The Second

UNIUYO & GIST

Joint Programme Workshop

In collaboration with

Lancaster Environment Centre, Lancaster University, UK

WASTE MANAGEMENT AND LAND CONTAMINATION

Centre for Energy and Environmental Sustainability Research (CEESR), University of Uyo, Uyo, Nigeria

June 13 ~ 16, 2016
Uyo, Nigeria

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Programme Coordinators

Dr. Edu Inam
Centre for Energy and Environmental Sustainability Research (CEESR), University of Uyo, Uyo, Nigeria

Dr. Kenneth Widmer
International Environmental Research Centre (IERC), Gwangju Institute of Science and Technology, Gwangju, South Korea

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PROCEEDINGS FOR THE SECOND INTERNATIONAL WORKSHOP ON WASTE MANAGEMENT AND LAND CONTAMINATION

June 13 – 16, 2016

Edited by
Edu Inam, Kenneth Widmer and Akanimo Odon

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WELCOME ADDRESSES

Welcome Address by the Director CEESR, UNIUYO

It is with delight and great humility that I welcome you all to the second University of Uyo (UNIUYO) & Gwangju Institute of Science and Technology, (GIST) Joint Programme Workshop, hosted in collaboration with Lancaster Environment Centre (LEC), Lancaster University, United Kingdom. I am excited to welcome our international and national delegates to Uyo, Akwa Ibom State, the land of uncommon transformation. The UNIUYO & GIST linkage which commenced on May 6, 2013, has witnessed several activities in the area of researches, trainings and workshops, all geared towards building indigenous capacity in the field of environmental sciences. We, at the Centre for Energy and Environmental Sustainability Research (CEESR) are appreciative of the opportunity to host this workshop the second time.

The theme of the workshop "Waste management and land contamination" is very topical and was conceived as fallout of the previous workshop held in Abuja. In emerging economies like Nigeria and in other African countries, waste management and land contamination remains a fundamental challenge. The plethora of challenges includes weak policy framework and legislation, inadequate funding, lack of political will, insufficient and sometimes lack of waste disposal infrastructures, education and human resources, unsuitable and poor technologies, lack of capacity in research and innovation and an uncooperative public among others. The result is that most countries in Africa still fall below in basic sanitation. The drive for industrialization, population explosion, urbanization, and changing food patterns will further exacerbate the challenges putting more pressure on the environment.

In Nigeria, only 29% of the population has access to basic sanitation, 25% still practice open defecation and open waste burning (especially agricultural waste) is still the preferred method of disposal. The consequences are that in Nigeria, 68,000 children under the age of five die annually from diseases caused by poor levels of access to water, sanitation and hygiene (Water Aid Nigeria, 2016). Four of the worst cities in the world impacted by air pollution are in Nigeria (WHO, 2016). Onitsha in Anambra State has the undignified honour of being the world's most polluted city for air quality. Other cities include Kaduna 5^{th} position, Aba 6^{th} position and Umuahia 16^{th} position. These cities are trade centres with huge volumes of municipal solid wastes disposed mainly by open burning.

It is well established in the literature that emissions from waste incineration poses serious environmental and human health risks. Medical experts have opined that short term exposures can cause headaches, nausea and rashes with increased risk of severe long term disease over time. Some of the pollutants in incinerated waste emissions include dioxins, furans, arsenic, volatile organic compounds (VOCs), mercury, lead, carbon monoxide and nitrogen oxides. Exposure to dioxins and furans has been linked to some types of cancer; liver problems; impairment of the immune, endocrine, and reproductive systems among other health effects. Similarly, dioxins and furans produced from open burning of garbage can lead to soil contamination and accumulation by plants which may end up in the food chain.

In order to achieve the sustainable development goals, (specifically goals 3, 7, 11 and 13 which include good health and wellbeing, affordable and clean energy, sustainable cities and communities and climate action respectively) wastes of all forms must be managed efficiently.

It is our hope that this workshop provides a robust platform for exchange of knowledge and research ideas from academia, government organizations, industries and private sectors on issues concerning management of waste and contaminated land in order to ensure environmental sustainability while aggressively pursuing industrialization.

We are very grateful to the Management, University of Uyo, Nigeria, the International Environmental Research Center, Gwangju Institute of Science and Technology, South Korea, Lancaster Environment Centre, Lancaster University, United Kingdom, CEESR team, participants, and the press whose efforts have contributed to the success of this workshop. Again, I welcome you all. Thank you.

Dr. Edu Inam
Director, Centre for Energy and Environmental Sustainability Research
Ag. Director, Centre for Research and Development
University of Uyo, Uyo

Welcome Address by the Director, IERC

Rapid urbanization, the management of waste, and anthropogenic environmental issues associated with urban waste are growing challenges that are facing the international community. The UNU & GIST Joint Programme recognizes this timely issue and has placed it to the forefront partnering with the University of Uyo in hosting the workshop, "Waste Management and Land Contamination." This is the second workshop that UNU & GIST Joint Programme has participated in within Nigeria and we are eager to foster the spirit of international collaboration by also welcoming representatives from the Lancaster Environment Centre at Lancaster University, UK.

I sincerely hope that the participants embrace this attitude of international cooperation, and have the opportunity to engage in thought-provoking discussion on various scientific topics related to waste management and environmental issues during this symposium. As part of the UNU & GIST Joint Programme's mission, the International Environmental Research Center actively seeks to promote international scientific collaboration, and provide opportunities for scientists in developing nations to have a voice in the dialog of current environmental and sustainable technology research efforts.

I wish to recognize the efforts of the University of Uyo for their tireless efforts in promoting and organizing the workshop. I also hope that participants and audience members find this workshop productive and it will help facilitate their future research endeavors.

Prof. Heechul Choi
Director, UNU & GIST Joint Programme
International Environmental Research Center
Gwangju Institute of Science and Technology, South Korea

PREFACE

The United Nations Development Programme (UNDP) continually works towards achieving the eradication of poverty, and the long-reaching effects of inequalities and exclusion. UNDP works in more than 170 countries and territories by assisting with developing policies, promoting leadership skills and partnering abilities, improving institutional capabilities, and contributing towards sustainable development results. In cooperation with the Korean Government, the Special Unit for South-South Cooperation under the UNDP is able to contribute support to the UNU & GIST Joint Programme. In turn we are able to host this workshop annually with our regional partner, the Centre for Energy and Environmental Sustainability Research (CEESR), University of Uyo. One of the main functions of this program managed by UNDP is to provide opportunities and resources for local stakeholders, so that they can be active participants in solving issues related to the Sustainable Development Goals. I feel that our outcomes from this workshop will certainly aid in fulfilling the mission goals of UNDP.

The topics discussed in this workshop address not only to improving sustainability,but also improving the well-being and public health of the region by tackling thedifficult issues related to waste management and land contamination in Sub-Saharan Africa. I sincerely hope that this workshop allows for an exchange of ideas and solutions, and can build a foundation where regional partners can work with Korea, UNDP, CEESR, and IERC GIST in achieving current and future Sustainable Development Goals.

Kenneth Widmer
Research Assistant Professor
International Environmental Research Center
Gwangju Institute of Science and Technology, Korea

Workshop Programme

Day 1: Monday, June 13, 2016 (Arrival)
Day 2: Tuesday, June 14, 2016

Morning Session

08.30 – 9.30 Registration

09.30 – 9.50 Welcome Addresses: (i) Dr. Edu Inam, Director, International Centre for Energy and Environmental Sustainability Research (CEESR), University of Uyo, Uyo, Nigeria; (ii) Prof. Heechul Choi, Director, UNU & GIST Joint Programme

09.50 – 10.10 Overview of the University of Uyo, Uyo – Professor Enefiok E. Essien, Vice Chancellor, University of Uyo.

10.10 – 10.30 Overview of UNU & GIST Joint Programme –Dr. Kenneth Widmer

10.30 – 10.45 Overview of Lancaster Environment Centre (LEC), UK - Prof. Kirk Semple, Director of International Engagement, Lancaster University, UK

10.45 – 10.55 Goodwill message - Ms. Itoro Inoyo, Member CEESR BoT

10.55 – 11.30 Group Photograph / Coffee Break

11.40 – 12.00 Internationalisation and Innovations in Research –the role of academia, government and Industry – Dr. Akanimo Odon, Africa Strategy Adviser, Lancaster University, United Kingdom

12.00 – 12.20 Practical Action Positioning for the Operationalisation of Post-Nip Activities: The Critical Role Of Development Partners - Oluyomi O. Banjo, Environment Expert/National Projects Coordinator, Environment UNIDO Regional Office, Abuja

12.30 – 12.40 Participants Expectations and Feedback –Dr. Edu Inam, Director, ICEESR

Afternoon Session
Session 1: INNOVATIONS IN ASSESSNING AND MANAGING WASTE

Chair: Amb. Ayo Olukanni (FADE)
Rapporteur: Dr. Valerie Solomon (CEESR)

Time	Topic and Speaker
	Sub-theme: Advances in Waste Characterization, Resource Recovery and Utilization
13.40 – 13.55	From Waste to Wealth with Musa Species (Plantain And Banana) Pseudostem: Production of Pulp, Paper and Decorative/Utility Objects- **Ukana Akpabio**, Department of Chemistry, University of Uyo,
14.00 –14.15	Waste Management: Towards Achieving a Sustainable Practice in Resource Recovery and Utilisation.- **N. V. Anyakora**, Research Unit, Federal Capital Territory Water Board, Abuja, Nigeria
14.20 –14.35	Microbial Assessment of Sludge Collected from Selected Water Treatment Plants for use as Soil Conditioner and Fertilizer in Nigeria - **Kayode Fatunla,** CEESR, University of Uyo
14.40 –14.55	Chemical Assessment of Sludge Collected from Selected Water Treatment Plants for use as Soil Conditioner and Fertilizer in Nigeria – **Emmanuel Dan**, CEESR, University of Uyo
15.00 – 15.15	Resource Recovery and Utilization of E-Waste – **E. T. Bot**, Department of Geography and Natural Resources, University of Uyo
	Sub-themes: Future-proofing Waste Management through Integrated Waste Management Plans
15.20 – 15.35	Key Drivers to Sustainable Waste Management: A Compendium of Academia and Waste Managers Perspective – **B. I. Alo**, University of Lagos,
15.40– 15.55	Anatomizing the Spatio-Cultural Discrepancy in Urban and Rural Waste Management, Lessons For Enhancing Environmental Quality Sustainability In Abak, Akwa Ibom State - **Nyeti-obong William**, Department of Geography, University of Uyo
	Sub-themes: Alternative Waste Solutions: Cornerstone of Sustainable Societies and Cities
16.00 – 16.15	An Assessment of Solid Waste Management in Nigeria, Making a Case for Alternative Waste Management in a Sustainable Society – **Opata Obinna Johnpaul,** Department of Chemical Engineering, Michael Okpara University of Agriculture, Umodike
16.20 – 16.35	The Application of GIS And Remote Sensing for Site Selection Criteria in Locating a Suitable Place for a Sanitary Landfill System and Its Environmental Impact Assessment: Case Study Abuja, Nigeria – **C. O. Agih**, KB & C Environmental Services, Uyo, Akwa Ibom State
16.40- 17.00	Discussions and Networking

Day 3: Wednesday, June 15, 2016
Session 2: INNOVATIONS IN ASSESSING AND MANAGING CONTAMINATED LAND

Chair: Prof. Kirk Semple (LEC)/ Dr. Effiom Oku (UNU-INRA)
Rapporteur: Prof. Joseph Essien /Dr. Godwin Ebong (CEESR)

Morning Session:

Time	Topic and Speaker
09.00 – 09.10	Opening Remarks –Dr. Kenneth Widmer
09.10- 09.30	Moving From Total Concentrations to Measures of Harm and Bioavailability for the Risk Assessment of Contaminated Land **Kirk T. Semple,** Lancaster Environment Centre, Lancaster University, UK
09.35 – 09.50	Microbiological and Physicochemical Analyses of Soil Samples Adjoining a Major Landfill in Uyo, Akwa Ibom State, Nigeria **U. A. Ofon,** Department of Microbiology, University of Uyo
09.55 – 10.10	Pollution Indices Of Trace Metals In Some Urban Dumpsite Soils Within Akwa Ibom State, Nigeria **Godwin A. Ebong** , Department of Chemistry, University of Uyo
10.15 – 10.30	A GIS Framework for Oil Spill Risk Monitoring in the Coastal Areas of Akwa Ibom State - **Joseph C Udoh,** Department of Geography, University of Uyo
10.35 – 10.45	Solid Waste Management And Land Contamination – **Alice Udoh,** Ministry of Environment and Mineral Resources, Akwa Ibom State
10.50 – 11.05	Modelling Crude Oil Degradation by *Pseudomonas* $Eshc_2$ Isolated From Sediments of Eniong River Itu, Nigeria – **G.E. Udofia**, Department of Microbiology, University of Uyo
11.05 – 11.15	*Micrococcus luteus*: A Potent Biosurfactant Source for Enhanced Remediation of Crude Oil Polluted Soil - **Nsikak Abraham,** Centre for Energy and Environmental Sustainability Research, University of Uyo
11.20 – 11.35	Bacterization of B iostimulant and its Diauxic Effects on Hydrocarbon Degradation and Remediation of Crude oil Contaminated Garden Soil – **Senyene I. Umana,** Centre for Energy and Environmental Sustainabiity Research, University of Uyo
Section 3	AGRICULTURE AND FOOD SECURITY
11.40 – 12.55	Complexities of Assessing Sources of Microbial Contamination in Foods for South East Asia – **Dr. Ken Widmer** , IERC, Gwangju Insitute of Science and Technology, South Korea

13.00 – 13.15	Bioaccumulation and cancer risk of polycyclic aromatic hydrocarbons in leafy vegetables grown in soils within automobile repair complex and environ in Uyo, Nigeria – **Felicia Ibanga**, CEESR, University of Uyo
13.15 – 13.30	Estimation and Health Risk Assessment ff Trace Metals In Imported Vegetables – **Imaobong Udousoro**, Department of Chemistry, University of Uyo
13.40- 14.15	Lunch

Afternoon Session:

Chair: Prof. E. D. Udosen (CEESR)

Rapporteur: Dr. Imaobong Udousoro (UNIUYO)

14.20 – 14.35	Agrochemicals: Elixirs of Life, threats to Human and Environmental Well-being - **Abdul - ganiyu Yunuss**, Federal Ministry of Environment, Abuja
14.40 – 14.55	Inhibitory efficacy of some agrochemicals on mycelial growth of *Phytophthora cinnamomi* isolated from heart-rot disease of pineapple (*Ananas cosmosus* (L.) Merr.) – **E. M. Ilondu**, Department of Botany, Delta State University
15.00 – 15.15	Mycostimulation in A Glyphosate Treated Arable Soil: Implications on the Yield and Agronomic Characters of *Talinum fruticosum* (L.) Juss. - **Adeniyi Akeem Adetola Sanyaolu**, Department of Botany and Ecological Studies, University of Uyo
Section 4	POLICY AND LEGISLATION
15.20 – 15.35	Nigeria and Basel, Rotterdam and Stockholm Conventions - **Amb. Ayo Olukanni,** Fight Against Desert Encroachment (FADE)
15.50 – 16.20	How Much Policy and Legislative Framework on Wastes and Contaminated Lands Management Input is Contained in the Nigerian Petroleum Industry Bill (PIB) Before the National Assembly – **I. R. Udotong**, Department of Microbiology University of Uyo

Session 5: "Speed Dating" Session

16.20 – 16.50	Networking Session
16.50 – 17.30	Closing Discussion: The Way Forward

Day 3: Thursday, June 17, 2016 (Departure)

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OVERVIEW OF UNIVERSITY OF UYO, UYO AKWA IBOM STATE, NIGERIA

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Professor Enefiok E. Essien
LLB (Hons) Calabar; BL (Hons) LLM, Lagos;Ph.D, Birmingham, Notary Public

The University of Uyo was established on October 1, 1991 by the Federal Government of Nigeria. The University inherited students, staff, academic programmes and the entire facilities of erstwhile University of Cross River State, Uyo, established by the then State Government in 1983. Academic activities commenced in 1991/92 session

Location: the University is located in the heart of Uyo, capital of Akwa Ibom State, Nigeria. Akwa Ibom is the largest oil producing state in Nigeria. Uyo is easily accessible by road and there are two international airports within 100 km radius; Margaret Ekpo International airport, Calabar and Ibom international airport, Uyo. Currently, the University operates from five campuses: the Town Campus as well as the Town Campus Annex and the Main Campus; the Ime Umanah Campus and the College of Health Science, all within a 10km from the city centre.

Population: the University of Uyo has One thousand four hundred and thirty one (1,431) academic staff of which two hundred and forty five (245) are full professors. The number of senior non-academic staff is one thousand three hundred and sixteen (1,316) while one thousand two hundred and thirty eight (1,238) are junior non-teaching staff. The University has a total student population of twenty one thousand six hundred and sixty

(21,660) comprising one thousand nine hundred and ninety four (1994) post graduate students and eighteen thousand six hundred and sixty six (18,666) undergraduate students.

Academic and Research Directorates: Academic Planning; Centre for Wetlands and Waste Management Studies; Clement Isong Centre for Development Studies; Centre for Skills Acquisition and Rural Development; Centre for Cultural Studies; Centre for Entrepreneurial Development, Centre for Research and Development Studies; Centre for Gender and Women Studies; General Studies Directorate; Directorate of Pre-degree Studies New Research Initiatives; Center for Energy and Environmental Sustainability Research (CEESR); Institute for Biomedical Research and Innovation; and Institute for Agricultural Research and Innovation.

List of Faculties: The University of Uyo has a total of Sixty Six (66) fully accredited programmes housed within twelve (12) faculties: Agriculture, Arts, Basic Medical Science, Business Administration, Clinical Science, Education, Engineering, Environmental Studies, Law, Pharmacy, Science and Social Sciences.

