FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

SCHOOL OF ENVIRONMENTAL TECHNOLOGY INTERNATIONAL CONFERENCE (SETIC 2016)

SETIC 2016

Conference Proceedings

EDITORS:

Yekeen A. SANUSI

Olatunde F. ADEDAYO

Richard A. JIMOH

Luqman O. OYEWOBI

THEME:

SUSTAINABLE BUILT ENVIRONMENT AND CLIMATE CHANGE: THE CHALLENGE OF POST 2015 DEVELOPMENT AGENDA

DATE:	VENUE:	TIME:
TUE. 10TH - THUR. 12TH MAY, 2016	SCHOOL OF ENVIRONMENTAL TECHNOLOGY COMPLEX	9:00AM - 5:00PM DAILY

CHIEF HOST:
PROF M. A. AKANJI
VICE CHANCELLOR, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

HOST:
PROF Y. A. SANUSI
DEAN, SCHOOL OF ENVIRONMENTAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SUPPORTED BY

School of Environmental Technology International Conference (SETIC) 2016

10-12 May 2016

Federal University of Technology Minna, Niger State, Nigeria

Conference Proceedings

Editors

Yekeen A. SANUSI,
Olatunde F. ADEDAYO,
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Conference Proceedings of the School of Environmental Technology International Conference (SETIC) 2016

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10th – 12th May 2016
School of Environmental Technology,
Federal University of Technology, Minna, Niger State, Nigeria.

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FOREWORD

The organising committee of the 1st School of Environmental Technology International Conference is pleased to welcome you to Federal University of Technology Minna, Niger State Nigeria.

The conference provides an international forum for researchers and professionals in the built and allied professions to address fundamental problems, challenges and prospects that affect the Built Environment as it relates to Climate Change and Sustainable Development. The conference is a platform where recognised best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. The papers and scope are quite broad but have been organised around the sub-themes listed below:

- Infrastructure Development and Financing
- Sustainable Practice Theories
- Urban Resilience and Energy Conservation
- Waste Management and Sanitation
- Health and Safety Issues
- Climate Change and Threat to Sustainability of the Built Environment
- Climate Change Induced Disaster
- Designing the Human Settlement for Climate Change
- Conceptual Issues on Climate Change and Sustainable Development
- Sustainable Materials
- Cross Cutting Issues

The peer review process saw us making use of 48 senior academics and specialist as reviewers drawn from institutions in Nigeria and England. There were some papers were outside the theme of the conference but we had to create a cross cutting issues to accommodate such papers this is in spirit that every knowledge is important.

We hope you enjoy your time at our conference, and that you have the opportunities to exchange ideas and share knowledge, as well as participate in productive discussions with the like-minded researchers and practitioners in the built environment and academia.

Professor Yekeen Adeeyo Sanusi
Conference Chair
School of Environmental Technology International (SETIC) 2016
Federal University of Technology Minna, Niger State Nigeria.
May 2016

ACKNOWLEDGEMENTS

The success of the 1st School of Environmental Technology International Conference holding at the Main Campus of the Federal University of Technology Minna, Nigeria is predicated on the support and goodwill from Vice-Chancellor of Federal University of Technology and many other highly motivated people.

I sincerely wish to appreciate you for attending this maiden event and to warmly welcome you to the city of Minna the capital of the *POWER STATE*. It is a great honour to have you in the beautiful campus of Federal University of Technology Minna, Nigeria, **THE MOST PEACEFUL UNIVERSITY IN NIGERIA**. I am aware of the great sacrifices made by many of you to be present in this occasion and I will definitely not overlook the long distances some of you have had to cover to get to this conference venue. We genuinely appreciate all your efforts. It is our singular hope and desire that the conference meets your expectations and gives you unquantifiable experience and tremendous developmental networking opportunities for a life fulfilling career.

We are grateful for the presence of the Vice Chancellor of the Federal University of Technology Minna – Professor Musbau Adewumi Akanji whose leadership and distinguished academic career has served as inspiration and encouragement to many young academics. His desire to see the University compete at International level has led to the upsurge in the organisation of International conferences, Public lectures and Seminars on regular basis within and outside the university. We are happy to have you as the Chief host to declare the conference open and deliver the welcome address.

