



**FACULTY OF ENGINEERING AND ENVIRONMENTAL SCIENCES**

**OSUN STATE UNIVERSITY**

**OSOGBO, OSUN STATE, NIGERIA**

# **PROCEEDINGS**

**OF THE**

***1<sup>ST</sup> INTERNATIONAL CONFERENCE ON  
ENGINEERING AND ENVIRONMENTAL SCIENCES***

**(NOVEMBER 5-7, 2019)**

**THEME**

**ADVANCING TECHNOLOGY AND ENVIRONMENTAL  
BURDENS: CHALLENGES AND SUSTAINABLE SOLUTIONS**

**EDITORS: Abidoye, L.K.; Okedere, O.B.; Alawode, K.O.; Ibrahim, R.B.;**

**Adebanjo, A.U.; Thanni, M.O.; Adeyemo, K.A.**

© Faculty of Engineering and Environmental Sciences, Osun State University, 2019

Proceedings of the 1<sup>st</sup> International Conference on Engineering and Environmental Sciences

All rights reserved.

No part of this publication may be reproduced or stored in a retrieval system, transmitted in any form or by any means, electronics, mechanical photocopying, recording or otherwise without the prior permission of the publishers.

Published in January 2020

ISBN:

Published by: Faculty of Engineering and Environmental Sciences, Osun State University,  
Osogbo, Osun State, Nigeria.

## **PREFACE**

The 1<sup>st</sup> International Conference on Engineering and Environmental Sciences was the first international conference organized by the Faculty of Engineering and Environmental Sciences, Osun State University. The aims of the conference include to foster interactions and collaborations among members of academia, industries and traditional stakeholders across the globe, with a view to tackling the challenges to sustainable development. To address socio-economic and environmental challenges facing our country and the world at large, the Faculty seeks to position itself strategically, using these formal and intellectual interactions, to proffer ingenious solutions and also initiate same with interested stakeholders. By so doing, the Faculty is promoting its ideals to the society and also fulfilling its part in the town and gown relationship.

As elucidated by the theme of the conference- *ADVANCING TECHNOLOGY AND ENVIRONMENTAL BURDENS: CHALLENGES AND SUSTAINABLE SOLUTIONS*, this conference brought to the fore, the burdens of development borne by the environment as a result of global strives for increased and improved production of building materials, automobiles, agriculture, healthcare, textiles and so on. During this conference, local, national and international participants have demonstrated the various approaches to the solutions theoretically, empirically and numerically.

Having evaluated, revised and edited the various submissions by the participants to produce this proceedings, it is believed that readers will find in this proceedings, intellectual treasures of inestimable values, to further push the frontiers of knowledge to the next level. It is hope that the last participants of the conference and readers of this proceedings will keep up the good work of research and intellectualism and produce qualitative works to qualify for the next edition of the conference.

Finally, our immense appreciations go to the members of the local organizing committee as well as the local, national and international participants for using their time, energy and material resources to make the event worthwhile.

**Engr. Dr. A.A. Bello**

Ag Dean, Faculty of Engineering and Environmental Sciences

## **Table of Contents**

<b>PREFACE</b>	<b>ii</b>
<b>TIME HEADWAY AS INDICES OF TRAFFIC CONGESTION</b>	<b>1</b>
<i>Emmanuel, A.A. and Mohammed, H.</i>	<i>1</i>
<b>SOME PHYSICAL PROPERTIES OF COMMON VARIETIES OF WATERMELON SEED</b>	<b>12</b>
<i>Obi, O.F.</i>	<i>12</i>
<b>EFFECTS OF PALM OIL POLLUTION ON THE SUBGRADE CALIFORNIA BEARING RATIO UNDER SOAKED CONDITION</b>	<b>24</b>
<i>Adeyinka, S.M., Adeyinka, A.I., Adeyinka, C.O. and Sobo, K.S.</i>	<i>24</i>
<b>RAINFALL INTENSITY-DURATION-FREQUENCY MODELS FOR IBADAN USING OPTIMIZATION TECHNIQUE</b>	<b>34</b>
<i>David, A.O., Nwaogazie, I.L., Opafola, O.T., Babalola, A.A. and Lawal, N.S.</i>	<i>34</i>
<b>DEVELOPMENT OF AN INTELLIGENT BATTERY CHARGING SYSTEM BASED ON PIC16F877A MICROCONTROLLER</b>	<b>45</b>
<i>Nwosu, E.U., Olalere, N.A., Shopade, G.N. and Ogbodo, J.I.</i>	<i>45</i>
<b>ASSESSMENT OF VOLUMETRIC SHRINKAGE AND HYDRAULIC CONDUCTIVITY OF LATERITE STABILIZED -COW BONE ASH ADMIXTURE AS LINER MATERIALS</b>	<b>63</b>
<i>Bello, A. A.; Raji, O.I. and Ameen, I.O.</i>	<i>63</i>
<b>DESIGN AND FABRICATION OF A PLASTIC CRUSHER</b>	<b>75</b>
<i>Adesina, A.O., Adediji, W.O. and Ajiboshin, I.O.</i>	<i>75</i>
<b>EFFECTS OF UNREGULATED CONCRETE PRODUCTION PRACTICES BY NIGERIAN MASONS: A CASE STUDY OF OSOGBO, OSUN STATE, NIGERIA</b>	<b>84</b>
<i>Oriafe, A.T. and Adeoye, A.A.</i>	<i>84</i>

<b>INFLUENCE OF COMPACTION ENERGIES ON SOIL SAMPLES FROM ABEOKUTA-SOUTH LOCAL GOVERNMENT AREA OF OGUN STATE, SOUTHWESTERN NIGERIA</b>	<b>95</b>
<i>Bello, A. A., Oriaje, A. T. and Raji, Z. A.</i>	95
<b>EFFECT OF PH AND SUGAR LEVEL ON HEAT RESISTANCE OF <i>ESCHERICHIA COLI</i> IN SWEET ORANGE JUICE (<i>CITRIUS SINENSIS</i>) SOLD IN KAURA NAMODA MARKET.</b>	<b>108</b>
<i>Hassan, A.B., Tanko, H.O. and Adegboye, Y..</i>	108
<b>USERS' LEVEL OF AWARENESS ON GREEN FEATURES IN RESIDENTIAL BUILDINGS: EXPERINCE FROM IBADAN MUNICIPALITY, NIGERIA</b>	<b>125</b>
<i>Adejumo, A.O., Oyedele, D.J., Adeosun, J.O. and Ehuleye, P.K.</i>	125
<b>AN ASSESSMENT OF EXISTING GREEN FEATURES IN RESIDENTIAL BUILDINGS IN IBADAN MUNICIPALITY.</b>	<b>137</b>
<i>Adejumo, A.O., Oyedele, D.J., Adedokun, A.R., Fayomi, I., Adeosun, J.O.</i>	137
<b>ASSESSMENT OF THE EXTENT OF PARTICIPATION OF INDIGENOUS CONTRACTORS IN MAJOR CONSTRUCTION ACTIVITIES IN OSUN STATE</b>	<b>148</b>
<i>Adeosun, J.O., ' Fadipe O.O. and Adejumo, A.O.</i>	148
<b>EXPERT WITNESSING IN REAL ESTATE LITIGATION PRACTICE IN IBADAN METROPOLIS: THE ESTATE SURVEYORS AND VALUERS' PERSPECTIVE</b>	<b>159</b>
<i>Adedokun, A. R. and Oladokun, T. T.</i>	159
<b>HYDRAULIC MODELING OF A NATURE-BASED APPROACH TO SUBMERGED FLEXIBLE DRAINAGE LINING</b>	<b>173</b>
<i>Suleiman, M. and Busari, A.O.</i>	173
<b>EFFECT OF CONTINUITY OF REFINERY ON THE WORKING INDEX OF ELECTRIC ARC FURNACE</b>	<b>188</b>
<i>Okediran, K. I., Idris, M.O. and Adetunji, R.O.</i>	188
<b>EVALUATION OF QUANTITY OF WATER SUPPLY IN MINNA METROPOLIS</b>	<b>198</b>

