

## Proceedings of the Expert Workshop

# Water Security

Editors: Chrispin Kowenje, Samuel Paré, Bizuneh Asfaw  
May 15-20, 2017 – Mekelle, Ethiopia



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Nowadays, deterioration of global fresh water resources is the most challenging question and it has become one of the forefront scientific and political agenda in relation to global environmental changes in climate, land-use, and bio-diversity. Water is not adequately available in required quantity and quality in many parts of the world especially in developing countries. Water still remains to be an essential component of life, and hence governments and other agents need to work on securing water to the society. Water security is regarded as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality of water for sustaining livelihoods, human well-being, and socio-economic development.

Thus, finding solutions to water security and related problems through strong collaboration among researchers, stakeholders, governments, non-governmental organizations and the communities is required. Therefore, stakeholders need to meet in a discussion forum such as expert workshop to explore water security related problems and to develop mitigation measures. The expert workshop also creates a co-learning environment among different experts and knowledge exchange through experiences from different parts of the world.

The workshop in Mekelle, Ethiopia of the Sub-Saharan Regional Network of Exceed Swindon focused on a multidisciplinary approach to water security challenges and its solutions with special emphasis on distribution and availability of fresh and drinking waters, water scarcity, quality and pollution aspects of water, water governance, trans-boundary water resources management, and other related issues, among which are the drivers land-use systems and climatic conditions.

Editors

Assoc. Prof. Dr. Chrispin Kowenje, Prof. Dr. Samuel Paré, Dr. Bizuneh Asfaw

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Chrispin Kowenje, Samuel Paré, Bizuneh Asfaw

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## CONTENT

Preface .....	1
Promotion of integrated water resources management practices In the context of climate change and variability in Malawi - A case study of Lake Chilwa Basin ( <i>C. Ngongondo, S.M.I. Sajidu, R.C.G. Chidya, W.O. Mulwafu</i> ) .....	2
Sediments reactivity relative to Cd, Pb and Zn in artificial lagoon water ( <i>M. Ayah, M. Grybos, I. Tchakala, L. Tampo, V.K. Akpataku, M.L. Bawa, G. Djaneye-Boundjou, H. Bril</i> ) .....	14
The efficiency of a wastewater treatment plant at Zartech poultry house, Ibadan, Nigeria ( <i>O.O. Oloyede, O. Morenikeji</i> ) .....	31
Bio-environmental and ecological evaluation of lentic water bodies in tropical Africa: Case of the lakes of Yaounde (Cameroon) ( <i>A.G. Aghaindum, K. Solngar, A.W.V. Bienvenu, G.E. Nkeng</i> ) .....	42
Evaluation of extractible forms of nitrogen in municipal solid waste (MSW) from Kara: Impact on the quality and eutrophication of the Kara River ( <i>K.N. Segbeaya, E.K. Koledzi, K. Djahini, G. Baba, G. Feuillad</i> ) .....	58
Phytoremediation of polluted water using Water Hyacinth ( <i>Eichhornia Crassipes</i> ) as a purifier and energy source: A molecular perspective ( <i>D.M. Onyango, C. Kowenje, C. Ayieko, P. Onyango</i> ) .....	69
Water quality indicator and water related hazards microbiological perspective ( <i>A.A. Ogunjobi</i> ) .....	82
Arsenic removal from groundwater using filtering through ferromagnetic carbon ( <i>Y. Sanou, S. Pare, N.T.T. Phuong, N.V. Phuoc</i> ) .....	93
Assessment of water quality and its suitability for domestic and irrigation purposes: The case of freshwater and Lome brewery wastewater in Adjougba District (Togo) ( <i>L. Tampo, G. Boguido, M. Ayah, D.T.M. Gnazou, I. Tchakala, I.M. Lazar, G. Djaneye-Boundjou, L.M. Bawa</i> ) .....	105
Mesoporous silica-based membranes for water and wastewater treatment: Overview, challenges and future prospects ( <i>E. Vunain</i> ) .....	123
Occurrence of selected triazine and phenyl urea herbicides and sorption behavior in soils and water from Nzoia River drainage basin, Western Kenya ( <i>A. Ngigi, S. Lagat, G. Mutua</i> ) .....	135
Synthesis of highly dispersed polymeric materials and application on wastewater remediation ( <i>M.S. Tamwa, J.R. Njimou, C.P. Nanseu-Njiki, E. Ngameni</i> ) .....	150

