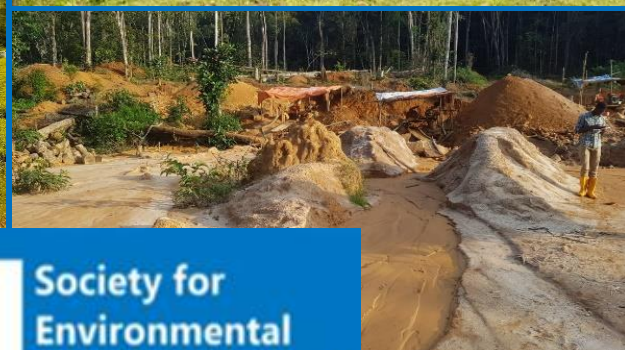


# 37<sup>th</sup> International Conference of Society for Geochemistry and Health



**SEGH** Society for  
Environmental  
Geochemistry and  
Health

**Eldoret, Kenya 2022**

*Date: 10<sup>th</sup> -14<sup>th</sup> October 2022*



# Abstract Book

37th International Conference of Society for Geochemistry and Health

10 - 14<sup>th</sup> October 2022

@

**Boma Inn Hotel, Eldoret, Kenya**

**Scientific and Organizing Committee**

**Organizing committee**

Prof. Odipo Osano, University of Eldoret (Conference Chair), Kenya  
Prof. Akinade Olatunji, University of Ibadan, Nigeria  
Dr Michael Watts, British Geological Survey, United Kingdom  
Dr Olivier Humphrey, British Geological Survey, United Kingdom  
Dr. Lydia Olaka, University of Nairobi, Kenya  
Diana Menya, Moi University, Kenya  
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Andrew Hursthouse, University of West Scotland, UK  
Prof Jane Entwistle, Northumbria University, UK  
Clay Prater, Oklahoma State University, USA  
Keith Torrance University of Strathclyde, UK

### SEGH Organizational Profile

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Dr Michael Watts, British Geological Survey, UK	-	Past President
Dr Jerry Olajide-Kayode, Osun State University, Nigeria	-	Secretary
Mrs Anthea Brown, Rt. British Geological Survey, UK	-	Membership Secretary/Treasurer
Dr Olivier Humphrey, British Geological Survey, UK	-	Webmaster

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Odipo Osapo (Kenya)  
Belinda Kaninga (Zambia)

### Americas Chairs

Mark Button (Canada)  
Ofelia Morton-Bermea (Mexico)  
Bob Finkelman (USA)  
Clay Prater (USA)  
Pauline Pornizzo (Uruguay)

### Asia/Middle East Chairs

Taicheng An (China)  
Xia Huo (China)  
Ahad Nazarpour (Iran)  
Hasham Zaffari (Pakistan)  
Munir Zia (Pakistan)

### European Chairs

Ariadne Argyraki (Greece)  
Maurizio Barbieri (Italy)  
Paula Marinho-Reis (Portugal)  
Keith Torrance (UK)  
Sanja Potgieter-Vermaak (UK)

### Co-Opted Members of the Board

Gillian Gibson - Fellows Affairs Coordination  
Andrew Hursthouse - Technical Presentation Coordination

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### **Welcome to SEGH 2022 in Eldoret, Kenya**

Africa presents varied and interesting geological features that apparently confers either devastating or advantageous health conditions on the populations in Africa. For example, the North to south easterly lying corridor from Ethiopia to South Africa proximal or lying within the Great Rift Valley has some of the world's highest concentrations of fluoride in the environmental media. Also a large area of agricultural land in the Eastern to Southern Africa has general low nutritionally essential minerals like Selenium and Zinc. The British Geological Survey in consortium with the University of Eldoret, Moi University, International agency for Research on Cancers, University of Nottingham, Kenya Marine and Fisheries Research institute have initiated research that connects Geological conditions in both water and land, land uses and management with health of the inhabitants in Africa. The partner institutions have engaged experts in fields ranging from range of soil, agriculture, health, analytical chemistry experts, and co-opted partners from the fertilizer industry to regulatory bodies that provide national agricultural and health policy advice.

Along with other projects by members of the SEGH, these initiatives underline the importance of Africa's diverse geological conditions on health. Capacity strengthening centered on building trained personnel, research experience, and institutional capabilities cannot be gainsaid. A focus on Africa where interests on interaction of health and geochemistry is on a steep rise by holding an SEGH conference would be in order. Already a number of North to south linked projects leverage global partnerships in Africa. The British Geological Survey and the University of Nottingham gained a Royal Society-UK Department for International Development (RS-DFID) Africa Capacity Strengthening project with seven university/research institutions in Malawi, Zambia and Zimbabwe. This project runs from 2015 to 2020 and is centered on the development of a doctoral training network researching the employment of soil geochemistry to improve human micronutrient dietary intake from staple crops and benefit subsequent health at a population scale. The Royal Society, Overseas Development Agency, Global Challenge Research Funds, the MRC, Newton Utafiti Funds, IARC, and other agencies have supported researches that have built levels of participation of African Research and by extent membership or potential members of SEGH. In addition, SEGH could build on the interests of a number of international companies and bilateral agencies on Africa some of which have been shown by offer to extend a financially support for a conference in Africa.

Exponential growth of interested in Africa could see a quick rise in growth of SEGH memberships and activities. So far the first meeting in Africa attracted large numbers of members and a meeting following closely the earlier one would strengthen the presence of SEGH in Africa. Africa is also rapidly developing, and its growing economic activities are centered on exploitation of Geochemical resources along with intensification of agriculture, rapid population growth and a predicted shift from rural to urban living over the next 50 years. This progress will place considerable pressures on natural resources and the protection of the environment and human health. Scientific capacity in Africa is developing quickly, with donor agencies recognising that science can benefit the Strategic Development Goals.

There exist immense opportunities for scientific community in collaboration with the growing African Expertise to partner (SDG 17) and positively change. A conference in Africa will provide



a platform for scientists currently engaged with SEGH to link and create networks with scientists in Africa who face a number of challenges in achieving their scientific goals. Such a meeting presents SEGH with an opportunity to promote environmental geochemistry for sustainable development across key topics of interest to SEGH, including mining, agriculture, urban development and health. In addition, an international meeting facilitates sharing of experiences, a learning environment and opportunities for setting off collaborations.

Why at ELDORET? Eldoret is a fast growing city with many world standard Hotels venues for conferences. Its climate and security are highly predictable and suitable for persons drawn from difference climatic zones. Lying at 2300 m above Sea Level it has a mostly balmy warm climate, safe and peaceful. It has good international air links from beyond and within Africa. It was founded by Boer farmers and has recently been a renowned home of the World's best long distance runners. It is a home of two key Nation's Universities (University of Eldoret and Moi University) and a number of tertiary level colleges, hence is a fairly young town. It is surrounded by a number of key tourists' attractions within reachable 100 km including the Kakamega Tropical Rain Forest, the iconic rift valley, Mount Elgon National Park and Bogoria hot springs – a sanctuary for birds especially the pink flamingoes.

### Conference Information

See General Information at <https://segh.net/register> – for location, venue and travel.

**Also see @SocEGH for Twitter and @SEGH Facebook for live updates during the event.**

**Conference venue:** Boma Inn Eldoret, Kenya.

<https://www.theboma.co.ke/inn-eldoret/>

The Boma Inn in Eldoret is located in Eldoret that is about 350 kilometers from Nairobi. It is located in the Uasin Gishu County, and on a plateau that is about 2100 m asl. The hotel features a health club with a gym, steam room, sauna, Jacuzzi as well as a spa and an outdoor swimming pool with sun loungers on the pool deck.

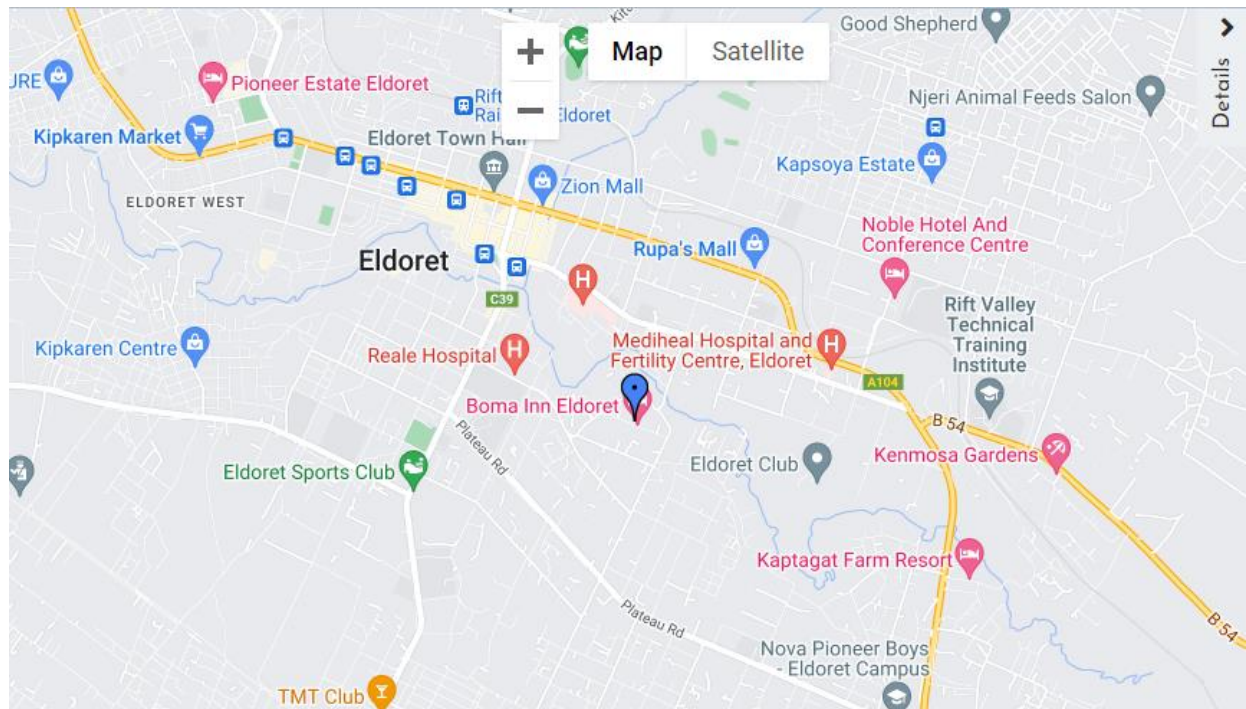


Fig 1. Finding the location of Boma Inn while in Eldoret. (0.504669, 35.283659)

**Registration** will be available 17.00 at the Boma Inn during the Ice breaker on Monday 10<sup>th</sup> October 2022. Drinks and buffet, with music will be provided.

Final registration on the 11<sup>th</sup> October is available between 08.30-09.15

**Oral presentations** – All presenters on the first day would be required to provide their PowerPoint slides for Oral presentations at the registration on the 10<sup>th</sup> October 2022 or email in advance to [seghconference2022@uoeld.ac.ke](mailto:seghconference2022@uoeld.ac.ke), Subsequent presenters to provide their presentations the day before. Please see the program of the conference below.

**Poster presentations (P)** – Posters are to be attached to a board on the morning of your session. The online presenters are requested to send their presentations to [seghconference2022@uoeld.ac.ke](mailto:seghconference2022@uoeld.ac.ke) before 18.00 on Monday October 10, 2022.

Flash presentations will need to be provided at the latest by the lunchtime – you can choose to present and promote your poster without slides – please let the session convener know in advance. The 1min59-second presentations will be linked and run on a timer – presenters will need to be ready to stand up for their talks. The audience will applaud at the end of the time slot and the next presenter will stand up whether finished or not.

A demonstration for the first flash presentation would be made.

## Training Session

Training courses are provided by volunteers on the afternoon of October 12, 2022. A provisional timetable is as follows, but maybe adjusted according to demand.