<i>Illo , N.A and Busari A.O.,</i>	198
<b>CARBON STORAGE IN CONCRETE: INFLUENCES OF HYDRATION STAGE, CARBONATION TIME AND AGGREGATE CHARACTERISTICS</b>	<b>209</b>
<i>Abidoye, L.K. and Das, D.B.</i>	209
<b>SEPTIC PLUME CONTAMINATIONS OF GROUNDWATER IN NIGERIA LOCAL COMMUNITY: INFLUENCES OF SEASONS AND TOPOGRAPHY ON PLUME MOBILIZATIONS</b>	<b>222</b>
<i>Abidoye, L.K., Alabi, O.O. and Wahab, A.A.</i>	222
<b>PARAMETRIC INVESTIGATION OF THE RELIABILITY OF ONE-WAY REINFORCED CONCRETE SLAB</b>	<b>234</b>
<i>Olawale, S. O. A., Tijani, M. A. and Ogunleye, O. E.</i>	234
<b>MULTINOMIAL LOGIT APPROACH TO MODELLING CRASH SEVERITY ON SELECTED TWO-LANE HIGHWAYS IN ONDO STATE NIGERIA</b>	<b>244</b>
<i>Ipindola, O.O</i>	244
<b>FACTORS INFLUENCING CORPORATE REAL ESTATE OUTSOURCING IN NIGERIA: AN EMPIRICAL STUDY FROM THE BANKING AND TELECOMMUNICATION SECTORS IN LAGOS, NIGERIA.</b>	<b>257</b>
<i>Fayomi, I., Oladokun T.T. and Adewolu T.O.</i>	257
<b>COMBINED INFLUENCE OF GRAVEL AND CRUSHED BURNT BRICKS ON THE PROPERTIES OF CONCRETE</b>	<b>273</b>
<i>. Kareem, M.A , Olawale, S.O.A., Bamigboye, G.O., Alade A. J.</i>	273
<b>GEOTECHNICAL INVESTIGATION OF THE SUITABILITY OF SOME SELECTED LATERITIC SOILS FOR ROAD CONSTRUCTION IN OSUN STATE</b>	<b>284</b>
<i>Oluremi, J.R., Ishola, K., Yohanna, P. and Etim, R.K.</i>	284
<b>ENHANCING TECHNO-ENVIRONMENTALISM AND UNIVERSITY ENTREPRENEURSHIP FOR DEVELOPMENT IN AFRICA: A POLYCENTRIC PLANNING PERSPECTIVE</b>	<b>296</b>

<i>Akinola, S. R., Olayode, O., Abiola, T. I., Adeosun, J. O. and Adejumo, A. O.</i>	296
<b>ASSESSMENT OF RELIABILITY OF A CONCRETE COLUMN RESISTING AXIAL AND A COMBINATION OF AXIAL AND MOMENT LOADS</b>	<b>317</b>
<i>Olawale, S.O.A., Adebajo, A.U. and Tijani, A.O.</i>	317
<b>ACOUSTIC BEHAVIOUR OF CRUMB-RUBBER MASONRY HOLLOW CONCRETE BLOCK “WALLETTE” BASED ON ITS INSTALLED SELF-WEIGHT</b>	<b>335</b>
<i>Sanni, M.Y., Ocholi, A., Abdulkarim, A.A., Ejeh, S.P. and. Amartey, Y.D.</i>	335
<b>EXPERIMENTAL STUDY ON THE PROPERTIES OF SORGHUM HUSK ASH PERVIOUS CONCRETE</b>	<b>351</b>
<i>Tijani, M.A., Ajagbe, W.O., Olawale, S.O.A., Ganiyu, A.A. and Agbede, O.A.</i>	351
<b>TRAFFIC ANALYSIS AT A MULTILEGED INTERSECTION IN OSUN STATE, NIGERIA</b>	<b>359</b>
<i>Olawuyi, O.A., Busari, A., Akintayo, F.O, and Ojagbule, T.E.</i>	359
<b>AN ASSESSMENT OF URBAN HOUSEHOLD OUTDOOR RECREATIONAL BEHAVIOURS IN OSOGBO, OSUN STATE, NIGERIA</b>	<b>370</b>
<i>Adedotun, S.B., Yakubu, D.A., Ajayi, O.A., Adedotun, D.O. and Tewogbade, M.</i>	370
<b>REDEFINING THE SCALE OF ENVIRONMENTAL POLLUTION IN NIGERIA USING SUSTAINABLE DEVELOPMENT GOALS</b>	<b>384</b>
<i>Gbadegesin, O.A.</i>	384
<b>APPRAISAL OF ENVIRONMENTAL SANITATION PRACTICES IN SELECTED MARKETS IN AKURE, NIGERIA</b>	<b>396</b>
<i>Ibrahim, R. B., Adedotun, S. B., Waheed, F. I. and Akinbosoye, B.O.</i>	396
<b>IMPACT ASSESSMENT OF SMOKING DURATION ON POLYCYCLIC AROMATIC HYDROCARBONS (PAH’S) CONTAMINATIONS OF CATFISH (<i>Clarias gariepinus</i>)</b>	<b>407</b>
<i>Abiona, O. O., Awojide, S. H., Adegunwa, A. O. and Tayo, A. S</i>	407