Mean concentration of lead and zinc in water and fish sample along Eleyele-Oluyole River in Ibadan, South Western Nigeria ( <i>M.E. Hauwa, O.I. Olatoye, R.C. Okocha, O.B. Adedeji</i> ) .....	161
The role of communication in disseminating water based messages ( <i>C.O. Nyambuqa</i> ) .....	171
Bacteriological safety of sachet drinking water sold in Benin City, Nigeria ( <i>A. Stephen Olusanmi</i> ) .....	179
The origins of water resources chemistry in the middle part of the Mono Basin, Togo ( <i>K.V. Akpataku, M.D.-T. Gnazou, L. Tampo, M. Ayah, I. Tchakala, G. Djanéyé-Boundjou, L.M. Bawa, S. Faye</i> ) .....	188
Impacts of flood hazards: psychological intervention ( <i>O.O. Owoseni, O.O. Olubodun</i> ) .....	204

## **PREFACE**

According to UNESCO Report 2016, about 3/4 of all new jobs in the world are water related and about 80% of common diseases worldwide are waterborne. And because human body consists of about 70% water, water is life and water security is basically dignified life security. To aid in attainment of the Sustainable Development Goals (SDGs) item 6 together with SDG item 14, which both deal with water availability, the Sub-Sahara Africa group of the International Network on Sustainable Water Management in Developing Countries (EXCEED – SWINDON) recently gathered experts in various domains to discuss water security and management. This book is written and published, thanks to the support of the Excellence Center for Development Cooperation (EXCEED), Federal Ministry of Economic Cooperation and Development, Germany (BMZ), German Academic Exchange Service (DAAD), and Technical University of Braunschweig (TUBS), to provide requisite knowledge-actions and elements to consider towards achieving sustainable use and management of water resources.

Generally, UNESCO - International Hydrology Programme (UNESCO-IHP) classifies Sub-Sahara Africa as water stressed region. Thus for the workshop, experts were gathered to present new findings and approaches to mitigate water security related problems, to promote communications among scientists, engineers, managers, stakeholders, and policy/decision makers on water security challenges and solutions, and to share ideas and experiences in and solutions under the ever dynamic real world conditions. Water security discussions must of necessity involve but not be limited to economic, agricultural, governance, environmental, water related disasters, and domestic water usage. Water security plays a pivotal role in human development and in attainment of the SDGs to an extent that of the 17 SDG goals about 9 are water related nexus.

The participants of the workshop discussed topics within the three future earth distinctions of SDGs agenda: (1) Dynamic planet (environment, water quality, climate change, etc.) for better understanding of drivers, interactions and processes in water issues, and anticipation of global thresholds and risks in the African context, (2) Global sustainable development (water management, communications, awareness, etc.) for deeper understanding of ecosystem functions and services for the African continent, and (3) Transformations towards sustainability (water engineering, waste management, eco-psychology, etc.) for sustainable integration of emerging technologies and economic development pathways in human development.

As reported in this book, the workshop introduced the concept of water security and the attainment of SDGs. It was realized that the media and the non-scientific discourse represent water scarcity as food scarcity only. Again, for precise solutions to be obtained there is need to identify whether the situation is industrial, economic, agricultural, domestic, environmental, or governance concerned water scarcity.

Thus to aspire for a better quality of life, the concerns regarding water scarcity and governance must be high scored at industrial, domestic, agricultural, environmental, and economic level . Understandably, to attain the above ideals, an integration of human-environment interaction dynamics as presented by an eco-psychologist in water related studies is paramount.

Prof. Dr. Samuel Pare – Université Ouaga 1, Prof. Josep KI-ZERBO – Burkina Faso

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**PROMOTION OF INTEGRATED WATER RESOURCES MANAGEMENT PRACTICES  
IN THE CONTEXT OF CLIMATE CHANGE AND VARIABILITY IN MALAWI  
A CASE STUDY OF LAKE CHILWA BASIN**

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**Keywords:** Climate Change, IWRM, Malawi, Lake Chilwa, MDGs, Water Resources