Introduction to QGIS

Embedding Ethics in Experimental Design

Basics in writing, reviewing and getting manuscripts published



## Programme

### 37<sup>th</sup> Annual Conference of the Society for Environmental Geochemistry and Health (SEGHS)

10 to 14 October, 2022

@

Boma Inn Hotel, Eldoret, Kenya

#### Monday 10<sup>th</sup> October 2022

#### Arrival and Registration

Time		
03:15 PM	REGISTRATION @ Boma Inn	
6:00 PM	ICE BREAKER AT BOMA INN	

## Oral Presentations Summary

Tuesday 11<sup>th</sup> October 2022

Time		MODE
<b>9:15 AM</b>	<b>OPENING CEREMONY</b>	
10:15 AM	<b>Keith Torrance</b> - Could emerging contaminants limit re-use options for dredged river and canals sediments?	In person
10:45 AM	<b>Chris Aura</b> - Sustainable community-based cage aquaculture in lake Victoria, Kenya.	In person
<b>11:00 AM</b>	<b>BREAK</b>	
11:30 AM	<b>Frank Onderi Masese</b> - Drivers of water quality in Afromontane - savanna rivers	In person
11:45 AM	<b>Chrispine Nyamweya</b> - Water circulation patterns and implications on suitable sites for cage aquaculture in Lake Victoria	In person
12:00 PM	<b>Safina Musa</b> - Mixed feeding schedule of low and high frequency in the diet of Nile tilapia ( <i>Oreochromis niloticus</i> ) fingerlings: effect on growth performance, body composition and haemato-immunological, stress responses and economics in low input ponds"	In person
12:15 PM	<b>Naftaly Mwirigi</b> - Harmful Algal Blooms in Lake Victoria, Kenya: Dunga versus Mfangano bloom status review of in situ data combined with Google Earth Engine imagery.	In person
12:30 PM	PANEL DISCUSSION	
<b>12:50 PM</b>	<b>LUNCH</b>	
2:00 PM	<b>James Ilast</b> - Status of pollution and effects on fish ecology in Ferguson's Gulf of Lake Turkana	In person

2:15 PM	<b>Hilda Nyaboke</b> -The urban fish: Assessment of eutrophication impacts on fish communities within Kisumu Bay	In person
2:30 PM	<b>Fonda Jane Awuor</b> - Heavy metals concentration in the muscle of Nile tilapia ( <i>Oreochromis niloticus</i> ) from different sources in Kisumu City, Kenya	In person
2:45 PM	<b>Collins Onyango Ongore</b> - Geophysical classification of Lake Victoria's lakebed and assessment of its influence on fish stocks using acoustically acquired data	In person
3:00 PM	<b>Maryam Abdus-Salam</b> - Entropy water quality index and probabilistic health risk assessment from geochemistry of groundwater in the vicinity of an active dumpsite in Ibadan, Southwest Nigeria	Virtual
3:15 PM	<b>Temitope A Laniyan</b> - Health Risk Assessment of potentially toxic metal pollution of groundwater around an exposed dumpsite in Southwestern	Virtual
3:30 PM	<b>Olubukola O. Afolabi</b> - Environmental assessment of potentially toxic elements in surface sediments from Lagos megacity and potential health implications, South Western Nigeria	Virtual
3:45 PM	PANEL DISCUSSION	
<b>4:05 PM</b>	<b>BREAK</b>	
4:35 PM	POSTER	

### Wednesday 12<sup>th</sup> October 2022

9:00 AM	<b>Maurizio Barbieri</b> - Trace metal element pollution in media from the abandoned Pb/Zn	Virtual
9:20 AM	<b>Maureene Ondayo</b> - Artisanal gold mining in Kakamega and Vihiga counties, Kenya: potential human exposure and health risk	In person
9:35 AM	<b>David King</b> - The Development of a field-based preservation method for total mercury in water samples using Functionalised C18 Solid-Phase Extraction	In person
9:50 AM	<b>Ivy Chepkoech Ronoh</b> - Effects Of Chronic Fluoride Toxicity On Thyroid Iodine Metabolism In <i>Xenopus laevis</i> Tadpoles	In person
10: 05 AM	<b>Shakirat Mustapha</b> - Health risk assessment of artisanal gold mining on miners and residents of Osu and Itagunmodi areas, Southwestern Nigeria	Virtual
10:20 AM	<b>Rapant Stanislav</b> -Proposal of new Health Risk Assessment method for Deficient essential elements in Drinking water -Case Study of the Slovak Republic	In Person
10:35AM	PANEL DISCUSSION	
<b>10:35 AM</b>	<b>BREAK</b>	
10:50 AM	<b>Isaboke Job</b> - Spatial distribution and loss of micronutrients in soils from two different land use management	In person
11:20 AM	<b>Khadija Jabeen</b> - What can dust tell us about the microbiological and chemical exposures in indoor environments?	Virtual



11:35 AM	<b>George Morara Ontumbi</b> - Modelling spatial variation, distribution, and prediction of fluoride levels in groundwater in the river Njoro catchment	In person
11:50 AM	<b>Sophia Dowell</b> - Plutonium as a soil erosion tracer in East Africa	Virtual
12:05 PM	<b>Olivier Humphrey</b> - Predictive geochemical mapping using machine learning in Western Kenya	Virtual
12:20 PM	<b>Felicia F. Ajayi</b> - Geochemical and geotechnical investigation of colluvium erosional soils, of Nanka Town, Anambra Basin, Southeastern Nigeria	Virtual
12:35 PM	<b>Clay Prater</b> - Predicting animal growth responses to energy and macronutrient limitation using compositional Data	Virtual
12:50	<b>Rapant Stanislav</b> - Improving Vascular Elasticity after starting to consume Drinking Water enriched with Ca and Mg: A case study of Slovak Republic	In Person
1:15 PM	PANEL DISCUSSION	
1:15 PM	LUNCH	
2:10 PM	POSTER	33
3:10 PM	TRAINING	In person

### Thursday 13<sup>th</sup> October 2022

9:30 AM	<b>Diana Menya</b> - Building collaborations in Multidisciplinary Research using esophageal squamous cell carcinoma in Eastern Africa as case	In person
10:00 AM	<b>Michael Watts</b> - Geochemistry and health data to inform public health outcomes in Western Kenya	In person
10:15 AM	<b>Awwal Bamanga</b> - Influence of particle size distribution on heavy metal geochemistry of Lagos Harbour, Nigeria.	In person
10:30 AM	<b>Salome Chelimo</b> - Quenching fumonisin b1 radicals by differential sequence of ascorbic acid and selenium.	In person
10:45 AM	<b>Alex Chebor</b> - Prognostic cogency of FETAX protocol over the use of rats in assessing <i>Carissa edulis</i> roots, ethanolic extracts toxicity	In person
11:00 AM	PANEL DISCUSSION	
11:20 AM	BREAK	
11:40 AM	<b>Julie Bwoga</b> - Fish parasites and diseases: context of Kenyan Aquaculture	In person
11:55 AM	<b>Lucy Wanjohi</b> - Wastewater treatment using green technology	In person
12:10 PM	<b>Miguel Izquierdo Diaz</b> - Mining legacy in a former mining area and trace elements phytoavailability	In person
12:25 PM	<b>Salia Shelif</b> - Enhanced phytoremediation of potentially toxic elements (PTEs) chromium and lead polluted soils using <i>Raphanus raphanistrum</i>	Virtual
12:40 PM	<b>Kiri Rodgers</b> - water treatment plants: a reservoir of antimicrobial resistance?	Virtual
12:55 PM	PANEL	
1:05 PM	AGM	
2:05 PM	Wrap up	

2:30 PM	LUNCH	
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**Field Excursion**  
**Friday 14<sup>th</sup> October 2022**

Time		
10:00 AM	Departure to the Rift Valley Escarpment and Timoi National. Park	
6:00 PM	RETURN TO BOMA INN	

**Poster Presentation Summary**  
**Tuesday 11<sup>th</sup> October 2022**

NAME	TITLE	THEME	MODE
4:35:00 PM	<b>Faith Onyangore</b> - Aberration of iron metabolism after histopathological alterations in <i>Oreochromis niloticus</i> and <i>Clarias gariepinus</i> after exposure to aflatoxins	HEALTH	In person
4:38:00 PM	<b>Pauline Long'or Lokidor</b> - Modelling Nature-Based Solutions (NbS) to control flooding in Kibera slum Nairobi, Kenya	Water Resources	In person
4:41:00 PM	<b>Elliott Hamilton</b> - Resolving the unresolved: online microdialysis coupled to icp-qqq for the simultaneous sampling and analysis of dissolved elements in soil solution	TECHNOLOGY	Virtual
4:44:00 PM	<b>Horace Owiti Onyango</b> - Public Nuisance or latent problem: The Human Dimensions of Harmful Algal Blooms (HABs) on small-scale fishing communities of Lake Victoria Basin	Water Resources	Virtual
4:47:00 PM	<b>Aminat Olaitan Adebayo</b> - Planetary health: the intersection of human health and environment health	HEALTH	Virtual
4:50:00 PM	<b>Morenike Abimbola Adeleye</b> - Mineralogical studies of talcose rocks in Wonu-Apomu area, southwestern Nigeria; health implications of chrysotile-asbestos	Health (Environmental Health)	Virtual

### Wednesday 12<sup>th</sup> October 2022

Time	TITLE	THEME	MODE
2:10:00 PM	<b>Philomena Cheptanui Sergon</b> - Evaluation of Carcass and Meat Quality traits among domesticated rabbit breeds crosses in Western and North-rift Kenya	AGRICULTURE	In person
2:13:00 PM	<b>Paul Mutai</b> - To determine feed intake and feed conversion efficiency(FCE) of the small East Africa goats(seags) fed on mature green pods of <i>Acacia. brevispica</i> , <i>a. mellifera</i> , and <i>A.tortilis</i> processed differently as supplements to growing (seags).	AGRICULTURE	In person
2:16:00 PM	<b>Stella Gatama</b> - Opportunities and Constraints in Green Economy development in Kenya's Forestry Sector	AGRICULTURE AND NUTRITION	In person
2:19:00 PM	<b>Anne Mokoro</b> -Assessment of the response of different age groups of <i>O.variabilis</i> towards stress caused by poor water quality during fish transportation from Kisumu to Siaya counties in Kenya	AGRICULTURE AND NUTRITION	In person
2:22:00 PM	<b>Emmy C. Kerich</b> -A Review f Low-Cost Atrazine Herbicide Biochar Adsorption Techniques from Water	URBAN AND INDUSTRIAL	Virtual
2:25:00PM	<b>Agan Leonard</b> - subcellular partitioning of as, cr, pb and cd in gastrointestinal tract in xenopus laevis as a result of exposure to mine tailings.		

## CONFERENCE ABSTRACTS

**Disclaimer:**

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**COULD EMERGING CONTAMINANTS LIMIT RE-USE OPTIONS FOR DREDGED RIVER AND CANALS SEDIMENTS?**

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**Abstract**

Flood defences to mitigate climate change will require large volumes of aggregates for seawall construction and clean fill for levees and dikes. The beneficial reuse of dredged sediments from Europe's canals and waterways for these projects is a vital step in reducing waste and transitioning towards a sustainable future. However, the viability of using this readily-available material source can be compromised by the presence of both legacy and emerging contaminants particularly where canals and rivers traverse urban areas. The potential health hazards from elevated levels of metals such as nickel, zinc, and lead are well documented, but those of emerging contaminants such as PFAS, microplastics, and 6PPP are poorly understood.

Dredged sediment from inland waterways are usually characterised by total organic matter contents in excess of 10%, high moisture contents, and an unfavourable particle size distribution for infrastructure applications. From 2019 to 2021, pilot studies up to 15,000m<sup>3</sup> in scope were undertaken on Scotland's canal network; at Laggan on the Caledonian Canal, at Bowling on the Forth & Clyde Canal and at Falkirk on the Union Canal to determine the viability of using dredged sediment for infrastructure projects. As part of the Interreg-funded SURICATES project, we have demonstrated through that passive conditioning methods can be successfully applied to enhance the geotechnical properties of dredged sediments, whilst remediating certain contaminants through phyto-conditioning. By recovering usable coarse fractions, concerns over emerging contaminants, which can preferentially accumulate in urban waterways, can be managed.



## **SUSTAINABLE COMMUNITY-BASED CAGE AQUACULTURE IN LAKE VICTORIA, KENYA**

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### **Abstract**

Cage aquaculture is quickly expanding in the African Great Lakes Region, with the potential to boost fish output and act as a source of food security, poverty reduction, and job creation. However, there is growing concern that the proliferation of fish cages in Lake Victoria may have significant consequences on the lake's ecology. The current socioecological study across the five riparian counties of Lake Victoria, Kenya assessed the sustainability of community-based cage aquaculture in the lake and proposed possible mitigation measures. The survey recorded a total of 5242 cages across the five counties with Siaya County having the highest number of cages attributed to the special support from the Ministry of Devolution in 2018. The carrying capacity with best management practices is estimated to be more than 500% of the current cage culture production, which is estimated to be 21,000 mt. The water quality parameters were generally within the optimal levels recommended for aquaculture. However, there was no clear gradient on the concentration of the parameters in cage locations probably due to the dilution effect of the lake water which may deteriorate in the long run. Fish exhibited normal growth with uniform length and weight gain. It was established that farmers had no access to quality affordable seed and feed, and extension services thereby limiting cage productivity. Lack of quality feeds locally was the main reason for importing feeds. Appropriate policies and regulations are required for improved lake and resource management, as well as to guide cage culture business, improve security, and facilitate resource usage dispute resolution procedures.