Academic Programmes: The University of Uyo runs the following programmes:

- Regular Undergraduate programmes
- Regular Postgraduate programme
- Part-time diplomas and degrees coordinated by the School of Continuing Education in collaboration with the Postgraduate School
- Sandwich and undergraduate long vocation programmes strictly for Teachers already in Employment and coordinated by the Institute of Education in collaboration with the School of Continuing Education
- Pre-degree Programmes strictly for science students in the Faculties of Sciences, Agriculture and Education
- Basic studies programmes which prepares students for Advanced Level Examinations Papers through Cambridge/JUPEB Examination bodies

Strides

- **One of the Nine Federal Universities in Nigeria selected for e-learning by the Federal Government of Nigeria**

- **The 10th most preferred university out of the 124 universities in the country by UTME candidates. About 45,000 candidates choose UNIUYO as 1st Choice University**

- **One of the two Universities in Nigeria selected for the study of Space Technology**
- **The only Nigerian University where Computational Language Documentation and Technology is Studied at Masters and Doctorate degrees levels in conjunction with Bielefield University, Germany**
- **Has the largest number of programmes with full accreditation**
- **Honored as the Information and Technology School of the year 2012**
- **UNIUYO is a Fulbright affiliated institution visited by the AMERICAN Ambassador to Nigeria, Mr Terence McCulley and parades six Fulbright scholars at the moment.**
- **Four students of faculty of engineering were selected for the award of 2015/2016 Deltaafrik Charitable foundation undergraduate scholarship.**
- **Students from department of chemical and petroleum Engineering came 3rd in the Nigerian Society of Chemical Engineers 2015 student annual project designed competition**
- **Students from department of mathematics came 2nd in the Nigerian Mathematics Competition for university students**
- **UNIUYO won overall 1st Position in the 6th Edition of Nigerian Universities Research and Innovation Fair 2016.**

OUR MISSION

To diligently pursue scholarship and deploy its output for human capacity development and economic growth in the society, with active participation in Information and Communication Technology, sensitivity to Nigeria's rich cultural heritage and responsiveness to global environmental changes

OUR VISION

To be a center of academic excellence by utilizing the available human and technological resources for teaching, research, community service and sustainable development

OUR CORE VALUES

Faith in God
Academic Excellence in Teaching and Research
Institutional Autonomy
Peer and Professional Review
Qualitative Service Delivery
Strong Work Ethics
Equal Opportunity
Creativity and Innovation
Integrity
Transparency and Accountability
Peace and Orderliness

Introducing CEESR, UNIUYO

The Centre for Energy and Environmental Sustainability Research is a research and Innovation centre in the University of Uyo, Uyo, Akwa Ibom State, Nigeria dedicated to generation and transfer of knowledge, strengthening individual and institutional capacities in furtherance of the mission and vision of the University of Uyo. CEESR is envisaged to be a model research centre for international technological cooperation and has linkages with renowned International Research Centers like the Massachusetts Institute of Technology's Media Laboratory, USA, Strategic Energy Institute, Georgia Institute of Technology, USA, the International Environmental Research Centre at Gwangju Institute of Science and Technology, Korea, and Lancaster Environment Centre, Lancaster University, UK. In ensuring sustainability of research and training excellence CEESR brings in private ownership through a consortium of local, national and international businesses, NGOs and governments including American Chemical Society. For partnership and collaboration opportunities please contact:

Website: www.iceesr.org.ng
Email: contact@iceesr.org.ng
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IERC at a Glance

Situated on the campus of the Gwangju Institute of Science and Technology, the UNU Pilot Programme on Science and Technology for Sustainability was founded in 2001 and operated until 2003. In 2004, the Korean government committed larger financial support and the UNU & GIST Joint Programme on Science and Technology for Sustainability was established with the management of the Programme conducted by the International Environment Research Center. IERC has implemented three main aspects of the UNU & GIST Joint Programme:

- To carry out research and training in science and technology for environmental sustainability.
- To contribute to capacity building of developing countries in the area of sound environmental management and sustainable development.
- To disseminate the information and advisory services through an international environmental information network.

Since 2004, IERC has continued these mission goals and expanded its efforts of scientific research, international collaboration, and information dissemination (as both educational and professional development programs) continuously promoting work with developing countries. With a supporting budget of 1.5 mil USD/year, IERC is fully expecting to continue its mission and broaden our outreach with new partners and strive to address the pressing environmental and societal issues regarding future sustainability, particularly those challenges facing developing countries.

Overview of Lancaster Environment Centre (LEC), Lancaster University, UK

Lancaster University is in the top 1% of world universities and has recently been ranked 8th in the UK. The University has approximately 15,000 full-time students and approximately 700 academic staff, with a total staff complement of over 2000. The University's annual income was £220 M in 2015.

Lancaster is pioneering, pushing the boundaries of research and teaching on the environment. We were one of the first universities in the world to establish a Department of Environmental Science and to offer Ecology as a full degree subject. In 2007, we brought together Geography, Environmental Sciences and Biological Sciences to create the Lancaster Environment Centre, knowing that together we would be more than the sum of our parts. Our vision is to work across disciplines, and societal and national boundaries, to address the major environmental challenges facing the world.

As one of the world's largest centres for environmental research, our academic expertise spans the natural and social sciences, offering balanced perspectives on what are complex societal challenges. Our teaching programmes and research reflect this diversity, operating at the crucial interface between the environment and society.

Our teaching continues to win high praise. Our Geography and Environmental Science courses were rated 5th in the UK, with Biological Sciences and Ecology programmes coming 9th, beating all other universities in the North West.

We are the largest department in Lancaster University and our staff, students and visitors come from around the globe. Through university and strategic partnerships, we are working in Africa, Asia and the Americas, offering opportunities to our students and researchers to be based abroad and to influence the major environmental debates of the future.

Our teaching approach is both theoretical and practical, in the lecture room, laboratory and the field. All our students get the opportunity to carry out fieldwork, either on our doorstep in the beautiful North West of England, with its national parks and contrasting terrestrial and aquatic habitats, or in Europe, Amazonia, the Himalayas, North America, Asia and Iceland. So when our students graduate they have excellent job prospects across a wide range of careers globally.

While we are recognised for the quality of our fundamental research, our ambition is to use that research to provide holistic solutions for today's big issues, such as living with environmental change, species loss, pollution, energy, waste and water management and providing enough food for the world. So we work in partnership with governments, businesses and communities to put our expertise to good use.
We share our facilities (laboratories and offices) with the Environment Agency and 26 businesses in our purpose-built Gordon Manley Building, a facility to encourage commercial sector partnerships. We are also home to one of the Government's top environmental research laboratories, run by the Natural Environment Research Council's Centre for Ecology and Hydrology, and that partnership feeds into our own research, providing additional expertise and facilities.

Brief remarks on Waste Management and Land Contamination at the International Centre of Energy and Environmental Sustainability Research (ICEESR) at the 2nd UNIUYO and GIST Joint Program Workshop-

Itoro Inoyo, MPH

I believe that we can one day live in a world where health is a human right attainable to all people – no matter the color of their skin, their gender or where they call home. Like Kofi Annan, the former United Nations Secretary General, it is my aspiration too "that health will be seen, not as a blessing to be hoped for, but a human right to be fought for" – and I am willing to do my part to ensure that this becomes a reality for our people and country, Nigeria. This must also be the same for many of you sitting in the room today.

I recently graduated from the Dornsife School of Public Health, Drexel University with a Master's of Public Health (MPH) in Global Community Health and Prevention – where I was given the opportunity to work on public health research projects in the field of Water, Sanitation, and Hygiene (WASH) and HIV prevention; projects tailored to women and children of color, both in our home continent of Africa and my home of residence in the United States. I am also delighted to have been asked recently to join the Board of trustees of this research center-(ICEESR) and I look forward to working with other Board members to advance the goals of the Center.

You know, the issues at stake here is such that we must be practical...getting our hands dirty and taking the message to where it really matters. Recently, I was involved in a project which entailed living in the heart of Balaka and Blantyre, Malawi, for three months, working along side brilliants minds at the World Vision Malawi (WVM), on water, sanitation and hygiene education project. This was a life-changing experience for me, as a newly bestowed public health professional – experiences filled with life lessons and new public health insights on sanitation and how it relates to our health and livelihood. It sharpened my community health skills but also allowed me to build long lasting relationships with the women of the Njerenje village care group, my primary school students in Balaka, and the numerous kind-hearted people I met along the way.
Overall, it reinforced in me again what I have always been told by my parents, that the purpose of life, is to help and bring joy to other people.

Some of us cannot be living in comfort while majority of our people remain in squalor and unsanitary conditions. Sanitation is a cornerstone of public health. If we as a people are able to improve the sanitation of our communities, this will greatly improve the health outcomes and well being of individuals in our communities and country as a whole.

We know that waste management is a fundamental issue we face as a country. For example, only 29% of our people have access to basic sanitation facilities and services - that means over 60 percent of Nigeria's population still lacks access to the basic sanitation facilities such as toilets and hand-washing stations. 57 million of us do not have access to clean water and nearly 68, 0000 children under the age of five die from diseases caused by our nation's poor levels of access to water, sanitation and hygiene. This is simply unacceptable.

I say this not to discourage you all but to inform you of our country's current situation. Sitting in this room today are change agents, policy makers, physicians, researchers and men and women eager to do their part to make a long-lasting impact to improve the health and well being of Nigerians. We need all of you – we need people passionate to improve our policies and legislations surrounding sanitation and waste management. We need innovators and out-of-the-box thinkers to create initiatives and provide the technology to improve waste disposal; we need people who are led to fund these initiatives and efforts – and we need educators who are willing to teach young men and women in Nigeria on proper hygiene and ways to keep our communities clean.

This will take team effort, dedication and perseverance – but it can be done. To the men and women already leading the way in creating a safer environment for us all, I thank you. Thank you to the organizers of this event. Workshops and open dialogue coupled with action are what our country needs to create a better and safer future for us all.

Thank you again for coming and lets continue to work to create a world where health, as a human right, is attainable for all.

Academic Presentations

From Waste to Wealth with Musa Species (Plantain and Banana) Pseudostem: Production of Pulp, Paper and Decorative/Utility Objects

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Abstract
Several tonnes of pseudostems of matured Musa species (Plantain and Banana) plants, felled daily in the rain forest zones of the Southern States of Nigeria and the Cameroons as the edible fruits are cut off, remain as waste agricultural materials. In this study the pseudostem waste was analyzed and found to contain mostly cellulose, hemicelluloses and very low level of lignin. It was pulped and bleached, and converted into paper. The waste was also fabricated into pieces of household decorative/utility objects, such as hand fans, lawyer's wig, belts, hats and fibre boards suitable for use as ceiling board. The qualities of these industrial products made from the pseudostem waste were good and compared well with other commercial products.

Summary
Musa species plants are commonly identified as plantain (*Musa paradisiaca*) and banana (*Musa sapientum*). The plants have underground stem called rhizome and an aerial stem (pseudostem), made up of leaf-folds and a central core. The pseudostem core bears the fruits and when the fruits are matured or ripe the entire plant is felled and the fruits cut off the pseudostem, while the remaining parts of the aerial stem are left to rot away. However studies in our laboratory have shown that the pseudostem of Musa species can be utilized in pulp and paper making, production of cellulosic plastics (Akpabio *et al.,*2005), conversion into sugar and bioalcohol (Akpabio et al., 2008), fabricated into decorative textile costumes (Akpan, 2014), fibre boards and floor tiles (Udofia, 2014). Some of the products are illustrated in the Flex and presented in this Exhibition.

The lignin which binds the cellulose fibres together in the pseudostem is very low, usually less than 5% as against over 25% present in wood, the usual source of paper pulp; this makes the Musa pseudostem consume less chemicals during pulping, hence a cheaper source for the production of cellulose pulp both for paper making and other uses. Several tonnes of Musa species pseudostems are felled every day in the rain forest zone of Nigeria and the Cameroons as agro wastes, but from our studies they can serve as raw materials for the Micro, Small and Medium Enterprises (MSMEs) for the manufacture of industrial and consumable objects as stated above.

Plate 1: *Musa paradisiaca* (plantain) with matured fruit

Plate 2: *Musa sapientum* (banana) with matured

Plate 3: Transverse Section of *Musa paradisiaca* (plantain) pseudostem

Plate 4: Transverse Section of Musa sapientum (banana) pseudostem

Figure 5: Plantain Pseudostem Filaments (Raw material)

Pilot Study

PLATE 1: Handfan I

PLATE 2: Wine container I

PLATE 3: Handfan II

PLATE 4: Mat

PLATE 5: Lawyer's wig

PLATE 6: Farmer's cap

PLATE 7: Jewelries container

PLATE 8: Purse

PLATE 9: Belt

Musa Species Fibre Products

DECORATIVE/UTILITY *MUSA* PRODUCTS

PLATE XIII: Sweater Knitting

PLATE XIV: Hand fan III

PLATE XV: Dance Costume

PLATE XVI: Purse 1 and II

PLATE XVII: Flower Vase

PLATE XVIII: Jewelries Container

PLATE XIX: Slippers

PLATE 15: Farmer's hat

PLATE 16: Piles of fibres

PLATE 17: Dance costume

PLATE 18: Plate

PLATE 19: Chieftaincy cap I

PLATE 20: Lady's hat

PLATE 21: Chieftaincy cap II

Musa Species Fibre Products

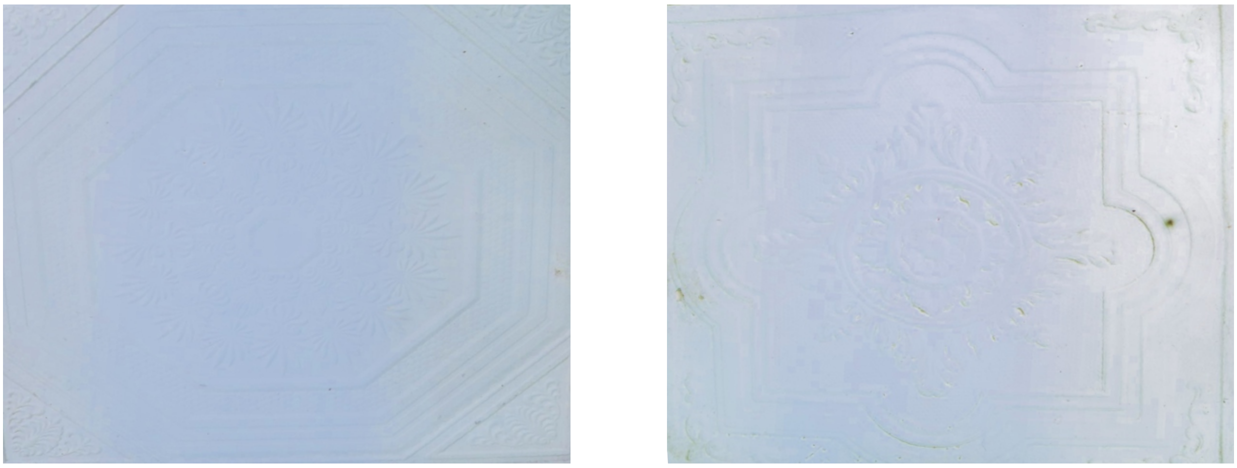

Plate XXXIII: Musa Filament Re-Enforced Fibre Boards

Figure 7: Handmade papers from a locally available paper making raw materials (fibrous and non-fibrous)

Waste Management: Towards Achieving a Sustainable Practice in Resource Recovery and Utilisation.

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ABSTRACT: Waste management becomes paramount in actualizing the mandate of sustainable development goals (SDGS) through Waste-to-Wealth Initiative. A review of innovations in assessing and managing water works wastes including advances in waste characterization, resource recovery and utilization is presented. It is objected to assist the sub-Sahara African countries in attaining long-term approach in managing the risk of water scarcity, food scarcity, poor sanitation and hygiene, towards achieving the global vision of the SDGs. The expected outcome is to strengthen Integrated Resource Recovery (IRR) Approach in waste management as to foster collaboration between the government, academia and industry for research-driven solutions.

Key words: Waste Management, Resource Recovery, Utilization, Sustainable Development, Water Works Sludge.

Introduction: The year 2016 ushers in the official launch of the Sustainable Development Goals (SDGs) globally.The SDGs global vision is to improve lively-hoods and protect the planet for future generations and realizing the future we want. At the Paris Climate Conference (COP21) in December 2015, world leaders adopted the first-ever, legally binding global climate deal which is seen by many as the first test of political will to implement the SDGs Agenda. For the first time, every country in the world has pledged to curb their emissions, strengthen resilience and act internationally and domestically to address climate change. Turning the SDGs vision into reality is primarily the responsibility of everyone. Waste management becomes paramount in actualizing this vision. This could be actualized through waste-to-wealth initiative by adopting the principles of Integrated Resource Recovery (IRR) in waste management.

IRR is a new way of thinking about waste. Rather than viewing waste as something to be disposed of, IRR views waste as a resource that can continually provide value and add to the inventory of opportunities available for use by communities. Outputs from human and industrial processes are considered as inputs into other processes to enhance the natural environment.

IRR systems provide economic, environmental and social benefits such as: power generation, energy efficiency, water reclamation and reuse, recovery of nutrients as commercial fertilizer, production of biopolymers and bio plastics, sequestration and recovery of metals, and heat recovery and utilization. IRR approach on water works sludge management becomes necessary to foster collaboration between the academia and industry while contributing to research driven solutions. This Paper therefore, is aimed at bringing to fore, some of the critical applications of IRR approach in waste management desirous in the successful implementation of SDGs in Nigeria and sub-Sahara African countries.

The Sustainable Development Goals: The SDGs seek to build-on and complete the unfinished business of the Millennium Development Goals (MDGs); realize the human rights of all; achieve gender equality in all sectors and spheres of life; and importantly, strike a balance between economic, social and environmental dimensions of development (United Nations, 2014).There are 17 SDGs and 169 Targets. Of interest is the SDG 6 "Ensure availability and sustainable management of water and sanitation for all" (ICSU 2015), which is the responsibility of government necessitating construction and rehabilitation of state-of-the-art-water infrastructure in compliance with global best practice. This includes incorporation of a waste water treatment facility, an IRR system, for the management of sludge residue and supernatant. It is of note that actualizing SDG 6 entails indirect actualization of other SDGs.

Nigeria's Vision on SDGs Implementation:
To leave no Nigerian Behind
To integrate the SDGs in an inclusive and people-centred manner
To focus on institutional and policy strengthening.

Review on Innovations in Assessing and Managing Water Works Wastes: Water is the essential building block of life for which nearly all jobs, regardless of the sector, depend directly on water. Thus, water is vital for creating jobs and supporting economic, social, and human development. Production of potable water gives rise to production of wastes which includes water works sludge, an inevitable by-product. Sludge can be referred to as a sustainable raw material as long as water is, and remains a basic amenity.

Quantitative analysis of sludge indicates that it consists of sludge residue and supernatant while the qualitative analysis through proper characterization using modern instrumental analytical techniques reveals existence of valuable mineral composition desirous for utilization in many industries. Water works sludge has found useful application in various sectors, and its water content is the most determining factor for its optimal applicability in material application through recovery and utilisation (Syed, 2000).

Sustainable technology-based strategy for processing water works sludge for resource utilization was reported by Anyakora et al., (2012). In this work, suitable process condition was demonstrated for processing of water works sludge using different treatment processes that are flexible to local conditions, regulatory and economic constraints while assuring long-term and sustainable measures for resource utilization.

Some researchers reported the utilisation of water treatment sludge residue as soil substitute (Cornwell et al., 1987; Dayton et al., 2001; Anyakora et al., 2012). The IRR approach in these works becomes useful in promoting sustainable agriculture and food security; managing contaminated land through land reclamation and conditioning, while improving quality of natural resources.

Several researches have shown that water works sludge could find useful application in brick making (Anderson et al 2003; Weng and Chiang, 2003; Mohammed et al., 2008; Anyakora, 2013[1;2]). Similarly, the IRR approach in these works becomes useful in water reclamation and reuse; recovery of minerals and utilization; production of sustainable eco-materials for affordable housing; improving water quality; reduction in the consumption of scarce and non- renewable natural resources; energy efficiency; cost efficiency; reduction of environmental pollution associated with effluent discharge.

Recent research on water works sludge-ash from Lower Usuma Dam Water Treatment Plant (LUDWTP) revealed that sludge-ash has potentials for use as pozzolanic material (Anyakora, 2014; Anyakora, 2015). Again, the IRR approach in these works becomes useful in the production of eco-materials for affordable and sustainable housing infrastructure.

Research on Supernatant from LUDWTP was reported by Anyakora et al., (2015). The qualitative analysis of the Supernatant was undertaken using various instrumental analytical techniques. The characterization result revealed that the supernatant investigated has potential for reuse in agriculture. This IRR approach will add value in promoting sustainable agriculture; achieve food security, end hunger, environmental sustainability, water security, sanitation and hygiene.

The characterization results of sludge using XRF, XRD, SEM, EDX, and AAS showed that the sludge investigated composed mainly of aluminum-silicate minerals similar to clay minerals (Anderson et al., 2003; Weng and Chiang, 2003; Mohammed et al., 2008; Anyakora, 2012 Anyakora, 2013[1;2]). At higher temperatures (800°C and 1000°C), sludge-ash characterized using XRF, showed potential for use as pozzolanic material, Table 1 (Anyakora, 2014).