**Abstract**

Integrated Water Resources Management (IWRM) has been widely accepted as the most effective approach for the management of water resources, and the ecosystem goods (EG) and services (ES) derived from them. In Malawi and other developing countries, there has been a low degree of implementation of IWRM practices in order to optimize socio-economic and environmental benefits from EG and ES in response to climate change effects. This study examined the existing capacities and challenges facing Malawi in terms of implementation of ecosystem based approaches for effective IWRM practices under changing climatic conditions using the Lake Chilwa basin ecosystem as a case study. Both qualitative and quantitative methods were used to collect and to analyse data. The results showed that most organisations have no existing policies, laws, practices, and institutional structures to support IWRM practices. The study also revealed lack of political will in implementation of IWRM practices, internally contradicting policies, weak laws, and low funding. As result, catchment degradation is evidenced by the poor results of physicochemical characteristics of surface water in the area attributed to increased nutrient loading and anthropogenic activities. The lake registered low water levels and increased Total Dissolve Solids (TDS) (2,000 mg/L), high Electrical Conductivity (EC) levels (3,998  $\mu\text{S}/\text{cm}$ ), and surface water temperatures (28.5-41.5 °C). These are indications of a highly committed ecosystem with many activities competing for the EG and ES in the catchment. The hydro-meteorological analysis showed clearly consistent downward insignificant trends in basin wide rainfall but significant decreasing trends in river discharge and Lake Chilwa levels that can be attributed to anthropogenic activities. This calls for a review of existing policies and coordinated efforts in management of water resources and ecosystems to mitigate the effects of climate change and variability.

## SEDIMENTS REACTIVITY RELATIVE TO Cd, Pb AND Zn IN ARTIFICIAL LAGOON WATER

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**Keywords:** adsorption, desorption, trace metals, sediment, hydrosystem

### **Abstract**

Sediments samples were collected to study their reactivity relative to Cd, Pb and Zn in the lagoon system of Lomé (Togo). Batch adsorption experiments were performed on four different sediments in artificial lagoon water for three ranges of concentrations of Cd, Pb and Zn, and desorption tests by a molar solution of ammonium acetate (1M). The results made it possible to demonstrate an adsorption capacity of almost 100% of Cd, Pb, and Zn for the ranges applied. The adsorption rates are higher in Equilibrium Channel (Cm) for Cd and Pb. Zn adsorbs more on the sediments of Bè Lake (Bm). The results of desorption tests showed low rates according to the metals. The desorption percentages were important for highest concentration, i.e., 44% Cd in sediments of Equilibrium Channel (Cm), 89% Pb in sediments of lake Bè (Bm), and 93% Zn for the sediments of West Lake (Om). These results confirmed the role of total organic matter, grain size, and mineralogy in promoting the capacity of sediment adsorption. However, the stability of trace metals in the sediments depends on environmental conditions like pH and Eh, which may cause their bioavailability in Lomé lagoon system.

# THE EFFICIENCY OF A WASTEWATER TREATMENT PLANT AT ZARTECH POULTRY HOUSE, IBADAN, NIGERIA

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**Keywords:** Metropolitan Regions, wastewater treatment plant, wastewater reuse, water usage, Nigeria

## **Abstract**

Wastewater treatment plant is a major solution to the water crisis facing the agricultural sector especially the poultry industry in the metropolitan regions of Nigeria. Zartech Ltd. Ibadan, a leading poultry company in Nigeria makes use of a homemade wastewater treatment plant. The efficiency of the plant was determined based on percentage reduction of various contaminants in water by analyzing wastewater and treated water using standard methods. The company's water usage inventory and the unit costs of treated water against those supplied by commercial water tankers were determined by administering questionnaires, and interviewing operation and account managers. The study was conducted in April, 2015 around 11.30 am to 12.30 pm and 8.00 pm to 8.30 pm for five consecutive working days. Industrial productive process was recorded to consume the highest volume of water. The percentage efficiency obtained from waste water treatment was on the average of 99%. The cost of treated water was observed to be four times lesser than those of commercial water tankers. The plant's efficiency can be further improved by adjusting the chlorine applied by using an advance chlorine dose pump, reducing the liquid waste load, and equipping the waste water outlet channels with screens and fat traps.