We are grateful to the Dean of School of Environmental Technology, Federal University of Technology Professor Yekeen Adeeyo Sanusi for providing the robust platform, academic support and leadership for the organisation of the conference. You threw the challenge and provided the required resources and strategies for achieving its success, it is a great honour of having the opportunity to learn at your feet. We are happy to have you as the host and keynote speaker at the conference. I wish to thank also all the special guests particularly leaders of the Industry, Built Environment and Academia.

SETIC is beginning at the foundation this year and for this I wish to thank all those who have supported us through various forms of participation. Specifically I wish to thank the delegates and the partners for contributing significantly to the conferences. I wish to thank Prof. Oluwole O. Morenikeji (DVC Academic), Prof. Stella N. Zubairu and Prof. A. M. Jinadu who genuinely and consistently monitored the progress of the conference preparations. It is my desire that SETIC becomes a constant feature in the calendar of the university and global conference listings.

Delegates to SETIC 2016 are from 39 different academic and research institutions that are spread across six different countries. This offers participants a wonderful opportunity for exchange of cultural, social and academic ideas during the conference periods. It is also an opportunity to create awareness about programmes and events at the participants' individual institutions. I encourage you all to make good use of the networking opportunities that are available.

We received a total of 226 abstract, based on a quick review we were able to accept 175 of them and the authors were communicated on what they needed to focus on while developing the full papers. A total of (129) full papers were received and reviewed, the reviewers report for the authors to make corrections and submit revised papers. It was after the process that we were able to accept 112 papers for presentation at the conference, I therefore congratulate all the authors whose papers made it to the conference. We acknowledge the amount of hard work you had all put in producing these papers. It is my sincere believe that the presentation of the different ideas in your paper would go a long way in improving the knowledge of the participants and also generate meaningful discussions at the tea beaks, lunch and beyond.

I wish to express my utmost gratitude to each reviewer for a wonderful job done and for tolerating our deadlines and Oliver Twist syndrome. It is your dedication and expertise that has ensured that the conference is a success.

Special thanks to all our keynote speakers, Prof. Oluwole O. Morenikeji (Deputy Vice-Chancellor Academics, Federal University of Technology Minna), Prof. Hussein Makun (Director, Directorate of Research Innovation and Development, Federal University of Technology Minna), Prof. Musa Aibinu (Director, Centre for Distance Learning), Prof. Mustapha Zubairu (Director, Centre for Human Settlement and Urban Development), Dr. Appolonia A. Okhimamhe (Director, WASCAL) and Prof. Yekeen Sanusi, (Dean School of Environmental Technology, Federal University of Technology Minna).

It is important to appreciate the roles and efforts of the following people for their selfless and very significant contributions made towards the successful organization of the conference: Adedokun John, Idowu Oqua, Akhabue Oriwoh and Ailoyafen Dorcas (for being available to run around at very short notice), Arc. Oyetola Stephen and Tpl Samuel Medayese (for typesetting the papers for the conference proceedings).

I have come to realise that it is not easy to organize conference without dedicated individuals offering to serve. My heartfelt gratitude goes to Dr. R.A. Jimoh, Dr. L.O. Oyewobi, Dr. Taibat Lawanson, Dr. P. Ayuba, Dr. J.J. Dukiya, Dr. A.I. Anunobi, Dr. N.I. Popoola and Dr. O.A. Kemiki for their unflinching support all through the process.

It is our sincere hope that this conference will serve as a forum for the advancement of research in the urban sphere towards achieving a sustainable environment. It is our sincere believe that academics and professionals in practices will continually participate in this forum.

Once again I wish to thank you all for creating time out of your busy schedule to attend this conference. Please do enjoy your stay at Federal University of Technology Minna, and the city as a whole. Ensure that you make use of the different fora created throughout the conference to build new relationships for the future and strengthen existing relationships. I look forward to seeing you all in future.

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016 Organising Committee
May 2016

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DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

10th May 2016

TO WHOM IT MAY CONCERN

I wish to state that all the papers published in SETIC 2016 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, blind review of full papers by minimum of two referees, forwarding of reviewers' comments to authors, submission of revised papers by authors and subsequent evaluation of submitted papers by the Scientific Committee to determine content quality.