<b>ENVIRONMENTAL MANAGEMENT POLICIES IN NIGERIA</b>	<b>415</b>
<i>Adewoye, O.A., Oyewole, O. D. and Lawal, O. O.</i>	415
<b>ACCESSIBILITY AND PATRONAGE OF URBAN OPEN SPACES IN A SOUTH-WESTERN NIGERIA CITY.</b>	<b>424</b>
<i>Ajayi, A.O. and Amole, O.O.</i>	424
<b>MAPPING OF THE SUSCEPTIBILITY AREAS TO LANDSLIDE IN JOS SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA.-GIS APPROACH</b>	<b>443</b>
<i>Fadipe, O.O., Shitta, N. Okeke, O.J. Adeosun, J.O.</i>	443
<b>A STUDY OF SPATIAL ACCESSIBILITY TO PUBLIC SECONDARY SCHOOL EDUCATION IN OSUN WEST SENATORIAL DISTRICT, NIGERIA</b>	<b>452</b>
<i>Adeyinka, S.A.; Ojo, A.O., Olayode, O. and Ogundahunsi, D. S.</i>	452
<b>THE INFLUENCE OF CRUMB-RUBBER ADDITIONS ON THE WATER SORPTIVITY AND POROSITY OF MASONRY CONCRETE</b>	<b>463</b>
<i>Sanni, M.Y., Ocholi, A., Abdulkarim, A.A., Ejeh, S.P. and Amartey, Y.D.</i>	463
<b>EVALUATION OF STRENGTH CLASSES OF TWO SELECTED LESS-USED NIGERIAN TIMBER SPECIES FOR STRUCTURAL APPLICATIONS</b>	<b>481</b>
<i>Rahmon, R. O., Jimoh, A. A., Babatunde, O. Y.</i>	481
<b>LAND USE CHANGES BETWEEN 1986 AND 2016 IN OBA HILL FOREST RESERVE, OSUN STATE, NIGERIA</b>	<b>499</b>
<i>Asifat, J.T. and Ogunbode, T.O.</i>	499
<b>EFFECT OF COMPACTIVE EFFORTS ON THE DESSICATION-INDUCED VOLUMETRIC SHRINKAGE OF BLACK COTTON SOIL TREATED WITH CASSAVA PEEL ASH</b>	<b>512</b>
<i>Adeyemo, K. A., Yunusa, G. H., Bello, A. A. and Muhammad, A.</i>	512
<b>EVALUATION OF THE EFFECT OF PRECIPITATION VARIATION ON GROUNDWATER QUALITY IN ILORIN METROPOLIS, NIGERIA</b>	<b>524</b>



<i>Ayanshola, A.M., Sossou, P.M., Bilewu, S.O., Abdulkadri, T.S., Oluwaseun, V.O. and Owolabi, S.O.</i>	524
<b>REMOTELY CONTROLLED CAR SPEED GOVERNOR</b>	<b>536</b>
<i>Alonge, O.I., Abiola, O.A., Onigbogi, A.O., Akinbode, F.O., Okediji, A. P. and Alabi, I. O.</i>	536
<b>STALL CONTROL ON THE NACA 23012 AIRFOIL VIA SINGLE AND DOUBLE SUCTION</b>	<b>550</b>
<i>Alonge, O. I., Akinneye, A.O. and Julius, M. O.</i>	550
<b>BUS STOPS CHARACTERISTICS IN SELECTED LOCAL GOVERNMENT AREAS IN IBADAN METROPOLIS</b>	<b>565</b>
<i>Akintayo, F. O., Adibeli, S. A., Oyewale, P. K. and Olawuyi, O. A.</i>	565
<b>THE USE OF BAGASSE ASH AS A SUITABLE RAW MATERIAL FOR PRODUCTION OF CONTAINER GLASS</b>	<b>573</b>
<i>Muhammed, J.O. and Alemaka, E.M</i>	573
<b>PRODUCTION OF A DUAL-PURPOSE WASTE GLASS PROCESSING MACHINE FOR SMALL TO MEDIUM ENTERPRISE (SME)</b>	<b>585</b>
<i>Olasehinde, O. S., Gonah, C. M. and Fwatwmol, A. D..</i>	585
<b>OPTIMAL PLACEMENT AND SIZING OF CAPACITOR IN NIGERIAN RADIAL DISTRIBUTION NETWORKS USING CUCKOO SEARCH ALGORITHM</b>	<b>596</b>
<i>Salimon, S. A., Suuti, K. A. and Aderinko, H. A.</i>	596
<b>DEVELOPMENT OF A DUST EXTRACTOR</b>	<b>610</b>
<i>Adeboye, B. S. and Raji, A.W.</i>	610
<b>HEALTH IMPAIRMENT OF CLIMATE CHANGE AMONG AGED PEOPLE IN IBADAN, NIGERIA</b>	<b>616</b>
<i>Kehinde, O. J. and Adeboyejo, A. T.</i>	616

**COMBATTING ENVIRONMENTAL BURDENS THROUGH ANAEROBIC DIGESTION OF SELECTED ANIMAL WASTES CO-DIGESTED WITH FOOD WASTES AT MESOPHILIC TEMPERATURE 627**

*Oladejo, O.S., Salami, A. and Adebayo, A.O. 627*

**OPTIMUM AND NUTRITIVE UTILIZATION OF *OREOCHROMIS NILOTICUS* FED DIFFERENTLY PREPARED HOUSEFLY MAGGOT SUBSTITUTED DIETS. 641**

*Mustapha, A.K. 641*

**GEOSPATIAL ANALYSIS OF URBAN HEAT ISLAND OVER BAUCHI METROPOLIS AND ITS ENVIRONS 655**

*Isioye, O. A., Akomolafe, E. A., Abubakar, A. Z., Aliyu, A. O. and Maiwayo, T. 655*

**MOTORISTS' COMPLIANCE WITH ROAD TRAFFIC SIGNS IN IKEJA LOCAL GOVERNMENT AREA, LAGOS STATE 670**

*Ogundahunsi, D. S., Adedotun, S. B. and Usman, A. A. 670*

**IMPACT OF ROAD EXPANSION ON THE SOCIO ECONOMIC ACTIVITIES IN OSOGBO METROPOLIS 678**

*Yakubu, D. A., Adedotun, S. B. and David, O. J. 678*

**COMPRESSIVE STRENGTH CHARACTERISTICS OF STRUCTURAL-SIZE AKOMU (*Pycnanthus angolensis*) AND ERIRI (*Vitex doniana*) AS TIMBER COLUMN UNDER COMPRESSION 688**

*Rahmon, R. O. and Jimoh, A. A. 688*

**VISCOUS FLOW EFFECT FOR SIMULTANEOUS SQUEEZE AND SLIP FLOW OF A POROUS EMBEDDED NON-NEWTONIAN FLUID. 706**

*Ilegbusi, A.O. and Akinshilo, A.T. 706*

**INNOVATING ENGINEERING STUDENT CURRICULUM WITH ENTREPRENEURSHIP 721**

*Adeyemi, O.A. and. Idris, M.O. 721*

**A REVIEW OF WOVEN NATURAL FIBRE COMPOSITE FOR SPIRAL ANKLE FOOT ORTHOSIS 734**

*Oyewo, A., Ajide, O., Odusote, J., Adefajo, A. and Fakorede, D. 734*

**DETERMINANTS OF PROPERTY INVESTMENT INFLOW IN AN EMERGING ECONOMY: THE PERSPECTIVE OF REAL ESTATE DEVELOPERS IN LAGOS, NIGERIA 747**

*Adebara, O. B. and Olaleye, A. 747*

**FRONT AND REAR YARDS OF RESIDENTIAL BUILDINGS AS OPEN SPACES IN ILE-IFE, NIGERIA: SOME IMPLICATIONS FOR DEVELOPMENT CONTROL 762**