**Keywords:** Lacustrine water resources; cage culture; sustainability, Lake Victoria.

## DRIVERS OF WATER QUALITY IN AFROMONTANE-SAVANNA RIVERS

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### Abstract

Although several studies have investigated the relationships between water quality in rivers and the types of land use within their catchments, many aspects of these relationships remain unclear in Afromontane-savanna rivers, especially the interactions between catchment land use, seasonality, and stream size. Afromontane-savanna catchments present a unique situation where regions mid-elevation regions and lowlands have experienced more dramatic landcover change, but headwater regions remained rather natural. We examined the influence of seasonality, catchment land use and stream size, including their interactions, on water physico-chemistry, nutrients, and major ions in the Afromontane-savanna Mara River in Kenya, using data collected from 2010 to 2018 at >150 sampling sites in the Kenyan part of the river. We developed generalized linear mixed models (GLMMs) to explore the influence of seasonality (dry and wet seasons), land use (forest, mixed, agriculture and grasslands), stream size (stream orders 1 to 7), and their interactions on river water quality. Water quality variables included physical measures (pH, dissolved oxygen [DO] concentration, temperature, electrical conductivity, total dissolved solids [TDS], turbidity, total suspended solids [TSS] and particulate organic matter [POM]), nutrients (total dissolved nitrogen [TDN], total nitrogen [TN], soluble reactive phosphorus [SRP], total phosphorus [TP] and dissolved organic carbon), and major ions (Cl<sup>-</sup>, F<sup>-</sup>, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Fe<sup>2+</sup>, and Si). There were clear differences in average values of most water quality variables among land uses with sites in savanna grasslands having high levels of major ions, ammonium, and P while agricultural sites had higher dissolved fraction of N (except ammonium). Stream order was a poor predictor of water quality, and most parameters did not display any relationship (either linear or non-linear) with stream size. Our results could be used to efficiently enhance water quality by developing strategies for stream restoration and management based on the predomination type of land use in the catchments.

Keywords: linear mixed models; land use; non-linear relationships; savanna rivers; water quality

## WATER CIRCULATION PATTERNS' IMPLICATIONS ON SUITABLE SITES FOR CAGE AQUACULTURE IN LAKE VICTORIA

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### Abstract

Fish farming in cages in Lake Victoria has been rapidly increasing following the decline of catch rates of wild stocks. However, of recent, massive fish kills have been witnessed in some cage sites. Preliminary studies have attributed the fish mortalities to localized upwelling events that lead to depletion of dissolved oxygen due to release of decomposing matter into the water column. We developed ROMS model to be used to predict such events and ultimately play a critical role in cage culture site selection. We modelled these dynamics using a Regional Oceanographic Model System (ROMS) as from January 1st, 2000. Using the bulk flux technique, the model is based on real bathymetry, river runoff, and atmospheric forcing data. Annual cycles of thermo-stratification (September–May) and mixing (June–August) are observed in the water column, according to simulations. Surface water currents have several forms, ranging from a lake-wide northward flow to gyres of various sizes and numbers. Upwelling and downwelling zones arise as a result of an underflow. The lake's center and western inshore waters have the highest current velocities, implying that water circulation is better there. However, water exchange between the major gulfs (especially Nyanza) and the open lake is minimal, which could explain the water quality discrepancies found in those areas. The findings of this study add to our knowledge of the physical processes (temperature and currents) that influence diel, seasonal, and annual variations in stratification, vertical mixing, inshore—offshore exchanges, and nutrient fluxes, all of which have an impact on biotic distribution and trophic structure. Information from this study on upwelling areas/timing and vertical mixing, for example, will help anticipate high primary production and, eventually, fisheries productivity in Lake Victoria, as well as optimal cage culture sites.

**Keywords:** Lake Victoria; cage culture; upwelling; circulation;

**MIXED FEEDING SCHEDULE OF LOW AND HIGH FREQUENCY IN THE DIET OF NILE TILAPIA (ORECHROMIS NILOTICUS) FINGERLINGS: EFFECT ON GROWTH PERFORMANCE, BODY COMPOSITION AND HAEMATO-IMMUNOLOGICAL, STRESS RESPONSES AND ECONOMICS IN LOW INPUT PONDS**

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**Abstract**

The high costs of fish feeds and chemical fertilizers have been a major bottleneck to the development of Nile tilapia farming. Stable carbon and nitrogen isotopes was used to assess the relative contribution of commercial diet and natural food sources to the growth Nile tilapia reared in ponds. Haematological, biochemical, and body composition of fish were also examined. Nile tilapia fingerlings ( $5.6 \pm 0.14$  g; mean $\pm$ SE) were fed following a mixed feeding schedule with the feeding cycle of 28 days that consisted of either 28 days feeding once/day daily (28d-1/d) or 4 times/day daily (28d-4/d), or 14 days feeding once/day and 14 days feeding four times/day (14d-1/d+14d-4/d) or 21 days feeding once/day and 7 days feeding four times/day (21d-1/d+7d-4/d) or 25 days feeding once/day and 3 days feeding four times/day (25d-1/d+3d-4/d) for 90 days. Fish and water quality were sampled after every 28 days, while blood and various feed sources were sampled after 84 days. Stable carbon and nitrogen isotopes were carried out to determine the relative contribution of the nutrient sources to fish growth. Higher ( $P < 0.05$ ) growth and better health condition were found in the 14d-1/d + 14d-4/d group, which was similar to 21d-1/d+7d-4/d group. The highly enriched  $\delta^{15}\text{N}$  values of cattle dung in relation to phytoplankton and zooplankton in all the treatments suggest minimal contribution of cow dung to primary or secondary productivity. However, beyond their value as fertilizer, chicken droppings represent an immediate source of food for tilapia. Natural feed is the main contributor to the growth of Nile tilapia, hence enhancing natural productivity should be underscored under SIFS, especially for small-scale fish farmers whose profit margins tend to be marginal. Key words: Nile tilapia, stable isotope analysis, semi-intensive, mixed feeding frequency, fish welfare

## HARMFUL ALGAL BLOOMS IN LAKE VICTORIA, KENYA: DUNGA VERSUS MFANGANO BLOOM STATUS REVIEW OF *IN SITU* DATA COMBINED WITH GOOGLE EARTH ENGINE IMAGERY

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### Abstract

Aquatic ecosystems are changing as a result of climate change. These ecosystems are facing progressive increase in pollution, eutrophication and deoxygenation that will intensify over time due to rising population. At the same time, there is scientific agreement that over the past few decades, harmful algal blooms (HABs) have become more detrimental to ecosystems, fisheries, recreation, tourism, and public health. Cyanobacteria (blue-green algae) have existed on Earth for more than 2 billion years and are capable of producing a wide range of bioactive substances, including cyanotoxins. The most frequently detected cyanotoxin, microcystins (MCs), poses risk to both the aquatic environment and human health. The effects of MCs in fish depend on the exposure concentrations, doses, time, and routes of exposure. Despite the fact that human activity, including climate change, has been shown to support worldwide trends in HABs, individual events are still influenced by local, regional, and global factors, making it crucial to properly assess the circumstances and reactions at the right scales. The goal of the current review was to consolidate prior studies, analyze physicochemical *in situ* data from YSI sonde probes located in Dunga (Winam Gulf) and Mfangano (open waters of Lake Victoria, Kenya), trace nitrogen and phosphorus deposition pathways using the RUSSLE Model and compare the results with Google Earth Engine imagery for further study recommendations.

**Keywords:** Harmful algal blooms, cyanobacteria, microcystins, climate change



## STATUS OF POLLUTION AND EFFECTS ON FISH ECOLOGY IN FERGUSON'S GULF OF LAKE TURKANA

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### Abstract

Lake Turkana, located in north-western Kenya, has a surface area of 7,500 km<sup>2</sup>, making it Kenya's largest lake and the world's largest permanent desert lake. Ferguson's Gulf is linked to Lake Turkana via the gulf's mouth. Inflows are additionally provided by the intermittent River Kalotum and several ephemerals. It is one of the lake's most productive sections, with significant fish landings and a high human population. Sites with varied degrees of pollution in Ferguson's Gulf were identified and their coordinates marked using a Raymarine Dragonfly-7 Pro Sonar/GPS. Selected water quality parameters were measured using standard methods and fish samples were collected with variable mesh size monofilament gill nets. Questionnaires were administered to fisheries stakeholders. Results show that water quality parameters such as dissolved oxygen, temperature, and pH did not appear to differ significantly ( $p > 0.05$ ) within the Gulf, implying their minor influence on fish diversity and abundance. Twelve fish species were recorded and there was little to no substantial fish species overlap between Ferguson's Gulf and the open lake. The Gulf contained high amounts of faecal and plastic contamination and majority of the interviewed fishermen (62%) were aware of correct oil, plastic, and fish waste disposal methods, but the main challenge they faced was lack of approved disposal places. Long'ech was identified as the most contaminated location (39%), followed by Natirae (22%) in comparison to the Gulf's Mouth. Faecal, plastic, and engine oil wastes were the main sources of pollution in Ferguson's Gulf, however they have yet to have a significant impact on water quality, diversity, and abundance of fish in the Gulf. In-depth research on microplastics in fish and the effects of plastics on feeding and reproduction in demersal fish is recommended.

## THE URBAN FISH: ASSESSMENT OF EUTROPHICATION IMPACTS ON FISH COMMUNITIES WITHIN KISUMU BAY

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### Abstract

Kisumu Bay is a class H – Hydrographic bay within Winam Gulf nested within Kisumu city (the second largest city in Lake Victoria, Basin). The bay is home to an indigenous fish species community that have been subjected to environmental pressures from both point-source discharge and non-point loading of limiting nutrients from human activities accelerating the rate and extent of eutrophication. This study set out to identify and map pollution hotspots within the bay and assess the role of key environmental attributes on fish species diversity and abundance. A Correlation matrix between Fish species diversity and abundance and water quality was developed to describe eutrophication impacts on biodiversity. There were relatively high levels of fecal coliforms at Kisat river mouth between August-December 2021 (>10CFUs/100mL) whereas the DO levels remained fairly constant over the period of assessment. A total number of 17 fish species were recorded within the bay with the highest diversity recorded at Kisat River mouth (12 species). The mid-bay had lower habitat diversity ( $H=1.31$ ;  $D=0.40$ ;  $d=1.58$ ) with the least diversity recorded at Hippo point ( $H=1.29$ ;  $D=0.35$ ;  $d=1.14$ ). The most dominant species within the bay are Haplochromines, *Lates niloticus*, *Synodontis victoriae*, *Brycinus jacksonii* and *Brycinus sadleri*. Unique species recorded within the bay include: *Coptodon Zilli*, *O. leucostistus*, *O. esculentus*, *Enteromius apleurogramma* whilst *Rastineobola argentea* and *Synodontis afrofisheri* previously observed were not recorded during the period of assessment. DO profiling was assessed against water hyacinth coverage peaks within the bay and mapped pollution hotspot.

**Keywords:** Diversity, water quality, nutrients, hotspot, species

## HEAVY METALS CONCENTRATION IN THE MUSCLE OF NILE TILAPIA (*Oreochromis niloticus*) FROM DIFFERENT SOURCES IN KISUMU CITY, KENYA

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### Abstract

Safety and quality of fish have become progressively crucial in fish trade because fish is distinctly susceptible to biological and chemical contamination from the environment. This study sought to determine the levels of some heavy metals namely Cadmium (Cd), Manganese (Mn), Lead (Pb) and Cobalt (Co) in the muscles of wild captured Nile tilapia (*Oreochromis niloticus*) from Lake Victoria, imported frozen tilapia and farmed tilapia sold in Kisumu city. The highest concentration of Mn, Pb, and Co was recorded in wild captured compared to the other groups. The levels ranged between (0.526) for Mn, (0.467) for Pb and (0.330) for Co. Cadmium was significantly lower in wild captured tilapia. Farmed and imported frozen tilapia had significantly lower levels of heavy metal contamination which were well below the permissible limits for fish by European Union/World Health Organization standards and national guidelines. The current findings indicate that wild captured Nile tilapia, could be unsafe for human consumption based on the higher levels of metal bioaccumulation. As a result, very close monitoring of heavy metal loads in Lake Victoria is recommended given the potential risk to consumers' health. The study recommends that further studies be undertaken to compare the variation of heavy metal concentration in other fish body parts like the gills and liver and to assess the tenable threat linked to their consumption. Assessment of heavy metal concentration in fish feeds should also be undertaken to rule out all sources of heavy metal accumulation in farmed fish.

