to reduced Pb uptake by the plants and concentration, despite increased Pb mobilization in soil. It is recommended that these amendments can be used for remediating Pb contaminated soils, as they seem to reduce Pb concentrations in plant tissues.

**Key words:** contaminated lead (Pb) soil, bioavailability, remediation, amendments.

## **THE EFFECTS OF BIOCHAR ON CHEMICAL FRACTIONATION OF LEAD AND UPTAKE BY LEMON GRASS IN HEAVY METAL POLLUTED SOILS OF KABWE IN ZAMBIA**

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### **ABSTRACT**

Contaminated soil surrounding mining areas have raised environmental concerns due to high levels of toxic heavy metals (HM). Kabwe a major city in Zambia has serious lead (Pb) contamination with concentrations of over 4252 mg/kg soil in areas near the mine site. Biochar is an option that is used to stabilize or reclaim contaminated soils to reduce the risk of pollution to humans, animals and the environment.

A Field trial was conducted to test the effect of increasing amounts of soil organic amendment (biochar) in reducing lead (Pb) concentration in different fractions of the soil and the binding state. The trial had five treatments of biochar application rate 0% (control), 1.5%, 3%, 4.5%, and 6% weight/weight) of the soil by incorporation in 4m × 4m to which lemon grass was planted and the treatments were replicated 4 times. Lemon grass- a metal tolerant plant was used to assess the effect of the amendment on the uptake and growth of the grass in Pb affected area.

The results showed biochar can improve plant growth and help in regeneration while decreasing the uptake of Pb into plant tissues. The highest fraction of soil Pb was found in the residual fraction which reflects the low solubility and mobility of the Pb in the soil due to the stable complex formed between the organic amendment and Pb.

Therefore, incorporation of biochar into heavy metal polluted soil demonstrated a clear potential in reduction of exchangeable Pb and improved plant growth thereby minimizing the risk of pollution.

**Keywords:** Contaminated soil, mining areas, organic amendemnet

## **EFFECT OF ORGANIC AND INORGANIC AMENDMENTS ON LEAD, ZINC AND CADMIUM ACCUMULATION IN MAIZE GROWN IN CONTAMINATED SOILS**

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### **ABSTRACT**

In Kabwe, contamination resulting from lead (Pb), Zinc (Zn) and Cadmium (Cd) has led to high concentration of the heavy metals in the soils. Contaminations of heavy metals uptake by crops can be of threat to the food chain. This study was conducted to assess the effect of phosphate and manure amendments on the immobilization of Pb, Zn and Cd in soils and accumulation of these heavy metals (HMs) in different maize parts. An experiment consisting of five treatments: chicken manure (CM), bio-fertilizer (BF), ammonium nitrate (AN), triple super phosphate (TSP) and the control (CT) were replicated 4 times in a randomised complete block design. Maize was grown to maturity 120 days. Determination of Pb, Zn and Cd was done in roots, stems and grain of the maize using the AAS.

The results indicated that TSP was the most effective amendment for immobilization of Pb by 36% CM had the highest potential of reducing the bioavailability of Zn by 19% while BF was effective at Cd immobilization in the soil by 4%. The amendments had different effect on HMs uptake in different parts of maize, TSP and AN were effective in reducing the concentration of Pb, Zn and Cd in the roots while CM amendment was effective in reducing the concentration of Pb by 80% and Zn by 38% in the stover. The BF amendment was found to reduce the concentration of Cd in stover to 61% when compared to CT. Concentrations of Pb and Cd in the maize grain was also reduced by BF, while CM reduced the concentration of Zn in the grain.

Therefore, CM or BF amendments can be used in the gardens or fields to reduce the bioavailability of these HMs in the soil and subsequently reduce their concentration in the crops.

**Keyword:** Amendments, bioavailability, heavy metals, maize, Kabwe.



## **THE CONCENTRATION AND HEALTH RISK ASSESSMENT OF NITRATE IN GROUNDWATER OF LAGOS, SOUTHWEST NIGERIA**

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### **ABSTRACT**

The elevated concentration of Nitrate in groundwater is a global problem and has different hazards on human health through various intake pathways. Hence the aim of this study is to evaluate the nitrate concentration in groundwater and its associated human health risks.

One hundred groundwater samples including boreholes and hand dug wells were collected in Lagos, Southwest Nigeria. The concentrations of Nitrates in groundwater were determined using ion chromatography methods from British Geological Survey, Nottingham, UK.

The result shows that the Nitrates concentration ranges from  $<0.03$  to  $307\text{mg l}^{-1}$ . 52% of these samples were beyond the safe level of  $50\text{mg l}^{-1}$  according to World Health Organization (WHO). The high values were found mostly within hand dug wells. Health risks were investigated through oral/ingestion and dermal contacts in male, female and children population in various parts of Lagos metropolis. Oral exposure was higher than dermal. For non-carcinogenic risks, the Health Index ( $\text{HI}_{\text{Total}}$ ) varies from 0.00086 – 8.75(mean 4.38) for female, 0.00072-7.40(mean 3.70) for male and 0.0013-12.86 (mean 6.43) for children. The health risks assessment reveals that 58%, 55% and 62% of the groundwater samples pose health risks on female, male and children respectively.

**Keyword:** Groundwater, nitrates, health risk, Lagos.

## **INVESTIGATION OF POLLUTION OF SHALLOW AQUIFER WATERS BY THE DUMPSITE IN THE DOUALA CITY, CAMEROON USING ERT GEOPHYSICAL METHOD AND GECHEMICAL WATER TEST**

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### **ABSTRACT**

Waste dumping sites always pose serious environmental problems on air, soil, surface water and groundwater especially in sedimentary formations as in the Douala sub basin. Landfill leachate contains thousands of complex components and becomes part of groundwater after infiltration. The present study investigated the possible dumpsite pollution effects on shallow aquifer groundwater system in part of Maképe Missoké, Douala city, Cameroon.

A total of 08 profiles were used for the electrical resistivity tomography (ERT) (SYSCAL tool and Res2DINV software) to locate the aquifer and then afterward 10 points were selected for groundwater sampling in the study area and were analysed for selected geochemical and bacteriological analysis.