*Adebara, T. M. 762*

**ROTOR ANGLE DYNAMICS IN MULTI-MACHINE GRID-INDEPENDENT DISTRICT MINIGRID 776**

*Ajewole, T.O., Lawal, M.O., Alawode, K.O. and Omoigui, M.O. 776*

**STUDY OF GLOBAL USE OF GEOSYNTHETICS TECHNOLOGY AND IMPLICATIONS FOR NIGERIA 785**

*Oginni, F.A. and Dada, T. T. 785*

**AN IMPROVED MATHEMATICAL MODEL FOR ECOLOGICAL SURVEILLANCE OF PREY-PREDATOR. 803**

*Omotosho, L.O.; Olayiwola, M.O. and Olaleye, V.O. 803*

**PURIFICATION AND PHYSICO-CHEMICAL ANALYSIS OF CRUDE GLYCERIN PRODUCED BY TRANSESTERIFICATION PROCESS. 816**

*Aworanti, O.A., Agbede, O.O., Ogunleye, O.O., Agarry, S.E., Babatunde, K.A. and Akinwumi O.D. 816*

**LABORATORY INVESTIGATION OF SEDIMENT TRANSPORT IN OPEN CHANNEL FLOWS 824**

*Eya, S. A.; Saleh, J. Y.; Ekwo, J. E.; Nubiya, R. N. and Busari, O. A. 824*

**CONVERGENCE BETWEEN THE MARXIST AND INFORMATION THEORY IN  
RELATION TO MOTIVE-BASED OCCLUSION-INVARIANT FACIAL DISPARITY:  
AN ANALYSIS OF CONFLICT RESOLUTION 834**

*Alabi, A. 834*

**DISTRIBUTION SYSTEM POWER LOSS MINIMIZATION BASED ON NETWORK  
STRUCTURAL CHARACTERISTICS 849**

*Ayanlade, S.O., Komolafe, O. A., Adejumobi, I. O. and Jimoh, A. 849*

**SUSTAINABILITY OF IFE STEEL SLAG ON THE SPLIT AND FLEXURAL  
STRENGTHS OF CONCRETE 862**

*Adedokun, S. I., Anifowose, M. A., Oyeleke, M. O., Oduoye, W. O., Ibiwoye, E. O. 862*

**FACTORS INFLUENCING TIME PERFORMANCE OF CONTRACTORS ON  
CONSTRUCTION PROJECTS IN OSUN STATE, NIGERIA 870**

*Ademola, S. A., Akomolafe, M. A. and Buari, T. A. 870*

**Comparison of Physicochemical properties of two varieties of cucumber (*Cucumis  
sativus*) 885**

*Lamidi, W.A., Oyedun, T. D. and Adesigbin, A.J. 885*

**A PARTICLE SWARM OPTIMIZATION (PSO) BASED SMART GRID  
APPLICATION FOR OPTIMUM SIZING OF HYBRID RENEWABLE 899**

**ENERGY SYSTEMS IN NIGERIA 899**

*Oyelami, S., Azeez, N. A. and Ologunye, O. B. 899*

**APPRAISAL OF FLOODING AND DRAINAGE CONDITIONS IN OSOGBO, OSUN  
STATE, NIGERIA. 907**

*Gasu, M. B., Olaiyiwola, O. and Ezekiel, A. O. 907*

**DECENTRALIZED LOAD FREQUENCY CONTROL OF MULTI-AREA  
INTERCONNECTED POWER SYSTEMS 920**

*Yahaya, E. H., Kunya, A. B., Jibril, Y., Okorie, P. U. 920*

**METHYLENE BLUE RECOVERY FROM SIMULATED WATER USING BENTONITE CLAY, KAOLINITE CLAY AND WORM CASTING COMPOSITE ADSORBENT 937**

*Adeniji, A.T., Alade, A.O., Afolabi, T.J., Arinkoola, A.O., Araromi, D. O., Salam, K.K., Ajibike, M.A., Ganiyu, S.O. 937*

**BIOSORPTION OF METHYLENE BLUE USING CHEMICALLY MODIFIED CHRYSOPHYLLUM ALBIDIUM SEED SHELL 950**

*Omotayo, M. I., Dada, E.O., Alade, A.O., Ajani, A.O., Aworanti, O.A., Oyekunle, O.S., Adeniji, A.T., Ajibike, M.A., Adebayo, M.A. 950*

**DEVELOPMENT OF KIFILIDEEN (POWER OF BASE 11) AND ANTIKIFILIDEEN (ANTIPOWER OF BASE 11) TABLES 957**

*Osanyinpeju, K. L. 957*

**DEVELOPMENT, CONVERSION AND APPLICATION OF OSANYINPEJU (POWER OF BASE 2) AND ANTIOSANYINPEJU (ANTIPOWER OF BASE 2) WITH LEKAN (POWER OF BASE 5) AND ANTILEKAN (ANTIPOWER OF BASE 5) TABLES 969**

*Osanyinpeju, K.L., Aderinlewo, A.A., Dairo, O.U., Adetunji, O.R, Ajisegiri, E.S.A. 969*

**I-OPTIMAL DESIGN OPTIMIZATION OF SYNTHESIS OF SILVER-GOLD NANOPARTICLES FROM YAM, POTATO AND CASSAVA PEELS EXTRACT BIO-COMPOSITE 983**

*Ajibike, M.A., Alade, A.O., Adeniji, A. T., Adeniyi, B.A., Omotayo, M.I., Asinyabi, V.O. and Ajayi, K. 983*

**OPTIMIZATION OF SILVER-GOLD NANOPARTICLE SYNTHESIS FROM BANANA SPECIES PEELS EXTRACT BIOCOMPOSITE 997**

*Adeniyi, B.A. Alade, A.O., Afolabi, T.J., Agarry, S.E., Ajibike, M.A., and Adeniji, A.T. 997*

**URBAN CRIME AND INSECURITY: A STUDY OF OLODI APAPA LOCAL GOVERNMENT AREA, LAGOS, NIGERIA 1006**

*Asiyanbola, R. A. and Ayeolowo, S. D. 1006*

**EVALUATION OF RANDOM MUTAGENESIS ON BIOFLOCCULANT-PRODUCING ACTIVITY AND CASSAVA WASTEWATER PURIFICATION OF *Enterococcus* sp. OBTAINED FROM YAM PEEL** **1018**

*Fagbohunge, M. E., Oyedara, O. O., Jimoh, S. O., Akinde, S. B. and Olaitan, J. O.* 1018

**SOURCING RIGHT ERGONOMIC EXECUTIVE OFFICE CHAIR** **1030**

*Oddiah, A.O., Ismaila, S.O., Orintunsi, K.T., Kolo, J.G., Musilim, A.A., Ali, I.A., & Oloko, G.A.* 1030

**CONDITION ASSESSMENT OF OJUTU BRIDGE IN ILOBU OSUN STATE, NIGERIA USING RELIABILITY AND NON-DESTRUCTIVE TESTING ON SELECTED STRUCTURAL ELEMENTS.** **1040**

*Olawale, S.O. A., Adebajo, A.U., Thanni, M. O., and Fatokun, A. A.* 1040

**PROSPECTING FOR IDEAL BUILT ENVIRONMENT FOR THE MUSLIM FAITHFUL THROUGH THE INTEGRATION OF ISLAMIC DESIGN PRINCIPLES IN CONTEMPORARY HOUSING NEIGHBORHOODS** **1058**