**Keywords:** Permissible limits, Consumption, Concentration, health

## GEOPHYSICAL CLASSIFICATION OF LAKE VICTORIA'S LAKEBED AND ASSESSMENT OF ITS INFLUENCE ON FISH STOCKS USING ACOUSTICALLY ACQUIRED DATA

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### Abstract

Lake Victoria's bottom terrain may comprise varying underlying structure due to various denudation processes and the nature and distribution of its primary rocks. This may influence the distribution and overall ecology of the benthic and column-dwelling biota including fish. Lake bottom classification was acoustically performed to map the variability of the lakebed by textural classes of the substrate and assess its influence on the fish stocks lake wide. A dual frequency Simrad® 70kHz and 120 kHz split-beam echosounder system with an EK 80 data acquisition system was used to collect the acoustic data. Echoview 8.0 software was subsequently used to process and export raw acoustic backscatter data for both fish density and bottom classification. The 70 kHz echosounder data was used entirely for the determination of Lakebed roughness and lakebed hardness using the best bottom candidate algorithm. It was determined that the lake comprises a mixed occurrence of sediment classes based on the Bottom Surface Backscattering Strengths system and is dominated by Sandy-silt and silt at -10 to -20 dB occurring mostly in the deeper strata, followed by Silt and mud class at <-20 dB found in shallow inshore areas. Lake bottom hardness was negatively correlated with densities of Nile perch and *dagaa* ( $r = -0.8$ ) indicating that areas of the lake with softer bottoms may favor the reproduction and growth of these fishes.

**ENTROPY WATER QUALITY INDEX AND PROBABILISTIC HEALTH RISK  
ASSESSMENT FROM GEOCHEMISTRY OF GROUNDWATERS IN THE VICINITY  
OF AN ACTIVE DUMPSITE IN IBADAN, SOUTHWEST NIGERIA**

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**Abstract**

Man's continuing survival is strongly dependent on the availability of clean drinking water because it is essential to human physiology. Regular groundwater quality monitoring is vital to safeguard the ecosystem and human health. Consequently, it is crucial to frequently monitor the groundwater in the vicinity of dumpsites so that the neighbourhood may be swiftly informed of risk if the quality is compromised. Forty-five groundwater samples were collected from the surroundings of Awotan dumpsite in southwestern Nigeria during dry and rainy seasons and studied for hydrogeochemistry and groundwater quality. Furthermore, the US Environmental Protection Agency mathematical model was used to analyse the probabilistic non-carcinogenic human health hazards associated with fluoride and iron concentrations. The physical and geochemical parameters fall within permissible limits for domestic purpose during both seasons. However, 2% of them exceeded the prescribed limits of nitrate (45 mg/L) and 100% of these groundwater samples exceeded limit of iron (0.3mg/L). The values of EWQI calculated for the samples range from 20 to 528 with 13% classified as extremely poor, 18% as poor, 51% as medium, 16% as good and 2% as excellent water quality for domestic purposes. The hazard quotients of nitrate ( $HQ_{\text{Nitrate}}$ ) and iron ( $HQ_{\text{Fe}}$ ), as well as their overall non-carcinogenic health risk ( $HI_{\text{Total}}$ ), are less than one, indicating that they are not harmful to health, but children are more susceptible to the risk than adults. We recommend water treatment procedures to enhance water quality and minimize any public health threats.

## HEALTH RISK ASSESSMENT OF POTENTIALLY TOXIC METAL POLLUTION OF GROUNDWATER AROUND AN EXPOSED DUMPSITE IN SOUTHWESTERN

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### Abstract

Groundwater quality is faced with severe challenges in most developing countries like Nigeria. This emanates from indecisive dumping of refuse which acts as point source for Potentially Toxic Metals (PTM) within the environment. The research is aimed at assessing the impact of metal pollution on groundwater quality around an active dumpsite in Ijebu-Igbo, Southwest Nigeria. Water sample from hand-dug wells were collected around the dumpsite, the closest being 20m away from dumpsite. Two samples were picked at each spots for cation and anion analyses, those for cation analysis were acidified with concentrated hydrochloric acid to preserve the elements in samples while those for anion analysis were not acidified. Samples collected were analysed using ICP-MS and AAS. All samples were found to be within permissible limits except As (0.13 mg/L), K (29.94 mg/L), Pb (0.38 mg/L), Cd (0.003 mg/L) and temperature (31.93°C) due to the effect of mixing of corroded service pipes that contains lead dropped on the dumpsites and reaction of leachates with the various materials such as used battery, tins, electronic wastes found on the dumpsites that later washed into the groundwater. Geoaccumulation index revealed Pb to be moderately to highly contaminated in the groundwater. Government should provide disposal bags to all houses in the environment for better disposal and a centralised deep double cased well should be constructed in a clean environment at the study area mainly for drinking and domestic use.

**Keywords:** Contaminated; Groundwater; Toxic Metal; Dumpsite



## ENVIRONMENTAL ASSESSMENT OF POTENTIALLY TOXIC ELEMENTS IN SURFACE SEDIMENTS FROM LAGOS MEGACITY AND POTENTIAL HEALTH IMPLICATIONS, SOUTH WESTERN NIGERIA

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### Abstract

Information on the causes and sources as well as the ecological implications of potentially toxic elements (PTEs) pollution is very important in order to abate environmental pollution especially within aquatic system. This study intends to assess the concentrations distributions of PTEs in sediments across Lagos city and evaluate the potential health risk of exposure.

This study presents the results of fifty-eight (58) surface sediment samples collected from drains and canals within Lagos mainland. Samples were air-dried, pulverized and sieved to clay fractions for chemical analysis. The sieved samples were partially digested using aqua regia while the concentrations of the PTEs were determined using ICP-MS. The results (mg/kg) showed that Pb ranges from 22.0–729.0; Zn(125.0–1510.0); Cu(19.0–630.0) and Mn(111.0–952.0). Virtually all the studied sediments display elevated Pb, Zn and Cu that exceed the local background concentrations. The results showed that over 60% of the samples have values far greater than some regulatory standards/Intervention levels with the exception of Cu. Evaluating the results using geochemical indices showed that the surface sediments are moderately to heavily contaminated with Cu, heavily to extremely contaminated with Pb and Mn, and extremely contaminated with Zn. The ecological risk assessment indicated that Cu and Zn were within moderate to very high risk while Pb ranged within high to very high ecological risk factor. The overall Risk Index which determines the potential ecological risk of the environment, indicated high to very high risk potential of the sediments to the entire ecosystem in the study area.

**Keywords:** Potentially-toxic-elements, Sediments, Contamination, Lagos, Ecological Risk

## TRACE METAL ELEMENT POLLUTION IN MEDIA FROM THE ABANDONED PB/ZN MINE OF LAKHOUAT, NORTHERN TUNISIA

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### Abstract

This study aimed to determine the contamination status, dispersion mechanisms, and risks associated with trace elements in environmental media collected from the abandoned Pb/Zn mine of Lakhouat, northern Tunisia. A total of 41 samples, including 3 tailings, 21 stream sediments, and 17 soils, were collected. The concentrations of As, Pb, Hg, Cd, Cr, Co, Ni, Cu, Zn and Zr were determined by inductively coupled plasma–atomic emission spectroscopy. From the results, contamination status in samples was attained using pollution indices, ecological and health risks were obtained using adequate risk indices, while dispersion mechanisms were achieved using multivariate statistics. Principal component analysis revealed that the mining activities mainly controlled As, Pb, Hg, Cd, and Zn, particularly mineral tailings. The concentration of trace elements generally decreased with the distance from the mining site. The tailings were considerably enriched with As, Pb, Hg, Cd and Zn (enrichment factor values up to 800 for Cd and 300 for Zn). Soil and stream sediments were contaminated with As, Pb, Hg, Cd and Zn, as evident by several pollution indices. The values of the ecological risk factor suggested that the media posed moderate to high ecological risks, mediated mainly by Hg and Cd. In addition, high non-carcinogenic and carcinogenic health risks were associated with trace elements in media from this mining region, particularly in the vicinity of tailings. Overall, the results painted the need for undertaking epidemiological studies to outline the extent of the occurrence of diseases related to mining activities in the region.

## ARTISANAL GOLD MINING IN KAKAMEGA AND VIHIGA COUNTIES, KENYA: POTENTIAL HUMAN EXPOSURE AND HEALTH RISK

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### Abstract

Release of potentially toxic elements (PTEs) from artisanal small-scale gold mining (ASGM) activities into the environment is of great global public health concern and has prompted widespread research on environmental pollution. While increasing information on PTEs occurrence in soils, water and sediments in the developed world is available, there is still limited data in Africa. This multi-element analysis covering trace and major elements using inductively coupled plasma mass spectrometry was performed on soil, sediment, and water samples from 19 ASGM villages in Kakamega and Vihiga Counties, Kenya. Related health risks for the ASGM workers and local communities were also assessed. This paper focuses on As, Cd, Cr, Hg, Ni and Pb for which 96% of soil samples (n=64/68) from mining and ore processing sites had As concentrations up to 7,937 times higher than US EPA 12 mg kg<sup>-1</sup> standard for residential soils. Soil Cr, Hg, and Ni concentrations in 98%, 49% and 68% of the samples exceeded the standards. Community drinking water sources samples (25%) were polluted with up to 22 µg L<sup>-1</sup> As, compared to WHO 10 µg L<sup>-1</sup> guideline. Pollution indices indicated significant enrichment and pollution of soils, sediment, and water in decreasing order of As>Cr>Hg>Ni>Pb>Cd. The human health risk assessment revealed high mean non-cancer (98.60) and cancer (6,680) risks depicting health implications for the local communities and ASGM workers. This points to the critical need for evidence-based interventions in ore processing, industrial hygiene, and public health policy formulation to ensure sustainable mining and ore processing in Kenya.

## THE DEVELOPMENT OF A FIELD-BASED PRESERVATION METHOD FOR TOTAL MERCURY IN WATER SAMPLES USING FUNCTIONALISED C18 SOLID-PHASE EXTRACTION

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### Abstract

Mercury (Hg) is considered one of the most toxic elements to human health, due to its persistent and bioaccumulative properties, and is present in all spheres of the environment. Artisanal small-scale gold mining (ASGM) activities in countries, such as in Kenya, use Hg as a method to amalgamate gold from the geological matrix, with the potential to release Hg into the environment and subsequent public health exposure. In order to measure Hg in environmental samples improvements are required on existing recommended preservation methods for Hg in water samples that may not be fit for purpose e.g. acidification or use of glass bottles—are potentially hazardous to operators in the field. Additionally, challenges are faced when samples are collected in remote locations far from laboratories with sufficient analytical sensitivity for Hg, requiring a preservation method that is safe to use during fieldwork, will preserve the analytical integrity of the sample and provide sufficient stability over a time period to allow for return to an appropriate laboratory. Therefore, a dithizone functionalised C18 solid phase extraction cartridge (SPE) was developed to preserve Hg in water samples, with the aim of presenting minimal risk to the operator when used in the field and to provide sufficient stability over a minimum of four weeks for subsequent elution and measurement in a laboratory environment – in this case, by ICP-MS.

Performance characteristics were defined using a 0.8 µg L<sup>-1</sup> Hg spike of a synthetic water matrix typical from an ASGM outflow – 30ml of this spike was passed through the functionalised cartridge and Hg eluted with 15ml of 2-mercaptoethanol (1% v/v with deionised water). The SPE cartridge retained 100% of Hg in the spike solution and provided stability for Hg preservation across a 57-day period, with recoveries of >75% Hg achieved following elution. Further work shows promising recovery rates of up to 90% with adjusted dithizone functionalisation of the SPE, without compromising retention of Hg on the SPE. Initial test data will be presented for ASGM sites in Kakamega County, Kenya.