The ERT results show predominantly low to intermediate (0.03ohmm-1173ohmm) resistivity zones of leachate which extend down to a depth of > 30m below the surface.

The physicochemical analyses results show that the elemental composition values (in mg/l) for Ca<sup>2+</sup>(0.63-26.64), K<sup>+</sup> (0.52-19.41), Cl<sup>-</sup>(2.21-52.51), SO<sub>4</sub><sup>2-</sup>(0.71-83.27), NO<sub>3</sub><sup>-</sup>(8.38-51.44), Na<sup>+</sup>(4.95-64.42), Mg<sup>2+</sup> (<0.03-3.79) tie with what was obtained in other areas worldwide for a typical dumpsite or landfill leachate and wells A4 and A6 and borehole A3 are not within the Cameroon drinking water standard based on their K and NO<sub>3</sub> concentrations respectively (14.35mg/l, 19.31mg/l and 51.44mg/l). Results of bacteriological analyses show that 05 of the water samples (A4: >3000cfu, A6: 44cfu, A7: >3000cfu, A16: 32cfu, A17: 13cfu) which are especially from hand dug wells and streams are not within the Cameroon drinking water and WHO standards. This study is due to the lack of portable water and water borne diseases in the study area just like the other precarious quarters in Douala. The Douala aquifer at Makepe Missoké was characterized and observed to be polluted at the landfill site.

**Key words:** Dumpsite, Shallow aquifer, Electrical resistivity tomography, Douala basin, Leachate, Landfill

## **MINERAL SOURCE(S) OF FLOURIDE IN GROUNDWATER OF KALTUNGO AND ENVIRONS, NORTHEASTERN NIGERIA**

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### **ABSTRACT**

Consumption of fluoride in drinking water of less than 0.5 mg/l may result in the development of dental caries and in excess greater than 1.5 may result in dental fluorosis. Dental fluorosis is a common manifestation in school children in Kaltungo area, Northeast Nigeria. The aim of the study was to determine the mineral source(s) and spatial distribution of fluoride and other ions in different water sources (boreholes, hand dug well and springs) that are used for drinking purposes in the area.

A total of 40 water samples, 6 rocks and 4 soil samples were collected for this study. Fluorine in rocks and soils were analyzed using the fusion method and microprobe analysis of minerals was carried out using JEOL JXA-8200 Super Electron Probe Micro-Analyzer (FPMA). Four out of the six rock samples were selected for microprobe analysis after determining fluorine content in them. Cation analyses in water were carried out using an Inductively Coupled Plasma Optical Emission Spectrophotometer. The anions ( $\text{Cl}^-$ ,  $\text{SO}_4$ ,  $\text{NO}_3^-$ ) were determined using UV Multi-Ion Parameter and bicarbonate was by titration method. Fluoride was determined by Ion Selective Electrode.

Results indicate concentration of fluorine ranged from 62 – 1100 ppm in rocks and 164 – 560 ppm in soils. Average concentration of fluorine in biotite across the lines are porphyritic hornblende biotite granite - 0.805 and 0.963, porphyritic biotite granite – 1.128 and 0.745, coarse porphyritic hornblende biotite granite – 0.111 and 0.346 and coarse-grained hornblende biotite granite – 0.522 and 0.487 wt%. Average concentration of fluorine in hornblende are 0.443 and 0.474, 0.255 and 0.318, 0.179 and 0.209 wt% respectively. The biotite in coarse porphyritic biotite granite has the highest content of fluorine of 1.13wt % and has chemical formula  $(\text{K}_{0.85})\text{A}(\text{Ti}_{1.17}\text{Fe}_{1.55}\text{Mg}_{0.93}\text{Mn}_{0.02})\text{M}(\text{SiO}_{2.83}\text{Al}_{1.37})\text{TO}_{10}(\text{F}_{1.13}\text{Cl}_{0.10}\text{OH}_{1.73})$ . Since biotite is likely to release fluorine on the onset of weathering, it is the major contributor of fluoride in the groundwater of Kaltungo area with minor contribution from hornblende. Sixty-five percent of water sources have concentration of fluoride above the WHO recommended upper limit of 1.5mg/l for what should be in drinking water and this manifest in form of dental fluorosis in mostly children.

**Keywords:** Dental fluorosis, porphyritic hornblende biotite granite,

## **HEAVY METAL CONCENTRATION IN DETERMINATION OF WATER QUALITY AND THEIR POTENTIAL RISK FOR HUMAN HEALTH**

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### **ABSTRACT**

This study examined the concentrations (of heavy metals) such as (Manganese (Mn), arsenic (As), chromium (Cr), cadmium (Cd), and lead (Pb) and zinc (Zn)) in water and risk they pose to in selected areas of Bunkure (Gafan) of Kano State northern Nigeria.

The determination of heavy metals in water was carried out by atomic absorption spectrophotometry after digestion with a di-acid mixture 9:4 (v/v) (nitric acid: per chloric acid). A total of 6 water samples were collected for chemical analysis from wells and boreholes of residents in the study area, over three months ranging from April to July 2022. Each water sample was analyzed for heavy metals in which the measured concentrations were used to compute the heavy metal evaluation index (HEI).

The findings of the study revealed that the mean concentrations of heavy metals decreased in the order of Zn > Mn > As > Cr > Cd > Pb > Hg with higher concentrations recorded during the period of high precipitation. The concentrations of heavy metals in both wells and boreholes exceeded the WHO (2011) and NSDWQ (2007). The HEI values in the sampling locations ranged from less than 10.00 (low-level pollution) to greater than 20.00 (high-level pollution) with 29 % of the samples recorded in the high-level pollution zone, 14 % in the medium pollution zone, and 57 % in the low-level pollution zone. Therefore, it is recommended that the water resources of this area should not be used for human consumption and measures to reduce heavy metals concentration levels should be implemented.