Table 1: Result of Chemical Composition (X-Ray Fluorescence) of processed sludge from LUDWTP at different temperatures

S/N	Component (%)	Normal feed	105°C	800°C	1000°C
1.	Al_2O_3	28.029	28.28	34.73	35.82
2.	SiO_2	29.60	30.3	36.18	37.35
3.	K_2O	0.84	0.90	0.81	0.85
4.	CaO	1.48	1.55	1.27	1.34
5.	TiO_2	0.85	0.885	0.762	0.80
6.	MnO	2.96	3.11	2.48	2.62
7.	Fe_2O_3	8.05	9.17	17.49	17.90
8.	CuO	0.044	0.054	0.035	0.034
9.	LOI	22.6	20.78	1.36	0.04

Source: (Anyakora, 2014)

Conclusion: The adoption of the SDGs by the United Nation's 193 Member States at a historic summit in September 2015 is a clarion call for all to be actively involved in transforming our World. Waste management through IRR approach in achieving this quest becomes inevitable in turning the global vision of these SDGs into reality, as this will improve livelihoods and protect the planet for future generations & realizing the future we want.

Government is encouraged to strengthen and revitalize policies that support IRR approach in waste management for sustainable development.

All stakeholders (government, industry, and academia) are therefore exhilarated to be actively involved in the implementation of SDGs for research-driven solutions.

Recommendations: In recognition of the aspiration by nations including Nigeria to diversify her economy with increased activity in the solid minerals sector, through mineral exploration and utilization, with attendant negative environmental effects on land contamination and degradation, integration of IRR approach in waste management becomes expedient in actualizing this quest for environmental sustainability. Further work is therefore recommended on resource recovery from sludge-ash in support of the SDGs Agenda. The proposed research on IRR approach seeks to promote sustainable economic growth while reducing poverty, hunger and promoting healthy lives and well-being for all.

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6. Dr. H. Abba, Chemistry department.

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Microbial assessment of sludge collected from selected water treatment plants for use as soil conditioner and fertilizer in Nigeria

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Introduction: The problem of waste generation, control and management has become a well-known phenomenon in a typical Nigerian city. Nigeria's major cities are among the fastest growing cities in the sub-Saharan Africa with increasing population (1.1 - 1.4 million as at 2006) and infrastructural development (NPC, 2006). Like in many other mega cities in the world, there is increasing demand for basic industrial needs and potable water. The resultant effect is the ever increasing wastes generation and contamination of surface water and land (Ogbonna, Ekweozor and Igwe, 2002). Several tonnes of sewage sludge is being generated across waste water treatment plants in Nigeria with no defined means of disposal. Sewage sludge has been reported to contain elements essential for plant growth; hence it has unique fertilizing benefits (Fytili and Zabaniotou, 2008). This study evaluates the characteristics of sewage sludge with the aim of articulating possible ways of utilizing as alternative low cost agricultural soil amendments/biofertilizer.

Materials and Methods: Sludge samples were obtained from Lower Usuma dam Water treatment plant located in Abuja Nigeria between latitude 9º 01' 12″ N and longitude 7º 25' 16″ E. It has a capacity to process 120 million litres of waste water and provide Abuja and its neighboring areas with the same amount of clean drinking water per day.

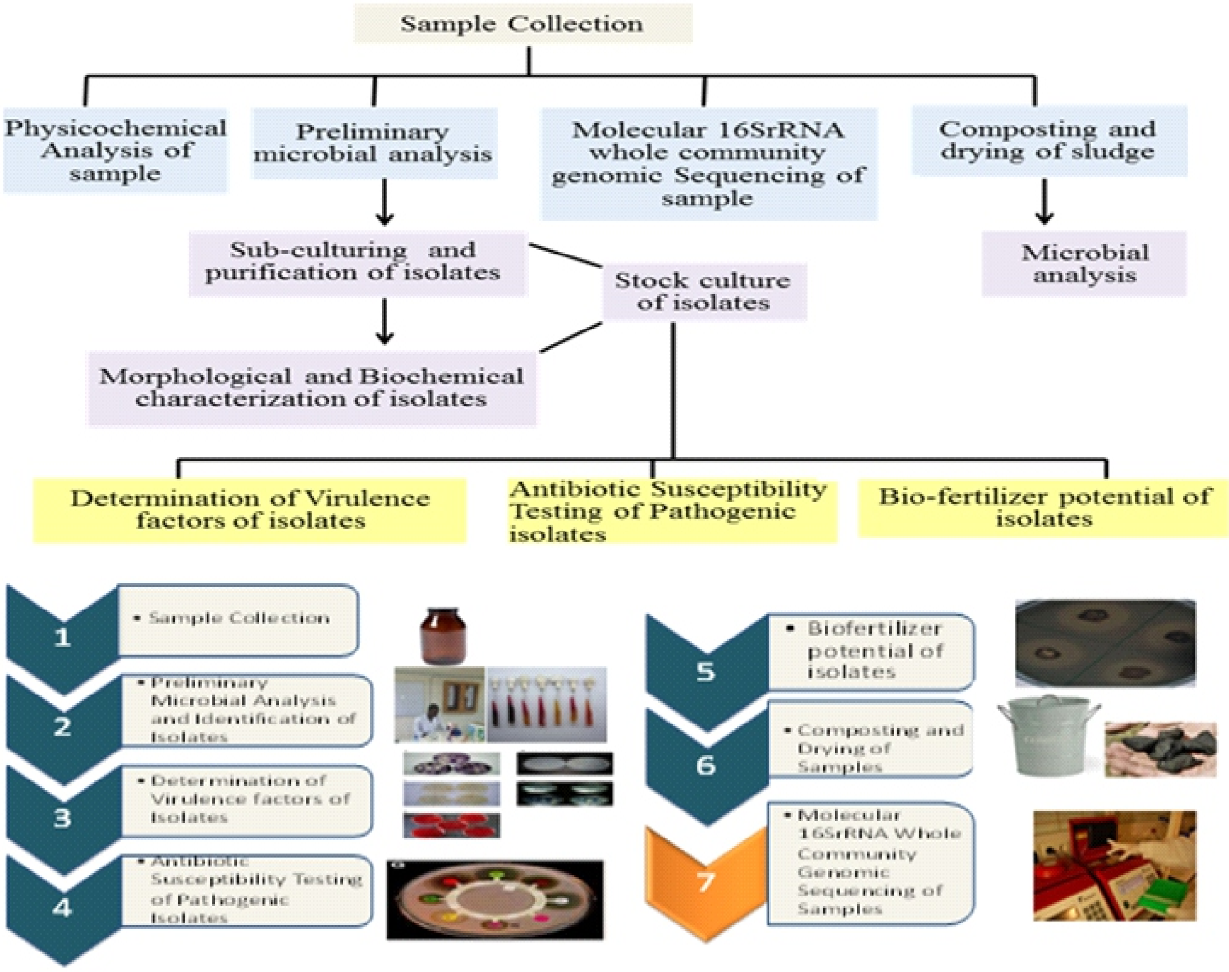

Figure 2: Flow Chart of Procedure Adopted for the Study.

Results and Discussion: The quantitative estimates of the microbial burden of the sludge samples are presented Table 4. The result shows that the sludge is laden with microorganisms including potential bacterial pathogens and helminthes eggs an indication of the efficacy of the treatment process in this regard. However the relatively low heterotrophic and oil degrading bacteria counts encountered is a challenge to its possible use in improving soil fertility in crude oil impacted environment. The wastewater treatment process tends to remove pathogens from the treated wastewater, thereby concentrating the pathogens in the sludge. The culturable bacterial isolates identified were Pseudomonas, *Salmonella, Shigella, Aeromonas, Klebsiella, Citrobacte, Providentia, Micrococcus, Staphylococcus, Streptococcus* and *Enterococcus.* The enzymatic and virulence factors of the bacterial isolates are presented in Figure 1. It shows that the isolated microorganisms exhibited variable levels of virulence and saprohytic potentials while the antibiotic susceptibility assay revealed that most of the pathogenic isolates were resistant to two or more of the antibiotics and hence monitoring is important to ensure these pathogens do not survive treatment process.

Table 4: Microbiological burden of the Wastewater Sludge Samples

Microbial Group	LUDWTP	LMWTP	AKWTP
Fecal Coliform (x 10^2 CFU/g)	5.58$\pm$ 0.22	3.50$\pm$ 0.12	1.58$\pm$ 0.45
Total Coliform Count (x 10^3 CFU/g)	3.45 $\pm$ 0.49	5.58 $\pm$ 0.35	ND
Pseudomonas aeruginosa (x 10^3 CFU/g)	3.96 $\pm$ 3.5	2.6 $\pm$ 0.14	7.45$\pm$ 0.78
Salmonellae-Shigellae Count (x 10^3 CFU/g)	1.50 $\pm$ 0.42	2.27 $\pm$ 0.03	ND
Heterotrophic bacteria count (x 10^3 CFU/g)	2.19 $\pm$ 0.88	1.34 $\pm$ 0.04	1.03 $\pm$ 0.09
Oil degrading bacteria count (x 10^1 CFU/g)	12	15	16
Fungal Count (x 10^2 CFU/g)	1.63 $\pm$ 0.74	-	-
Staphylococcal Count (x 10^3 CFU/g)	4.40$\pm$ 1.60	4.90 $\pm$ 1.13	2.55 $\pm$ 0.35
Helminthes eggs	368	246	180

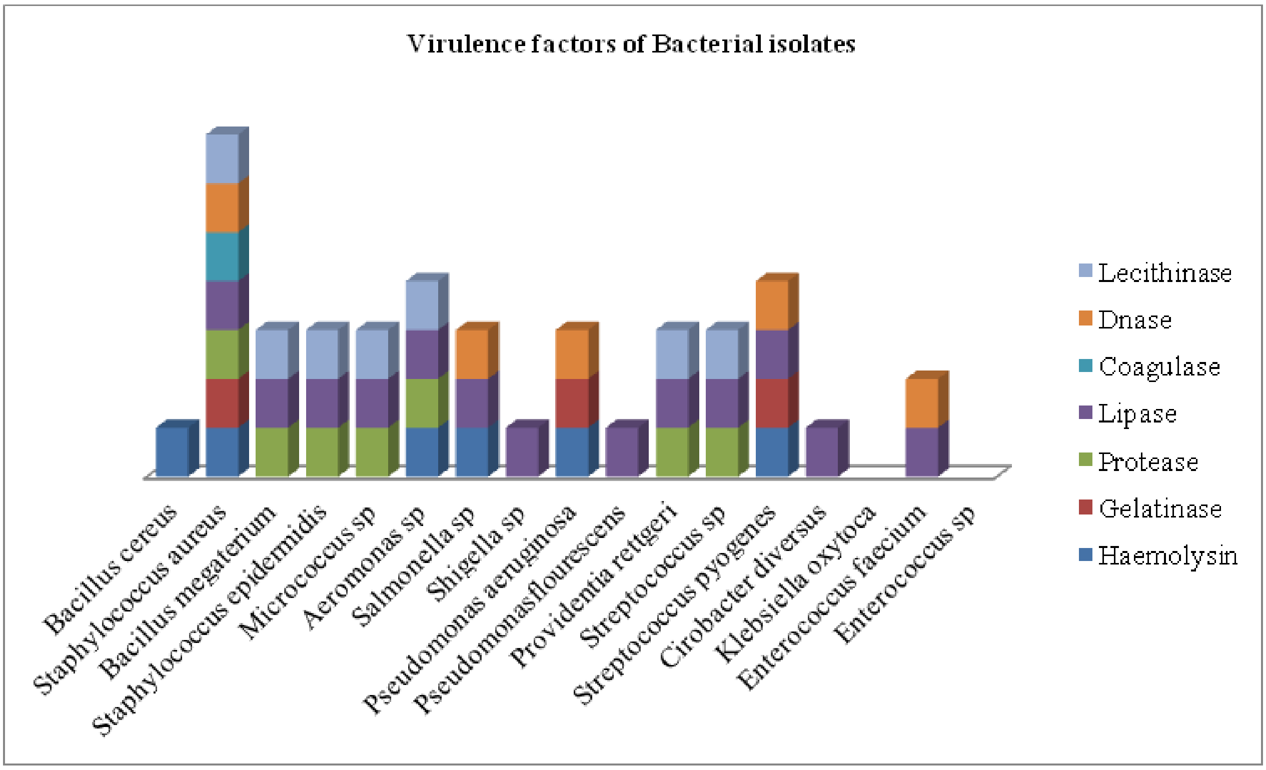

Figure 1: Enzymatic/Virulence factors of bacteria isolated from wastewater sludge samples

Conclusion and Recommendation: The research findings have revealed rich microbial consortia that do not only consist of pathogens but also heterotrophic microorganisms whose beneficial attributes can be harnessed to produce nutrient rich biofertilizer and soil amendment. Research is however ongoing to reduce the pathogens in sludge from the Bwari water treatment plant and improve its heterotrophic potency through heat drying, aerobic digestion/composting and bacterization with consortia of oil-degrading and bio-surfactant producing indigenous bacterial isolates.

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Keywords: Sludge, Utilization, Soil Amendment, Sequencing, Bacterization

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Chemical assessment of sludge collected from selected water treatment plants for use as soil conditioner and fertilizer in Nigeria

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Introduction: Sludge is defined as residue or waste generated from the treatment of waste water (smith *et al*., 2009). Whitehead (2006) has reported that sludge are very rich in nutrients (nitrogen, and phosphorus), organic matter and trace elements and others that are beneficial for plant growth and better crop yield. Application of sludge to soil has also been reported to improve the physico-chemical and biological properties of soils, increases humus content, porosity, field capacity, physical condition and other properties of soil (Aggelides *et al*., 2000, Kumar *et al*., 2013, Pakhnenkoa *et al*., 2009). Although commercial inorganic fertilizer has similar capacities as listed above, the quantity produced locally is insufficient farmers in Nigerian are only able to have access to 20% fertilizer required to meet up with their counter parts in South East Asia. Therefore, locally made alternatives and or supplements to inorganic fertilizers would prove beneficial in helping protect Nigeris's food security and agricultural sustainability. This research therefore focuses on assessing the physico-chemical characteristics, trace metal levels and poly-aromatic hydrocarbon (PAHs) levels of sludge generated from various waste water treatment plants (WWTP) in Nigeria, for use as soil conditioner and fertiliser.

Materials and Methods: Sludge samples for nutrients, physicochemical and trace metal analyses were collected using clean polythene sample bottle with caps. Samples for polycyclic aromatic hydrocarbon analysis were collected using amber glass bottles. Samples for nutrients, physicochemical analysis were prepared based on the method of Lei *et al*., 2013; Dimpe *et al*., 2015) and analysis done following standard analytical protocols as described by Mtshali *et al*.,2014; Fytili and Zabaniotou, 2008; Sekoai *et al*., 2014; Nathao *et al*., 2013; Subbiah *et al*., 2006; Lenores *et al*., 2012. Samples for metal analysis were pre-treated by adding 2ml HNO_3 to prevent precipitation before being stored in a refrigerator at 4°C. Prior to analysis, the samples were digested using aqua regia in a hotplate before atomization using Inductive Coupled Plasma Optical Emission Spectroscopy (ICP-OES). PAHs levels were measured using Gas Chromatography Mass Spectrometry (GC-MS) following the method described by Hale *et al.,* 2012. Pyrolysis and composting was carried out as treatment options and the samples obtained were characterised using the same method listed above for nutrients, physicochemical properties, metals and PAHs.

Results and Discussion: The sludge samples are characteristically fresh with high concentrations of organics, ammonium and solids, a typical high strength sludge commonly associated with poor chemically treated wastewater. However it contains relevant characteristics including rich levels of nutritive salts (Table 1) and resource elements, such as organic matter, along with phosphorus, nitrogen and potassium which are major plant nutrients. Comparatively higher levels of PAHs and trace metals were also detected in the sludge samples. The sludge density index; an index of good soil conditioner is also a pointer to the potential use of the sludge as soil conditioner

Table 1: Variation in some physicochemical attributes of Sludge Samples from the different wastewater treatment plants

Parameters	LUDWTP	AKWTP	LMWTP	CBWTP
pH	7.2	8.05	7.4	7.8
Temperature ^{O}C	29	27	27.5	27.2
Total hardness (mg/l)	18	22	30	23
Total Dissolve solid (mg/l)	78.2	NA	439.78	243.8
Total Suspended solid (mg/l)	112.2	NA	183.5	104.6
Total solid (mg/l)	206.5	NA	689.2	481.7
Turbidity (NTU)	22	NA	156.4	182.89
Electrical Conductivity (µS/Cm)	520	480	988	640
Moisture content (%)	24.57	12.81	18.65	20.22
Ash content (%)	8.89	7.54	9.23	11.45
Organic matter (%)	91.7	92.46	90.77	88.55
Volatile substance (%)	17.68	12.34	8.2	10.57
Non volatile substance (%)	82.32	87.66	91.8	89.43
Settle sludge volume (ml)	750	NA	900	650
Settling rate	0.25	NA	0.1	0.35
Sludge index	1.54	NA	1.79	1.36
Sludge density index (%)	64.35	NA	55.86	73.53
Phosphate (mg/l)	1.55	0.56	2.4	1.88
Nitrate (mg/l)	10.48	6.9	14.98	16.1
Ammonium ion (mg/l)	2.2	1.4	6.56	4.05
Sulphate (mg/l)	8	4	15	12
Nitrogen (%)	10.58	8.56	13.44	11.78
Chlorides (mg/l)	0.4	0.38	0.51	0.43
BOD (mg/l)	16	NA	25	18
COD (mg/l)	976	755	895	894
Total Organic Carbon (%)	6.89	8.94	8.63	7.45

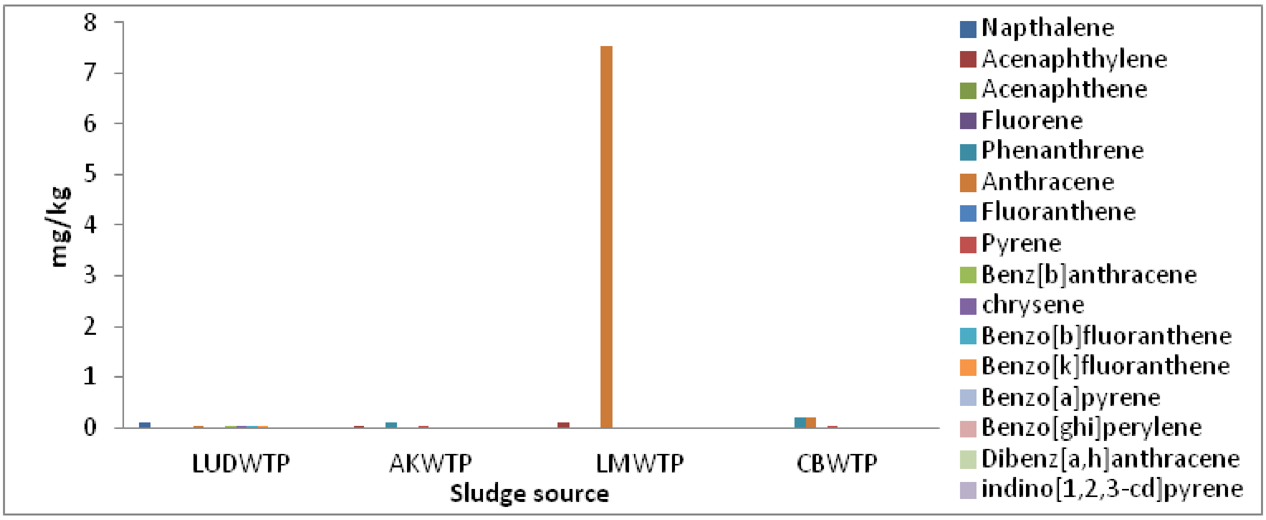

Fig 1: Polycyclic aromatic hydrocarbon profile of sludge in the four locations

Conclusion: Sludge from selected water treatment plants in Nigeria are rich in nutrients and may be used in agriculture as soil conditioner to restore or maintain the humus layer or as bio-fertilizer. However research is ongoing to understand

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Keywords: sludge, biochar, soil conditioner, plant fertilizer, trace metal.