## EFFECTS OF CHRONIC FLUORIDE TOXICITY ON THYROID IODINE METABOLISM IN *Xenopus laevis* TADPOLES

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### Abstract

Fluoride is abundantly found in the earth's crust with most contamination of ground water occurring at levels of between 1-25 mg/l. The study aimed at evaluating the effects of chronic toxicity of fluoride (452.8µg/l) to *Xenopus laevis* tadpoles and to evaluate the possible interactions of 8.135µg/l triiodothyronine(T3), 11.652µg/l thyroxine(T4), 0.5µg/l Iodine and 0.005µg/l methimazole on iodine metabolism in the tadpoles. The experiments were done using Amphibian metamorphosis assay (AMA) test. The endpoints in the study were; daily observations to record the mortality of the tadpoles including any other observable changes in their behavior. For the whole duration of the experiment- 21 days, the development stages, hind-limb length (HLL), snout-vent length (SVL) and the body weights of the tadpoles were performed at the 7<sup>th</sup> and 21<sup>st</sup> day. Histology of the thyroid gland was evaluated at the termination of the experiment on day 21. Fluoride treated tadpoles showed a delay in growth and development of the tadpoles, Methimazole was able to inhibit the development of the tadpoles and prevent the tadpoles from reaching the climax of metamorphosis, T4, T3 were able to reverse chronic Fluoride toxicity in the tadpoles.

## SPATIAL DISTRIBUTION AND LOSS OF MICRONUTRIENTS IN SOILS FROM TWO DIFFERENT LAND USE MANAGEMENT

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### Abstract

Land use – land cover changes affect the ecosystems' status and integrity to support and supply the services. Agricultural activities and attendant soil erosion, leaching or depletion of nutrients may result in increased soil degradation. The study investigated micronutrient spatial distribution and concentration in soils within two different agricultural land use management. The study employed RUSLE equations to determine the erosion rate within the selected plots. Topsoils (5-10cm) from different points within the plots were collected and analyzed for micronutrients using ICP-MS(QQQ). The plots are located in high potential soil erosion places with soil erodibility (K) factor OF  $0.031\text{-ton ha}^{-1}\text{MJ}^{-1}\text{mm}^{-1}$  within the Ombeyi river catchment. The soil erosion was estimated to be  $> 50\text{t ha}^{-1}\text{year}^{-1}$ , implying the high loss of nutrients; hence, over 52 elements were analyzed. The two plots compared micronutrients iodine (I), calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), selenium (Se), zinc (Zn), and molybdenum (Mo). In Plot 1(no terraces), micronutrients were concentrated at the base of the plot, while in plot 2 ( terraces), some elements were evenly distributed. There is a significant difference in the concentration of elements between the plots; I, Se, Cu, Ca and Mg, depicting a p-Value of  $<0.05$ , while Fe, Zn and Mo with P-value  $>0.05$ . Elements in plot one were mapped with high concentration at the lower part of the plot as related to plot two which most of the elements were evenly distributed hence reduced micronutrients in plot 2. This encourages educating farmers on the importance of good terrain soil management.

Keywords: Micronutrients, Erosion



## WHAT CAN DUST TELL US ABOUT THE MICROBIOLOGICAL AND CHEMICAL EXPOSURES IN INDOOR ENVIRONMENTS?

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### Abstract

Dust is a ubiquitous environmental matrix found in the built environment which has been known to exhibit significant compositional complexity. As a repository for a variety of microbiological and chemical contaminants, it is of significant public health concern, especially in recent years with a spike in the time spent indoors due to the 2020 SARS-CoV-2 pandemic. We sampled >250 households in the UK from 2019-21, as part of a national survey, to characterise the microbiological and trace element composition of settled dust of  $\leq 250 \mu\text{m}$  grain size. ED-XRF analysis of dust from 254 households indicated significant contamination with regards to Pb, Cu and Zn as determined by geochemical indices. Geomean concentrations for metal(loid)s were 56.1 mg/kg for Cr, 238 mg/kg for Mn, 32.5 mg/kg for Ni, 125 mg/kg for Cu, 506 mg/kg for Zn, 5.90 mg/kg for As and 102 mg/kg for Pb. 16S rRNA amplicon sequencing of a subset of 60 households revealed the abundance of bacterial families closely associated with the human respiratory tract, skin and gut including *Staphylococcaceae*, *Streptococcaceae* and *Enterobacteriaceae*, indicating species-oriented origins for most of the bacteria. Proteobacteria, Actinobacteria and Firmicutes emerged as the most dominant phyla across all dust samples. Culture-dependant analysis further showed that the mean bacterial dust loading across samples was  $4.37 \times 10^6$  CFU/g of dust, in agreement with previous studies. Our findings have important implications for the development of evidence-based management strategies to modify potential benefits and hazards posed by our indoor exposures to dust and its associated microbiota.

## PLUTONIUM AS A SOIL EROSION TRACER IN EAST AFRICA

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### **Abstract**

Subsistence farmers in Africa are often dependent on food grown within a limited area, and therefore, their health can often be associated with geochemical factors that influence the soil-to-crop transfer of micronutrients (MN) essential for health. Loss of essential MN because of soil erosion can affect both crop yields and the protection of crops against disease, which could dramatically increase the likelihood of food shortages worldwide. In addition to the effects on land, the associated downstream transport of sediments to water bodies associated with soil erosion can impact water security. A large proportion of the degradation caused by soil erosion processes is a direct result of poor land management practises as well as vegetation clearance, and so there is a need for reliable quantitative data detailing rates of soil erosion and sedimentation. This data can then help to reinforce sustainable soil conservation measures in areas where resources to manage soils sustainably can be limited. This research aims to investigate the potential of using plutonium as an alternative tracer of soil erosion in challenging environments such as tropical Africa. This will allow for further research into the extent of soil erosion across East Africa and inform future mitigation efforts to reduce further erosion in the future.

## PREDICTIVE GEOCHEMICAL MAPPING USING MACHINE LEARNING IN WESTERN KENYA

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### Abstract

Digital soil mapping is a cost-effective method for obtaining detailed information regarding the spatial distribution of chemical elements in soils. Machine learning (ML) algorithms such as random forest (RF) models have been developed for such tasks as they are capable of modelling non-linear relationships using a range of datasets and determining the importance of predictor variables, offering multiple benefits to traditional techniques such as kriging.

In this study, we describe a framework for spatial prediction based on RF modelling where inverse distance weighted (IDW) predictors are used in conjunction with auxiliary environmental covariates. The model was applied to predict the total concentration ( $\text{mg kg}^{-1}$ ) of 56 elements, soil pH and organic matter content, as well as to assess prediction uncertainty using 466 soil samples in western Kenya (Watts et al 2021). The results of iodine (I), selenium (Se), zinc (Zn) and soil pH are highlighted in this work due to their contrasting biogeochemical cycles and widespread dietary deficiencies in sub-Saharan Africa, whilst soil pH was assessed as an important parameter to define soil chemical reactions. Algorithm performance was evaluated to determine the importance of each predictor variable and the model's response using partial dependence profiles. The accuracy and precision of each RF model were assessed by evaluating the out-of-bag predicted values. The IDW predictor variables had the greatest impact on assessing the distribution of soil properties in the study area, however, the inclusion of auxiliary values did improve model performance for all soil properties.

The results presented in this paper highlight the benefits of ML algorithms which can incorporate multiple layers of data for spatial prediction, uncertainty assessment and attributing variable importance. Additional research is now required to ensure health practitioners and the agri-community utilise the geochemical maps presented here, and the webtool, for assessing the relationship between environmental geochemistry and endemic diseases and preventable micronutrient deficiency.

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Link to web tool:

<https://bgs.maps.arcgis.com/apps/webappviewer/index.html?id=078c49c2f263462bb82009a2164a3a1f&extent=3679311.4591%2C102523.9557%2C4168508.4401%2C117308.9377%2C102100>

## **GEOCHEMICAL AND GEOTECHNICAL INVESTIGATION OF COLLUVIUM EROSIONAL SOILS, OF NANKA TOWN, ANAMBRA BASIN, SOUTHEASTERN NIGERIA**

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### **Abstract**

Gully erosion is considered one of the severe natural geo-hazards capable of posing threats to life, properties, biodiversity, arable land and source of livelihood. South-eastern Nigeria is known to be vulnerable to gully erosion which has defied several applied interventions. Colluvial soil act as reservoirs of Soil Organic Carbon (SOC) and it can be used to study intensity of soil erosion. In this study, the geochemical and geotechnical properties of colluvial soil from Nanka erosion site in Anambra, Southeastern Nigeria, was used to determine parameters that influence the formation of gullies and how to mitigate it.

Representative soil samples were collected from ten locations in the erosional site. Geochemical analysis was done with Atomic Absorption Spectrometer (AAS) to determine elemental composition and Exchangeable Base values. Physicochemical parameter test includes, Organic Matter Content (OMC), pH and Total Dissolve Solids (TDS). Geotechnical parameters such as Atterberg Limits, Plasticity Index, and Bulk Density, were measured using appropriate laboratory procedures and apparatus.

Trace elements concentration in g/kg ranges Zn(0.022-0.098), Cu(0.017-0.073), Fe(33.24-74.49) and Mn (0.061-0.281). Exchangeable Bases (Ca, Mg, K and Na) ranges from 0.003% to 0.095%. The pH ranges from 4.57 to 5.61, TDS ranges from 11.00ppm to 40.00ppm, and OMC ranges from 0.16% - 1.6%. Plasticity Index ranges from 15%- 22% while Bulk Density ranges from 1.35g/cm<sup>3</sup> to 1.75 g/cm<sup>3</sup>.

The lithology, poor OMC and clay/silt fractions suggest poor soil cohesion. To help prevent negative environmental impact and slow down devastation; reforestation and the use of organic manure is recommended.

**Keywords:** Colluvial soil, Gully erosion, Environmental Impact, Nanka erosion site, Anambra

## **PREDICTING ANIMAL GROWTH RESPONSES TO ENERGY AND MACRONUTRIENT LIMITATION USING COMPOSITIONAL DATA**

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### **Abstract**

Animal nutrition is determined by the balance of energy and elements in their diets. Insufficient supplies of either resource can reduce animal growth; however, as these currencies are typically studied separately (energetics and nutrients), we lack a general understanding of how they interact to affect animal growth. In our study, we imposed different forms of resource limitation on the aquatic herbivore *Daphnia* and measured changes in its energy (adenosine triphosphate; ATP) and elemental (carbon, nitrogen, phosphorus; CNP) content. Animals exposed to N-, P-, and food quantity-limitation showed unique energy and elemental profiles, highlighting the complex physiological responses of animals to resource limitation. Rather than decreasing their body content of the most limiting nutrient in their diets, multivariate changes in C, N, P, and ATP were made to reduce energy:mass ratio imbalance and improve overall resource use efficiency. By comparing the combined use efficiencies of C, N, P, and ATP in resource limited animals to those growing optimally on nutrient replete diets, we derived a simple model capable of predicting daphnid growth rates to an accuracy of ~5% across all diets. We suggest that this growth efficiency framework could be used to formulate balanced energy and macronutrient diets for animals and briefly discuss extensions for integrating micronutrients into these models.

## GEOCHEMISTRY AND HEALTH DATA TO INFORM PUBLIC HEALTH OUTCOMES IN WESTERN KENYA

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### Abstract

Environmental geochemistry data can reveal spatial differences in dietary intake with implications for health status. For example, soil and subsequently crop chemistry data is influenced by changes in soil type, pH, geology and geographical features (amongst other factors). Specific soil and food composition data can support estimates of dietary mineral supplies (Watts et al. 2019, 2021a). However, additional metrics can supplement the understanding of links between geochemistry and health in Western Kenya. Here we present a summary of data from a survey of soil and crops, but will focus in particular on the private drinking water and urines as an estimate of nutritional status or exposure to potentially harmful elements collected across 20 Counties in Western Kenya. We discuss the potential for interpreting health metrics, including: food dietary estimates, drinking water and biomonitoring data (urine – Watts et al. 2020; 2021b). Comparisons between these metrics will be discussed, along with the limitations in interpreting these data. These datasets were presented to stakeholders from each of the 20 Counties in June 2022 to provide feedback on data outcomes and to co-design the data delivery to assist in dissemination. Stakeholders included the leaders of agriculture and public health offices in each County government office and from academia. This second point of discussion will raise the importance of information flow back and the challenges in doing so e.g. mis-/over-interpretation of data, opportunities to incorporate into decision making and the stimulation of new research. In particular, the value of undertaking a multi-disciplinary research project to encourage stakeholders to plan intervention strategies with a multi-disciplinary consideration.

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## INFLUENCE OF PARTICLE SIZE DISTRIBUTION ON HEAVY METAL GEOCHEMISTRY OF LAGOS HARBOUR, NIGERIA.

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### Abstract

The Coastal Zone of Lagos Harbour, Nigeria, is vulnerable due to the potentially contaminating consequences of human activities. The basin of Lagos Harbour has restricted water circulation and typifies this situation. The aim of this investigation was to determine the influence of particle size distribution (PSD: clay, silt, sand and coarse) on heavy metal geochemistry of Lagos Harbour Area.