**Keywords:** Heavy metal evaluation index, Gafan, Water quality Atomic Absorption Spectrometer

## **EVALUATION OF THE IMPACT OF POLLUTION POINT SOURCES (SOLID WASTE DUMPSITES) ON THE SOILS AND HAND DUG WELLS IN JOS, BUKURU, RAYFIELD AREAS, NORTHCENTRAL NIGERIA**

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### **ABSTRACT**

The Jos Plateau has one of the best weather conditions in Nigeria and has recently attracted the emigration of people. This has led to rapid urbanization, industrialization, and changes in lifestyle with consequent indiscriminate dumping of solid wastes. This study was aimed at investigating the impact of solid waste dumpsites on soils and hand dug wells use for drinking purpose.

Five (5) major dumpsites were chosen for this study. Forty-five soil samples and ten (10) water samples and three controls each for the soils and water were collected. A radial sampling technique was adopted for sampling the soil. Samples were collected at 40m intervals and away from the foot of the dumpsites. Three water samples (one each were collected for microbial, anions and cations analyses) from hand dug wells in houses located close to the dumpsites. Field parameters were determined in the field with the Hach Kits. The soil samples were oven dried at a temperature of 37°C, disaggregated, sieved and 5g was measured and packaged for geochemical analysis. Selected trace metals were analyzed using the Inductively Coupled Plasma Mass Spectrophotometer (ICPMS) as well as for the waters for cations analysis. Membrane filtration was used to determine the contents of coliform counts. Determination of anions was done by titration using the Hach Kits. Anthropogenic Factor (AF) and Index of Geo-accumulation (Igeo) were used to evaluate the extent of contamination on the soils.

The five dumpsites have a common physical characteristic in terms of composition (all containing plastic bottles, leather bags and broken glasses/bottles). Building material, Rukuba Road and Bauchi Road dumpsites differ from others in that they contain metal sheets, roofing sheets, and corrugated iron rods. The colour of the soils vary from one site to another but generally are reddish brown to dark with a pH > 6. Each dumpsite varies regarding the content of trace elements in the soils but with the following mean ranges for all the sites; Mo, 1.14-25.41ppm, Cu, 5.9-114.1ppm, Pb, 15.61-94.49 ppm, Zn, 26.8-816.5 ppm, Cd, 0.02-0.54 ppm, As, 1-15.3 ppm, Co, 2.3-20.5 ppm, U, 3.1-100 ppm and Th 14.1-994.2 ppm. Sources of trace elements are however, generally geogenic with little anthropogenic contribution from the dumpsites probably indicating the non-degradable nature of constituent materials from the dumpsites. However, Building Material site is very highly contaminated with Th, U and Sn which could be from both the rock type and radioactive materials and rusted iron materials. The waters are generally low in contents of trace elements and slightly acidic to alkaline conditions, but coliform counts in all wells are above 50 cfu/100ml. The microbiological isolates are diverse (*Staphylococcus aureus*, *Proteus spp*, *Escherichia coli*, *Streptococcus faecalis* and *Salmonella typhi*) and vary from one well to the other. This study shows that different dumpsites have impacted differently on the soils and waters in their different environments. There is the need to put into place policies and laws to curtail the excesses of dumping wastes in these areas so as not to add to the existing contents of these toxic trace elements in the soils and minimize the pollution of shallow groundwater sources.

**Keywords:** Urbanisation, industrialisation, dumpsites, radioactivity,

## **HYDROGEOCHEMICAL FACIES CLASSIFICATION AND IRRIGATION QUALITY ASSESSMENT OF WATER SYSTEM IN OKIGWE, SOUTHEASTERN NIGERIA**

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### **ABSTRACT**

The physicochemical properties of water in Okigwe and its environs was evaluated to determine the factors controlling its quality and changes, accessing its usage for irrigation purpose.

A total of 15 water samples were collected, including 5 surface and 10 groundwater samples. The water samples were analyzed using American Public Health Association methods for examinations of water and wastewater. Results showed that the water is slightly alkaline (mean pH = 7.05) and fresh, having a total dissolved solid value ranging from 8.96-28.6 mg/L, electrical conductivity values between 5.15 and 23.5 $\mu$ S/cm and a mean concentration of 1.011 mg/L and 5.505 mg/L for iron and phosphate respectively. The mean values of the major cations are in the order of  $Mg^{2+} > Ca^{2+} > Na^+ > K^+$  and  $Mg^{2+} > Ca^{2+} > K^+ > Na^+$  for ground and surface water, while the major anions are  $HCO_3^- > Cl^- > SO_4^{2-} > NO_3^-$  and  $HCO_3^- > Cl^- > NO_3^- > SO_4^{2-}$  respectively. Irrigation quality assessment indicated that; sodium absorption ratio was between 0.23 and 0.35 meq/L (mean values = 0.29meq/l and 0.25 meq/L), magnesium hazard was between 47.71 and 70.58 % (mean values = 54.36 and 52.99%) and Kelly's ratio was between 0.07 and 0.15 (mean values = 0.13 and 0.12) for ground and surface water respectively. Piper Trilinear plots, in conjunction with stiff diagrams, revealed two hydrogeochemical (Ca-Mg-HCO<sub>3</sub> and Ca-Mg-Cl-SO<sub>4</sub>) water facies and three water types (i.e. Ca - HCO<sub>3</sub><sup>-</sup>; Mg-HCO<sub>3</sub><sup>-</sup> and Mg-Cl water types).

The study showed that the changes in the water chemistry within the study area were due to anthropogenic activities and that the water was polluted with iron though still within the limits that are suitable for industrial and irrigation purposes.

**Keywords:** Hydrogeochemistry; Okigwe; Irrigation water; Anions; Cations; Pollution index.

## HEAVY METAL ANALYSIS IN FISH IN SELECTED SURFACE WATER BODIES AND POTENTIAL HEALTH EFFECTS IN HUMANS IN CENTRAL PROVINCE, ZAMBIA

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### ABSTRACT

The contamination of fish by heavy metals poses a health risk to humans who are one of the final consumers. Fish is prone to contamination by heavy metals due to living and feeding within the aquatic environment which may be polluted due to natural and anthropogenic activities. The current study was aimed at determining the concentrations of Cadmium (Cd), Copper (Cu), Zinc (Zn) and Lead (Pb) in fish muscle.