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Resource Recovery and Utilization of E-Waste

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Abstract
Much has been said about the hazardous substances found in solid waste, especially electronic waste, better known as e-waste or Waste Electrical Electronic Equipment (WEEE). Here in Nigeria, researchers have not looked so much at the other side of the coin-exposing the great business opportunities realizable from precious substances found in e-waste. This in itself does not motivate the recycling of e-waste in the country. In most developing countries like Nigeria, waste disposal is unregulated, and recycling and recovery of valuable materials are often run out of small family workshops using crude or primitive recycling methods. Besides well-known precious metals such as gold , silver , platinum and palladium also scarce materials like indium and gallium start to play an important role, due to their application in new technologies (e.g flat screens, photovoltaics). This review exposes the value and great gain in e-waste recycling and how this can be done.

Introduction: Mankind goes to an immense effort to extract metal from out of the ground. We dig holes thousands of meters deep into the earth, blow up mountains and dig laboriously in sand dunes. But in fact, there are much easier ways to find precious metals. There is a treasure trove of gold and silver stored in household and industrial trash -- in discarded electrical devices, to be more exact. According to a report by the United Nations Environment Program (UNEP) around 40 million tons worth of electronics end up in the trash annually.

Recycling these materials properly would assist in preserving the earth's stocks of raw materials, says Rüdiger Kühr of the United Nations University (UNU) who is also the executive secretary of the Solving the E-Waste Problem Initiative (StEP). To mine one gram of gold, most companies will move a tone of ore. But it would be far simpler to get the gold through recycling -- you can find the same amount of gold in 41 mobile phones. Even mines with higher production ratios such as the Kalgold Mine in South Africa where five grams of gold are found per ton of rock are overshadowed by the mountain of electrical trash.

Reasons for Recycling E-Waste

Economic Reasons: Electronic devices contain up to 60 different elements, many of which are valuable, such as precious and special metals, and some of which are hazardous. They have a high economic value, as demonstrated by the two most well-known precious metals; gold and silver. Special metals include nickel, nickel base alloys, cobalt base alloys, titanium and titanium base alloys. It is imperative that a circular flow is established in order to recover these metals and valuable elements. Investments are being made to treat e-scrap and reclaim the valuable metals, especially as raw materials become more scarce and expensive.

Environmental/Resource: In addition to recovering precious metals, recycling electronics also reduces the environmental impact associated with primary production of electronic products. The primary production of precious and special metals, including energy intensive stages such as mining and smelting, has a significant impact on carbon dioxide emissions.

Public Health Reasons: It is estimated that 50 to 80 percent of e-waste collected in developed nations is exported to developing countries such as China, India and Pakistan due to cheap labor and lenient environmental regulations (StEP, 2009). These developing nations lack the health and safety infrastructure to process and dispose of materials safely, and consequently workers handle toxic metals without proper equipment. Common techniques for processing e-waste in developing nations such as Nigeria include manual dismantling of hazardous materials and open-air burning, which generates significant accounts of dioxins and furans if performed without proper emission control systems.

Data Security Reasons: Privacy protection concerns have also fueled the processing of electronic waste. A bad example is the alarming incidence in Ghana, where hard disk drives are recovered to have access to company and personal information for advance fraud. Confidential and personal data must be destroyed properly in order to ensure the safety of organizations and individuals information

Reuse, refurbishment or repair of electronic products is most desirable since this option increases the lifespan of the electronic product in order to achieve greater resource efficiency. However, in order to reuse electronics, the equipment must be functional and working. The minimum requirements for donation vary depending on the organization receiving the electronics.

SOME FACTS ABOUT E-WASTE

I. 20 to 50 million metric tons of e-waste are disposed worldwide every year.

II. Cell phones and other electronic items contain high amounts of precious metals like gold or silver. Americans dump phones containing over $60 million in gold/silver every year.

III. Only 12.5 percent of e-waste is currently recycled.

IV. For every 1 million cell phones that are recycled, 35,274 pounds of copper, 772 pounds of silver, 75 pounds of gold, and 33 pounds of palladium can be recovered.

V. Recycling 1 million laptops saves the energy equivalent to the electricity used by 3,657 U.S. homes in a year.

VI. E-waste is still the fastest growing municipal waste stream.

VII. A large number of what is labeled as "e-waste" is actually not waste at all, but rather whole electronic equipment or parts that are readily marketable for reuse or can be recycled for materials recovery.

VIII. It takes 539 pounds of fossil fuel, 48 pounds of chemicals, and 1.5 tons of water to manufacture one computer and monitor.

Recycling Processes: The selection of the recycling process depends on three main factors: Type of material and its complexity, Metal Content and Volume.

Classification: The initial step in the recycling and recovery process is to classfiy, evaluate and separate the type of material according to metal content and recoverability.

Enrichment: The next step in the recycling process is the removal of critical components from the e- waste in order to avoid dilution of and / or contamination with toxic substances during the downstream processes.

Mechanical Processing: Mechanical processing is the next step in e-waste treatment, normally an industrial large scale operation to obtain concentrates of recyclable materials in a dedicated fraction and also to further separate hazardous materials. Typical components of a mechanical processing plant are crushing units, shredders, magnetic- and eddy-current- and airseparators. The gas emissions are filtered and effluents are treated to minimize environmental impact.

Chemical Stripping: The chemical stripping of precious metals from e- waste or i-waste material normally requires acids, usually cyanide. The secure handling of these substances is extremely critical – Italimpianti Orafi has therefore designed units to reduce all environmental and safety hazards to a minimum, including cyanide neutralization and treatment installations.

Refining: The subsequent step of e-waste recycling is refining. Refining of resources in e-waste is possible and technical solutions exist to get back raw with minimal environmental impact. Most of the fractions need to be refined or conditioned in order to be sold as secondary raw materials.

Incineration: Incineration is the process of destroying waste through burning. Because of the variety of substances found in e-waste, incineration can be associated with a major risk of generating and dispersing contaminants and toxic substances. In view of this, Italimpianti Orafi designs incineration plants to specifically avoid risks to the environment by incorporating state-of-the-art technologies for real-time process analysis and automatic fume treatment, thus meeting EP requirements as stated by the majority of EPA regulators worldwide.

Milling Operation: The milling operations are a step in the recycle process, subsequent to the incineration process, in which the resulting materials are crushed to a fine powder.

Smelting: The smelting process is used to separate precious metals (PM) and base metals (BM) from inert material residues from the incineration process. High temperature melting furnaces are used in conjuction with special melting fondents.

Leaching: Leaching operations are very similar to chemical stripping, as previously mentioned.

Leaching agents work on the surface of the material being treated and basically strip the metal surface content into solution. Embedded metals e.g. in components or inter-board layers are not reached unless the material is finely milled.

Cost Analysis: There are several key factors used to analysis the cost effectiveness of recycling e-waste and i-waste materials : Initial contents of precious metals Local manpower costs Electricity costs Chemicals PM recovery rate and efficiency Equipment investment costs Other costs like transportation, warehousing, Marketing, Sampling etc.

Conclusion

There are indeed great and endless opportunities in the recycling and resource recovery of e-waste in what Kühr describes as some form of "urban mining". Many European recycling firms have figured this out and have profited from recent high prices for metal. Still, the costs of working with the recycled metal have an impact on profits. And the majority of electronic devices have not yet made it as far as recycling. In China alone, four tons of gold, 28 tons of silver and 6,000 tons of copper are used to make mobile telephones and computers each year. The gold is worth around €100 million ($135 million), equivalent to the monthly output of many a gold producing nation Meanwhile gold, silver and palladium are rarely recycled in Europe, UNEP says. Every year around €5 billion are lost in this way. The massive growth in the manufacture of electronic products means that this waste of resources threatens to grow even greater. Therefore if the government of Nigeria and other investors will key into this great fit, a lot will be done to not only reduce significantly, the amount of e-waste but create jobs and wealth for the nation.

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Key Drivers to Sustainable Waste Management: A Compendium of Academia and Waste Managers Perspective

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Abstract
Global sustainability has been defined as the ability to "meet the needs of the present without compromising the ability of future generations to meet their needs. The new SDGs recognizes and stipulates in Goal 6 the necessity to "ensure the sustainable management of water and sanitation for all by the year 2030".
Similarly, sustainable development "is a process of achieving human development... in an inclusive, connected, equitable, prudent, and secure manner". A sustainable waste management, therefore is one that aims to address these long term pressures through the recovery, recycling, and reuse of resources, minimisation of waste streams and system drivers. But of course this includes management of resources in an environmentally sound and economically manner.
The concept of 'System Drivers' is defined as an event that changes the status quo of an existing waste management system (in either positive or negative direction), be it legislation that encourages an integrated approach to waste management or change of public perception of a MSW management system.

Anatomizing the Spatio-cultural Discrepancy in Urban and Rural Waste Management, Lessons for Enhancing Environmental Quality Sustainability in Abak, Akwa Ibom State

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The complexities of phenomena in rural and urban environment have increased the rate of resource consumption with increasing impact on space. One significant recognized impact is the associated aftermath of waste disposal. It is on this ground that modern environmental researchers provide volumes of researches on the subject matter within politico-cultural, geospatial and socio-temporal framework.

In Akwa Ibom State, the rises in population and status upgrade have accumulated catalogues of wastes in various regions of the spatial area. Abak local Government in Akwa Ibom State of Nigeria nis one of the notable places where the effect is significant. Waste disposed in Abak is a serious issue of concern to search for ways to mitigate the phenomenal crises. Since developing countries have less sensation to environmental imbalances, the problem is on the increase and persists. However, some localized approaches have been adopted to control this problem. The question is are there variations in waste disposal process and do their waste management process really depict quality or degrade landscape.

Therefore, this paper seeks to anatomize the spatio-cultural discrepancy in urban and rural waste management as lessons for enhancing sustainable quality environment in Abak.

To generate data for research analysis, primary data through interview, field observation, focused groip discussion and quantification; and secondary data from journals, reports and other relevant materials. 12 communities where sampled out for the study (6 rural and 6 urban centres) using stratified random sampling and households of these areas were purposively sampled.

It was hypothesized that there is no significant variation in rate of waste disposal between urban and rural regions. The two way anova used at 0.05 level of significance shows that the F-value of 15.03 confirmed the test that there is a significant variation in waste disposal rates between urban and rural regions of Abak. Findings reveal that waste disposed are domestic (from kitchens, farms, households and schools), commercial (from shops, stores, local business centres, mechanic workshops and markets); industrial (local mills, restaurants, local craft industries and manufacturing industries, local drillers).

Table 1 showing Rate of Waste Disposal in Rural and Urban Environment

Regions	Rates of waste disposal		
	Domestic	Commercial	Industrial
Rural	6 2 4 5 8	9 6 5 11 2	1 7 6 7 11
	Σ=25 ΣD^2= 145 $\bar{X}$=5	Σ=33 ΣC^2=267 $\bar{X}$=6.6	Σ=32 ΣI^2=256 $\bar{X}$=6.4
Urban	11 14 8 12 9	13 14 9 10 12	7 3 11 8 12
	Σ=54 ΣD^2= 606 $\bar{X}$=10.8	Σ=58 ΣC^2=690 $\bar{X}$=11.6	Σ=41 ΣI^2= 387 $\bar{X}$=8.2
Total	Σ= 79 X= 7.9	Σ= 91 X= 9.1	Σ= 73 X= 7.3

F- 15.03

Table 2: Anova table

Source of Variation	Sum of squares	Degrees of Freedom	Variance Estimate
Total	382.7	29	13.2
B/w Subclass	171.5	5	34.3
B/w Columns	16.8	2	8.4
B/w Rows	132.3	1	132.3
Interaction	22.4	2	11.2
Error	211.2	24	8.8

The methods of waste disposal vary from space to space since the rate of waste disposal varies as well as sources of waste generation. Although, there are some similarities.

Rural areas	Methods of Disposal	Urban areas	Effect on Environment	Factors
Solid	Dispose in farmlands, bushes and backyards, in pits, wayside, burning	Dumped in neglected farms and abandoned lands, gutters, burning	Degrades the land scape beauty, dangerous to human health	Poor waste management policy and fragile institutional frame work on waste management, low concern on sanitation and individual attitudes.
Liquid	Disposed without treatment at any location	Less treatment, gutters, at any location	Creates habitat for infectious parasites and rodents, air quality defection	Technical cost, material cost and political less - concern

Before, attempting programmes on waste management in any place, there must be an understanding of the waste generation sources and local efforts to management, which becomes the fundamental to management since management is source-specific. Scientific method like recycling is necessary with respect to other appropriate tools that cannot be side-lined. Therefore, to enhance sustainable quality environment in waste management operations, there is need to invest into waste management inventory, synergy of local and global approaches in waste management, incorporation of stakeholders and resource management experts in policy making and integrated learnings from rural technology and urban tools in management of waste. The anatomy of waste disposal culture of these spatial territories is pivotal while anticipating the industrialization agenda realization in Akwa Ibom State.

An Assessment of Solid Waste Management in Nigeria, Making a Case for Alternative Waste Management in a Sustainable Society

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Abstract: Basically, solid waste problem has not been solved effectively by mankind. This is because strong forces conspire to make the issue of waste management an awesome challenge. Furthermore, other issues such as consumption habits, public awareness, inadequate waste management scheme as well as constant creation of new and more complex materials that mix with the waste chain and government regulations all affect the solid waste practices in Nigeria. This work is to analyze the solid waste practice in Nigeria and look at alternative waste management with a view to profer solutions to the Nigerian solid waste management situation.

Keywords: Alternative waste solutions, solid waste management, Nigeria

Introduction: According to Bhatia (2011), solid wastes may be defined as any solid matter which is discarded as no longer being useful in the economy and it consists of organic and inorganic matter in a variety of form. Also, solid wastes are one of the three major interacting pollution vectors, the others being air and water pollutants. Furthermore, solid matter if improperly handled will be a source of land, air and water pollution.

Also Bhatia (2011), the main sources of solid wastes are – municipal, industrial, demolition, construction, sewage and agriculture. While the methods of disposal prevalently used are – landfill, incinerations, recycle, dump and open burning. However, the methods for future considerations are – compaction, composting, recycle and reclamation, chemical processing and incineration.

Thus, the main drivers of a new waste management synergy appear to be increasing cost of landfill and environmental awareness of community. Although, awareness have impacts on environmental policy. It is pertinent to highlight that the Local government authorities in Nigeria are not doing enough in this regard. This is because solid waste management falls under the Local government administration or residual list of legislation.

However, the range of drivers for implementing various waste technologies includes:

I. Higher environmental standards and landfill regulations.
II. Increasing environmental awareness
III. Increasing the empowerment of local governments on solid waste management.
IV. More public- private waste management partnerships
V. The local government having the edge and initiative on solid waste management.

Moreover, alternative waste technologies offer a range of options on the way we manage waste, as well as its own benefits, costs, environmental and social benefits.

Nigeria is one of the developing countries of the world and it has an estimated population of one hundred and seventy million people, which is the largest in Africa. It has thirty-six states and capital as last created in 1996. Each state in Nigeria has at least two cities. In Nigeria, the role of solid waste management is with the local government authorities. However, the Federal Government and the various state governments help out by designing and implementing intervention schemes.

Fundamentally, one of Nigeria's major challenge is how to provide energy to its teeming population in a sustainable manner. This is so because of over reliance on fossil fuels for foreign exchange and the prevailing focus on further expansion of this sector of the economy by the Federal Government of Nigeria. Thus, as the effect of the global shifts away from fossil fuels is bound to cripple the Nigerian economy if drastic measures are not taken in funding research for alternative energy sources.

Alternative energy technologies are beginning to find their place in the utility resources portfolio. Worldwide, many utilities and regulatory bodies are increasingly interested in acquiring hands-on experience with alternative energy technologies in order to plan effectively for the future. Eze 2004.

Materials and Methods

Study Sites

This study was conducted on all the geo-political zones of Nigeria. These include – North Central, North East, North West, South East, South South and South West. However, the Federal Ministry of Environment has field offices across the thirty-six states and FCT. These were used to collect the data. Nigeria lies within latitude 4°N – 14°N of the equator and longitude 3°E-15°E of the Greenwich meridian. It occupies a land area of 356,669 sq.miles or 923,768 sq. Kilometers.

Materials and Methods

The questionnaires which were used in the collection of the required information were structured into one category. The category include questionnaire for the unit in charge of waste management in the Federal Ministry of Environment across all the states of the federation. Alongside the questionnaire administration photographs of the various disposal points, major dump sites, waste collection equipment and sewage treatment were obtained. The methodology involves direct waste sampling and analysis approach given by Brunner & Ernst , (1986) and reported by Moore *et al* (1994) as well as waste characterization method of Bernache- Perez *et al*, (2001) given by Bamgboye and Ojolo ,(2004) which was employed and described by Oyelola and Babatunde (2008) was used in this study. This approach entails sampling from a particular waste stream and manual sorting into various material types. Thus generated solid waste samples were obtained from bins and waste disposal sites, before the delivery of the materials to dump sites which is operated by truck disposal system from various locations in the states. The waste characterization study was carried out for a period of two weeks. Subsequently, the average waste was taken in kg per day. The monitoring was carried out over a period of one year (1997).

Results and Discussion: The quantity and rate of solid waste generation in the states were estimated. The average Mass - based compositions of the characterized wastes in the different sites studied in the states are presented below.

Table 1: A breakdown of waste characterization in major Nigerian cities is shown below.