A total of twenty-six sampling sites was established for the determination of PSD of sediment samples from Lagos Harbour & Lagoon. The method was developed according to British Standards (BS 1377-2,1990) and was analysed using a Malvern Instruments MASTERSIZER 2000 laser diffractometer. This instrument analyses particle size ranges from 0.02 to 2000 µm using a diffraction model based on Mie Theory.

The results from the analyser were revealed in percentage fractions with a corresponding grain sizes (clay, silt, sand and coarse) in µm which ranges from 0.1-3.90, 7.81-15.63, 62.50-500 and 500-2000 for clay, silt, sand and coarse respectively. The results obtained were correlated with heavy metal contamination. The particle size distributions (clay and silt) showed significant positive correlations ( $p < 0.05$ ) with As, Cr and Cu, based on 1 M HCl extraction method. Significant positive correlations ( $p < 0.05$ ) were also obtained based on an *aqua-regia* method for all the elements (Al, As, Cd, Co, Cu, Cr, Fe, Mn, Ni, Pb, Sn, V & Zn).

The strong correlation between decreasing sediment size and increasing heavy metal concentration which is well documented and suggests that adsorption is the main mechanism by which trace metals accumulate on particles, given that small particle has much higher surface area relative to their volume than large particles. It is also generally accepted that trace metals are mainly concentrated in the clay/silt sediment fraction, consisting of particles of grain sizes  $< 63\mu\text{m}$ .

The study contributes to knowledge in respect to developing a basis for a more extensive investigation of heavy metal in the sediment of Lagos Harbour area. Grain size determination which is relevant in the assessment of metal contamination in surface sediments since it influences the distribution of heavy metals in the surface sediment for the assessment of metal contamination that will lead to sediment pollution and possible development of sediment quality guidelines.

**Keywords:** Particle Size, Heavy metals, Sediment pollution, Marine pollution, Lagos Harbour, Nigeria

## QUENCHING FUMONISIN B1 RADICALS BY DIFFERENTIAL SEQUENCE OF ASCORBIC ACID AND SELENIUM

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### Abstract

Mycotoxins are prone to tropical climates, more so Fumonisin. Transfer across the food chain and its risk reduction has not been studied. The study seeks to investigate the toxicity of Fumonisin and its reversal using both antioxidants, ascorbic acid, and selenium. Using *Xenopus laevis*, the study employed Frog embryo teratogenesis assay (FETAX) protocol in assessing FB1 toxicity and the reversals using well-known metabolic antioxidants, Selenium, and Ascorbic Acid. The 96-h LC 50 were determined by Probit analysis, and the teratogenic index (TI) was deduced and used to quantify teratogenicity. Fumonisin showed a lethal concentration of 24.9 µg/L with several teratogenicities: tail abnormalities and severe stunting. Using Fumonisin LC50 concentration to trigger impact, the tadpoles were exposed to different ascorbic acid and selenium concentrations. There was an observed reversal effect between 11.25µg/l and 22.5µg/l with reduced malformations in ascorbic acid, compared with selenium which was observed at 3.75µg/l and 15.0µg/l. Results also showed multiple malformations exhibited with increased concentrations from both the antioxidants. The window of Essentiality of Selenium was smaller than for ascorbic acid at low exposure concentrations.

## PROGNOSTIC COGENCY OF *FETAX* PROTOCOL OVER THE USE OF RATS IN ASSESSING *CARISSA EDULIS* ROOTS, ETHANOLIC EXTRACTS TOXICITY

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### Abstract

Due to the upward surge in the use of herbal medicine in the world today, so to the increasing concerns about their safety and the ways of assessing that safety. Animals like mice and rats have been used since time immemorial (in-vivo protocol) in evaluating the safety of herbal medicinal products. The hallmark of any safety study protocol is to ensure an accurate, scientifically sensible, and ethically humane study, which this study tried to do by assessing the safety of a commonly used herb in Kenya and other parts of Africa, *Carissa edulis vahl* roots and back. A herb widely used in managing Diabetes Mellitus and other ailments (Chebor *et al.*, 2020). This study, therefore, assessed the safety of this *Carissa edulis vahl* roots and back ethanolic extracts by use of Frog Embryo Teratogenesis Assay- Xenopus (FETAX- Amphibians) protocol and later (using the dosages estimates obtained from the study), studied the toxicological (histological studies) effects of the herb on male *Rattus norvegicus* (mammal) protocol. On the FETAX protocol, a TI (teratogenic index) of 0.34 was obtained. A TI of less than 1.5 does not predict toxicity (Mouche *et al.*, 2017; Osano *et al.*, 2002), an outcome which was seen upon exposure of the herb to selected tissues (Kidney, Liver, Spleen, Brain, Pancreas, and Thyroid) of the male *Rattus norvegicus* (no significant histological changes was manifested). FETAX toxicity studies successfully predicted the toxicity outcome of exposure to C.E. extracts on *Rattus norvegicus* tissues, though much more studies are needed on a larger scale.

**Keywords;** *Carrisa edulis* roots and back ethanolic extracts, FETAX-Xenopus studies, male *Rattus norvegicus*, and Histological studies

## FISH PARASITES AND DISEASES: CONTEXTUAL ANALYSIS OF THE KENYAN AQUACULTURE

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### Abstract

Successful fish health management begins with prevention of disease rather than treatment. Rise in intensification and commercialization of aquaculture predisposes fish stocks to disease due to rise in stress levels and consequent reduction in the fish immunity. There exists a balance between, parasites, their fish hosts and the environment. However, when this balance is broken parasites spread rapidly in culture facilities inducing severe epizootics. This study was conducted with an objective of highlighting stocking density and seasonality as drivers of monogenean and digenean trematode parasitism in *Oreochromis niloticus* in cages in Uhanya Beach, Lake Victoria, Kenya. The study adopted a systematic random sampling technique to sample an aggregate 600 fish during the rainy and dry seasons. Parasites isolated from the sampled fish were the monogenean *Dactylogyrus* and the digeneans; *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 considerably augmented with higher stocking density of fish ( $p < 0.05$ ;  $df = 298$ ). On the contrary, *Clinostomum sp.*, *Tylodelphys sp.* and *Neascus sp.* exhibited significantly reduced infestation with increased stocking densities ( $p < 0.0001$ ). 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 setting up of a specialized fish diagnostic laboratory recognized by the World Animal Health Organization and the development of a health management strategy for farmed fish in Kenya.

**Keywords:** Fish Parasites, Diseases, Health management, Aquaculture

## WASTEWATER TREATMENT USING GREEN TECHNOLOGY

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### Abstract

Water is a vital, indispensable resource which organisms requires for the sustenance of life. Currently, problem of water scarcity persists due to water pollution by heavy metals and eutrophic nutrients that has resulted in degraded environment and adverse effects on biota. Conventional methods are employed to remove heavy metals from wastewater but are un-economical especially while the metals are in low but significant concentration. Alternative method is phytoremediation which effectively removes pollutants from environments. This research was carried out to establish the ability of macrophytes to remediate pollutants from wastewater. Locally available macrophytes which included *Azolla pinnata*, *Typha latifolia*, *Nymphaea* spp. and *Ceratophyllum demersum* were collected from Marura wetland and identified. Wastewater samples were collected from University of Eldoret sewage treatment plant. Water indicator parameters, nutrients and heavy metals were determined using standard methods. Growth chambers containing wastewater samples were prepared in the laboratory. Macrophytes were established in these chambers. Wastewater analysis was carried out initially on setting up the experiment and then after every five days for 25 days to determine the changes in the levels of the parameters investigated. Means of mentioned parameters were calculated and analyzed using ANOVA and significant means separated using Tukey's test at 5% level. Reduction efficiency was calculated. The range of removal efficiency of the investigated parameters was as follows; TDS 66.01-74.03%, pH 18.15-20.30%, conductivity 51.79-57.11%, turbidity 67.55-86.10%, faecal coliforms 100%, phosphates 88.65-100%, nitrates 89.38-100%, cadmium 88.96-92.19%, copper 78.87-85.86%, nickel 100%, cobalt 94.67-95.04%, lead 100%, manganese 85.81-88.81%, zinc 91.78- 93.64% and iron 85.81-88.81%. There were significant differences in reduction of phosphates, nitrates, lead and cadmium among the macrophytes, ( $P = 0.00$ ). The macrophytes were found to be efficient in wastewater treatment. The order of removal efficiency was *Azolla pinnata* > *Nymphaea* spp > *Typha latifolia* > *Ceratophyllum demersum*. These macrophytes can be used to treat domestic, agricultural and industrial wastewater.

**Key words:** Phytoremediation, Macrophytes, Heavy metals, nutrients

## MINING LEGACY IN A FORMER MINING AREA AND TRACE ELEMENTS PHYTOAVAILABILITY

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### Abstract

The aim of this study was to characterise the total and phytoavailable trace elements concentrations in the soil and sediments of a former mining area in the north of Spain (mainly deposits of iron sulphides and oxides minerals, such as arsenopyrite, chalcopyrite, magnetite and pyrrhotite). For this purpose, a total of 27 soil and 14 sediment samples were collected from the mineral extraction and processing locations, mine spoils, together with downstream areas. After initial preparation of the samples, these were extracted with *aqua regia* at 95°C and with 0.05 M EDTA. Finally, concentrations in the solutions were analysed for 8 trace elements (As, Cd, Co, Cr, Cu, Ni, Pb and Zn) by ICP-OES. Very high *aqua regia* concentrations of several trace elements were found, especially in the case of As and Cu, in areas where mining operations took place, in which generic reference levels were exceeded by up to 2 orders of magnitude. However, the phytoavailable fraction in soils was significantly lower than their total concentrations. The results showed generally low average phytoavailability values, below 24.2% (Cd), in the following order: Cd > Pb > Cu > Ni > Co > Zn > As > Cr. These results lead to the conclusion that most of the elements analysed are strongly retained in the soil matrix (especially in the case of As and Cr), and thus weakly phytoavailable. This highlights the importance of taking this parameter into account in ecological risk assessments to estimate pollutants soil-plant transfer.



## ENHANCED PHYTOREMEDIATION OF POTENTIALLY TOXIC ELEMENTS (PTES) CHROMIUM AND LEAD POLLUTED SOILS USING *RAPHANUS RAPHANISTRUM*

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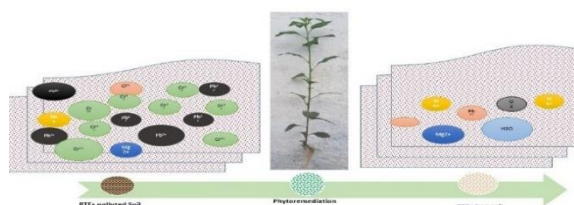
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### Abstract

Potentially toxic elements (PTEs), including Chromium (Cr) and Lead (Pb), naturally occur within the environment, but human activities such as extensive farming, industrialization, and mining have increased their concentrations in soils. This study was aimed to assess enhanced phytoremediation of Cr and Pb contaminated soils using *Raphanus raphanistrum* (wild radish). Mature wild plant seeds were collected from Moiben, the same site from which soils were collected for study. *Raphanus raphanistrum* seeds were treated with 0.00%, 0.25%, 0.50%, and 1.00% concentrations of colchicine and their growth, morphological development and PTEs uptake observed under greenhouse conditions starting from parent ( $M_0$ ), first ( $M_1$ ) to second ( $M_2$ ) generation plants. The soil samples were analyzed for physicochemical parameters using standard procedures. Soil sample results showed that pH, total organic matter (TOC), cation exchange capacity (CEC), and electrical conductivity determined were 5.20, 2.57%, 21.50 meq%, and 0.05 mS/cm, respectively. The treated *Raphanus raphanistrum* at 0.50% colchicine removed  $226.69 \pm 1.22$  mg/Kg and  $236.95 \pm 0.82$  mg/Kg of Cr and  $880.49 \pm 1.46$  mg/Kg and  $518.80 \pm 0.81$  mg/Kg Pb in the first ( $M_1$ ) and second ( $M_2$ ) generations respectively. At the same treatment level, the putative mutant plant hyperaccumulation of PTEs at  $M_1$  and  $M_2$  generations removed from soils 68.60% and 22.00% of Cr and Pb, respectively. Plants treated with colchicine showed higher effectiveness in phytoremediation than the wild type. This findings from this study contribute significantly to phytoremediation techniques in ecological restoration and recommends *Raphanus raphanistrum* for Cr and Pb polluted soil decontamination.