The current study used an embedded mixed method approach. Three fish species (*Clarias gariepinus*, *Tilapia rendalli* and *Oreochromis andersonii*) of different sizes were collected from three different water bodies and assessed in the laboratory for heavy metal concentration using Atomic Absorption Spectrophotometry (AAS). For the qualitative part, a focus group discussion was conducted using the interview guide. STATA version 14 was used for statistical analysis and NVIVO 11 was used for qualitative data management.

The median concentration in fish muscle of Cd was 0.388mg/kg (IQR 0.204 – 0.96 mg/kg). Cu, Zn and Pb were found to have medians (IQR) of 0.87 (0.61-1.23), 0.95 (0.50-1.84), 0.77 (0.54-1.12) mg/kg respectively. On species type, there was a statistically significant difference in the median concentration of Pb and Cd among the three fish species (p= 0.0221 and p=0.0504 respectively). *C. gariepinus* and *O. andersonii* had concentrations of Cd and Pb above the European Union and Food and Agricultural Organisation's permissible limits in fish muscle for human consumption.

The calculated Estimated Daily Intake (EDI) from this study was found to be below the WHO Permissible Tolerable Daily Intake and therefore safe for human consumption. About 90% of fishermen were found to have no knowledge of heavy metal contamination.

With Cd and Pb concentration exceeding FAO and EU safety limits, consumption of such fish is likely to put the health of consumers at risk due to the ability of heavy metals to bio accumulate in consumers. Therefore, there is need for frequent monitoring of water bodies to ensure safety of humans through fish consumption as well as promotion of fish exports to other countries.

**Keywords:** Aquatic environment, anthropogenic activities, heavy metals

## EFFECTS OF STOCKING DENSITY AND SEASONALITY ON DIGENEAN TREMATODE AND MONOGENEAN INFECTIONS IN NILE TILAPIA (*Oreochromis niloticus*, Linnaeus 1758) REARED IN CAGES IN UHANYA BEACH IN LAKE VICTORIA, KENYA

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### ABSTRACT

Parasites and their hosts live in equilibrium, however, when this balance is broken parasites spread rapidly in culture facilities inducing severe epizootics. This study was conducted from December 2019 to May 2020 with the objective of highlighting the effects of stocking density and seasonality on monogenean and digenean trematode parasites in *Oreochromis niloticus* in cages in Uhanya Beach, Lake Victoria, Kenya.

Systematic random sampling technique was used to sample a total of 600 fish during the rainy and dry seasons. Parasites isolated from the sampled fish were the monogenean *Dactylogyrus* and the digenean; *Tylodelphys*, *Clinostomum* and *Neascus*. *Dactylogyrus sp.* was predominantly abundant in the fish from all the 10 cages. Mann-Whitney U-test revealed that mean intensity of *Dactylogyrus sp.* infestation significantly increased with increased fish stocking density ( $p < 0.05$ ;  $df = 298$ ). On the contrary, *Clinostomum sp.*, *Tylodelphys sp.* and *Neascus sp.* exhibited significantly reduced infestation with increased stocking densities ( $p < 0.0001$ ). Temperature significantly differed between the seasons ( $df = 28$ ;  $p < 0.0001$ ). All the individual fish showed allometric growth and the general fish condition as depicted by condition factor ( $Kn$ ), which was significantly better in cages with stocking densities of 2500 individuals/ Cage ( $df = 298$ ;  $p < 0.05$ ). Kruskal-Wallis test indicated significant variation in prevalence of attack between the parasite species both in wet season ( $H = 17.793$ ;  $df = 3$ ;  $p < 0.0001$ ) and dry season ( $H = 30.226$ ;  $df 3$ ;  $p < 0.0001$ ). There was a general positive correlation between water temperatures and mean parasite intensity, however, this relationship was weak in all the parasite species ( $r^2 < 0.5$ ). The relationship between intensity of parasite infestation and fish condition factor was not also weak and significant in all the parasite species (*Dactylogyrus sp.*:  $r^2 = 0.017$ ; *Clinostomum sp.*:  $r^2 = 0.001$ ; *Tylodelphys sp.*:  $r^2 = 0.008$ ; & *Neascus sp.*:  $r^2 = 0.026$ ). The study recommends proper site selection for cages, water quality management and sourcing of fish seed from certified hatcheries to prevent the spread of parasitic diseases.

**Keywords:** Monogenea, Digenea, Stocking density, Seasonality, Cage culture



## **MICROBIAL DIVERSITY AND RISK ASSESSMENT OF BIOAEROSOLS FROM SELECTED DUMPSITES IN SOUTHWEST, NIGERIA**

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### **ABSTRACT**

Dumpsite is one of the hot spots of both environmental and public health hazards emitting airborne pollutants such as bioaerosols. Ambient air microflora around waste dumpsites is known to cause respiratory and infectious diseases. This study was undertaken to assess microbial diversity and risk of bioaerosols from selected dumpsites around Ibadan, Southwest, Nigeria.

Ambient air at the dumpsites were sampled for bioaerosols [Total Bacteria Counts (TBC) and Total Fungi Counts (TFC)] using culture-based method. Sedimentation technique using open petri-dishes containing Nutrient Agar and Sabouraud Dextrose Agar was used for bacterial and fungal sampling respectively. Each plate was placed 0.5 meter above the heap of refuse for 20 minutes at different sections of each dumpsite. A total 70 culture plates were exposed for bioaerosols at the dumpsites. Non-cancer risk of exposure to bioaerosols was estimated using hazard quotients. Descriptive statistics such as proportions, means and frequencies were calculated and presented with the use of tables and charts.

Average mean total bacteria and fungi counts were  $232.56 \pm 159.36$  cfu/m<sup>3</sup> and  $281.86 \pm 113.60$  cfu/m<sup>3</sup>;  $99.08 \pm 58.75$  cfu/m<sup>3</sup> and  $231.62 \pm 197.78$  cfu/m<sup>3</sup> at the dumpsites. The distribution of the bacteria isolated from dump sites were *Bacillus spp*, *Staphylococcus aureus*, *Klebsiella spp*, *Coagulase Negative Staphylococci* and *Proteus spp*, while the fungal isolates from the dumpsites were *Saccharomyces spp*, *Aspergillus spp*, *Mucor spp*, *Cladosporium spp* and *Rhizopus spp*. Non-cancer risk of exposure to bioaerosols via routes of exposure at the dump sites in children and adults presents low values below maximum acceptable levels of 1 except for children via ingestion route.