S/N	Cities	CAP/Day (kg)	Tonnage/ month	Yearly Tonnage	Organic Waste %	Organic Waste Yearly (Ton)
1	Umuahia	0.23	15,895	190,740	65	123,981
2	Abuja	0.281	14,684	176,213	54	95,155.02
3	Yola	0.28	25,365	304,380	68	206,978.4
4	Uyo	0.253	16,112	193,344	58	112,139.52
5	Awka	0.31	25,395	304,740	60	182,844
6	Bauchi	0.31	25,372	304,464	64	194,856.96
7	Yenagoa	0.23	14,246	170,952	65	111,118.8
8	Makurdi	0.281	24,242	290,904	70	203,632.8
9	Maiduguri	0.28	32,956	395,472	66	261,011.52
10	Calabar	0.26	15,248	182,976	68.2	124,789.63
11	Asaba	0.28	15,950	191,400	60	114,840
12	Abakaliki	0.24	14,346	172,152	70	120,506.4
13	Benin City	0.63	27,459	329,508	54.18	177,934.32
14	Ekiti	0.28	14,784	177,408	65	115,315.2
15	Enugu	0.31	16,009	192,108	58	111,422.64
16	Gombe	0.275	14,006	168,072	70	117,650.4
17	Owerri	0.297	15,846	190,152	70	114,091.2
18	Dutse	0.30	16,340	196,080	70	137,256
19	Kaduna	0.23	44,433	533,199	63.05	336,181.97
20	Kano	0.56	156,676	1,880,112	50.5	940,056
21	Katsina	0.32	18,452	221,424	70	316,320
22	Birin Kebbi	0.28	15,456	185,472	70	129,830.4
23	Lokoja	0.26	15,478	185,736	70	130,015.2
24	Ilorin	0.25	34,560	414,720	70	290,304
25	Lagos	0.73	255,556	3,066,672	35.5	1,104,001.92

26	Lafia	0.21	13,956	167,472	70	117,230.4
27	Minna	0.246	14,989	179,868	68	122,310.24
28	Abeokuta	0.36	36,116	433,632	60	260,179.2
29	Akure	0.32	15,089	181,068	60	108,640.8
30	Osogbo	0.24	14,957	179,484	60	107,690.4
31	Ibadan	0.31	135,391	627,250	60.61	992,622.5
32	Jos	0.23	27,667	332,004	56.7	189,242.28
33	Port Harcourt	0.7	117,825	1,413,900	60	848,340
34	Sokoto	0.281	15,255	183,024	65.8	120,429.79
35	Jalingo	0.25	14,253	171,036	70	119,725.2
36	Damaturu	0.242	14,001	168,012	70	117,608.4
37	Gusau	0.26	14,967	179,604	70.5	126,620

Table 2.0 WASTE QUANTITIES GENERATED IN TONNES/ANNUM

S/N	STATE CAPITAL & PROJECT TOWNS	Volume of Waste
1	Abakaliki	40,776.6
2	Abeokuta	53,227.5
3	Abuja	36,669.4
4	Ado- Ekiti	28,014.5
5	Akure	45,757.0
6	Asaba	45,889.8
7	Awka	22,878.5
8	Badagry	19,382.4
9	Bauchi	43,388.3
10	Benin	287,296.5
11	Birnin- Kebbi	13,301.2
12	Calabar	42,481
13	Damaturu	31,339.8
14	Dutse	14,576.6
15	Enugu	86,184.4

16	Gombe	48,558.4
17	Gusau	57,213.3
18	Ibadan	274,029.4
19	Ilorin	105,988.1
20	Jalingo	12,606.5
21	Jos	50,866.4
22	Kaduna	190,498.5
23	Kano	373,313.8
24	Katsina	71,425.5
25	Lafia	13,696
26	Lagos	1,164,126.9
27	Lokoja	8,404.3
28	Maiduguri	144,251.8
29	Makurdi	40,085.8
30	Minna	71,231.9
31	Osogbo	15,768.6
32	Owerri	42,720.2
33	Port-Harcourt	103,972.4
34	Sapele	20,164.4
35	Sokoto	73,832.2
36	Umuahia	37,014.8
37	Uyo	21,348.7
38	Warri	36,623.8
39	Yenogoa	26,405
40	Yola	51,929.3
41	Zaria	42,648

Source- UDBN –1997

A look at the tables above shows that most cities with high volume of activities turn out high waste as a result of population density, life styles, production activities, volume of trade and consumption patterns. However, the results shown above is a reflection of Nigeria as at 1997. This shows that Lagos has the highest volume of waste, followed by Kano and Ibadan. While Birin-Kebbi and Lafia has the least volume of waste. Also, some cities were not included in the data such as Onitsha, Nnewi, Aba, Omoku, Eket, Brass.

Conclusion: Basically, a national, centralized Data base management system is required for purpose of consolidating and integrating waste streams generation, disposal data in Nigeria. This will help the use of the data for planning and waste related infrastructural development. Also, there is the need for Sanitary Landfill's to be built across the geo-political zones of Nigeria. While awareness programmes and schemes should be made to reduce waste at source. The proximity principle should also be utilized. Also, the private sector should be more involved and as a result, public-private partnership should be encouraged by all stakeholders involved.

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The Application of Gis And Remote Sensing For Site Selection Criteria in Locating A Suitable Place For A Sanitary Landfill System And Its Environmental Impact Assessment: Case Study Abuja, Nigeria

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Rapid increase in volume and types of solid and hazardous waste as a result of continuous economic growth, urbanization and industrialization, is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste and more also developing countries face uphill challenges to properly manage their waste (UNEP, 2009).

Landfill is a system of trash and garbage disposal in which the waste is buried between layers of

earth to build up low-lying land —called also *sanitary landfill (merriam-webster online dictionary, 2007)*, it is also defined as an engineered method of disposing of solid waste on land in a manner that protects the environment, by spreading the waste in thin layers, compacting it to the smallest practical volume and covering it with compacted soil by the end of each working day or at more frequent intervals if necessary (CORBIT, 2012). Modern landfills are well-engineered facilities that are located, designed, operated, and monitored to ensure compliance with federal regulations.

For obtaining of the criteria from several research and study, Remote sensing imagery, geological map and Abuja topographic maps was used to extract information on rock outcrop and other land use features, geology, hydro geomorphology, drainage, road network and slope of the area. The approach used in this research work was to exclude all areas where the development of a waste disposal site would not be permitted namely, proximity to residential areas, airfields, nature reserves, indigenous forests, dams or rivers. Once these areas have been identified, the remaining areas were assessed according to the geological, hydrological, topographical and environmental characteristics. From the combination of these factors favorable areas were identified. GIS helps in the development of a suitable decision support system (DSS) for siting the new landfill.

Altogether eleven criteria have been defined that are based on efficient functioning of a landfill, as well as on efficient environmental protection at specific landfill site and its surroundings. A multi criteria evaluation model has been offered and value scale for evaluation of each criterion defined. Comprehensive consideration of the problem associated with landfill site selection for physical elements of waste management system

implies the use of GIS tools, thus providing a more sophisticated process of spatial analysis and searching for better options, as well as accelerating and visually enriching the process.
A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater or surface water and ensuring efficient collection of leachate. Also, a landfill site should be kept as far as possible away from population density, for reducing pollution impact to public health. On the other hand, the landfill site should be placed as close as possible to existing roads for saving road development, transportation, and collection costs. Furthermore, the landfill site with slope either too steep or too flat is not appropriate for constructing the landfill.

Moving From Total Concentrations to Measures of Harm and Bioavailability for the Risk Assessment of Contaminated Land

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Contaminated land has and continues to impact on daily life, whether it be from historically contaminated/legacy sites from our industrial heritage or from recent deliberate or accidental releases of potentially toxic chemicals. Leaving these contaminants in the environment is now considered to be unacceptable due to their acknowledged impacts on environmental and human health. To assess and manage contaminated land, risk assessment and management strategies have developed over time, with many countries developing their own approaches. As our understanding of chemical behaviour and impact grows, contaminated land risk assessment needs to evolve to meet the needs of pragmatic management of such sites. This presentation will give an overview of the approaches used in the UK.

For over 30 years, investigations into the bioavailability of organic chemicals have been an important focus on a significant amount of research directed at understanding the behaviour of organic pollutants in soils and sediments. Despite this, there is still an apparent lack of understanding and acceptance within environmental regulatory and industrial sectors. However, regulators are now starting to consider bioavailability within risk assessment frameworks for soils and sediments contaminated with organic pollutants. By doing this, more realistic risk assessment and management is possible, rather than using total extractable pollutant concentrations. However, inclusion of bioavailability measurement within risk assessment strategies has been and remains problematic because the lack of standardised methods and statuatory guidelines has hampered the application of bioavailability into the RA and management of contaminated systems. In this presentation, the role and application of bioavailability will be considered.

A number of researchers have investigated how the formation of non-extractable residues (NERs) could be used as a remediation strategy for contaminated land, by reducing the mobility and bioavailability and thereby reducing the risk associated with the target pollutants. For example, black carbon (biochar, activated charcoal, etc) are known to strongly sorb organic chemicals, particularly those considered to be hydrophobic (e.g. PAHs, PCBS, organo-chlorine pesticides). Many studies have shown that the addition of black carbon to contaminated soil can lead to the formation of residues that are no longer/minimally extractable and considerably less bioavailable than in soils that have not received black carbon amendments. Although the formation of NERs means that the pollutants themselves may not be removed from the soil, by actively reducing mobility and bioavailability of the chemicals, the hazards posed by the contamination may be reduced such that the risks to humans, ecological receptors or waters are either removed completely or considered acceptable. However, what is less well known is how permanent NERs are in the environment and what the likelihood of remobilization of the target chemicals may be in the future. This presentation will also consider the importance of NERs within risk assessment and management of contaminated land.

Ultimately, this presentation will propose a framework in which the inclusion of bioavailability measurement(s) may be adopted. This new proposal will provide an opportunity for the inclusion of more detailed interrogative assessment procedure in which bioavailability plays a role, potentially leading to a more pragmatic and realisticrisk assessment. The proposed system is simple and is limited to measuring the totally extractable pollutant, as well as the bioavailable concentration. Under normal circumstances, NERs would not be considered within this proposed RA framework because the risk comes from the extractable fractions in the soils and sediments. Measurement of bioavailability would mean the application of validated and preferably standardised chemical and biological methods and the authors believe that the knowledge already provided by science supports this simplification.

Microbiological and Physicochemical Analyses of Soil Samples Adjoining a Major Landfill in Uyo, Akwa Ibom State, Nigeria

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ABSTRACT

Introduction: Most developing countries are faced with noteworthy environmental and waste management problems. Ayalon *et al.* (2000) reported that landfills (open dumps) have been the most organized and cost effective methods of solid waste disposal and remains so worldwide. The World Watch Institute (2012) prediction reveals that current global municipal solid waste generation levels (approximately 1.3 billion tonnes/day) are expected to increase to approximately 2.2 billion tonnes/year by 2025; reflecting a rapid deterioration in sanitation and air quality levels in metropolitan cities. Unsanitary landfill presents a threat to soil health as surface run-off carrying dissolved chemical compounds, diverse microbiota and leachate leakages can contaminate surface/ground water (Kalwasinska *et al*., 2012). Therefore acquiring an in-depth knowledge of the influence of landfill sites on the environment, human and soil health requires a comprehensive long-term monitoring the microbial quality indices and physicochemical properties of the soils, hence the need for this study.

Materials and Methods**:** This study was carried out around the biggest landfill within Uyo metropolis (latitude 5°2'N of the equator and longitude 7°55' E of Greenwich meridian). The landfill particularly receives household, municipal and industrial wastes. Composite soil (0-20cm depth) samples were collected from four (4) transect sampling points marked horizontally eastward (0, 10, 100 and 1000m) away from the landfill. The samples were analyzed using standard microbiological (culture-dependent) and physicochemical techniques. Statistical analysis of data was performed using SPSS statistics 21 software and tested using two-way ANOVA.

Results and Discussion: A typical landfill waste stream comprises approximately 70% compostable materials, contributing to increased bacterial populates as reflected at sampling point I (Figure 1). The species of *Proteus, Streptococcus, Bacillus, Micrococcus, Pseudomonas*, *Staphylococcus*, *Citrobacter*, *Escherichia*, *Salmonella* and *Shigella* observed in this study agrees with earlier findings by Egbere *et al.* (2001); Obire *et al.* (2002) and Grisey *et al.* (2010) that these isolates are major indigenous microbial genera associated with waste materials and/or degradation.

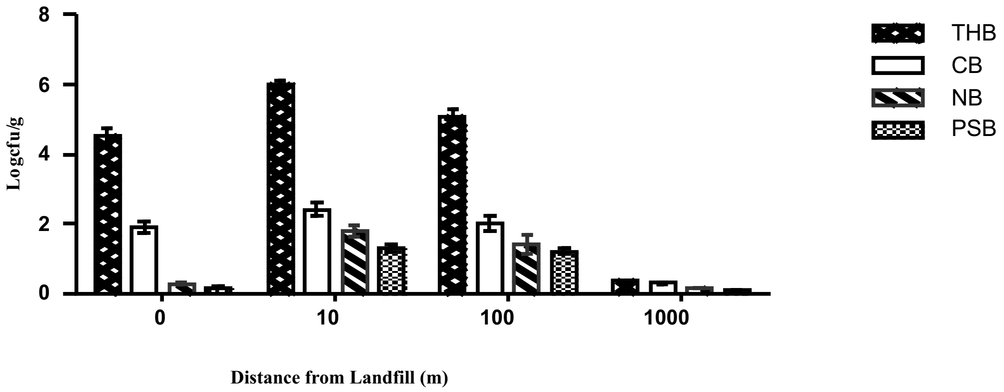

Fig. 1: Diverse Bacterial Groups from different sampling points

TABLE 1: Physicochemical Analysis of Adjoining Soil .

Physicochemical Parameters	Sampling Points			
	I	II	III	IV
pH	5.90±0.10	6.30±0.06	7.20±0.06	7.50±0.12
Temperature (°C)	28.60±0.12	28.30±0.06	27.80±0.06	27.50±0.10
Organic Carbon (%)	15.05±0.03	13.65±0.02	10.72±0.03	7.22±0.02
Total Nitrogen (%)	14.72±0.03	12.88±0.03	9.43±0.03	7.66±0.02
Zinc (mg/kg)	2.11±0.02	1.47±0.02	1.36±0.02	1.13±0.01
Calcium (mg/kg)	2.03±0.02	1.57±0.01	1.35±0.10	1.08±0.01
Potassium (mg/kg)	0.49±0.05	0.38±0.02	0.31±0.01	0.26±0.02
Sodium (mg/kg)	0.14±0.02	0.12±0.02	0.08±0.01	0.07±0.01
Lead (mg/kg)	3.29±0.02	2.53±0.01	1.76±0.01	1.07±0.02
Magnesium (mg/kg)	47.93±0.02	28.93±0.03	18.22±0.02	11.13±0.02

Key: I, II, III and IV are sampling points. Results are mean values of duplicate readings with standard deviation. The presence of coliforms and other enteropathogens suggest that the landfill also received large amounts of faecal wastes. These organisms are implicated in food borne infections such as typhoid, diarrhoea and gastroenteritis (Egbere *et al.,* 2001). The population of the different bacterial groups was significantly different at sampling point II. However, the population of Nitrifying bacteria (NB) and Phosphate solubilizing bacteria (PSB) at sampling points II and III were not statistically different at $p<0.05$.

The observed temperature range (27.5±0.10 to 28.6±0.12 °C) agrees with Karin (2002) who reported that mesophiles are responsible for most metabolic activities and predominate initial compost development. Organic carbon, acidity, temperature, nutrient and heavy metal concentrations reduced progressively with distance from landfill (Table 1), conferring relative influence on soil bacterial population and distribution.

Conclusion: Although frequent monitoring is required, the presence of indicator organisms and enteropathogens reveal the poor health status of adjoining landfill soils.

This could pose serious health risks to the inhabitants of neighbouring settlements. To prevent land contamination, effective landfill management and its operation are recommended in order to achieve and/or maintain a standard/sanitary environmental health status.

Keywords: landfill wastes, soil health, bacterial proliferation, physicochemical analyses and adjoining soil.

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POLLUTION INDICES OF TRACE METALS IN SOME URBAN DUMPSITE SOILS WITHIN AKWA IBOM STATE, NIGERIA

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ABSTRACT
Surface soil samples were obtained from six (6) urban dumpsite soils namely: Uyo, Abak, Eket, Onna, Ikono and Ikot Ekpene within Akwa Ibom State, Nigeria. Control samples were also collected from a forest in Etinan local government area of the same State. Samples collected were treated and analyzed based on standard techniques to ascertain the pollution status of Pb; Cd; Ni; Cr and Fe at each dumpsite and Control using geo-accumulation index (Igeo) and Contamination factor (CF) analyses. The source of metals to dumpsite soils and Control was identified using enrichment factor (EF) model. Pollution status of each dumpsite soil was also established using degree of contamination (Cdeg). Igeo results showed that, Pb; Ni; and Cr moderately polluted dumpsite soils studied, Cd varied between unpolluted to moderately polluted status. However, Fe indicated very low Igeo values indicating the low availability of the metal in the study area. Enrichment factor analysis showed that Pb and Cr were primarily from anthropogenic source; Ni and Fe were mostly from natural source while Cd source varied between anthropogenic and natural at the different dumpsite soils but, the source of all the metals at Control site was predominantly natural. Contamination factor analysis revealed that Cd, Ni, Cr and Fe moderately contaminated dumpsite soils evaluated while Pb showed a considerable level of soil contamination. Cdeg indicated that Uyo dumpsite soil recorded the highest degree of soil contamination while Ikot Ekpene dumpsite was the least polluted location. Cd indicated highest mobility potential in both dumpsite soil and Control whereas, Cr was the least mobile element. Speciation results indicated that, Pb existed mostly in reducible form, Cd in acid extractable form while Ni, Cr and Fe occurred mainly in the residual fraction.

A GIS Framework for Oil Spill Risk Monitoring in the Coastal Areas of Akwa Ibom State

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Abstract

The lethal nature of petroleum in the environment has long been established. However oil spill as long as petroleum resources are being explored and exploited, there is always the likelihood of spills. The people and areas most meeting the challenges of oil spill management in an information age: the case of the Niger Delta. Affected are the host communities and the environment as the greatest possibility of oil spill often occur here the exploitation and exploration of the crude is being carried out from the ongoing, it can be seen that predicting, planning for and containing oil spills are highly essential due to the potential damages that result. The Niger Delta region of Nigeria where country's oil and gas deposits are found is by nature a difficult environment to clean up of contamination. The highly productive life of all kinds of directing here is intermingled with various networks of oil exploration, production and distribution facilities hence more and very vulnerable to damages by any oil spillage. Oil spill records show that a lot of petroleum products spilled is lost to the environment thereby bringing negative consequences as some are never recovered.

From the foregoing, it can be seen that planning for and containing oil spills is highly essential as to reduce the economic, ecological and even social consequence that follow. This paper examines the application of Geographical Information System (GIS) in the monitoring of oil spill risk in the coatal areas of Akwa Ibom state. GIS is a fast developing technology for integrating massive data sets through unique characteristics of handling and processing spatial (geographical) data. It facilitates the capturing; processing, manipulating, storing, retrieving, analyzing and displaying spatial and tabular (attribute) real world data. The paper examines the application of GIS in oil spill risk monitoring. The various datasets needed for the database are identified and application strategies like environmental sensitivity index mapping, hazard, vulnerability and risk modeling are demonstrated.

Solid Waste Management and Land Contamination

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Abstract

Of the many common threads that bind cities across the world, waste handling, is possibly one of the strongest. Regardless of the context, waste, directly and indirectly, is one of biggest challenges of the urban world. It's also a city's calling card. If a city is dirty, the local administration is written off as ineffective. If not, governance is presumed in the public eye to be effective. Open burning of solid wastes emit air pollutants. These pollutants include Carbon Monoxide (CO), Hydrocarbons (HC), Particulate Matter (PM), Nitrogen Oxides (NOx) and Sulfur Dioxide (SO_2). Since open burning happens at ground level, the resultant emissions enter the lower level breathing zone of the atmosphere, increasing direct exposure to humans. Thus, open burning should be discouraged. Rapid and uncontrolled urbanization, lack of public awareness, and poor management by municipalities have intensified environmental problems in towns in Akwa Ibom State, including unsanitary waste management and disposal. While solid waste management (SWM) has become a major concern for municipalities and the country as a whole, the status of SWM is not fully understood due to the lack of SWM baseline data, which are also essential for effective planning. In developing countries there is a need to promptly identify which sites need remediation, and prioritize them, so that adverse effects can be minimized and sites can be returned to their intended use as quickly as possible. Through initiatives such as the Obsolete Pesticides Programme and the Toxic Sites Identification Program, developing countries are gradually compiling inventories of potentially contaminated sites. Although their progress in remediating sites has so far been modest, it is likely to gain strength in the future as specific policies and regulations are introduced. As the rate of site identification and assessment increases, developing countries will need to have clear and comprehensive national laws or policies in place to guide decision-makers and other stakeholders in remediation efforts.