*Babangida, H. M.* 1058

**COAL BOTTOM ASH AS PARTIAL REPLACEMENT OF FINE AGGREGATE IN ASPHALTIC CONCRETE** **1074**

*Adebunmi, F.A., Mohammed, H. and Adewole, B. Z.* 1074

**MODELING A WIRELESS ALARM RESPONSE CENTER—A SCIENTIFIC APPROACH TO SOLVE FARMERS AND HERDSMEN CONFLICT IN NIGERIA** **1085**

*Awofolaju, T. T. and Yahaya, J. A.* 1085

**DESIGN AND CONSTRUCTION OF A STAND-ALONE ATTENDANCE SYSTEM** **1095**

*Awofolaju, T.T., Orolugbagbe, D. O., Oladoye, S.O. and Obiyemi, O.O.* 1095

**STUDIES OF CLIMATE CHANGE ON RAIN RATE PREDICTION OVER SOUTHWESTERN NIGERIA** **1108**

<i>Semire, F.A., Adekunle, A.J. and Adegbola, O.A.</i>	1108
<b>DEVELOPMENT AND PERFORMANCE EVALUATION OF A PV-BASED SOLAR TRAINER</b>	<b>1117</b>
<i>Lawal, M. O., Olanrewaju, M. D. and Afolabi, O. O.</i>	1117
<b>POWER FLOW ANALYSIS OF OSOGBO 33-KV DISTRIBUTION NETWORK</b>	<b>1124</b>
<i>Lawal, M.O. and Olasupo, B.I.</i>	1124
<b>DEVELOPMENT OF A DYNAMIC DEMAND FORECAST MODEL FOR JOB SHOP</b>	<b>1134</b>
<i>Idris, M. O., Enwerem, G. C. and Kareem, B.</i>	1134
<b>A STUDY OF RESIDENTS' ROAD TRANSPORT SAFETY PERCEPTION AND AWARENESS IN OSOGBO, NIGERIA</b>	<b>1151</b>
<i>Fadare, S.O. and Olasupo, B.O.</i>	1151
<b>DESIGN, CONSTRUCTION AND ANALYSIS OF 1 KVA INVERTER POWERED BY SOLAR PANEL VIA A 12V INDUSTRIAL BATTERY</b>	<b>1164</b>
<i>Olatona, G.I., Akinloye, I.A., Ogunbiyi, D. M., Sulaiman, F. A. and Adegbola. F.</i>	1164
<b>A REVIEW OF COMPUTATIONAL TECHNIQUES USED IN LOAD MODELING</b>	<b>1175</b>
<i>Mohammed, M., Abdulkarim, A., Abubakar, A. S., Kunya, A.B. and Jibril, Y.</i>	1175
<b>HARMONIC REDUCTION IN THREE PHASE INVERTER USING SVPWM AND SHUNT ACTIVE FILTER</b>	<b>1186</b>
<i>Mohammed, M. and Abdullahi, M.</i>	1186
<b>DELAY OF CATASTROPHIC BOUNDARY LAYER SEPARATION OVER NACA 23012 AIRFOIL; A NUMERICAL STUDY</b>	<b>1195</b>
<i>Julius, M.O. and Alonge, O. I.</i>	1195
<b>COMPARATIVE ASSESSMENT OF PROPERTIES OF LOCAL AND IMPORTED STEEL REINFORCING BARS IN SELECTED AREAS IN OSUN STATE</b>	<b>1210</b>

*Kareem, M.A., Adesiyun, T.O. and Oduoye, W.O.* 1210

**APPLICATION OF TAU METHOD TO LINEAR AND NON-LINEAR INTEGRO-DIFFERENTIAL EQUATIONS. 1222**

*Olayiwola, M.O., Adediji, J.A. and Aregbesola, Y.A.S..* 1222

**SENTIMENT ANALYSIS ON SOCIAL MEDIA PRODUCT REVIEWS USING MACHINE LEARNING TECHNIQUES 1239**

*Jamiu, S.A. and Akanbi, C.O.* 1239

**PARTIAL REPLACEMENT OF CEMENT WITH PALM KERNEL SHELL ASH IN CONCRETE 1255**

*Adeyanju, D.O., Awogboro, S.O., Kareem, M.A.* 1255



## **EVALUATION OF THE EFFECT OF PRECIPITATION VARIATION ON GROUNDWATER QUALITY IN ILORIN METROPOLIS, NIGERIA**

Ayanshola, A.M.<sup>1</sup>, Sossou, P.M.<sup>2</sup>, Bilewu, S.O.<sup>1</sup>, Abdulkadri, T.S.<sup>1</sup>, Oluwaseun, V.O.<sup>1</sup> and Owolabi, S.O.<sup>3</sup>

<sup>1</sup>Dept. of Water Res. & Env. Engg University of Ilorin, Ilorin, Nigeria

<sup>2</sup>Dept. of Civil Engg University of Ilorin Ilorin, Nigeria

<sup>3</sup>Dept. of Civil Engg Adeleke University Ede, Nigeria

Corresponding author: [engramayanshola@gmail.com](mailto:engramayanshola@gmail.com)

### **ABSTRACT**

Groundwater is an essential part of the hydrological cycle serving as the primary source of water where public water supply is neither available nor adequate. This study evaluated the seasonal variability of water quality with respect to monthly rainfall depth in Ilorin metropolis, Nigeria. This was achieved by the determination of the month with minimum and maximum rainfall depth as well as determination of the concentration of Physico-chemical and bacteriological parameters of water sample in the study area. Twenty years historical data of monthly rainfall depth was obtained and analysed and a total of 32 water samples were collected from Shallow wells in the month with minimum and maximum rainfall depth from 8 different locations in year 2018 to determine their concentration. The Physico-chemical and bacteriological properties of water samples were analysed using Standard Methods. The potability of the water samples were assessed with respect to WHO standard. The study revealed that Turbidity, Fe<sup>2+</sup>, Dissolved Oxygen, Total Viable Count and Total Coliform Count concentration exceeded the World Health Organization (WHO) standard in all the samples. Hence, the Shallow well water sources are polluted and the concentration of these pollutants increased in the month with minimum rainfall depth. The reduction in the pollutant concentration during the month with higher rainfall depth might be as a result of dilution through groundwater recharge from precipitation. The study also shows that the wells are not safe sources for drinking purposes and some form of treatment will be required before consumption.

***Keywords – well water; rainfall depth; bacteriological; physicochemical***

## **I. INTRODUCTION**

Groundwater is an essential resource that cannot be ignored in any part of the world (Llamas, 2005). It is indispensable for human survival and sustaining societal development. Changes in the Earth's climate

or seasonal variation have the potential to affect both the quality and the quantity of available groundwater, primarily through impacts on recharge, evapotranspiration and (indirectly) on pumpage and ABSTRACTION. The provision of clean potable drinking water, especially in developing countries like Nigeria, has always been a major challenge (Raji and Ibrahim, 2011) and many people rely on well and borehole water for their domestic drinking purpose due to the lack of access to potable water (Shittu, *et al*, 2008). According to Gronwall, *et al* (2010), an estimated 269 million urban dwellers depend on wells as their principal source of drinking water. In urban Nigeria, it is estimated that almost 60 per cent of the population rely on local wells. There is an increasing trend of groundwater overexploitation and deterioration at both the regional and global scales, mainly due to anthropogenic activities (MacDonald, *et al*, 2016). Groundwater usually requires less microbiological and physicochemical treatment owing to its good quality and it is better protected against pollution than surface waters. The seasonally different intensities in precipitation considerably influence both water quantity and quality (Sakakibara, *et al*, 2017). Therefore, evaluating seasonal variability effects of groundwater quality has gradually become the focus of research on groundwater source areas.