# BIO-ENVIRONMENTAL AND ECOLOGICAL EVALUATION OF LENTIC WATER BODIES IN TROPICAL AFRICA: CASE OF THE LAKES OF YAOUNDE (CAMEROON)

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**Keywords:** Bio-environmental characterization, ecosystems, Lake Yaounde, Cameroon

## **Abstract**

The Municipal Lakes that are situated in the city of Yaoundé, Lake of Obili and the Lake of Efoulan are famous lakes of Yaoundé. From the analysis of the physical, chemical and biological characteristics we derived the conclusion that the Municipal Lake of Yaoundé is eutrophic, the Lake of Obili is hyper-eutrophic, and the Lake of Efoulan is dystrophic. This is mainly due to the absence or low treatment of waste effluents combining with the lack of incentives in environmental laws. Treatment of water in these lakes is, therefore, vital as it will greatly contribute to protect the environment and people as well as to mitigate poverty through tourism and safe fishing. Analysis of physicochemical parameters by standard methods revealed an organic pollution of water resulted in very high values of turbidity, nitrate, phosphate, and suspended solids. Biologically, macro-invertebrates belonging to 3 branches, 5 classes, 10 orders, and 26 families were identified. High taxonomic richness is noted in the municipal lake, small municipal lake and Obili with 22 families, 19 families, and 15 families versus 9 families in the Efoulan Lake. These different families are essentially pollution tolerant or resistant to pollution.

# EVALUATION OF EXTRACTIBLE FORMS OF NITROGEN IN MUNICIPAL SOLID WASTE (MSW) FROM KARA: IMPACT ON THE QUALITY AND EUTROPHICATION OF THE KARA RIVER

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**Keywords:** Eutrophication, Kara River, nitrogen, solid waste, water quality

## Abstract

The Kara River and the streams crossing the city of Kara (northern Togo) receive more than 30% of the MSW products in this city. The results of biodegradation of this waste show that the river water contains high water-soluble and easily extractable organic and mineral matter. In addition to mineral nitrogen, a not less important part of the nitrogen released is bound to the water-soluble organic material. These different forms of nitrogen participate at the eutrophication of the river. The aim of this study is to quantify the various forms of nitrogen easily released in order to evaluate the real contribution of solid wastes in the eutrophication process in Kara River. To extract the nitrogen, an accelerated leaching test was applied. The principle consists of immersing the waste in pure water and stirring for 120 h to extract the maximum of the water-soluble compounds without causing saturation. The amounts of  $N_{Tot}$ ,  $N_{Org}$ , TKN,  $NH_4-N$ , and  $NO_3-N$ , which can be transferred to the river, are respectively estimated at 2,093, 2,040, 2,087, 50.6, and 3.6 kg N, respectively, in 2015, and the values calculated for 2025 are 3,435, 3,349, 3,432, 83.2, and 5.9 kg N, respectively. These quantities express an annual nitrogen pollution estimated to 6.4  $\mu g N-NH_4/L$  and 4.7  $\mu g N-NO_3/L$ , respectively, by 2025. These concentrations may contribute to the development of eutrophication in the river.

**PHYTOREMEDIATION OF POLLUTED WATER USING WATER HYACINTH  
(*Eichhornia crassipes*) AS A PURIFIER AND ENERGY SOURCE:  
A MOLECULAR PERSPECTIVE**

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**Keywords:** Bioethanol, *Eichhornia crassipes*, bio-energy, molecular perspective

**Abstract**

The presence of water hyacinth (*Eichhornia crassipes*) has been reported in more than fifty countries in the tropical and subtropical regions of the world and its rate of spread remains one of the top ten worst weeds. Its effects on aquatic ecosystems are aggravated by the impact of climate change resulting in substantial negative environmental, social and economic effects including loss of biodiversity, oxygen depletion and reduced water quality, breeding ground for pests and disease vectors, and blockage of waterways. However, despite its numerous negative impacts, the weed is associated with some benefits including advantages such as its role in reducing eutrophication, in water purification, and its potential in generation of bioethanol and biogas as well as in production of briquettes. However, major gaps in knowledge persist on the molecular mechanism used by water hyacinth in remediating waste water through bio-absorption of pollutants, organic contaminants, and high concentrations of plants nutrients. In the literature, the potential of the plant as a likely source of biofuels has been evaluated. This review offers a comprehensive look at the untapped potential of water hyacinth in reducing the pervasive challenge of eutrophication and wastewater management as well as its potential in generation of biofuels. We conclude the review by creating potential avenues for future research and knowledge.