Exposure to bioaerosols from the dumpsites can be detrimental to the health of people, especially those living close to the dump sites. However, children are found likely to be more affected compared to adults. Therefore, it is a matter of must for the government to resettle people living close to the dumpsites.

**Keywords:** Dumpsite. Bioaerosol. Cancer Risk. Microbial diversity

## **SPATIAL ANALYSIS AND ELEMENTAL DISTRIBUTION OF TRACE ELEMENTS IN ARTISANAL AND SMALL-SCALE GOLD MINING ACTIVITIES (ASGM): ESSENCE ON ENVIRONMENTAL HEALTH**

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### **ABSTRACT**

The Tarkwaian and Birimian geological rocks of Ghana are found predominantly in the western part of the Northern and Upper Regions of Ghana. Additionally, these rocks are found in the Eastern, Central, and Western Regions, including Ashanti and Brong Ahafo regions of Ghana. These rocks in the study areas make it possible to have small-scale gold mining (ASGM) activities. Artisanal and small-scale gold miners get involved in mining activities as it is believed to be one of the sure ways to get out of poverty. There is this growing pattern in Ghana where most small-scale mining activities are giving way to small scale gold mining activities (ASGM). In 2013 there were 13 million individuals in industrial mining, meanwhile, there were just 6 million of people in ASGM in 1993. Currently, the number is on the rise. The districts where most of these activities take place areas include: Tarkwa, Bolgatanga, Asankragwa, Bibiani, Assin Foso, Akim Oda, Dunkwa Onoffin, Konongo and Wa. There have been varying reports of changes in pathological patterns of illness in recent times in these areas, however, there has not been much work on the role of invasion of geological materials through ASGM affecting their illness prevalence. Most of these mining communities remain polluted however, the toxicity in the environment remains due to the release of heavy metals such as mercury (Hg), cadmium (Cd), lead (Pb), arsenic (As), etc. through activities such as artisanal small-scale gold mining (ASGM). Cycling of the trace elements in air, land and water in the local environments determine the influence on the quality of health and the type of drinking water in the area

This research work is therefore to determine spatial extent and trace element distribution that is affecting the environment via the activities of artisanal and small-scale gold mining and then juxtaposing it to morbidity rates in health centres in the mining communities. If trace elements are well studied in the geologic space, disease patterns can also be monitored hence lead to good health and wellbeing. It is germane to know that the generation of geospatial maps can help policymakers and earth scientists to devise mitigation measures and strategies to curb environmental and public health of geologic elements. Methodologies to be used includes the using of Geographic Information systems (GIS) the generation of the geospatial maps, secondly, the use of Statistical package of social sciences (SPSS) to analyse trends of health data from health facilities and thirdly, the sampling of rocks, rocks, sediments and water to aid in determining the concentrations of the various trace elements. Some scientific instruments that will be using in doing the analyses include, the scanning electron microscope (SEM) and the XRF other instruments include the XRF, ICP-MS to aid in trace element concentration.

At the end of the research, it is expected that, findings will enable the determination the spatial extent and distribution of element exposure in the study area. The determination of the various toxic elements and their likely sources in the geologic media, determination of the level of concentrations of the various toxic elements in study area and identification of the link between morbidity data from health facilities with trace element concentration in the area.

Keywords: Tarkwaian and Birimian rocks, geological materials, mining communities

## **ENVIRONMENTAL POLLUTION BY MICROPLASTICS AND PUBLIC HEALTH RISKS IN ABUJA NIGERIA**

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Environmental pollution is a major factor that affects population health. Increasing population will result to a corresponding increase in environmental pollution. In the last decade, concerns about possible health hazards associated with exposure to environmental pollution have been on the surge. Consequently, an established connection exists between human exposure to certain environmental contaminants and maladies such as cancer, reproductive dysfunction, chronic neurodevelopmental disorder, and dysfunction of the immune and endocrine systems. Environmental pollutants include plastics, metals, metalloids, synthetic materials, organic waste and a host of other disposable materials.

Plastic waste has become the predominant pollutant in our environment. The presence of microplastics in our environment, landfills, fresh water and sea water is a factor to the imperilment of the eco-system. Microplastics find their way into the human body through ingestion and respiration. Microplastics can carry a range of contagions such as trace metals and some potentially harmful organic chemicals. These chemicals can osmose from the plastic surface once in the body, thus, increasing the potential for toxic effects. Microplastics can have carcinogenic properties, meaning they potentially cause cancer. Epidemiologic studies have drawn a relationship between drinking water and cancer mortality rates.

The plan of this proposal is to investigate the effects of microplastics on population health and examine the presence of microplastics in drinking water supplied within Abuja, Nigeria. Fourier transform infrared spectroscopy (FT-IR) will be used to examine water samples while Microplastic Finder (MPF software) will be used to analyze the FT-IR images from samples. This proposal will also examine the presence of microplastics in the atmosphere and how respiration is a channel through which microplastics osmose into the human system.

**Keywords:** Environmental pollution, population health, harmful organic chemicals

## **GIS MAPPING OF POTENTIALLY HARMFUL ELEMENTS IN FARM SOILS, FARM PRODUCTS AND MINE PONDS LOCATED IN AREAS DEVASTATED BY TIN AND COLUMBITE MINING AROUND THE JOS – BUKURU AND BARIKIN LADI TIN FIELDS**

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### **ABSTRACT**

The Jos-Bukuru and Barkin Ladi area was a beehive of tin and columbite mining activities in the early 60s and 70s. The activities left over 1500 open mine ponds of various sizes and depth and mine dumps scattered all over these areas of different volumes of materials. Small scale artisanal mining is still on going in these areas till today. Because of her climatic conditions, the Jos Plateau is the largest producer of all kinds of vegetables (cabbage, spinach, lettuce, celery, parsley, tomato) and root crops (carrot, potato, radish) which is distributed all over Nigeria. These farms are in areas devastated by the mining activities and are irrigated with water from the mine ponds in the dry season. Several works have shown high concentration of these potentially heavy elements in mine dumps and low in the waters However, concentration and the forms of occurrence of these elements in farm soils, waters, vegetables, and root crops have not been reported. The aim of this work is to determine concentration of potentially heavy elements in farm soils, crops and waters used to irrigate the farms and to speciate the toxic forms of these elements, which may be harmful to both humans and animals.