In Nigeria and particularly in Ilorin, groundwater is an important source of water for drinking and other purposes. Ifabiyi and Ashaolu (2013) reported that the coverage of public water supply in Ilorin is limited to some area while others lack access to this service. Based on all these evidences, greater portion of the city rely more on groundwater (shallow, borehole and deep well) to meet their domestic and drinking water needs since groundwater is often potable at source and does not require heavy investment.

## **II. DESCRIPTION OF THE STUDY AREA**

Ilorin, the capital of Kwara State is located on latitude 8°30' and 8°50'N and longitude 4°20' and 4°35'E of the equator (Figure 1). It occupies an area of about 468sqkm and it is situated in the transitional zone within the forest and the guinea savannah regions of Nigeria. It is about 300 kilometers away from Lagos and 500 kilometers away from Abuja the federal capital of

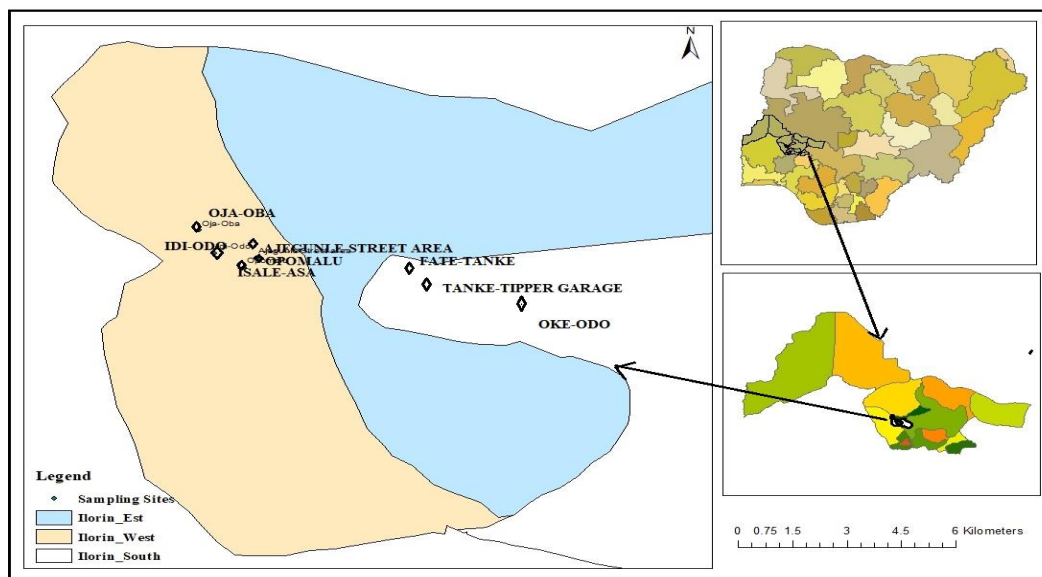
Nigeria. The climate of Ilorin is tropical under the influence of two trade winds prevailing over the country. Ilorin metropolis experiences two climatic seasons (rainy and dry season). The rainy season is between March and November and the annual rainfall varies from 1000 mm to 1500 mm, with the peak between September and early October. The total annual rainfall in the state ranges from 800mm to 1,200mm in the northwest and 1,000mm to 1,500mm in the southeast. Ilorin had a population of 847,582 making it the 13th largest city in Nigeria by population (The World Gazetteer, 2013).

## 1. MATERIALS AND METHODS

Historical daily rainfall data of Ilorin Metropolis spanned from 1999 to 2018 was obtained from the Nigerian Metrological Agency (NIMET) in order to determine the month with average minimum and maximum rainfall depth. Water samples from selected wells in the study area were then obtained in the months with average minimum and maximum rainfall depths earlier determined.

A total of 32 waters samples were collected from open wells for the month with maximum and minimum rainfall depth within ilorin metropolis (16 samples each) in the months of Septemer and December, 2018. The analyses was done at the chemistry and bateriological Laboratory of University of Ilorin. Water samples were collected using standard method as described by Aminu annd Amadi (2014) and tested according to Standard Methods (APHA, 2002). Water parameters considered include temperature, pH, Total Dissolved Solide (TDS), Total Dissolved Oxygen (TDO), Total Solid (TS), Total Suspended Solid (TSS), Total Hardness (TH), Alkalinity, Electrical Conductivity (EC), turbidity, iron ( $\text{Fe}^{3+}$ ), chloride, magnesium, Nitrate ( $\text{NO}_3^{2-}$ ), Sulphate ( $\text{SO}_4^{2-}$ ), calcium and zinc. The occurrence of Fecal Coliform, Total Viable Counts (TVC) and Total Coliform Counts (TCC) were also rxamined.

Laboratory results of the samples were subjected to statistical analysis and the results were then compared with the standards set by WHO.



**Figure 1:** Geographical map of Ilorin showing the sampling sites.

### III. RESULTS AND DISCUSSION

#### A. Monthly Rainfall Variation

The monthly variation of rainfall depth analysis shows that the minimum and maximum rainfall depths occurred in the months of December and September respectively between years 1999 and 2018. This is the reason why the samples were obtained for the study in the months of December and September respectively for dry and wet season.

#### B. Physico-chemical Parameters

The statistical summary of Physico-chemical Parameters of the water sample for the months with minimum and maximum rainfall depth for the study area is as shown in Table 1.

The monthly physicochemical analysis results indicate that the temperature of all the water samples falls within recommended values set by the WHO for groundwater (0-30°C). The temperature of groundwater is lower in the month with minimum rainfall depth than in the month with maximum rainfall depth. The higher temperature values recorded may be due to the prevalent atmospheric conditions. On the other hand, pollutants, among many other factors

may cause temperature increase in water in the present situation and similar result was also recorded by Al Sabahi, *et al.* (2009)

The results of analyses of water samples show that the pH of groundwater is all within the WHO allowable limit of 6.5-8.5 for drinking water for both months. The concentration of pH was found slightly high in December than September in each sample respectively from A to H except in samples E, G and H for the month of September. This lower pH of the groundwater in wet season may not be unconnected with dilution of rainfall with carbon dioxide as a result of aquifer recharge. The increased pH in samples E, G and H may be due to the increase of pollutant concentration occurring in these point sources of water. However, the result is in consonant with the finding of Ogbona, *et al* (2010) for various groundwater samples.

Electrical conductivity (EC) is viewed as a valuable indicator of the amount of dissolved materials in water (Olajire and Imepeoria, 2011). Potable water should not have high electrical conductivity as opined by Hutton (1983). The analyses show that electrical conductivity in all the water samples was below 1000  $\mu\text{S}/\text{cm}$  recommended by the WHO for potable water. EC in the wells are noted to be higher in December than in the month of September. Conductivity in groundwater is dictated primarily by the geology of the area through which the water flows.