### Graphical Abstract



**Keywords:** Brassicaceae, Putative, Phytoremediation, Potentially toxic elements, mutation, and colchicine

## **WATER TREATMENT PLANTS: A RESEVOIR OF ANTIMICROBIAL RESISTANCE?**

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### **Abstract**

Antimicrobial resistance (AMR) is amongst the most significant growing threats to human health, with bacteria, viruses, fungi and parasites developing resistance to commonly used medicines. This resistance complicates treatment and increases the risk of disease spread, severe illness and death. Environmental factors, including anthropogenic pollutants, are known to contribute to AMR, however we need to further our understanding to develop preventative strategies and policies.

With the task ahead being so vast, our research starts its investigations in the direct and surrounding environments of chemical and wastewater treatment plants, across Scotland and India. Acting as a hub of human, anthropogenic and pharmaceutical waste streams, we can evaluate a wealth of potential contributory factors and identify trends in resistance in correlation with geochemical and physico-chemical parameters, PTE's, anions, pharmaceuticals and microbiomes. This data can then be used to develop surveillance strategies and implement effective methods of intervention.

With research in its early stages a few initial observations have been made and are continuing to be explored:

- *Acanthamoeba* harbours different bacteria that are resistant to amoeba digestion. Evidence suggesting a potential for eukaryotic species (i.e. *Acanthamoeba*) to act as a vector for AMR bacteria.
- Stressful environments, e.g. high metals, high / low pH, cause *Acanthamoeba* to encyst which increases resistance of amoebae, and consequently any bacteria intracellular to *Acanthamoeba*.

## **MODELLING SPATIAL VARIATION, DISTRIBUTION, AND PREDICTION OF FLUORIDE LEVELS IN GROUNDWATER IN THE RIVER NJORO CATCHMENT**

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Fluoride, whose levels are higher than the World Health Organization (WHO) recommended level of 1.5 mg/l, results in health issues. Therefore, fluoride contamination is a matter that calls for concern by all people and governments, especially in countries where volcanicity has been experienced. This study sought to model spatial variation, distribution, and prediction of fluoride levels in groundwater in the river Njoro catchment. This study aimed to observe the levels of fluoride and give recommendations for identifying and delineating potential sites for safe groundwater for use by the local population and advice on the water treatment and de-fluoridation methods. In this study, borehole water samples were collected for laboratory analysis of fluoride levels. The study adopted descriptive and correlation statistical analysis. The sources of data included; field surveys where data on fluoride levels were collected, remotely sensed data, GIS, and geostatistically interpolated data. The results through geostatistical interpolation observed various distribution and variations of fluoride levels in the River Njoro catchment.

**Keywords:** Contamination, Delineation, volcanicity, spatial variation, Geostatistical

**ABERRATION OF IRON METABOLISM AFTER HISTOPATHOLOGICAL ALTERATIONS IN *OREOCHROMIS NILOTICUS* AND *CLARIAS GARIEPINUS* AFTER EXPOSURE TO AFLATOXINS**

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Aflatoxin which is a non-essential metabolic by-product of molds *Aspergillus flavus* and *Aspergillus parasiticus* is toxic and often lethal at low concentrations to livestock, poultry, fish and human beings. Toxicogenic *A. flavus* produces aflatoxin B<sub>1</sub> and B<sub>2</sub> whereas *A. parasiticus* produces aflatoxin G<sub>1</sub> and G<sub>2</sub>. It may also cause hematochromasis or iron overload in the liver to cause the reverse of anemic effects. The purpose of the study was to determine liver histopathological changes in the fish after exposure to aflatoxins in *Oreochromis niloticus* and *Clarias gariepinus* diet fish at Kenya Marine and Fisheries Institute (KMFRI) Sagana. The fish were obtained from experimental tanks and rivers and transported in plastic bags to Moi teaching and Referral hospital for analysis. Fish were dissected and prepared for histology through fixation, wax impregnation, embedding and sectioning. A histological assessment was conducted and aflatoxin exposed had a histological disorder index of 18, compared to 42 from river Nyando which was severe due to different chronic exposures compared to the latter acute single type exposure. Routine samples parts of food to ascertain toxicological effects on food sources before distribution.

## RESOLVING THE UNRESOLVED: ONLINE MICRODIALYSIS COUPLED TO ICP-QQQ FOR THE SIMULTANEOUS SAMPLING AND ANALYSIS OF DISSOLVED ELEMENTS IN SOIL SOLUTION

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Assessing rapid chemical-elemental reactions in soils is significantly inhibited by the spatial and temporal resolution of current sampling techniques [Rhizon<sup>TM</sup> samplers, diffusive gradients in thin films (DGTs)]<sup>1</sup>. Soil chemistry is typically investigated over hours-days-weeks and with poor sampling density; the vast majority of reactions occur within seconds-minutes. Microdialysis (MD) is a new technique in the field of soil science that uses small probes to sample compounds dissolved in soil solution, with minimal disturbance to the external environment<sup>2</sup>. Initially developed for use in neuroscience, MD has the potential for translation to environmental geochemistry to define soil chemical/physical parameters, and better inform predictive models for soil-to-plant transfer of potentially harmful elements (PHEs) or essential nutrients. One considerable experimental challenge for MD is balancing the target analyte recovery efficiency with the sample volume required for the analytical chemistry technique, which can significantly affect how often elemental speciation changes and soil fixation events can be measured<sup>3</sup>. To overcome this challenge, we have begun development of a novel integrated online MD sampling and analysis technique, through direct coupling of MD probes with triple quadrupole inductively coupled plasma mass spectrometry (ICP-QQQ) using a microflow total consumption nebulizer with no additional modifications. This poster will present the initial setup, optimisation and application of the technique to the sampling and analysis of multiple elements in soil solution, alongside future perspectives on how information gained from this promising technique can contribute to the management of global societal and agricultural issues (e.g. nutrient supply to staple crops, contaminated land remediation).

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**PUBLIC NUISANCE OR LATENT PROBLEM: THE HUMAN DIMENSIONS OF HARMFUL ALGAL BLOOMS (HABS) ON SMALL-SCALE FISHING COMMUNITIES OF LAKE VICTORIA BASIN**

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**Abstract**

With approximately 40 million inhabitants living within the Lake Victoria Basin and depending on the lake's ecosystem goods and services, the emergence of Harmful Algal Blooms (HABs) portends significant socioeconomic and health challenges among local communities. Whereas some impacts of HABs on water quality and safety of fisheries resources in the Lake have been documented, human exposure pathways and health risks associated with HABs have not been adequately communicated to primary resource users. Using a mixed methods approach that integrated existing literature with household interviews and a water testing assay, our study assessed the perception of households on HABs vis-a-vis and the scientific reality of their presence. Results indicate that there is a dichotomy between indigenous knowledge systems and scientific findings on HABs. Whereas 20% of household drinking water showed contamination at source, most (65%) households still perceived HABs as a public nuisance rather than a latent health problem; an opinion largely shaped by complete reliance on traditional knowledge systems. Many (70%) households also experienced respiratory illnesses which are related to health impacts of HABs. We recommend a science-based public education strategy for Lake Victoria resource users to mitigate the misperception of HABs created by over-reliance on indigenous knowledge systems.

**Keywords:** Lake Victoria Basin; harmful algal blooms; communities; information

## MINERALOGICAL STUDIES OF TALCOSE ROCKS IN WONU-APOMU AREA, SOUTHWESTERN NIGERIA; HEALTH IMPLICATIONS OF CHRYSOTILE- ASBESTOS

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### Abstract

Talc is formed from diverse geological processes including hydrothermal alteration and contact or regional metamorphism of pre-existing mafic and ultramafic rocks as well as dolomitic carbonates. These processes give rise to large quantities of asbestos minerals. Exposure to chrysotile-asbestos have health implications, therefore this study elucidates the mineralogy of talcose rocks with the attendant health implications of chrysotile-asbestos composition.

Thin sections of the talcose rocks were prepared for petrographic analysis while polished sections were subjected to Scanning Electron Microscope-Energy Dispersive Spectrometry (SEM-EDX). Pulverized rock samples were subjected to X-ray diffraction analysis.

The petrographic, SEM-EDX, X-ray diffraction analyses reveal that the talc schist samples are composed of talc and talc-chlorite constitute up to about 80% with lesser proportions of saponite, tremolite, actinolite, anthophyllite, amesite, diabante (clinichlore), antigorite, chrysotile, ferritchromite, magnetite, forsterite, serpentine and quartz.

This study reveals the evidence of chrysotile-asbestos in the talcose rocks. Exposure to chrysotile-asbestos could cause cancer of the lung, larynx and ovary, mesothelioma and asbestosis. It is recommended that an epidemiological investigation should be carried out at the talc mining site in the area, to determine the possible effects of chrysotile-asbestos exposure to humans and the environment.

**Keywords:** Chrysotile-asbestos, Talcose rocks, Mesothelioma, Asbestosis, Epidemiological investigation



## **PLANETARY HEALTH- THE INTERSECTION OF HUMAN HEALTH AND THE ENVIRONMENT HEALTH**

*Aminat Olaitan Adebayo*

### **Abstract**

The health of people is inextricably linked to the health of the planet. At no other time in human history has there been a rate of environmental change that poses such a grave threat to human and planetary health. The most fundamental human needs, clean water, clean air, food, and shelter, are in jeopardy due to habitat destruction and climate change. According to recent WHO research, the environment is a factor in more than twenty percent of all fatalities worldwide. The integrity of the natural system is a prerequisite for human health, survival, and prosperity, as human and natural systems are interconnected. This concept of "planetary health" takes that into account. Some of the world's most serious health risks come from environmental factors such as contaminated food and water, air pollution, poor sanitation, hazardous chemicals and toxins, and extreme weather conditions. This article adopts qualitative research to examine and evaluate the gaps in planetary health and the transition to a sustainable planet. To identify advances and setbacks, current research and practices to improve planetary health, adaptation mechanisms, and supporting policies will be categorized and examined. Our planet faces tremendous challenges, many of which stem from environmental problems. This review aims to describe the context and current state of global environmental change, its actual or potential health impacts, and how human societies should respond through adaptation strategies to lessen the effects.

## HEALTH RISK ASSESSMENT OF ARTISANAL GOLD MINING ON MINERS AND RESIDENTS OF OSU AND ITAGUNMODI AREAS, SOUTHWESTERN NIGERIA.

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### Abstract

Artisanal gold mining in Nigeria has been ongoing for a long time without proper safety checks to prevent adverse health effects on both miners and residents within the immediate surroundings of the mine sites. Thus, this study assessed the health risk associated with three active gold mines on miners and residents of Osu and Itagunmodi areas by collecting thirty-nine soil samples along horizontal profiles at Orogo, Amuta and Itagunmodi pits and three soil samples away from the mines as controls. These samples were analyzed to determine the concentrations of Potentially Toxic Elements including Mo, Cu, Pb, Zn, Ag, Co, As, Cd and Hg using Inductively Coupled Plasma- Mass Spectrometer and results interpreted to determine level of contamination and/or pollution. Calculated Enrichment Factor, Geoaccumulation Index, Contaminated Factor and Pollution Index all indicated very high contamination and severe pollution of the three mine sites environs with Ag and Hg. Calculated dermal exposure for miners assumed to be working on the mine sites for 250 days per year over a 25 year period showed exposure rate of Ag and Hg at Orogo (46889.7mg/kg-d), Amuta (44337.4mg/kg-d) and Itagunmodi (29110.5mg/kg-d) respectively which are highly significant while the residence adult and children were not likely affected through dermal exposure. Calculated Health Quotients (HQ) and Health Indices (HI) also showed that miners are more likely to experience adverse effect of Ag and Hg when compared with the residents. The high level of Ag and Hg pollution and possible health effects on the miners should be mitigated as prolonged exposure can lead to long term diseases and in some cases death.

Keywords: Health risk, Contamination, Pollution, Potentially Toxic Elements, Miners.

## EVALUATION OF CARCASS AND MEAT QUALITY TRAITS AMONG DOMESTICATED RABBIT BREEDS CROSSES IN WESTERN AND NORTH-RIFT KENYA

Sergon. P.C<sup>1</sup>, Rachuonyo H. <sup>2</sup>, Wanga, J. O<sup>3</sup>., Nandwa, A. N<sup>4</sup> and Chemoiwa, E. J<sup>5</sup>.