# WATER QUALITY INDICATOR AND WATER RELATED HAZARDS MICROBIOLOGICAL PERSPECTIVE

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**Keywords:** Diarrhea, bacterial infection, water contamination, resistant determinant, chlorine tolerance

## **Abstract**

Provision of water for human domestic use can be viewed as a fundamental example of water security: survival is impossible without consuming water in some form. In most part of the developing countries, underground water had become the major source of domestic water without any form of treatment. Obviously, it was believed that groundwater is safe as a result of the filtration capacity of sand layer through which the water had percolated. Recent outbreak of infection diseases associated with consumption of untreated groundwater had nullified the proposition. Indeed, reliance on the water quality indicator organisms such as coliform bacteria seems to be inadequate to guarantee the safety of domestic water supplies. Thus, the availability of water that is free from peculiarity of colors, odor, and taste does not translate to water security. Recent study in the southwestern part of Nigeria showed the presence of microbial contamination in sources of water supply. The isolated bacteria from most of the water sources and distribution channels also carried multi-drug resistance genes. This increases the medical burden of infected individuals. The complexity of this problem is seen in the fact that these microbial contaminant are also resistant to the WHO recommended dosage of chlorine for the treatment of municipal water supplies.

## ARSENIC REMOVAL FROM GROUNDWATER USING FILTERING THROUGH FERROMAGNETIC CARBON

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**Keywords:** Arsenic Removal, Ferromagnetic Carbon, Groundwater

### Abstract

Drinking water supply systems are limited in Burkina Faso and Vietnam, in particular in rural area. There is still lack of appropriate systems of water treatment for tube wells, groundwater being used by rural populations without any prior treatment. Arsenic pollution of groundwater is a global issue for drinking water supply. Out of the occurring trace elements in the groundwater of Dong Thap Province, Vietnam arsenic has the greatest impacts on human health. Observed skin lesions among the population studied in the Deltas of Mekong River and Red River coincide with high arsenic concentrations in the drinking water being extracted from deep boreholes. To mitigate this water pollution, Ferromagnetic Carbon (FC) has been prepared by chemical activation, and fixed-bed column studies were undertaken to evaluate the performance of FC in arsenic removal from groundwater. In this work, the parameters affecting the process are investigated under varying operating conditions. Results revealed that FC was microporous with the presence of iron minerals inquiring the magnetic property. When the initial concentration of arsenic was varied, the removal capacity varied from 0.12 to 3.66  $\mu\text{g As/g carbon}$ . The increase of pH showed a variation of arsenic removal with the decrease of removal capacity from 2.20 to 1.62  $\mu\text{g As/g carbon}$ . The exhausted carbon was regenerated to 99% using 1 M NaOH after the removal of 5.65  $\mu\text{g}$  of arsenic.

## ASSESSMENT OF WATER QUALITY AND ITS SUITABILITY FOR DOMESTIC AND IRRIGATION PURPOSES: THE CASE OF FRESHWATER AND LOME BREWERY WASTEWATER IN ADJOUGBA DISTRICT (TOGO).

**Tampo, L.<sup>1</sup>, Boguido, G.<sup>1</sup>, Ayah, M.<sup>1</sup>, Gnazou, D.T.M.<sup>1,3</sup>, Tchakala, I.<sup>1</sup>, Lazar, I.M.<sup>2</sup>, DJaneye-Boundjou, G.<sup>1</sup>, Bawa. L.M.<sup>1</sup>**

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**Keywords:** irrigated agriculture, index, suitability, wastewater, water quality