**Table 1:** Descriptive Statistics of Physico-chemical Parameters of Water samples for the month with maximum and minimum rainfall depth Ilorin metropolis.

Month of September						Month of December					
Code	Min	Max	Mean	STD	CV	Min	Max	Mean	STD	CV	WHO
TP	27	28.5	27.88	0.5	1.79	26	29	27.19	0.83	3.06	0-30
PH	5.98	7.5	6.93	0.67	9.7	6.65	7.55	7.19	0.3	4.16	6.5-8.5
TBD	5.33	6.38	5.82	0.42	7.14	5.53	6.84	6.05	0.41	6.75	5
TDS	1.97	3.93	2.84	0.64	22.61	2.94	3.5	3.29	0.2	6.05	500

TSS	1.73	2.39	1.88	0.23	12.4 4	2.25	3.94	2.82	0.58	20.3 7	500
EC	40.3	41.8 1	41.09	0.54	1.31	40.4 2	41.9 8	41.2 8	0.55	1.33	1000
TS	3.75	5.75	4.72	0.72	15.2 9	5.65	6.87	6.12	0.39	6.37	1500
Cl <sup>-</sup>	2.36	8.26	5.53	2.09	37.7 6	1.48	8.38	5.2	2.21	42.4 3	200
Ca <sup>2+</sup>	0.51	1.41	1.07	0.33	30.3 7	0.65	2.36	1.4	0.62	44.3 6	75
Mg <sup>2+</sup>	0.57	2.36	1.37	0.59	43.0 9	0.81	2.55	1.64	0.55	33.3 8	50
TH	1.08	3.74	2.44	0.88	36.1	1.46	4.14	3.04	0.97	31.9 5	500
Fe <sup>2+</sup>	0.42	0.79	0.54	0.14	26.3 7	0.63	0.83	0.76	0.07	9.1	0.1
NO <sub>3</sub> <sup>2-</sup>	0.88	1.54	1.09	0.23	21.2	1.2	1.35	1.26	0.05	4.01	50
SO <sub>4</sub> <sup>2-</sup>	39.2 6	41.9 7	40.76	1.04	2.55	41.0 2	44.8	42.4 9	1.33	3.13	200
Zn <sup>2+</sup>	0.36	0.56	0.42	0.06	15.1 3	0.51	0.67	0.59	0.05	9.12	5
DO	88.8	145. 6	116.9 4	21.2 9	18.2	86.8	125. 2	109. 2	13.3 2	12.2	7.5
AKL	3.18	5.55	4.62	0.96	20.9 1	3.81	4.36	4.21	0.21	5	50

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The turbidity of all the water sample collected in the study area did not comply with the standard requirements. Their values exceeded the 5-NTU recommended by WHO (2006). Turbidity concentrations in groundwater are noted to be higher in December (dry season) than in the month of September (wet season). This may be due to

parental rock activities and the level of water in the wells. Excessive turbidity, in drinking water, may represent a health concern.

The results of Total dissolved solids (TDS), total suspended solids (TSS) and Total solids (TS) in the study area fall all within the prescribed limit set by WHO. But their values are higher in the month with minimum rainfall than the month with maximum rainfall depth. High total dissolved solids give objectionable odour or offensive taste in water (Aydin, 2007). Also the highest concentrations of TSS in sample H and F respectively in September and December may be attributed to accidental discharges entering the water from local drainages.

As for chloride ion, all the samples were below the WHO limit of 200 mg/l for drinking water. The chloride concentration is higher in September than December. High concentrations of chloride make water unpalatable and unfit for drinking and livestock watering.

The Calcium and Magnesium concentration is high in December than in the month of September but all the wells sampled have calcium and magnesium concentration below the WHO's highest permissible limit of 75mg/l and 50mg/l respectively. Higher concentrations of calcium and magnesium in water causes poor lathering during washing and deterioration of the quality of clothes. High intake of magnesium causes gastro-intestinal irritations and it also contributes to the hardness of water (WHO, 2006).

Total hardness in water samples as shown by the analyses have concentrations all below the WHO guideline (500mg/l) for drinking water both for the month of September and December. From the mean concentration of total hardness, concentration in water is higher for the month of minimum rainfall depth than the month with maximum rainfall. The water in the study area is soft. Hard water is useful and also detrimental to the human health. Hard water causes poor lathering with soap, deterioration of the quality of clothes, scale forming, skin irritation, and boiled meat and food become poor in quality. Soft water also increases the chances of heart failure in humans.

The iron concentration was higher for the month with minimum rainfall than the month September and the analyses result did not comply with the maximum permissible limit set by the WHO. The iron occurs naturally in the aquifer but levels in groundwater can be increased by dissolution of ferrous borehole and handpump components. Long term consumption of drinking water with a high concentration of iron can lead to liver diseases (hemosiderosis).

High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items.

The results showed that nitrate level in water sampled was higher for the month of December than the month of September. However, the values obtained in this study were well below the maximum permissible limits set by WHO. Water that is contaminated with nitrate is harmful especially to infants causing methemoglobinemia, otherwise called infantile cyanosis or blue baby syndrome if consumed.

From the result, sulphate concentrations have a mean and coefficient of variation of 40.76mg/l and 2.55% against 42.49mg/l and 3.13% respectively for the month of September and December. The sulphate concentration is higher for the month of December than the month of September. Sulphates are a compound containing Sulphur and oxygen ions and are a part of naturally occurring minerals in some formations of soil and rock that contain groundwater. The minerals dissolve over a period and are released into groundwater (Okpokwasili, *et al*, 2013). The sulphate levels of the water samples were below the 200mg/l recommended value by WHO (2006).

The concentrations of Zinc have a mean and coefficient of variation of 0.42mg/l and 15.13% against 0.59mg/l and 9.12% respectively for the month with maximum and minimum rainfall depth. Its values is higher in December than September but fall below the maximum permissible limit of 5.0mg/l standardized by WHO. Higher zinc application appears to protect people from cadmium poisoning. Zinc may also decrease lead absorption.

Measures of dissolved oxygen (DO) refers to the amount of oxygen contained in water. All the water sampled have a high concentration of dissolved oxygen. The result exceeded the recommended 5mg/l set by WHO (2006). Dissolved oxygen is one of the most important parameters of water. Direct and indirect information such as nutrient availability, the level of pollution, metabolic activities of microorganisms, stratification, and photosynthesis can be deduced from its correlation with water body [17]. The concentration of DO is higher for the month with maximum rainfall depth than the month with minimum rainfall.

The results of analyses of water samples for alkalinity have a mean and coefficient of variation of 4.62 mg/l and 20.91% against 4.21mg/l and 0.21% respectively for September and December. alkalinity concentration in the sampled water in the study area was below the WHO



allowable limit (50mg/l) for drinking water but higher in the month with maximum rainfall than in the month with minimum rainfall depth.