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### Abstract

High-quality meat can be produced through rabbit farming, which has a potential in improving nutrition and poverty alleviation. The current study sought to investigate the carcass and meat quality traits of domesticated rabbit (*Oryctolagus cuniculus* L) crosses. The local breeds in the study were from Kenya's Western and North-rift areas. On-site research was carried out in University of Eldoret. Rabbits were reared in cages with standard specifications. The F1 rabbits were sacrificed at roasting age. The weights of the carcasses, heads, viscera, pelts and tails were recorded. In preparation for sensory evaluation of domesticated rabbit crosses meat, a total of 22 panellists aged 18 to 25 years were randomly sourced from the school of consumer science. A five-point hedonic scale was used for sensory evaluation of meat across the breed crosses. Least square means for carcass and its parts' weight as well as sensory qualities were estimated using the GLM procedure of SPSS version 20. Live weights (g) before fasting were significantly high in NZW\*SF (2319±164) and low in NZW\*FG (2188±156). In terms of hot carcass weight, NZW\*R (1083±96.0) cross had significant higher weight in comparison to other crosses. Giblets' weights did not differ significantly among crosses irrespective of NZW\*Pr (89.5±7.65) which differed. A higher dressed weight of the head was recorded for NZW\*SF (147±16.2) which was non significantly different with other crosses ( $p>0.05$ ). Primal cut up parts of rabbit crosses carcasses were established where they did not differ significantly with crosses. Ranking of sensory quality from New Zealand cross with other breeds was not significant  $P>0.05$ , despite this the general acceptability ranked high in NZW\*Sf. In conclusion, various carcass` weights as well as sensory traits did not significantly differ across the crosses. This could be due to the fact that the rabbits were kept in same environment, amount and type of feeds. Research recommends more work be done to compare the rabbit crosses with pure breed in terms of carcass characteristics. Additionally, effects of feed distribution mode, management, sex and age need to be tested to ascertain their influences in carcass characteristics. Similarly, more work needs to be done to compare the crosses' meat organoleptic characteristics with those of pure breed.

**Keywords:** Domesticated rabbit, carcass, sensory qualities, Meat: bone, organoleptic properties.

**TO DETERMINE FEED INTAKE AND FEED CONVERSION EFFICIENCY(FCE) OF THE SMALL EAST AFRICA GOATS(SEAGS) FED ON MATURE GREEN PODS OF ACACIA. *brevispica*, *A. mellifera*, AND *A. tortilis* PROCESSED DIFFERENTLY AS SUPPLEMENTS TO GROWING (SEAGS).**

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**Abstract**

The objective of this study was to compare the feed intake(F/I) and Feed Conversion Efficiency(FCE), of growing Small East Africa Goats (SEAGs) in Emining ward, Mogotio sub-county Kenya. Total of 20 uncastrated male bucks (Male goats) with average weight of  $(12.4 \pm 0.11)$  kg body weight) were randomly allocated to five treatments and fed on mature green pods *Acacia. brevispica*, *A. mellifera*, and *A. tortilis* processed differently. The bucks were kept in individual pens raised 1 m high with slatted floor measuring 1.5by 1.5 meter with feeding and drinking troughs and given minerals salts and water *adlibidum* for the 90 days' experimental period, in a Randomized Complete Block Design (RCBD) arrangement and replicated four times with four animals per treatment. The treatments were: T1- (control-unprocessed) pods of mature *Acacia brevispica*, *A. mellifera* and *A. tortilis*, T2 (shade –dried pods for 48hrs.), T3 (sun-dried pods for 48 hrs.), T4 (soaked pods in wood ash -alkali) solution mixed at 200gm per/liter of water for 48 hrs.) respectively and T5 (bucks fed on none-tanniniferous basal diet of ground Rhodes grass hay mixed with wheat brand at a ratio of 3:1) and recorded. Among the acacia species, all supplements processed in alkali were ingested in large amounts with a significant difference( $p<0.05$ ) with other treatments. *A. tortilis* pods processed in alkali were taken in large amounts ( $416.50\pm6.50$ ), sun ( $305.25\pm15.19$ ), shade ( $250.92\pm8.66$ ), and control ( $194.42\pm6.17$ ), while for *A. brevispica* pods processed in alkaline were ( $397.46\pm3.46$ ), sun ( $281.29\pm11.77$ ) and shade ( $250.92\pm8.66$ ) There was significant difference ( $p<0.05$ ) in feed conversion ratio within the acacia species pods treated differently. Low feed conversion ratio (high feed conversion efficiency) of 7.0 were recorded in *Acacia tortilis* treated in alkali as compared to other treatments.

**Keywords:** Feed intake, processing, acacia species pods, Feed conversion efficiency, goats

## OPPORTUNITIES AND CONSTRAINTS IN GREEN ECONOMY DEVELOPMENT IN KENYA'S FORESTRY SECTOR

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### Abstract

Green Economy is a socially inclusive concept that aims at improving livelihoods through efficient use of natural resources to promote sustainable economies without degrading the environment (UNEP, 2012). About 42% of Kenya's Gross Domestic Products and 70% of the overall employment is derived from natural resources related sectors (UNEP, 2012). Kenya displays a potential economy but faces challenges; ranging from climate change, natural resource depletion to high poverty rates. Overdependence on forest resources results to depletion at an alarming rate of 5,000 hectares per annum. (MoE&F, 2018). Sustainable forest products value chains such as briquette fuel, wood pellets, fruits and honey obtained from the use of clean technology contribute to the achievement of health, wellbeing and sustainable environments. This in turn trickles down to mitigating against negative effects of soil erosion and promote low Green House Gas emissions hence protecting the atmospheric conditions. As a result, sustainable food production, clean air and quality water sources are obtained and thus protect societies from airborne diseases. Through the sustainable development principles and the Constitution of Kenya (2010), the country's governance system is guided to achieve a clean and healthy environment to all citizens (Art 42). By identifying opportunities and constraints in green economy within the forestry sector, the on-going research work and applied methodologies could be utilized for a variety of applications in the forestry, health and wealth-being sectors, as well as application of forestry to remediation of legacy contaminated sites in order to achieve transformation to Green Economy Pathways.

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**ASSESSMENT OF THE RESPONSE OF DIFFERENT AGE GROUPS OF  
*O. VARIABILIS* TOWARDS STRESS CAUSED BY POOR WATER QUALITY DURING  
FISH TRANSPORTATION FROM KISUMU TO SIAYA COUNTIES IN KENYA**

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**Abstract**

Research into the response towards stress of cultured fish is vital given the continued growth of the aquaculture industry and increasing scientific discussion over the potential for negative events associated with stress. Strength and duration of stress that fish is exposed to may lead to the death of the fish, disease outbreak, fail to reproduce or exhibition of poor growth performance. In this experiment the response of *O. variabilis* exposed to stress caused by various oxygen levels and load weight in sealed polythene bags during transportation was tested. Two blood samples were taken from the experimental fish at the beginning of the transportation in Kabonyo and at the end at Dominion farm to determine blood parameters that included cortisol, glucose, sodium and chloride ions. The treatments packaged at 1kg, 3kg, and 5kg load weights recorded insignificant ( $p < 0.05$ ) mortalities within treatments compared to the control and among themselves while treatments packaged at 7kg and 9kg load weights recorded significant ( $p < 0.05$ ) mortalities compared to the control and among themselves regardless of the amount of oxygen supplied to polythene bags. As the load weights increased from 1kg to 9kg the mortality at the end of the experiment increased following a linear trend. Cortisol and glucose concentrations of the blood serum of the fish were significantly ( $p < 0.01$ ) different from the cortisol concentration drawn before the commencement of the experiment and among all the five treatments (1kg, 3kg, 5kg, 7kg and 9kg) ( $p < 0.01$ ). A significant ( $p < 0.05$ ) reduction of the concentration of sodium ions in the blood plasma of fish was observed at the end of the experiment compared to the commencement of the experiment and among all the five load weight (1kg, 3kg, 5kg, 7kg and 9kg). The concentration of chloride ions in blood plasma in various polythene bags and packaged at various oxygen percentages were significantly different at the end of the experiment from the one measured at the beginning ( $p < 0.05$ ). Concentration of oxygen also had significant effects on the said parameter.

**Keywords:** Chloride ions; Cortisol concentration; Glucose concentration; Mortalities;

Sodium ions; Stress

## **BUILDING COLLABORATIONS IN MULTIDISCIPLINARY RESEARCH USING ESOPHAGEAL SQUAMOUS CELL CARCINOMA IN EASTERN AFRICA AS A CASE**

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### **Abstract**

Esophageal squamous cell carcinoma (ESCC) is a malignancy of the esophagus or food pipe. It is the eighth most common cancer in men in the world, while in Kenya it is the second most common in men, third most common in women and is a leading cause of cancer deaths. In addition, and in contrast to other high-incidence areas, very young cases, in their 20s and 30s are reported in the African esophageal cancer corridor. It is a devastating cancer whose 5-year survival rate is extremely rare even in the best centres worldwide. With very limited treatment options, in the region, the majority of patients hardly survive 6 months from diagnosis. Our hope of reducing its incidence, therefore, lies in primary prevention. However, in order to do, the etiology or causation must be clearly elucidated through well-designed research. A review of the literature revealed that multiple putative risk factors are responsible for causing this cancer. These include behavioral, nutritional and environmental factors. As a result, it is necessary to conduct multidisciplinary research involving professionals not only from the health field but also from others such as environmental sciences. This requires building collaborations with a number of different organizations. Currently, we are conducting the largest case-control study in the east African region to investigate factors associated with ESCC in western Kenya. The study began in 2013, and so far, we have identified a number of risk factors such as alcohol, tobacco and consumption of hot beverages. These factors do not tell the whole story about cancer causation, and we, therefore, have had to seek collaborations such as the University of Eldoret and the British Geological Survey, among others to help us elucidate the problem. One of the important outcomes of these collaborations has been capacity building in the form of doctoral training of Kenyan scientists by the BGS which increases the pool of highly trained scientists to help us in etiological research on ESCC.



## SUBCELLULAR PARTITIONING OF As, Cr, Pb AND Cd IN GASTROINTESTINAL TRACT IN *Xenopus laevis* AS A RESULT OF EXPOSURE TO MINE TAILINGS.

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Potentially Toxic Elements from the mine tailings are exposed to the gold miners occupationally; this exposure also affects the residents around the gold mining areas. During excavation, the dust particles are inhaled; the skin is exposed and through feeding and drinking contaminated water and food, causes PTEs entry to the human system, which then are transported to different organs through the digestion and absorption process. This as well avails PTEs to human circulatory system, once at the sites of action, like the human gut, the PTEs can partition differently within sub cells within the body organs. Other laboratory specimens have been used to established partitioning of PTEs once they gain entry to organs and tissues of the organisms in different environmental set ups. Therefore, this study is focused to understand partitioning of four metals (As, Cr, Pb and Cd) in the subcellular fractions of the gut in *Xenopus laevis*. Metal partitioning among potentially heat-sensitive fractions termed as Heat-Denatured Proteins (HDP), mitochondria and microsomes and potentially biologically detoxified fractions termed as Heat-Stable Proteins (HSP) and metal-rich granules within cells are determined through differential centrifugation, NaOH digestion and heat-denaturation steps; metal-handling strategies between gastric tissues are key aspects of consideration in this case. Heat Denaturable Protein (HDP) and soluble supernatant of Heat Stable Protein (HSP) are separated and the subcellular fractions obtained by centrifugation procedure are analyzed for Toxic elements concentrations.

**Key words:** *Exposure, Mine tailings, Subcellular partitioning, xenopus laevis, PTEs.*

## A REVIEW OF LOW-COST ATRAZINE HERBICIDE BIOCHAR ADSORPTION TECHNIQUES FROM WATER

*Emmy C. Kerich*

Globally, the usage of the pesticide atrazine to manage pre- and post-emergence broadleaf weeds on maize farms is increasing. Extensive usage of atrazine has resulted in the accumulation of pesticide residues in the environment, which constitute a concern to human health, particularly via drinking water. Several atrazine removal processing technologies have been developed; however, the majority of these processes are costly. Researchers have recently shown a great deal of interest in technologies that employ biochar since they are biodegradable and are abundant in nature. This review focuses on the low-cost atrazine herbicide biochar adsorption techniques from water. The literature review revealed that robust biochar adsorbents such as corn straw biochar, rice straw, wheat straw, stalks, corn stalks, soybeans, Eucalyptus camaldulensis bark-mediated char, sugarcane bagasse, mango seed powder, sawdust, pine needles, eucalyptus bark), modified Moringa oleifera Lam. Seed husks have been utilised for the effective removal of atrazine from water. The study recommends focusing on atrazine removal methods that are inexpensive, non-toxic, regenerable, and have a high efficiency for pollutant uptake.

**Keywords:** Adsorption, Atrazine, Water, Biochar

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