### Abstract

Togo is a country situated in Sub-Saharan Africa with a tropical climate. The hydrographic network is dense and divided into three great basins. In terms of quantity, Togo has a great potential of water resources, which is often impacted by pollution. This limits the availability of water for domestic and agricultural use. Meanwhile, market gardening activities are performed in Adjougba district along the Zio River. The water used for this irrigated agriculture is the stagnant water in the bed of the Zio River, where wastewater from the beer brewery of Lomé is poured. The residents of this area drink water from shallow wells and boring, and sometimes surface water because the Togolese water network distribution is deficit and does not cover this area. The objective of this study is to assess the state of water quality for consumption and suitability of the water used for irrigation in Adjougba district. Thus 33 sites were sampled. These sites include boring waters, well waters, surface waters, and wastewater from outlet. AFNOR methods were used for the determination of all physicochemical and bacteriological parameters. The brewery wastewater shows pollution levels above the WHO discharge standards according to some parameters. But wastewater treated by biological treatment in aerated ponds presents a favorable COD/BOD ratio, which is 1.25 in average. Moreover, total phosphorus content is 17.7 mg/L and total nitrogen 30.7 mg/L in mean and show that this wastewater is a source of nutrients and fertilizing elements, and can be reused in restricted irrigation agriculture. Microbiological parameters show slightly elevated of total coliforms in treated wastewater (in mean  $118 \times 10^4/100$  mL) but compatible with agricultural use because of the absence of *Escherichia coli*. The surface water used for irrigation and consumption has physicochemical and bacteriological contents that are acceptable for irrigation but unfit for consumption. Well and boring water show physicochemical characteristics that are consistent with drinking water quality standards but with low bacterial contamination by total germs. In view of these, groundwater can be used for domestic uses, but surface water is unfit for consumption. Wastewater constitutes a supply of nutrients and a potential of fertilizing elements and can be used in irrigated agriculture after biological treatment like waste stabilization ponds.

# MESOPOROUS SILICA-BASED MEMBRANES FOR WATER AND WASTEWATER TREATMENT: OVERVIEW, CHALLENGES AND FUTURE PROSPECTS

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**Keywords:** Mesoporous Membranes, Membrane Fouling, Pollutants, Wastewater Treatment

## **Abstract**

It has been shown that membrane separation techniques compete favourably with other separation techniques for the removal of pollutants from water and wastewater. Mesoporous silica molecular sieves are materials with pore sizes between 2 nm and 50 nm. These materials offer novel physicochemical properties such as large surface areas, large pore volumes, adjustable pore diameters, narrow pore-size distribution, and easy surface functionalization (due to the presence of surface silanol groups). Their excellent porous framework is suitable not only for applications in catalysis, biosensors, thermal energy storage, protein separation, imaging, as well as purification of water and wastewater. This paper reviews the use of mesoporous silica-based membranes to remove pollutants from water and wastewater.

# OCURRENCE OF SELECTED TRIAZINE AND PHENYL UREA HERBICIDES AND SORPTION BEHAVIOR IN SOILS AND WATER FROM NZOIA RIVER DRAINAGE BASIN, WESTERN KENYA

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**Keywords:** Drainage basin, herbicide residues, soil, sorption, water

## Abstract

Triazine and phenyl urea herbicides are extensively and frequently used in sugarcane farming in Nzoia River Drainage Basin (NRDB). Once applied in the farms, the herbicide residues can contaminate surface and groundwater through surface runoffs and leaching into the soils. Therefore, erosion of sugarcane soils and subsequent transport of sediment-bound contaminants in river runoffs into Lake Victoria as well as the fate of pesticide residues in the catchments is a growing concern as the sugar industry continues to expand. This study evaluated the environmental occurrence of selected triazine and phenyl urea herbicides in soils and water from the NRDB, and the sorption behavior of metribuzine. To this end, soil samples from the region were analyzed for the presence of atrazine, hexazinone, diuron, and metribuzine residues, and their metabolites. Water samples were obtained from Nzoia River and within Nzoia nuclear estates. Samples were cleaned up with SPE cartridges and analyzed by HPLC method. Highest amounts of herbicides residues in soils were found 0.85, 0.95, 0.86, and 0.32  $\mu\text{g/g}$  for atrazine, hexazinone, diuron, and metribuzine, respectively. In water, the highest amounts were 0.76 and 0.73  $\mu\text{g/L}$  at Kuywa-Matisi river confluence and at Port Victoria for hexazinone and diuron, respectively, which exceed the EU recommended limits of 0.1  $\mu\text{g/L}$  for drinking water. Sorption data for metribuzine were fitted to Freundlich, combined linear (Henry), and Langmuir isotherms. The  $K_f$  and  $K_{OC}$  values obtained were 14.9 and 182  $\mu\text{g/kg}$ , and  $K_d$  0.004 L/kg for 5 ppm exposure. Results obtained in this study would be useful for modelling and prediction of the impact of metribuzine in similar soils and nearby aquatic environments. Also, ways of minimizing the runoff from sugarcane fields containing soil bound herbicide contaminants may be explored to avoid the contamination of surrounding water bodies, especially at the Lake Victoria.