Farm soils, mine pond waters and cultivated edible vegetables will be collected following internationally acceptable standards. Soil samples will be analysed using the Inductively Coupled Plasma Mass Spectrophotometer and the waters by Inductively Coupled Plasma Optical Emission Spectrophotometer Methods. The vegetable will be analysed with and speciation of ions in soils will be modeled with the PHQREEC software and in water by the Wateq4f () software, where they may not be chemically determined.

Statistical analysis using appropriate software will be performed on the data to establish relationships among the ions for determination of possible sources. Maps of total concentration of ions of potentially harmful elements and their forms, for soils, waters and vegetables will be prepared and polluted farms and water delineated. Plants with high potentially harmful elements will be identified and isolated for further studies.

At the end of the study, concentration of potentially harmful elements in agricultural farm soils and produce from them and in the waters would be determined. Recommendations from the study will be made available to policy makers for further actions.

**Keyword:** Mine dumps, farm soils, mine pond water

## **FOREST-WATER NEXUS: AN EVAPOTRANSPIRATION ASSESSMENT OF THE KAFUE RIVER BASIN USING REMOTE SENSING**

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### **ABSTRACT**

Twenty percent of Zambia's land mass area is occupied by the Kafue River Basin (KRB) and hosts more than forty percent of the country's population, which is reliant on the basin's ecosystem goods and services, that is directly supporting their livelihoods. In the face of climate change and population growth, this harmony is projected to change in the next thirty years about water resources. The forest-water nexus is a crucial relationship in river basin management and water budget analysis. A global assessment report by the International Union of Forest Research Organisation (UIFRO) stated that "Successfully managing the world's forests will be key to mitigating water insecurity and ensuring safe and sustainable water supplies for all". Some forest plant species pump more groundwater and displacing it into the atmosphere causing water insecurity. More so, about 66% of precipitation returns to the atmosphere as evapotranspiration (ET). ET on the other hand, is very difficult to estimate and different estimation models have their own discrepancies, this makes ET a hotspot for research.

Hence, this study aims to evaluate the performance of five (5) ET estimation models and use the best performing model to identify forest types with a significant ET rate. Landsat satellite images, meteorological data and forest inventory data were collected and will be analysed using cloud computing Google Earth Engine (GEE) tool.

The models will be validated by the FAO56 penman monteith method and at least one or two models are expected to have Root Mean Square Error (RMSE) between 0.2 to 0.5. Different forest types are expected to show significant ET rates. The findings of this study will highlight a better understanding between the disparities of different model products, attempt to optimize the trade-off between forest and water resource and will assist in policy making.

**Keywords:** Kafue River Basin, Forest-Water Nexus, Evapotranspiration, Google Earth Engine, Remote Sensing.

## **THE DANGERS OF UNCONTROLLED COAL FIRES IN AFRICA: A REVIEW**

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### **ABSTRACT**

Coal is one of the most abundant energy resources found in Africa. Its uses include being a major component of energy production, acting as a commercial and residential heat source, providing employment opportunities, and much more. But this same coal is also causing illnesses and even death in Africa through the uncontrolled burning of coal seams and coal waste piles. When coal's natural oxidation accelerates due to an exothermic reaction with oxygen and the coal surface, the internal temperature of coal increases. If the temperature exceeds 80°C, the coal self-ignites, leading to uncontrolled coal fires. These fires can burn for hundreds of years and have occurred in Botswana, Malawi, Mozambique, Nigeria, South Africa, Zimbabwe, and probably other African countries where coal is or has been mined. Environmental impacts of these fires include air pollution due to dangerous gas emissions (sulfur dioxide, methane, carbon monoxide, benzene, toluene, ethylbenzene, xylene etc.), toxic element release (arsenic, mercury, fluorine, selenium, lead, etc.), contamination of groundwater and crops, sudden ground sinkholes, and other community resource losses. Exposure to these harmful emissions/burnings has led to skin deformation, severe burns, pulmonary diseases, cancer, birth defects, poisoning, and ultimately death. Uncontrolled coal fires can burn for long periods and depending on the depth of the coal seam, can spread over long distances. They destroy homes, people's livelihoods and cause loss of lives and resources. It would be beneficial to all African countries to invest in solutions to counter the prolonged effects and dangers of uncontrolled coal fires and to educate coal mining companies, coal miners, and nearby communities on the dangers.

**Keywords:** Coal, Uncontrolled fires, Africa, Health Impacts

## **MEDICINE, GEOLOGY, AND ECONOMICS: THE SYNERGY FOR DEVELOPMENT AND ENVIRONMENTAL SAFETY**

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### **ABSTRACT**

Medicine, Geology, and Economics are important disciplines that affect human survival. Medicine examines the health and total wellbeing of humans, while also managing disease conditions. Geology studies rocks and minerals, and the processes leading to their formation. Economics on the other hand, measures factors responsible for wealth creation within a given space and time. Since geologic materials and processes are known to exact health burdens on human populations, the proper application of economic tools in the quantification of the impact of geomedical diseases (eye ailments, bronchial ailments/respiratory tract diseases, intestinal disorders, blood circulation conditions, silicosis, goiter, podoconiosis etc.) will help in the quick diagnosis and treatment of such diseases, as well as formation of policies that will enhance proper budgeting, research, and management of health conditions related to natural geologic processes. Common geologic phenomena that place health burdens on society include earthquakes, volcanoes, landslides, tsunamis, floods, dust storms, and man-made geologically related activities such as mining, quarrying, surface and underground construction works, as well as agriculture. A carefully framed synergy between these three disciplines is a necessary panacea for a healthier human populace and environment, hence creating wealthier nations on earth.