Modelling Crude Oil Degradation by *Pseudomonas* $Eshc_2$ Isolated From Sediments of Eniong River Itu, Nigeria

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Abstract

Introduction: Exposure of microbial habitats to pollutants have been known to cause substantial inhibition on certain members of microbiocoenosis, while increasing the relative abundance of those able to utilize the substance for growth and multiplication (Peresutti *et al.,* 2003). Assemblages from such contaminated ecosystem can adapt to the presence of pollutant producing shifts in the physiologic and generic diversity of the community (Macnaughton *et al.*, 1999; Hollaway *et al,* 1980). Margesin and Schinner (2001), have demonstrated that the density of hydrocarbon utilizers from a natural ecotope can be increased by improving their natural capacity to degrade contaminants. These capabilities are currently being exploited in enrichment procedures for naturally selecting populations that could attack and detoxify environmental pollutants in bioremediation strategies. Though there are no information currently available globally on hydrocarbon biodegradation by bacteria from sediments of humic freshwater, this study evaluates the degradation of crude oil by an isolate from this uniquely stressed habitat. Knowledge of the ecological functions of this strain may be adapted for strategies concerning technologies for restoring contaminated sites

Materials and Methods: Oil degrading bacteria were isolated from Eniong River (located between latitude 05° 12' 54'' - 007° 58' 48.6'' and longitude 05° 22' 56''-007° 54' 59.1'') using the enrichment culture technique of Okpokwasili and Okorie (1988). The isolates were screened for crude oil degradability and isolate with the strongest degradability was characterized and identified as *Pseudomonas* $EHSC_2$. Time-course degradation was performed and the crude oil degradability of bacterium determined by means of gas chromatography (GC) and detected by flame ionization. Rate of biodegradation was modeled based on the assumption that the amount of pollutant remaining at any particular time t during the degradation process is governed by a first-order function i.e. reaction proceeding at a rate directly proportional to the concentration. The model equation developed therefore was:

<u>dBiodegrade</u> = - k Biod(initial)dt

Where; Biodegrade= amount degraded
biod(initial)=initial concentration
t= time in days
k = first-order reaction rate constant

Results and discussion: The GC profiles of the saturate fractions belonging to the original crude oil (control) and the persistent residue after bioremediation with *Psuedomonas* ESHC$_2$ are presented in Figures 1-2. Peaks on the chromatogram correspond to the different fractions while the height determined components concentrations. The results revealed that more volatile, semi volatile and low molecular weight fractions were diminuted earlier on before analysis probably by evaporative and photo-oxidative processes. Lighter components including c_2-c_9 were not detected even in control sample, however heavier fractions from c_{10}-c_{29} were effectively eluted and detected in both control and test samples. Table 2 shows the measured/ modeled crude oil concentrations after exposure to *Pseudomonas* EHSC$_2$ for 21 days. It is obvious that *Pseudomonas* EHSC2 has high propensity to biodegrade crude oil. The bacterium exhibited > 90% degradation for all the fractions except c19 for which the percentage was lower at 89.9 and could reduce crude oil content from 371.8920mgl to 29.8737mgl after 504hrs of incubation.

Using the empirical data a model was developed to predict biodegradation rate. The model was derived from the relationship y = a-kt and formulated as $\underline{dBiodegrade}$ = -k Biod(initial)dt where: Biodegrade= amount degraded, biod(initial)=initial concentration, t= time in days and k = first-order reaction rate constant. Using the model it was established that at 21days of exposure both the measured (experimental) and calculated (model) concentrations of 334.7993mgl^{-1} and 332.5525mgl^{-1} respectively approached each other. Analysis of the regression data showed a Pearson correlation r= 0.99753 and coefficient of determination r^2= 0.995, which is prone to unity. This means that the model have a predictive value of about 99%. It implies that the empirical model developed is consistent and may be useful in predicting the amount of crude oil that was degraded by *Psuedomonas* EHSC-2 under the experiment conditions.

Conclusion: The significance is its potential for monitoring the rate of natural attenuation in a remediation course.

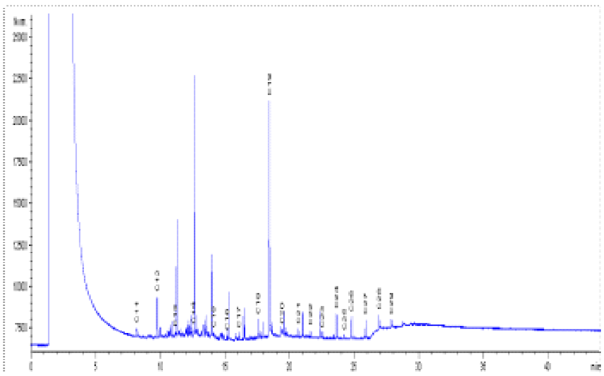

Fig. I: Chromatogram of residual crude oil after 21 days exposure to *Pseudomonas* EHSC 2

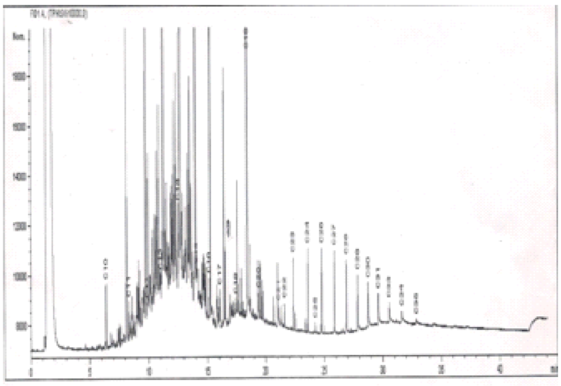

Fig 2. Chromatogram of un-inoculated crude oil (Control) after 21 days exposure

Table 1: Concentration of crude oil fraction in control and test sample after 21 days degradation by Pseudomonas EHSC2[mg/l]

organism ID	TPH Compound	control sample	test sample	amount degraded	% degradation
Pseudomonas EHSC2	C10	12.1486	0.00	12.1486	100
	C11	10.2658	0.0099	10.2559	99
	C12	42.5682	0.4215	42.1467	99
	C13	12.4587	0.6325	11.8262	94
	C14	51.2487	3.6521	47.5966	92.87
	C15	21.5641	0.6542	20.9099	96.9
	C16	21.2543	0.2044	21.0499	99
	C17	18.2652	0.0335	18.2317	99.8
	C18	14.2145	0.0049	14.2096	99.9
	C19	30.5648	3.1598	27.4042	89.6
	C20	11.2654	0.2154	11.0500	98
	C21	8.2415	0.0141	8.2274	99
	C22	1.2104	0.0102	1.2002	99
	C23	10.2248	0.1113	10.1135	98
	C24	15.4412	0.1324	15.3088	99
	C25	10.2241	0.0023	10.2218	99
	C26	17.5642	0.2567	17.3075	98
	C27	13.5487	0.2154	13.3333	98
	C28	10.2451	0.1457	10.1000	98
	C29	8.9654	0.0127	8.9527	99
	C30	2.6635	2.6635		00
	C31	1.5621	1.5621		00
	C32	5.6852	5.6852		00
	C33	0.4105	0.4105		00
	C34	0.1025	0.1025		00
TOTAL		371.8920	29.8737	342.0183	

Table 2: Calculated and modeled biodegradation of crude oil fractions after 21 days exposure to *Pseudomonas* EHSC2

Component	Measured Value mgl^{-1}	Calculated degradation value mgl^{-1}	Modeled value mgl^{-1}
C10	12.1486	12.1486	11.4804
C11	10.2658	10.2633	9.7011
C12	42.5682	42.5644	40.2269
C13	12.4587	12.4573	11.7734
C14	51.2487	50.2342	48.43
C15	21.5641	20.5596	20.3780
C16	21.2543	20.2265	20.0853
C17	18.2652	17.4196	17.26006
C18	14.2145	13.5618	13.4327
C19	30.5648	26.4490	28.8837
C20	11.2654	10.2507	13.4327
C21	8.2415	7.9858	28.8837
C22	1.2104	1.1232	10.6458
C23	10.2246	9.1773	7.7882
C24	15.4412	14.3368	1.1443
C25	10.2241	10.1673	9.6624
C26	17.5642	16.4497	14.5919
C27	13.5487	12.3591	9.6617
C28	10.2451	9.2227	16.5981
C29	8.9654	8.000	12.8035
C30	2.6635	2.3310	9.6816
C31	1.5621	1.4496	8.4723
C32	5.6852	5.6852	2.5170
C33	0.4105	0.4105	1.4761
C34	0.1025	0.1025	5.3725
Total	**351.9075**	**334.7993**	**332.5521**

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Micrococcus luteus: A Potent Biosurfactant Source for Enhanced Remediation of Crude Oil Polluted Soil

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ABSTRACT

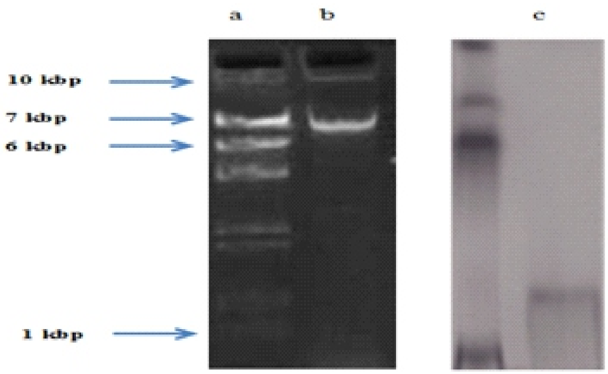
Introduction: Petroleum contains non-aromatic, mono-aromatic and extensive suite of polycyclic aromatic hydrocarbon (PAHs) which can be toxic to Organisms (Essien *et al.*, 2012) and pose significant hazard to human health and the earth's ecology (Urum *et al.*, 2005). These concerns have led to the development of various remediation technologies including bioremediation- which mainly depends on microorganisms to degrade, transform, detoxify or breakdown the contaminants. Despite the advantages of bioremediation, its efficiency is limited majorly by the limited availability of crude oil components (especially PAHs) to microbes. This is attributed to its low solubility and strong and/or irreversible sorption to soil (Rockne *et al.*, 2002, Essien *et al.*, 2015). To solve this problem, several methods have been developed to enhance the bioavailability of PAHs and these include the use of surfactants (biological of synthetic).The advantages of biological surfactant over their chemical counterparts in terms of being environmentally friendly, biodegradable, less toxic, non-hazardous with better foaming properties and higher selectivity as well as remaining active at extreme temperatures, pH and salinity (Urum *et al.*, 2005) have enhanced its use in the field of bioremediation This study is aimed at scavenging for indigenous bacteria as sources of biosurfactants to increase solubility and apparently enhance the biodegradation of crude oil and its components.

Materials and Methods: Sediments samples collected from a humic freshwater ecosystem were screened for the presence of biosurfactant producing bacterial species using the Haemolytic, Emulsification index, Oil spread and Drop collapse tests (Youssef *et al.*, 2004). Isolate with the best biosurfactant producing potential was subjected to plasmid profiling to determine if the potential is plasmid mediated as well as used to enhance the degradation of crude oil by *Bacillus subtilis* [obtained from our previous study; (Abraham and Essien, 2016)].After 21 days of incubation, the rate of degradation was then determined using Gas chromatography coupled with Flame ionization Detector (GC-FID).

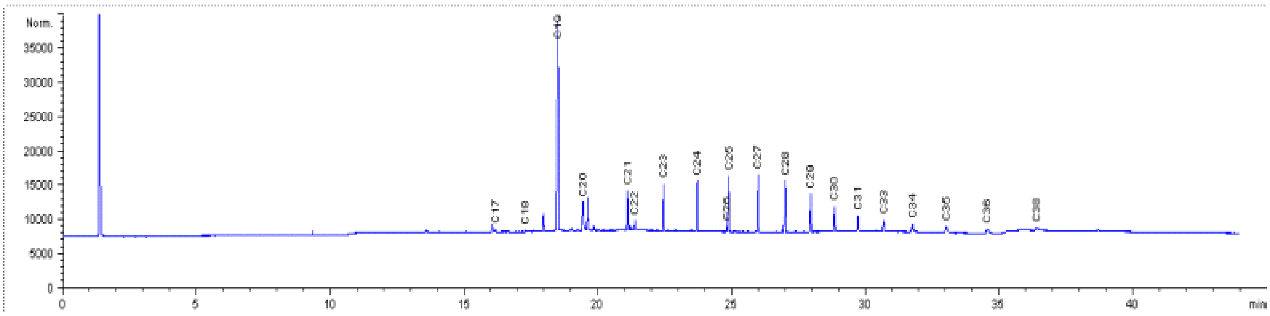
Results and Discussion: Of all the bacterial isolates obtained from the sample, three (3) had the potential to produce biosurfactant with *Micrococcus luteus* being the best producer. The degradation study revealed that, *M. luteus* was able to enhance the crude oil degrading capacity of *B. subtilis.* Crude oil degradation my monoculture of *Bacillus subtilis*

resulted in 19.65% degradation by reducing the Total Petroleum Hydrocarbon (TPH) content of crude oil from 20.3467 to 16.3082 mg/l within 21 days while the consortium (*M. luteus* and *B. subtilis*) enhanced degradation by 46.06% within the same duration by reducing the TPH to 10.9755 mg/l.

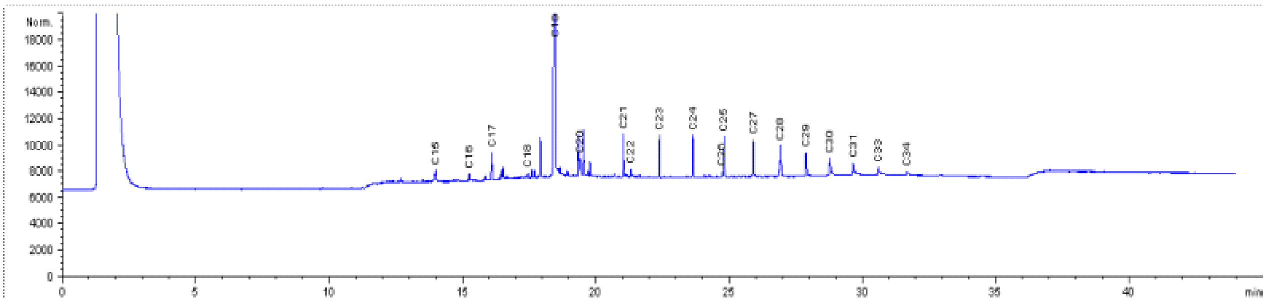
Emulsification Capacity of the Isolates



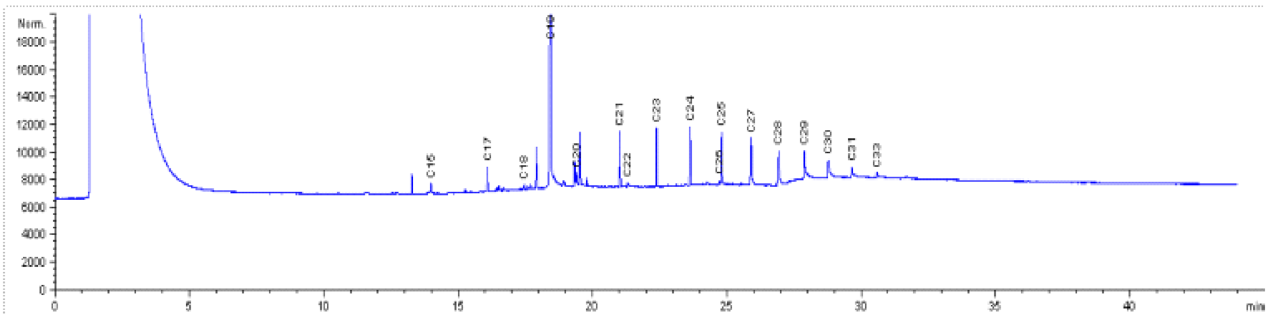
Uncured and cured plasmid DNA bands of *M. luteus*



Chromatogram of TPH of Crude oil before degradation



Chromatogram of TPH of Crude oil after degradation with *B. subtilis*



Chromatogram of TPH of Crude oil after degradation with consortium of *B. subtilis* and *M. luteus*

The plasmid of *M. luteus* was extracted cured and re screened for its biosurfactant producing potentials. The result showed that the isolate lost its potential when it lost its 6.5kbp plasmid.

Conclusion: The results of this study has shown that *Micrococcus luteus* isolated from a humic freshwater ecosystem has a strong plasmid mediated biosurfactant producing potential that can be explored and genetically manipulated for the production seeds for enhanced remediation processes.

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Bacterization of Biostimulants and Its Diauxic Effects on Hydrocarbons Degradation and Remediation of Crude Oil Contaminated Garden Soil

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ABSTRACT

Introduction: The deleterious and degrading effects of pollution on the environment have led to increased awareness of its effects on the environment. Organic pollutants are presumed to undergo degradation as result of the metabolic activities of the microbial communities in the environment (Okpokwasili and Olisa, 1991) though some man-made compounds are relatively refractory to degradation creating special problems for environmental protection. The resulting accumulation of intermediate metabolites can be toxic and/ or refractory to further metabolism and have fueled the request for financial compensation to losses and damaged lands in the Niger Delta. These concerns have led to the development of various remediation technologies including bioremediation – which mainly depends on microorganisms to degrade, transform, detoxify or breakdown the contaminant. Recent studies have shown that hydrocarbons degrading microorganisms are widely distributed in contaminated ecosystems (Jain *et. al.,* 2011) and may adapt to interact with heterogeneous materials which serve as primary environmental sorbent for PAHs and hydrophobic hydrocarbons in ways that facilitate these pollutants and their subsequent metabolism (Steinberg *et al*., 2008). Most studies carried out on bioremediation of soils impacted in the Niger Delta of Nigeria are majorly on enhanced remediation using biostimulation and bioaugmentation protocols. A combination of both protocols (Biostimulation - Bioaugmentation [BB] protocol) has not been attempted. This study is focused on the bacterization of biostimulants and it diauxic influence on the degradation of hydrocarbons in garden soil.

Materials and Methods: The effect various concentrations of simple carbon and energy sources (glucose and sucrose) on the crude oil degradability of hydrocarbons degrading strain bacterium, *B. subtilis* -HSC 1 isolated from a humic freshwater ecosystem was assayed *in vitro* and the rate of degradation after 15 days of exposure determined using Gas chromatography coupled with Flame ionization Detector (GC-FID). Thereafter viable cells (2.9 x 104 cfu/ml) of the oil degrading bacterium to used augment the bio-stimulating potential of complex biostimulants (spent grains and maize chaff) in field study on the remediation of crude oil contaminated garden soil.