# SYNTHESIS OF HIGHLY DISPERSED POLYMERIC MATERIALS AND APPLICATION ON WASTEWATER REMEDIATION

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**Keywords:** wastewater, composites, modified electrodes, electro analysis, adsorption

## Abstract

Congo red (CR) is a typical and the first synthetic dye. Cadmium Cd(II) is one of the heavy metals that are seriously hazardous to aquatic organisms and can cause cancer in humans. Due to the discharge of large volumes of effluents, wastewaters are rated as the most polluting specimens among industrial discharges. Their presence in water even at very low concentrations is distinctly visible and undesirable, and may dramatically affect the photosynthetic activity in the aquatic life due to reduced light penetration. In view of these, the present study was focused on the bio-analysis of CR and Cd(II) removal from wastewaters. The polymeric materials, highly dispersed on alginate and oxides of iron/aluminum, were synthesized based on wood sawdust and orange skin wastes. Characterization of the synthesized materials by FTIR confirmed the withdrawal of extractibles, hemicelluloses, and celluloses during the synthesis. The removal of Cd(II) ions from synthetic wastewater by using alginate containing wood sawdust (*Triplochiton scleroxylon*) was investigated with respect to the adsorption parameters. The highly dispersed polymeric materials were used as electrochemical materials for the preparation of carbon paste electrodes (CPE) named CPE-Fe and CPE-Fe/Al, for iron and mixed of iron/aluminium, respectively. They were used as a working electrode for the electro analysis CR in an aqueous medium. The obtained results by cyclic voltammetry have shown the reversibility of the system and by square wave voltammetry the electronic transfer process of analyte to the surface of the sensor that was controlled by diffusion. These values indicated that these electrodes were effective for the detection of CR in synthetic media. The results indicated that the highly dispersed polymeric materials could be used as alternative materials instead of more costly adsorbents for wastewater remediation.

## MEAN CONCENTRATION OF LEAD AND ZINC IN WATER AND FISH SAMPLE ALONG ELEYELE-OLUYOLE RIVER IN IBADAN, SOUTH WESTERN NIGERIA

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**Keywords:** Fish, Lead, Water, Zinc, Ibadan, Nigeria

### Abstract

Heavy metals accumulation in the environment has intensified in recent years. This threatens the health of aquatic life and humans. A study to determine the concentration of lead and zinc in water and fish samples from Eleyele-Oluyole River in Ibadan, Oyo State was conducted. 36 water samples were collected 9 monthly for the duration of the study for analysis using AAS. Data obtained were subjected to statistical analysis. Results showed that concentration of lead in water ranged between 0.02 – 1.81 mg/mL (mean  $0.57 \pm 0.09$  mg/mL), which was above WHO permissible level (0.03 mg/mL). Zinc concentrations ranged between 0.002 – 0.026 mg/mL with a mean of  $0.110 \pm 0.001$  mg/mL. In the fish samples, mean lead concentration in liver ( $67.83 \pm 43.27$  mg/mL) was significantly ( $t = 12.48, < 0.0001$ ) higher than in gills ( $32.98 \pm 19.8$  mg/mL), while mean levels of zinc was significantly higher in gills ( $20.5 \pm 2.18$  mg/mL) than in liver ( $9.54 \pm 4.63$  mg/mL). However, all mean values obtained for both lead and zinc in fish tissues were significantly beyond the recommended maximum acceptable limits. The study concluded that Eleyele-Oluyole River and its aquatic life is burdened with elevated levels of lead and zinc. This raises significant public health concerns.

# THE ROLE OF COMMUNICATION IN DISSEMINATING WATER BASED MESSAGES

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**Keywords:** Communication, Packaging, Framing, Water

## **Abstract**

This paper sets out to provide an understanding of how to package water based messages and also how those messages could be communicated to a diverse audience. Communicating water issues aims at setting a first general outlook at what communication of water means, who communicates and on what sub-topics are communicated. Many researchers conduct useful studies in the area of water, but few end up being adopted by practitioners either because of accessibility problems or packaging challenges. Despite substantial investments in water research or studies, and significant advancements in these areas of science, few evidence-based programs and services are rapidly implemented in the water sector as a result of failures of dissemination. Specifically defining the value of water is difficult. Its value is situational: during a drought, water has high value; during a flood, the flood water has negative value, although potable water could become more valuable in this situation compared with normal circumstances. Framing refers to the process of information packaging with a view of transmitting that message to a mass audience. Finally, communication remains the cornerstone for behavior or attitudinal change, which can be achieved through a pre-meditated communication plan. Water is life as has been stated before, but the realization of the same can only be communicated through prudent water message packaging and dissemination.