**Keywords:** Medicine, Geology, Geomedical diseases

## **BALNEO-GEOLOGY: A TOOL FOR ENHANCING BALNEOTHERAPY AND BALNEOTECHNOLOGY**

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### **ABSTRACT**

Geologic materials are in wide use for treatment of various disease conditions in the health care industry. Thermal medicine, health resort medicine, balneotherapy, and/or SPA medicine utilises balneal resources such as peloids, muds, clays, salts, mineral waters, medicinal waters, rocks, and minerals for various treatment types. Gynaecological, dermatological, gastro-intestinal, cardiovascular, as well as rheumatological ailments are known to be treated using the natural healing materials. Balneogeology seeks to underscore the geochemistry, petrogenesis, orogenesis, mode of occurrence, as well as mode of formation of these very precious geomedical resources with the aim of easily locating and classifying them for various health/medical applications. Intensive development and deepening of this discipline will guaranty effective balneotherapy and an enhanced balneotechnology industry.

**Keywords:** Balneo-geology, Balneotherapy, SPA Medicine, Balneotechnology



## **CONTRIBUTION OF TOXIC TRACE ELEMENTS IN EARTH MATERIALS TO THE PREVALENCE OF KIDNEY DISEASES IN PARTS OF NORTHEAST AND NORTHWEST NIGERIA**

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### **ABSTRACT**

Toxic trace elements in earth materials such as rocks, soils, water and food substances find their way to the human body through ingestion, inhalation, and dermal contact. Their occurrence and accumulation level in humans may cause kidney diseases and may eventually result in deaths. The USA Institute of Health at the Bayero University Kano in collaboration with the Nigerian Institute for Medical Research reported rising cases of kidney disease in the northeast states of Borno, Yobe, Adamawa, as well as Jigawa and Kano states which have resulted in many deaths. Toxic trace elements consumed in food substances have been implicated in kidney diseases but, concentrations of such toxic trace elements have not been reported in soils and commonly consumed food substances and waters of the region.

This research aimed to determine the concentration of toxic trace elements in earth materials and their contributions to prevalence of kidney diseases in the region.

Samples of rocks, soils, water and commonly consumed food substances grown in the areas of the regions will be collected. Blood and urine samples will also be collected from respondents in prevalent areas of the regions for laboratory analysis.

Soils and water samples will be analysed at the Bureau Veritas Mineral Laboratory in Canada with the Inductively Coupled Plasma Mass Spectrophotometer. Urine and Blood samples will be analysed at the University of Jos Teaching Hospital.

Data on incidences of death from kidney diseases and other related diseases will also be collected.

Geographic information system will be used to produce map concentration of toxic trace elements of the area and statistical analysis will be used to identify vulnerable groups in the region.

The map produced using GIS will delineate areas with high toxic trace elements and data from statistical analysis will identify the most vulnerable groups in the region and it will indicate if the individuals are genetically predisposed to the disease or not.

This study will bring out the main cause of rising cases of kidney disease in the region. Solutions, suggestions, and recommendation will be made to mitigate the effects of the diseases on the inhabitants of the region

**Keyword:** Food ingestion, consumed food substances, vulnerable groups

## **GEOETHICS AND MEDICAL GEOLOGY PROFESSION**

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### **ABSTRACT**

Ethics will continue to be required for the regulation of human activities in every facet of life. In the earth science profession, a lot of moral issues are well noted for contributing negatively to the growth of the mining, metallurgical, water, oil and gas, as well as the research and teaching sectors of national endeavors. These issues range from poor projects implementation, incompetent manpower, wrongful admissions, embezzlement, greed, to mischievous policies. In Nigeria for instance occupational health diseases are on the rise because of poor safety measures taken during mining and or exploration activities. Absence of proper safety gears has continued to threaten the health of miners and explorers, a phenomenon common with the rock quarry and the water drilling industries. This paper seeks to underscore these and many other unethical practices in the geoscience profession for proper redress in favor of a more sanitized geoscience community in Nigeria and beyond.

**Keywords:** Geoethics, Medical Geology, Profession, Nigeria

## **MEDICAL GEOCHEMISTRY, BALNEOTHERAPY, AND ECONOMIC DIVERSIFICATION**

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### **ABSTRACT**

Geologic materials are in wide use for treatment of various disease conditions in the health care industry. Thermal medicine, health resort medicine, balneotherapy, and/or SPA medicine utilises the medicinal/pharmacodynamic properties of geologic materials such as peloids, muds, clays, salts, mineral waters, medicinal waters, rocks, and minerals for various treatment types. Gynaecological, dermatological, gastro-intestinal, cardiovascular, as well as rheumatological ailments are known to be treated using the natural healing materials. Medical geochemistry seeks to underscore the chemistry, petrogenesis, orogenesis, mode of occurrence, as well as mode of formation of these very precious geomedical resources with the aim of easily locating and classifying them for various health/medical applications. Their utilisation in turn, apart from enhancing life expectancy is a huge source of revenue generation for private and state holdings.

Keywords: pharmacodynamic properties, rheumatological ailments, geomedical resources

## **ASSESSMENT OF BIOAVAILABLE HEAVY METALS IN ENYINGBA – ABAKALIKI MINE DISTRICT, NIGERIA: HEALTH IMPLICATIONS**

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### **ABSTRACT**

There is an increasing concern about the effects of invitro bioavailability of heavy metals on the biosphere and impacts on the environment and the populace. Many researchers have studied the bioavailability of these metals; wherein most of the results analyzed indicated significant amount of pollution rendered on the ecosystem. Data from the twelve (12) sampled localities indicated a pH range of 6.60 -7.06. Heavy metal concentration showed that As ranged from 8.64 to 16.02mg/kg; Cd ranged from 0.24 to 5.33mg/kg; Co ranged from 0.7 to 16.07mg/kg; Manganese ranged from 46.37 to 373mg/kg and were detected in six (6) locations. The concentration of Cu ranged from 7.08 to 160.17mg/kg; Ni ranged from 0.94 to 31.37mg/kg and were detected in seven (7) locations. The concentration of Pb ranged from 16.22 to 37.38mg/kg and was detected in four (4) locations; while Zn ranged from 2.48 to 55.55mg/kg. The Metal Enrichment Index (MEI) calculations indicated Cd with a high enrichment factor of 63.93 and Cu with a much lower enrichment factor of 12.76. Twelve sample points from Ameri, and Enyingba showed slight pollution at two (2) localities with metal pollution index (MPI) below 4.0. Eight (8) locations with MPI of 5 – 20 as moderately polluted, while one (1) locality within Enyingba with MPI value of 28.35 indicates a high pollution index. This review showed that Ni, Cd, Pb and Mn concentrations are highly elevated in the soil and water of Enyingba.