Results and Discussion: The results have revealed that the carbon sources had a stimulating influence on the process. The assay on the influence of glucose and sucrose as carbon and energy source for a known degrader *B. subtilis* - HSC 1 showed that degradation of crude oil and its component by *B. subtilis* - HSC 1 was faster when stimulated with sugars than when un-stimulated (Table 1). The best degradations were obtained with 5% levels of the stimulants when TPH content was reduced from 15.81 mg/kg to 10.19 mg/kg and 8.88 mg/kg in substrates stimulated with glucose and sucrose respectively within 15 days. However results obtained when microbially *(B. subtilis* HSC-1) -augmented bio-stimulants in a Bacterization-Biostimulation (BB) protocol were used for the remediation of process revealed that degradation of crude oil and it components was faster. Viable cells measurement showed that the higher the biostimulants/contaminant (BC) ratio employed the more the heterotrophic activities but less hydrocarbonoclastic activity. For soils remedied for 8 weeks with bacterized - spent grains (Tables 2 & 3), the degradation rates were remarkably high and near 100% as against 44.02 % recorded for the control (treatment with spent grains alone). This shows that biostimulation was better with "cropped" oil degrading bacterium. Similar trend was observed for bacterized-maize chaff stimulated-remediation, although the rates were lower. The least degradation rate was rate was recorded for un-bacterized maize chaff (28.95 %). Figure 1 shows that the best degradation (99.09 %) was achieved when 1% of brewer's spent grain was applied (2.08 %) at a BC ratio of 0.48: 1 when oil degraders growth rate and generation time were 0.00077 and 898.83 h^{-1} in 8 weeks respectively. For maize chaff the best degradation rate (98.28 %) was attained when 10 % was applied at a BC ratio of 3.34: 1 when oil degraders growth rate and decimal death rate were -0.0018 and -1256.07 h^{-1} in 8 weeks respectively. Beyond these ratios the treatments created diauxic influence, retarding the growth and activities hydrocarbonoclastic bacteria while heterotrophic bacteria proliferate.

Table 1: Level of petroleum hydrocarbons degradation by *Bacillus subtilis* (test isolate) stimulated by sugars

Parameter	Amounts (mg/l)						
	1% Glucose	5% Glucose	20% Glucose	1% Sucrose	5% Sucrose	Control 1	Control 2
C8							
C9							
C10							
C11	0.0241	0.0099					0.4280
C12	0.5211	0.4215		0.0145			0.4288
C13	0.9542	0.6325	0.0214	0.2145			0.5688
C14	4.0211	3.6521	0.1563	1.1024			3.1225

C15	0.9113	0.6542	0.1178	0.3652	0.2116	0.2256	1.1262
C16	0.2155	0.2044	0.1524	0.2127	0.1524	-	1.1265
C17	0.0584	0.0335	0.2058	0.0652	0.5422	0.4102	0.0568
C18	0.0045	0.0049	0.0101	0.0049	0.0063	-	1.4522
C19	3.1023	3.1598	4.0248	3.8342	3.9210	4.1122	1.9856
C20	0.6524	0.2154	1.0528	0.5228	0.6523	1.2154	0.2587
C21	0.1225	0.0141	0.3122	0.5113	0.6104	1.0217	2.0145
C22	0.0085	0.0102	0.2038	-	-	-	1.0258
C23	0.0547	0.1113	1.1048	0.4002	0.5112	0.9687	1.0699
C24	0.0365	0.1324	1.0455	0.3241	0.5009	1.0698	0.9856
C25	0.0035	0.0023	0.0254	-	-	-	0.6225
C26	0.0085	0.2567	0.5122	0.1114	0.4125	0.9614	0.521
C27	0.0101	0.2154	0.6918	0.1982	0.4217	0.9254	0.4552
C28	0.0112	0.1457	0.5922	0.1421	0.3937	0.6280	0.5114
C29	0.0036	0.0127	0.3627	0.0089	0.2046	0.5002	0.412
C30	-	-	0.1956		0.1253	0.4227	0.3245
C31	0.0015	-	0.0965		0.1025	0.2014	0.8489
C32	-	-			-	-	0.1524
C33	-	-			0.0985	0.1538	0.8489
Total	10.7219(47.30)	10.190(49.92)	10.8841(46.51)	8.0326(60.52)	8.8671 (56.41)	15.8165(22.27)	20.3467(100)

Key: (Percentage degradation)

Table 2 The rate of degradation obtained from the various bioremediation treatments using spent grains

A	B	C	D	E	F	G	% Deg.
4 kg BB	83.2 g (20.8 g/kg)	2.08 %	40g (1 %)	0.480	188.54	20611.46	99.09
4 kg BB	91.52 g (22.88 g/kg)	2.28 %	200g(5 %)	2.185	567.98	22312.02	97.51
4 kg BB	104 g (26 g/kg)	2.6 %	400g(10%)	3.346	745.12	25254.88	97.13
4 kg BB	124.8 g (31.2 g/kg)	3.12 %	600g (15 %)	4.807	4999.03	26,200.97	83.97
4 kg BB	166.4 g (41.6 g/kg)	4.16 %	800 g (20 %)	4.807	4913.92	36687	88.18
4kg Con. 2 Bio.	83.2 g (20.8 g/kg)	2.08 %	40 g (1 %)	0.480	11643.66	9156.34	44.02

Table 3 The rate of degradation obtained from the various remediation treatments using Maize chaff

A	B	C	D	E	F	G	% Deg.
4 kg BB	83.2 g (20.8 g/kg)	2.08 %	40g (1 %)	0.480	2149.49	18650.51	89.66
4 kg BB	91.52 g (22.88 g/kg)	2.28 %	200g(5 %)	2.185	819.39	22060.61	96.42
4 kg BB	104 g (26 g/kg)	2.6 %	400g(10%)	3.346	445.51	25554.49	98.28
4 kg BB	124.8 g (31.2 g/kg)	3.12 %	600g (15 %)	4.807	1535.66	29664.34	95.07
4 kg BB	166.4 g (41.6 g/kg)	4.16 %	800 g (20 %)	4.807	3673.34	37926.66	91.16
4kg Con. 2 Bio.	83.2 g (20.8 g/kg)	2.08 %	40 g (1 %)	0.480	14776.33	6023.67	28.95

A = Quantity of soil treated (kg); B = Amount of oil added (g); C = Level of Contamination (%); D = Amount of spent grains a dded (g); E = Bio-stimulant/Crude Oil Ration; F = Residual Load of TPH in remedied soil (mg/kg)
G = Rate of biodegradation

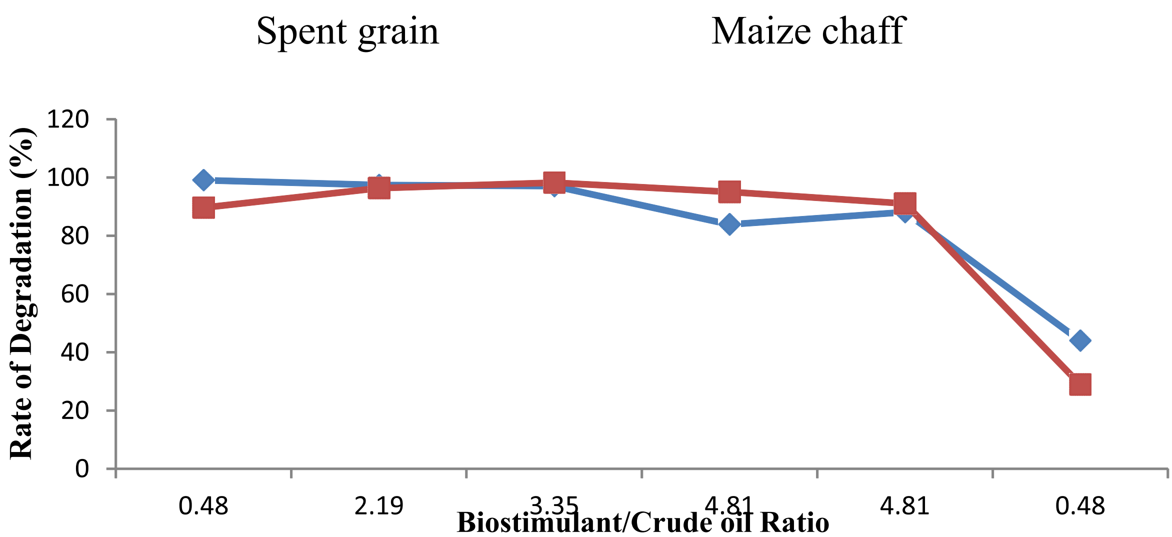

Figure 1: Influence of biostimulant/crude oil ratio on the rate of hydrocarbons degradation in garden soils

Conclusion: Enhanced remediation with brewer's spent grains using BB protocol is strongly recommended but will sustainable if the organic amendment stabilized with a fibre-rich carrier.

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Complexities of Assessing Sources of Microbial Contamination in Foods for South East Asia

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ABSTRACT

Foodborne illness is a burden to public health worldwide and may be an especially difficult issue for developing countries. The role of poor surface water quality and its impact on contamination of agriculture and aquaculture products has been studied. However the interaction of environmental contaminants with foods is complex. Further, methods of processing, packaging, and distribution of food can also significantly contribute to the spread of foodborne pathogens. This talk will highlight past efforts to assess fecal contamination in urban and rural surface waters for various South East Asian countries. Further, it will also discuss the relative incidence rates of fecal indicator organisms and other bacterial foodborne pathogens in agriculture and aquaculture products through the reporting of survey studies. Potential sources of contamination will also be highlighted regarding the quality of water at sources of food production with those at local markets. Lastly while the Millennium Development goals has a major focus of improving drinking water in developing countries, the additional impacts due to contamination of agriculture products may also under assess potential disease burdens for these populations.

Bioaccumulation and cancer risk of polycyclic aromatic hydrocarbons in leafy vegetables grown in soils within automobile repair complex and environ in Uyo, Nigeria

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Abstract

Using gas chromatography-mass spectrometry and incremental lifetime cancer risks (ILCRs) assessment model, the bio-accumulation and cancer risk of sixteen USEPA priority polycyclic aromatic hydrocarbons (PAHs) in leafy vegetables (*Vernonia amygdalina* and *Lasianthera africanum*) grown in soils within automobile repair complex environ in Uyo, Nigeria was studied. The total PAHs concentrations recorded for soils ranged from 0.02mg/kg to 1.77 mg/kg. The highest level of 1.77 mg/kg was recorded for soils from the main automobile repair complex (Site 1). Low molecular weight (LMW) PAHs were predominant although some high molecular weight (HMW) PAHs suites (0.04 mg/kg of chrysene and 0.04 of benzo[k]fluoranthene) were also found in Site 1. The leafy vegetables accumulated PAHs mostly the lower molecular weight (LMW) PAHs. The accumulation levels are similar but the extent of uptake of PAHs in vegetables was species dependent as *V. amygdalina* accumulated more (0.81 mg/kg) PAHs. The bioaccumulation factors (BaFs) calculated range from 0.22 to 0.63 for *L. africanum* and 0.18 to 0.55 for *V. amygdalina* in Site 1 where high PAHs level was recorded in soil. Pearson correlation coefficient analysis reveals a strong positive relation between the PAHs content of soil and the amount accumulated by *L. africanum* ($r = 0.5$) and *V. amygdalina* ($r = 0.8$) at $p = 0.05$. The vegetables potential to bio-accumulate PAHs is indicative of their use as good bio-indicators for PAHs contamination in soil. Only two of the USEPA possible human carcinogenic PAHs were detected and carcinogenic risk assessment based on occupational exposures to soil particles by adults reveals that the total risk level (7.17×10^{-5}) contribution from incidental soil ingestion, dermal contact and soil particle dust inhalation slightly exceed the USEPA acceptable limits ($< 1.00 \times 10^{-5}$). There is need for public education on consumption of vegetables grown in and around automobile repair complexes across Nigeria.

Estimation and Health Risk Assessment of Trace Metals in Imported Vegetables

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ABSTRACT

Vegetables are among the most commonly consumed food item in the human diet because of their nutritional value. Contamination by trace elements may prove hazardous, and is a major chain route for human exposure. Study to determine the levels of elements in imported vegetables consumed by the inhabitants of Uyo in Akwa Ibom State, was carried out using neutron activation analysis; and consumption risks (non-carcinogenic and carcinogenic) of the elements using risk models for adults and children also assessed. Information obtained from the questionnaire revealed spinach to be the most commonly consumed vegetable in the studied population. The elemental results indicated that Al, Fe, Ca, Na, Cl, Mg, As and K have the highest concentrations, followed by Mn, Zn, Sr, Br, Rb and Ba. Vanadium, Cu, Cr, Co, Sc, Eu, La, Th, Sm and Yb were in traces amount. Iron in celery, parsley, and broccoli in the months of September, October, and November, and Fe in broccoli (October) exceeded WHO/FAO and Standard Organization of Nigeria (S.O.N.) maximum permissible limits in food. Zinc in broccoli, celery, and parsley throughout the period of study exceeded WHO/FAO, and S.O.N, permissible limits in food. Arsenic in spinach (November) exceeded S.O.N maximum permissible limit but below the limit in parsley. Chromium in parsley (September) was above Chinese allowable limit while Mn and Co were below. Health risks associated with imported vegetable consumption were estimated using non-carcinogenic and carcinogenic health effects. Ingestion of vegetables was the only pathway of exposure used in the study. The non-carcinogenic chronic daily intake of elements through consumption of imported parsley and broccoli for adults was higher than for children while intake through consumption of celery, spinach and eggplant for children was greater than for adults. The non-carcinogenic hazard quotient of elements through imported vegetable consumption was less than one for both adults and children. The hazard index was also less than one for both adults and children consuming the vegetables. The computed cancer risk value for As in spinach was $1.91E^{-04}$ for children and $1.42E^{-04}$ for adults, and exceeded the acceptable risk value of 10^{-6}. The bio-available forms of As in imported spinach and other vegetables need further investigation to safeguard the health and inform the consumers appropriately.

Inhibitory efficacy of some agrochemicals on mycelial growth of *Phytophthora cinnamomi* isolated from heart-rot disease of pineapple (*Ananas cosmosus* (L.) Merr.)

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Abstract
Some agrochemicals have been tested and found effective in plant disease control to improve food security. Growth inhibitory efficacy of four agrochemicals against *Phytophthora cinnamomi* isolated from heart-rot disease of pineapple (*Ananas comosus*) in naturally infested farm at Site I of Delta State University, Abraka was evaluated using poisoned food technique. The fungicides (fungu-force, mancozeb, maneb and mackecknie gold) at the concentrations of 25 -5000 ppm were evaluated *in-vitro* for their effect on the colony diameter of *P. cinnamomi* in pre-amended PDA medium. The fungicides showed response in inhibiting the growth with a dose dependent effect except for the fungu-force which totally inhibited the fungus at all concentrations tested. Complete inhibition was recorded for Fungu-force at 25ppm, Mancozeb at 1000ppm, Mackecknie gold at 4000ppm and Maneb at 5000ppm. The result of this study can be utilised to develop suitable application regime of these fungicides for trials on farmer's field in the control of heart-rot disease of pineapple and other crop diseases incited by this pathogen thereby improving food security.
Keywords: Growth inhibition, *Phytophthora cinnamomi*, heart-rot disease, pineapple, agrochemicals, food security

Introduction

The attempt by man to improve crop yield in order to produce enough food for consumption by the increasing population is a decision in right direction. The most important problems encountered in this attempt are how to drastically reduce or wholly prevent plant disease which is a continual battle.

Chemical application is a highly effective technique to manage plant disease in agriculture (Adeniji and Olufolaji, 2014). Some agrochemicals have been tested and found effective in plant disease control (Nene and Thapliyal, 1993). Certain protective fungicides although hazardous to the environment are still used for the control of fungal disease (Palet et al., 2005; Ilondu, 2013).

Pineapple (*Ananas comosus* L. (Merr)), is an important tropical field crop in regions such as Latin America, Asia and Africa on commercial basis (Kaneshiro *et al* 2008) and a herbaceous, perennial crop in the family of Bromeliaceae . It is the third most important tropical fruit in the world production after banana and *Citrus* (Bartholomew *et al.,* 2003). Nigeria is sixth on the list of world pineapple producers with about 800,000 tonnes per annum. *A. comosus* fruit is a rich source of vitamin A, B1, B6 and C, copper, manganese and dietary fibre (OGTR, 2008). High concentration of Bromelain found in the ripe pineapple fruit is useful in confectionery and pharmaceutical industries as well as in diagnostic laboratories (Amao *et al.,* 2011). The pineapple leaves is a good source of fibre used in the production of Pina cloth (Kochhar, 1986).

Phytophthora cinnamomi is a soil-borne organism causing diseases of many crops including pineapple. Heart rot affects the basal leaf tissues and may cause rot of the fruit as well. The symptoms include rot of the basal tissues of the youngest leaves at the heart of the apical meristem. Such infected leaves may easily pull from the plant with a slight touch and as it advance may lead to total crop failure and subsequent yield reduction (Green and Scot, 2015). In this study, the efficacy of some agrochemicals against pineapple heart-rot pathogen was assessed.

Materials and Methods

Test fungus: *Phytophthora cinnamomi* (Plate 1) was previously isolated and identified (Alexopoulus *et al.,* 2002; Barnett and Hunter, 1999) from pineapple leaves with heart-rot disease symptoms (Plate 2) in a pineapple farm at Site 1, Delta State University, Abraka.

Fungicides: Mancozeb, Fungu-force, Maneb and Mackecknie Gold (Table 1) were purchased from Delta State Agricultural and Procurement Agency (DAPA) Ibusa near Asaba, Delta State.

Table1. Trade name, active ingredient and formulation of the fungicide evaluated in the study

Trade name	Active Ingredient	Formulation
Dithane M_{45}	Mancozeb	80% WP
Fungu-force	Carbendazim + mancozeb	70% WP
Trimangol	Maneb	80% WP
Mackecknie Gold	Metalaxyl + Copper oxide	72% WP

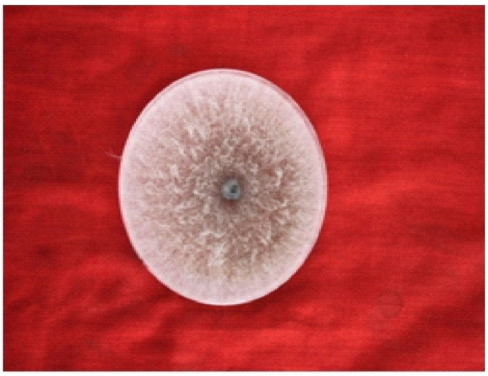

Plate: Culture of *P. cinnamomi*

Plate 2. Various degrees of heart-rot disease of pineapple in this study

In-vitro assay of fungicides

In vitro evaluation of the fungicides on the colony growth of *P. cinnamomi* was done through poisoned food technique (Taskeen, *et al.* 2011). Stock solutions of the fungicides were prepared in sterile distilled water to get the required concentrations of 25, 50, 100, 200, 500, 1000, 2000, 3000, 4000 and 5000 ppm of the active ingredient (Ilondu, 2011). One millilitre of each level of concentration was aseptically incorporated into 20ml of cool molten PDA in each of the test-tube prior to the transfer to 9 cm petri dishes.

Each plate was inoculated with 4mm mycelia disc cut from the periphery of 5-day old culture of the test fungus. Three replicates were maintained for each concentration of each fungicide including the control (PDA without fungicide). The mean colony diameter was recorded after 5 days incubation at temperature (30 ± 2 °C) in a complete randomised design. The experiment was repeated twice. The toxicity of the fungicides on the growth of the fungus in laboratory assay was assessed by poisoned technique. The percentage inhibition of growth due to various fungicidal treatments at different concentration was computed by the method of Ilondu, (2013)

Data analysis

Data collected were subjected to analysis of variance (ANOVA) with statistical package for Social Sciences (SPSS, IBM Version 20) and means were separated using Duncan's Multiple Range Test at the probability level of ($P<0.05$).