### C. Bacteriological Parameters

The Total Viable Counts (TVC) of the water samples within the eight (8) different sampling sites range from  $1.30 \times 10^5$  to  $7.00 \times 10^5$  cfu/ml and from  $3.10 \times 10^5$  to  $5.20 \times 10^5$  cfu/ml for the month of September and December respectively (Table 2). The mean of TVC is higher in the month of December ( $4.19 \times 10^5$  cfu/ml) than in the month of September ( $3.68 \times 10^5$  cfu/ml). The Total Coliform Count (TCC) in water increase also from  $1.20 \times 10^5$  to  $4.00 \times 10^5$  cfu/ml for the month of September and from  $1.60 \times 10^5$  cfu/ml to  $3.55 \times 10^5$  cfu/ml for December (Table 2). FCC was totally absent for both the month with maximum and minimum rainfall depth in the study area. This result contradicts the conclusion of Afolayan and Kolawole (2017), who reported that detected coliforms, primary bacterial indicator for fecal pollution in all samples. The absences of activities that leads to the the sources of coliforms in groundwater such as agricultural runoff, effluent from septic systems or sewage discharges, infiltration of domestic or wild animal fecal matter may be responsible for the result (Somaratne and Hallas, 2015). The microbial load observed in the well water samples are much higher than the recommended values set by WHO. However, the results comply with other studies across Nigeria which showed the presence of coliforms in most freshwater sources (Aminu and Amadi, 2014; Anyanwu and Okoli, 2012). The alarming increase in microbial loads may be as a result of increasing nutrients and aeration during the decomposition of organic matter. Coliforms are the most abundant bacteria in water responsible for water-borne diseases such as typhoid, dysentery, diarrhea and have also been implicated in mortality across the world (WHO, 2000), therefore drinking from any of the open wells used for this study will lead to serious health conditions.

**Table 2:** Descriptive Statistics of Bacteriological Parameters of the Water samples in the month of September and December

	Month of September			Month of December		
Parameters						FCC

	TVC (cfu/ml) x 10 <sup>5</sup>	TCC (cfu/ml) x 10 <sup>5</sup>	FCC (cfu/ml) x 10 <sup>5</sup>	TVC (cfu/ml) x 10 <sup>5</sup>	TCC (cfu/ml) x 10 <sup>5</sup>	(cfu/ml) x 10 <sup>5</sup>
Minimum	1.3	1.2	-	3.1	1.6	-
Maximum	7	4	-	5.2	3.55	-
Mean	3.68	2.5	-	4.19	2.37	-
WHO Standard	100	0 - 10	0	100	0 - 10	0
Standard Deviation	1.84	1	-	0.84	0.66	-
Coefficient of Variation	50.11	39.83	-	20.09	27.7	-

#### IV. CONCLUSION

The physicochemical and bacteriological properties of the well water samples examined in this study are on the reflection of man-made materials, country rocks through which has come into contact with and the influence of rainfall depth. The results of bacterial loads were higher in all the water samples especially in the month with minimum rainfall depth in Total Viable Counts and lower in Total Coliform Counts for the same month, but the results exceeded the maximum permissible limits recommended by WHO except for Fecal Coliform Counts that was totally absent in the study area. It was also found out that dissolved oxygen is the most abundant element found in all the sampled wells followed by turbidity and iron, and their values did not comply with the WHO Standards. Their occurrence in groundwater can be traced to their abundance in the earth crusts, through pollution by human impact on the environment and the intensity rain that falls. It is confirmed from the analyses that open well of Ilorin metropolis is more polluted in the month with minimum rainfall depth than the month with maximum rainfall. The life of residents in Ilorin Metropolis is endangered as long as people depend on ABSTRACTION of polluted water from open wells for domestic and drinking purposes.

#### REFERENCES

- Afolayan, O., Kolawole, O.M., 2017. Assessment of Groundwater Quality in Ilorin, North Central Nigeria. *Arid Zone Journal of Engineering, Technology and Environment*, 13(1), pp. 11-126
- Al Sabahi E, Abdul RS, Wan ZWY, Al Nozaily F, Alshaebi F., 2009. The Characteristics of Leachate and Groundwater Pollution at Municipal Solid Waste Landfill of Ibb City, Yemen, *Amer. J. Environ. Sci.*, 5(3), pp. 256-266.
- Aminu, T. and Amadi, AN., 2014. Bacteriological contaminations of ground water from Zango Local Government Area, Katsina State, North Western Nigeria. *Journal of Geoscience and Geomatics*, 2(5), pp. 186-195.
- APHA, 2002. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, Washington DC (20).
- Gronwall, J.T.; Mullenga, M; McGranaham, G., 2010. *Groundwater, Self-Supply and Poor Urban Dwellers: A Review With Case Studies of Bangalore and Lusaka. Human Settlements Programme*, International Institute for Environment and Development (IIED), London.
- Hutton, L., 1983. *Field testing of water in developing countries*, Water Resources Center, Unwin Brothers Limited, Britain.
- Ifabiyi, I.P & Ashaolu, E.D., 2013. Analysis of the Impacts of Rainfall Variability on Public Water Supply in Ilorin, Nigeria. *Journal of Meteorology and Climate Science*, 11(1), pp. 18-26.
- Llamas, M.R., 2005. Intensive Groundwater Use: A Silent Revolution that cannot be Ignored, *Water Science and Tech Series*, 51(8), pp. 167-174
- MacDonald, A. M., H. C., Bonsor, K. M. Ahmed, W. G. Burgess, M. Basharat, R. C. Calow, A. Dixit, S. S. D. Foster, K. Gopal, D. J. Lapworth, and R. M. Lark. 2016. Groundwater Quality and Depletion in the Indo-Gangetic Basin Mapped from in Situ Observations. *Nature Geoscience* 9: 762–766.
- Ogbonna, CE., Njoku, HO., Onyeagba, RA. and Nwaugo, VO., 2010. Effects of seepage from drilling burrow Pit wastes on Orashi River, Egbema, Rivers State, Nigeria. *Nigerian Journal of Microbiology*, 24(1), pp. 193-200.

Okpokwasili, G.C., Douglas, S.I. And Inengite, AK., 2013. Seasonal variations of some physicochemical parameters of groundwater in crude oil flow stations. *Journal of Environment, Science and Water Resources*, 2(1), pp. 22-26.

Olajire, AA. and Imeppeoria, FE., 2001. Water quality assessment of Osun River: Studies on inorganic nutrients. *Environmental Monitoring Assessment*, 69, pp. 17-28

Raji, MIO. and Ibrahim, YKE., 2011. Prevalence of water-borne infections in North Western Nigeria: A retrospective study. *Journal of Public Health and Epidemiology*, 3(8), pp. 382-385.

Sakakibara, K.; Tsujimura, M.; Song, X.; Zhang, J., 2017. Spatiotemporal variation of the surface water effect on the groundwater recharge in a low-precipitation region: Application of the multi-tracer approach to the Taihang Mountains, north China. *J. Hydrol*, 545, pp. 132–144.

WHO. 2006. *Guidelines for drinking water quality*. 3rd edition, WHO press, Geneva, Switzerland. Pp.355 – 398.

Somarathne, N. and Hallas, G., 2015. Review of Risk Status of Groundwater Supply Wells by Tracing the Source of Coliform Contamination, *Water* 7(7), pp. 3878-3905