**Keywords:** Bioavailability, heavy metals, Mining, Pollution, Enyingba.

## **THE EFFECTS OF CLIMATE CHANGE ON HUMAN HEALTH IN POTISKUM AREA OF YOBE STATE**

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### **ABSTRACT**

Potiskum Local Government Area has faced severe disruption of its health because of climate change. However, climate change is principally a major problem caused by the increase of human activities or human mismanagement of the earth leading to several direct or indirect impact on health. These climatic changes have wide-range harmful effect including increase in heart-related mortality deliration spread of both man and animals among others. Nigeria like other countries of the world has its own experiences of climate change disasters like the one that struck 25 years ago in the north-eastern region presently Borno and Yobe State, the southern part of lake Chad.

The study showed the climate variability, the factor caused by climate variability and their impact on human health (the effect of climate on human health). Climate change In the Sahelian region of Nigeria sadly conforms to the global extreme poverty stereotype. Climate change feature now account for approximately 580,841km<sup>2</sup> of Nigeria and accounting for up to 63.8% of the country landmass. Almost more than half of the national population are affected by climate change In Nigeria; however, climate change is a global factor. This is resulted in catastrophic consequences to affect human, animal, and plant population health in a variety of ways. Its impacts include forced human migration, increase erosion, surface groundwater depletion, increase temperature condition severe rainfall or precipitation, cold weather condition. All economics and social sector will be strongly impacted by climate change. Against a background of increasing demand for portable water, sea level rise or heavy rainfall may lead to flooding of lowlands and sea water intrusion into coastal aquifers, while variability in climate may see more intense rainstorms resulting both in increased run-off leading to increased flooding and reduced recharge leading to aquifer depletion. Such impact is already having negative ripple effect on other vital aspect of the economy in the area of Potiskum despite increasing media awareness around the theme of Nigerian people's potential vulnerability to actual and predicted changes in climate at the global level, detailed scientific evidence remains scanty. Much existing work has looked at the effects of climate on specific diseases, without making clear connections to overall change in population health.

This paper therefore explores the cause of climate change and the effects of climate change on human health population in Potiskum Local Government and how the town of Potiskum Responds to climate change and the possible solution to the effect of climate change in Potiskum. Therefore, the purpose of this paper is to highlight some of the important points that emerge from some relative scanty literature on climate change and population health in Potiskum area of Yobe state, with a view to both identifying some of the key issues that have been documented and revealing some of the possible gaps where further scientific research is urgently needed.

**Keywords:** climate change, diseases course by climate variability, population health, the impacts of climate change on the human health population.

## **EFFECTS OF LAND-USE CHANGE ON ECOSYSTEM SERVICES AND THE FUTURE SCENARIO OF THE BANGWEULU WETLANDS, ZAMBIA: A REMOTE SENSING APPROACH**

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### **ABSTRACT**

Wetlands play a vital role in the support and development of society as they provide approximately 40% of global ecosystem services (ES) despite covering only 1.5% of the Earth's surface; ES includes provisioning services, regulation services, habitat/support services, and cultural services. This research focuses on provisioning ecosystem services (freshwater supply). In Zambia, wetlands are threatened by land-use (LU) changes, Bangweulu wetlands have 50,000 people living on the islands and riverbanks, and in addition, there are also seasonal fishermen (mobile fishing communities) whose main activities are agriculture, fishing, and small-scale mining in the surrounding areas of the wetland. The excess nitrogen, phosphorus, heavy metals, and other substances from these activities may enter the water stream, which could lead to water deterioration. Therefore, timely and accurate detection of a wetland's LU changes at a large scale in a quantifiable manner is critical. Remote Sensing is well-placed to provide a realistic and cost-effective way to detect and monitor such changes with large spatial coverage and frequent observations.

The Machine learning techniques: Artificial Neural Network Algorithm will be used for LU classification, LU and water quality change detection, and future (2050) projection. Time series of wetland floods dynamics will be analyzed using Modified Normalized Difference Water Index (MNDWI), zonal pixel values of spectral reflectance (SR), Algae Biomass Index (ABI) <sup>3</sup>, will be extracted and used to assess any changes in the wetlands' water quality. Different factors/parameters that contribute to wetland water quality deterioration will be used for wetlands vulnerability analysis using Fussy logic classification techniques. The T-test will also be used to determine if the differences in water quality between 1980 and 2021 are significantly different. QGIS and R-studio software (open source) will be used for spatial and statistical analysis, respectively. The methods are designed to achieve the main objective, which is to assess if the land-use changes in the Bangweulu wetlands between 1980 and 2021 have effects on freshwater supply as well as analyze the vulnerability and project the future (2050) scenario of the wetlands.

The research output will include (1) a map of land-use and water quality changes between 1980 and 2021 and 2050; (2) graphs of water SR curves changes; and (3) a model of the relationship between SR and ABI with the field measured water quality parameters; (4) the established relationship between LU and water quality change hotspots; and (5) the wetland's water vulnerability analysis map and protocol.

The study will provide some insight into the past, current and future LU changes and the status of water quality in the Bangweulu wetlands. The research will also develop models and protocols that can be used for easier and more frequent wetland vulnerability analysis, water quality monitoring at a large scale, as well as track changes over time, which is vital for various government ministries and institutions in Zambia and southern Africa at large.

**Keywords:** Global ecosystem services, Machine learning, Freshwater wetland

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