Results and Discussion

The linear growth of the fungus was considerably reduced by the fungicides with the degree of inhibition being directly related to increase in chemical concentration in the medium (Table 2). The result showed that all the fungicides have *in vitro* toxicity to the pathogen but with varied effectiveness. The Fungu-force was the most prominent in its action on the pathogen with the minimum inhibition concentration of 25 ppm compared with the other fungicides. Complete inhibition was also observed at the concentration of 1000 ppm in Mancozeb, 4000 ppm in Mackecknie gold and 5000 ppm in Maneb. Nwanosike and Adeoti

(2002) opined that 100% inhibition of fungal growth is considered to be effective dose of a fungicide. The effectiveness of some of these fungicides on different plant pathogens has been observed (Patel *et al.,* 2005; Ilondu *et al.,* 2010, Taskeen *et al*., 2011; Ilondu, 2011; 2013; Chakrabarly *et al.,* 2013).

Table 2: Effect of different concentrations (mg/ml) of four fungicides on the radial mycelia growth (cm*) and inhibition (%) of *Phytophthora cinnamomi in-vitro*

Concentration (ppm)	Fungicides			
	Fungu-force	Maneb	Mackecknie Gold	Mancozeb
Control	4.30^{a} (0.00)	4.30^{a} (0.00)	4.30^{a} (0.00)	4.30^{a} (0.00)
25	0.00^{b} (100)	4.16^{a} (3.25)	3.53^{b} (17.90)	4.10^{a} (4.65)
50	0.00^{b} (100)	3.40^{b} (20.93)	3.33^{b} (22.56)	2.96^{b} (31.16)
100	0.00^{b} (100)	3.33^{b} (22.56)	2.80^{c} (34.88)	2.06^{c} (52.09)
200	0.00^{b} (100)	2.90^{c} (32.56)	2.43^{c} (43.49)	1.83^{c} (57.44)
500	0.00^{b} (100)	2.70^{c} (37.20)	1.96^{d} (54.41)	1.73^{c} (59.76)
1000	0.00^{b} (100)	2.36^{d} (45.12)	1.73^{d} (59.76)	0.00^{d} (100)
2000	0.00^{b} (100)	2.26^{d} (47.44)	1.43^{e} (66.04)	0.00^{d} (100)
3000	0.00^{b} (100)	1.73^{e} (59.76)	1.00^{f} (76.74)	0.00^{d} (100)
4000	0.00^{b} (100)	1.33^{f} (69.06)	0.00^{d} (100)	0.00^{d} (100)
5000	0.00^{b} (100)	0.46^{g} (89.30)	0.00^{d} (100)	0.00^{d} (100)

Values with the same superscript(s) in the same column are not significantly different at P > 0.05 by DMRT *Values are mean of three replicates; 0.00 = no growth/no inhibition; Figures in parenthesis are percentage growth inhibition

Conclusion

In this study, the best fungicide that could arrest the growth of *P. cinnamomi* is Fungu-force, followed by Mancozeb and Mackecknie gold. Therefore, the result of this study can be utilised to develop suitable application regime of these fungicides for trials on farmer's field in the control of heart-rot disease of pineapple and other crop diseases incited by this pathogen thereby improving food security. Further study is in progress with other chemicals and biocontrol agents to ascertain their efficacy in integrated approach to disease management.

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Mycostimulation in A Glyphosate Treated Arable Soil: Implications on the Yield and Agronomic Characters of *Talinum fruticosum* (L.) Juss.

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Abstract

Introduction

The most common use of pesticides is as Plant or Crop protection product. In general, pesticides are known to protect plants from damages caused by insects, molluscs, weeds, fungi, nematodes, birds, rodents etc. Through the use of pesticides, there has been a significant improvement in agricultural productivity (Kuo and Regan, 1999). The corollary to this improvement in yield is a corresponding reduction in the prices of food on a global scale. According to Braschi *et al.* (2000), active substances found in many herbicides may hamper the rate of a series of biochemical processes and microbial growth in the soil. These modifications in the count and activity of soil microorganisms may lead to upsetting the biological equilibrium of the soil environment, thus precipitating a concomitant decrease in soil fertility and the biological productivity of the plants cultivated on such soils. In view of all of these, this research sets out to investigate the effect of an ex situ stimulation of the population density of one of the resident fungal species in an arable land under the influence of glyphosate, on the biomass yield and some agronomic characters of *T. fruticosum* planted on this soil.

Materials and Methods

Isolation of fungi and preparation of pure culture from the experimental plot

One gram of top soil sample was aseptically taken from each of the 8 Blocks in the field and thoroughly mixed together to form a composite sample. This bulked sample was transferred under an aseptic condition to the laboratory, where serial dilution using sterile distilled water was then carried out on the sample to the 6th concentration.

Re-introduction of harvested fungal spores (*P. variotii*) to the experimental site

At the end of the harvesting of the spores of fungus in the laboratory, about 4000 ml of suspension of sterile distilled water containing the spores of this fungus was collected into a pre sterilized, fine nozzle watering can. The content of this watering can was thereafter applied to the different Treatment cells in each of the Blocks earmarked to receive the fungal spores. The portions marked out to not receive the spore of this fungus were equally sprayed with about 4000 ml of sterile distilled water using another pre sterilized, fine nozzle watering can.

Layout of experimental site

The experimental field was laid out in a 3 × 8 Randomized Complete Block Design (RCBD) containing 3 Treatments each in a total of 8 Blocks. Each of these 3 Treatments were randomly assigned within each of the 8 Blocks. Treatments assigned were as follow: Treatment 1 (T1) = − fungus + glyphosate + fungus; Treatment 2 (T2) = fungus + glyphosate + *T. fruticosum* and Treatment 3 (T3) = fungus − glyphosate + *T. fruticosum*, where +indicates presence or addition and – indicates not added or not present.

Planting of *T. fruticosum* and application of glyphosate on the experimental site

After the layout of the experimental site, and prior to the re-introduction of the fungus to the site, glyphosate was applied at the recommended rate to the required portions on the site. Two days after the application of this herbicide, *T. fruticosum* seedlings were transplanted from the nursery (at the rate of 35 seedlings per each Treatment cell of $1m^2$**)** into the experimental site, while the fungus was re-introduced into the required portions on the field 4 days and 2 days after the application of glyphosate and the transplanting of *T. fruticosum* seedlings respectively.

Data were taken on the *T. fruticosum* at between 1-6 weeks after planting (WAP) on such parameters as plant height, plant density, leaf size and internode space by measuring with a ruler while data on the biomass yield ($kgha^{-1}$) were taken on harvesting at 6 WAP by uprooting the each plant, and their roots washed under a running tap before weighing on the Mettler top loading weighing balance.

Processing and analyses of data

The size for each Treatment cell in each Block was $1m^2$**.** Data on the mean value of biomass yield was thereafter converted from gram per square metre to kilogram per hectare. Data reported for each Treatment were mean values from 8 replicates. These data were analysed using the IBM SPSS Statistics version 20 software statistical package. Using the same software package, mean values were separated for statistical significance at 95% confidence interval, using the Least Significant Difference (LSD).

RESULTS

- Plant height

The results for this parameter (Fig. 1) show that the ex situ stimulation of the population of *P. variotti* and the use of glyphosate had a significant effect (P = 0.05) on the height of *T.fruticosum* at each of the WAP.

- Plant Density

The results as presented in Figure 2 below show that the Treatments exerted a significant effect (P = 0.05) on the number of transplanted *T.fruticosum* that survived at the different WA

- Leaf size

The results here also show (Fig. 3) that the Treatments had a significant effect (P = 0.05) on the size of the laves of *T.fruticosum*

- Internode spacing

Treatment 1 had a significantly higher (P = 0.05) internode spacing compared to Treatments 2 and 3. Between Treatments 2 and 3 however, there was no significant difference (P= 0.05) in internode spacing (Fig. 4)

- Biomass yield

The result as shown in Figure 5 reveals that the Treatments had a significant effect on this parameter. The highest mean yield was obtained for T3 while the lowest was for T1.

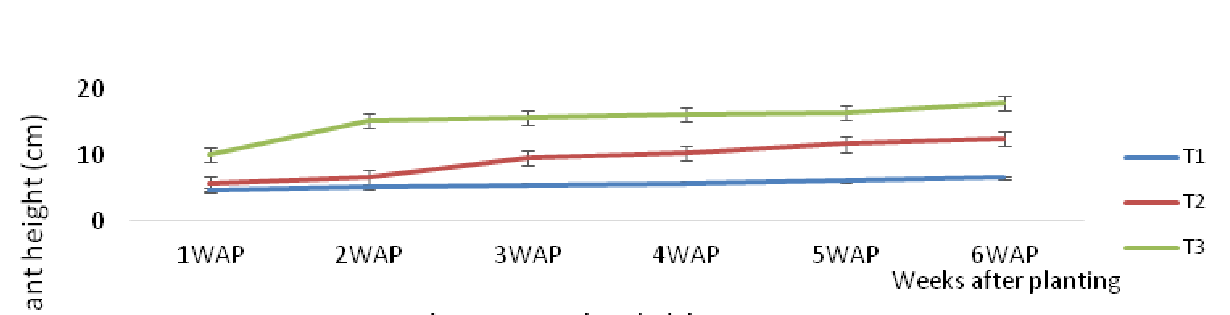

Fig. 1: Mean Plant height at 1-6 WAP

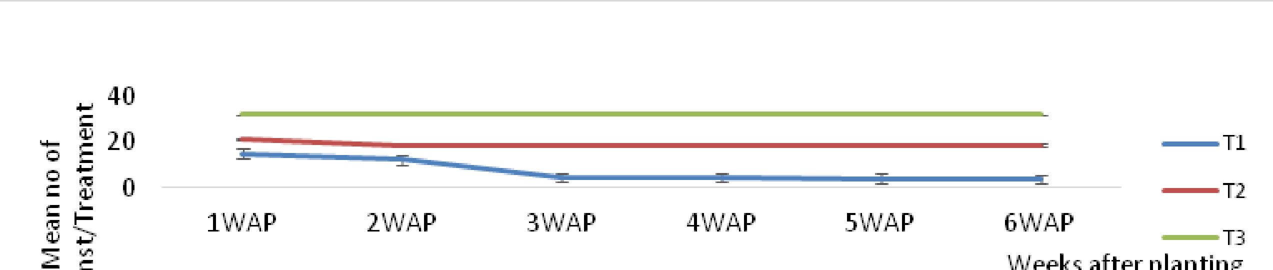

Fig.2: Mean number of plants for each Treatment at 1-6 WAP

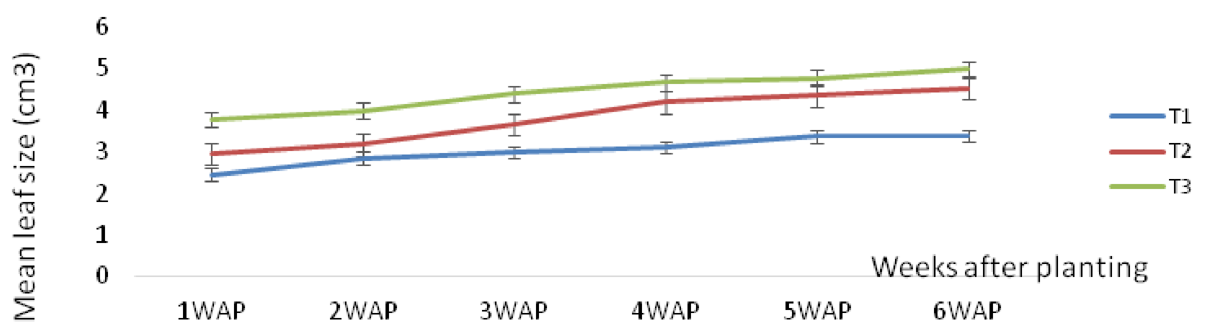

Fig. 3: Mean leaf size for the different Treatments at 1-6 WAP

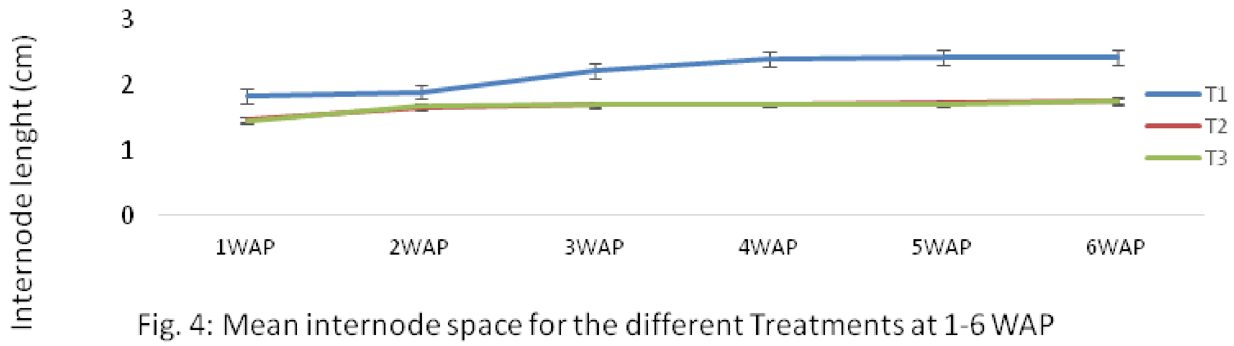

Fig. 4: Mean internode space for the different Treatments at 1-6 WAP

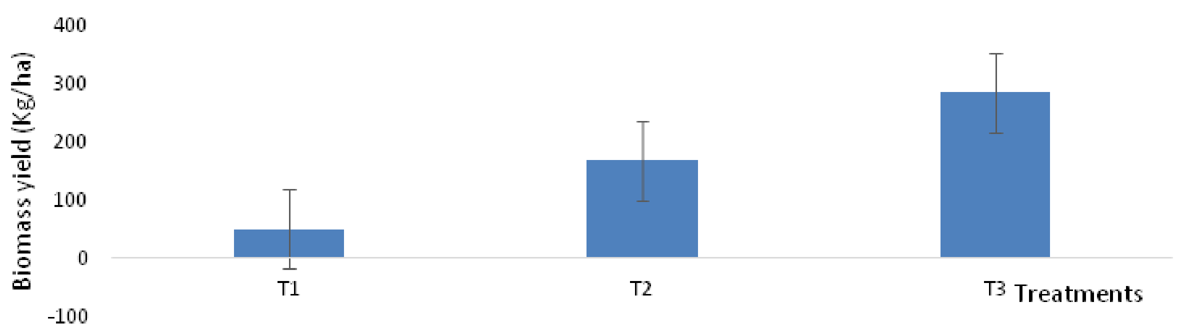

Fig. 5: Mean Biomass yield for Treatments at harvest

Discussion and Conclusion

The results of this research show that the use of herbicide led to a significant reduction in the agronomic properties (such as leaf size, number of plants and height of plants, internode) and biomass yield of *T. fruticosum*. Also, stimulating the population density of one of the resident (in situ) fungal species led to a significant improvement in some of the salient indices depicting the state of health of the plant, and ultimate biomass production.

How Much Policy and Legislative Framework on Wastes and Contaminated Lands Management Input is Contained in the Nigerian Petroleum Industry Bill (PIB) Before the National Assembly

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ABSTRACT

Introduction

Nigerian Government had been desirous of reforms in her industrial sector particularly in the petroleum industry sector. This led to the proposal for the Petroleum Industry Bill (PIB). In 2012, a draft bill was presented to the National Assembly and till date, the draft PIB has not been passed.

In view of the fact that about 90% of Nigeria's foreign exchange earnings is derivable from the petroleum sector, and the huge oil and gas activities, enormous wastes are generated and can contaminate the environment, if not properly managed in line with industry best practices. Many petroleum industry sites have been contaminated from previous activities or can become contaminated through accidental releases of various materials. In many cases, remediation include oil spill sites, old reserves pits, onshore release sites of hydrocarbons or contaminated water, and places where oil slicks from offshore releases are blown onshore, etc.

Past environmental practices by the petroleum industry operators have led to loss of public confidence that the petroleum industry is able to regulate itself and still protect the environment to ensure sustainability. This loss of confidence is partly earned by the IOCs and partly as a result of deliberate misinformation by environmental activists. It is important to note that all companies, including the petroleum industry, exist by the grace and will of the people in the society. If residents do not want an industry to exist, that industry can be shut down, either through legislation, litigation or economic boycotts. Unfortunately, the social pressures imposed on an industry are not necessarily based on accurate scientific information. Many are politically based, and will thus do very little to protect human health and the environment.

In Nigeria, there are multiple, overlapping regulatory agencies that govern various aspects of oil and gas exploration and production. There is therefore the need to ensure that the policy and legislative framework for wastes and contaminated land management in the Nigerian PIB before the National Assembly is adequate to ensure environmental sustainability.

Materials & Methods

The 233-page draft PIB which is divided into 362 sections was reviewed with a view to identifying how much policy and legislative framework for wastes and contaminated land

management is contained in the Nigerian PIB currently before the National Assembly. Existing legislations and policy framework and current industry practices in managing wastes and contaminated lands in the Niger Delta by IOCs was reviewed by the authors. The exposure and research experiences of the authors in the field of wastes and contaminated land management in the Niger Delta region helped in proffering recommendations to this review.

Results & Discussions

The first mention of policy and administrative framework for wastes and contaminated land management in the draft PIB was mentioned in sections 13- Establishment of the upstream Petroleum Inspectorate; 14- Objectives of the inspectorate; 15- Functions of the inspectorate, and 16- Powers of the inspectorate. Similarly, sections 43, 44, 45 and 46 report the Establishment of the Downstream Petroleum Regulatory Agency, Objectives, Functions and Powers of the agency, respectively. Sections 200 of the PIB reports Environmental Quality Management, while section 204 reports abandonment, decommissioning, and disposal of oil and gas facilities. The responsibility over the environment is reported in section 289 while obligations of license, lessee and contractors as well as duty to restore the environment are reported in sectors 292 and 293, respectively.

Conclusions and recommendations

Conclusion

The huge and enormous environmental degradation experienced today in the Niger Delta region after long years of neglect is partly due to lack of adequate policy and legislative framework for wastes and contaminated lands management and partly due to political will to enforce existing legislations. The draft PIB currently before the national assembly is an important document that should be reviewed by all professionals including Wastes and Land Resources Management experts and the academia with a view to providing adequate professional and technical input into it. To the best of my knowledge, this is the first time PIB is discussed in a forum of this nature to ensure that adequate policy and legislative input is made into it for sustainability.

Recommendations

i. For environmental sustainability, adequate policy & legislative framework for environmental management should be put in place in the draft Nigerian PIB. It is the opinion of the authors that not much policy and legislative framework for wastes and contaminated land management have been put in place in the Nigeria PIB currently before the National Assembly.

ii. The authors propose that the policy and legislative frameworks to tackle the challenges of managing wastes and contaminated lands in the Nigerian PIB should be based on the concept of strict liability, meaning that neither negligence nor wrongful intent are necessary for liability to be imposed. The company or person that violated the law will be held responsible, no matter what mitigating circumstances may be present, including sabotage or natural disaster.

iii. There should be a policy and legislative framework to ensure that impact of wastes and contaminated land on humans health is **reported** against international standards. Nigerian Environmental Consultants that mortgage their salvation, scientific knowledge and consciences at the altar of greed and avarice should be made to understand that impacts of wastes and contaminated lands on human health in Nigeria is likely to be the same in any other parts of the world. A situation where Environmental Consultants to IOCs in Nigeria report impacts of major / 3rd tier spills as "insignificant" just to fulfill the principle of "he who pays the piper detects the tune" should be condemned all and they should be seen as scientific fraudsters!

iv. The most important thing the petroleum industry can do is to adopt an attitude of working in harmony with the public will. Mutual education between regulators, the petroleum industry and the public at all levels is an important step in environmentally-responsible, cost-effective operations.

v. Avoidance of responsibility for environmental protection by the IOCs should be greatly discouraged and should carry sanctions.

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