# BACTERIOLOGICAL SAFETY OF SACHET DRINKING WATER SOLD IN BENIN CITY, NIGERIA

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**Keywords:** Coliform, heterotrophic plate count, sachet water, *Staphylococcus aureus*, *Staphylococcus epidermidis*

## **Abstract**

Access to safe drinking water remains a major challenge in Nigeria, and where available, the quality of the water is often in doubt. An alternative to the inadequate clean drinking water is being found in treated drinking water packaged in electrically heated sealed nylon and commonly referred to as “sachet water”. “Sachet water” is a common thing in Nigeria as the selling price is within the reach of members of the low socio- economic class and the setting up of a production unit does not require huge capital input. The bacteriological quality of selected “sachet water” stored at room temperature over a period of 56 days was determined to evaluate the safety of the sachet drinking water. Test for the detection of coliform bacteria was performed and the result showed no coliform bacteria that indicates the absence of fecal contamination throughout 56 days. Heterotrophic plate count (HPC) was done at an interval 14 days, and the samples showed HPC between 0 cfu/mL and 64 cfu/mL. The highest count was observed on day 1. The count decreased between day 1 and 28, while no growths were observed between day 42 and 56. The decrease in HPC suggested the presence of residual disinfectant in the water. The organisms isolated were identified as *Staphylococcus epidermidis* and *S. aureus*. The presence of these micro-organisms in sachet water is indicative for contamination during processing and handling.

## THE ORIGINS OF WATER RESOURCES CHEMISTRY IN THE MIDDLE PART OF THE MONO BASIN, TOGO

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**Keywords:** anthropogenic contamination, Mono Basin, silicates weathering, Togo

### Abstract

The objective of this study is to evaluate the water quality and to determine the main hydrogeochemical processes influencing water chemistry in the middle part of the basin having nitrate vulnerable zones. Conventional hydrogeochemical and multivariate statistical methods were applied to a set of chemical data from groundwater and surface water samples. The chemical results show that river waters are very soft (TDS <180 mg/L) with pH between 7.4 and 8.4, indicating basic character. The average values of TDS and pH of groundwater were 515 mg/L and 6.9, respectively. The control of hosting rocks, flow conditions, and anthropogenic contamination on the acidic hydrolysis of silicates leads to a water chemistry characterized by Ca-Mg-Na-HCO<sub>3</sub>, Ca-Na-HCO<sub>3</sub>, Mg-Na-HCO<sub>3</sub>, and Ca-Mg-HCO<sub>3</sub> with some Ca-Mg-Cl water types, and the equilibrium of the aqueous phases with kaolinite and Ca/Mg-montmorillonites. Anthropogenic and geogenic processes contribute together to the increasing of water salinity. This study has also demonstrated the usefulness of hydrochemical characteristics to support identification of the main groundwater flow paths. It provides an improved understanding of geochemical processes in the Mono Basin and can serve as a tool for the better management of water resources in the basin.

## IMPACTS OF FLOOD HAZARDS: PSYCHOLOGICAL INTERVENTION

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**Keywords:** Floods, Impacts, Psychological Interventions, Vulnerability, Water Hazards

### Abstract

The provision and availability of fresh water for human consumption has become an important and critical global discourse. The demand for water and its management has invariably become a vital issue, which researchers in the field of psychology, particularly, environmental psychology have tried to contribute to. This becomes imperative in the face of trying to understand what behaviors (attitudes, beliefs, habits, or routines) are expedient in realizing the goal of water for all. Water is viewed as a common good for all, although it also has its challenges such as flood, drought, building on flood plains, or the destruction of mangroves for commercial fish farming being brought about by global climate change and also recognizing the complexity and multiple meanings associated with it. Susceptibility to storms or floods are obviously important, but so too are the adaptive or maladaptive responses of individuals and communities to such hazards. This paper, therefore, tries to look at some classes of psychological impacts on floods in Nigeria, namely the direct, indirect, and psychosocial. Coping strategies and mechanisms provided as responses include providing psychological interventions in the wake of acute impacts and also reducing the vulnerabilities, especially the risk factors, contributing to their severity, and also promoting emotional resiliency.