It is the policy of the School of Environmental Technology International Conference (SETIC) that for papers to be accepted for inclusion in the conference proceedings it must have undergone the blind review process and passed the academic integrity test. All papers are only published based on the recommendation of the reviewers and the Scientific Committee of SETIC

Names and individual affiliation of members of Review and Scientific Committee for SETIC Conference 2016 are published in the SETIC 2016 Conference Proceedings and made available on www.futminna.edu.ng

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016
Federal University of Technology, Minna, Nigeria

Papers in the SETIC 2016 Conference Proceedings are published on www.futminna.edu.ng.

REVIEW PANEL

We wish to express our deepest and sincere gratitude to the following people in no particular order who provided comprehensive scientific reviews and made commendable suggestions towards improving the over 200 abstracts and 100 full papers submitted to SETIC 2016. They provided constructive comments to authors regarding their papers, it is necessary to state that there was no reported case of conflict of interest by any of the reviewers or the authors.

Dr. J.J. Dukiya, Department of Transport Technology, Federal University of Technology, Minna

Dr. Naomi I. Popoola, Department of Estate Management, Federal University of Technology, Minna

Dr. Anthony I. Anunobi, Department of Architecture, Federal University of Technology, Minna

Dr. Philip Ayuba, Department of Architecture, Federal University of Technology, Minna

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Dr. Olatunde F. Adedayo, Department of Architecture, Federal University of Technology, Minna

PROFILE OF KEYNOTE SPEAKERS

SETIC 2016 organisers wishes to thank our keynote speakers for accepting to create time to share from their rich wealth of knowledge and interact with delegates and participants on varied issues being examined at this year's conference. A brief profile of each keynote speaker is provided here, this would allow for future interaction and networking with them.

Prof. Hussaini Anthony MAKUN

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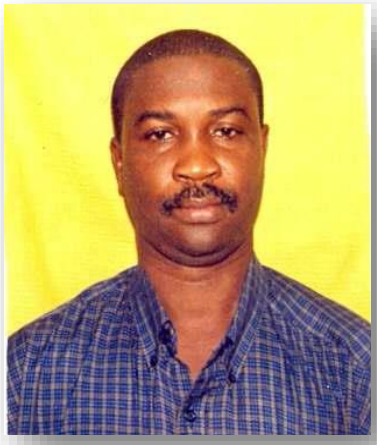
Hussaini Anthony Makun is currently working as Professor of Biochemistry in the Department of Biochemistry, Federal University of Technology, Minna where he has being since 1992. He completed his PhD in 2007 in Biochemistry (Toxicology) from same University. The researcher was a National Research Foundation Postdoctoral Fellow (PDF) with Food Environment and Health Research Group of the University of Johannesburg (UJ) between 2008 and 2010. He is teaching basic and advanced courses in biochemistry, and toxicology related courses at both undergraduate and postgraduate levels.



He has supervised and graduated over seventy B-Tech and ten M-Tech students and two PhDs. He is currently the Lead Researcher of the Food and Toxicology Research Group (FTRG) of the University which has 2 Senior Researchers, 3 M.Tech and 4 PhD students. FTRG conducts researches on environmental health monitoring and mycotoxins at national and international levels. The researches focus on detection and health impacts of mycotoxins and establishing novel integrated intervention strategies approach against mycotoxins. The intervention strategies include exploration of natural preservatives from African traditional medicinal plants with fungicidal effects for production of fungicides for storage of crops. Other approaches at animal farms include formulation of nanoparticle based multi-mycotoxin feed binder against exposure to common, toxic mycotoxins. The research group is also involve in studies to produce simple medicinal supplements encapsulated in

nanoparticles with protective effects against diseases induced by mycotoxins from African traditional medicinal plants; such supplements will alleviate the adverse health impact of mycotoxins in animals and human beings. The research group is also interested in toxicological studies of medicinal plants used in the folkloric treatment and drug toxicology. Following the trend of drugs abuse in Nigeria, the research group is embarking on research titled "Elucidation of the chemical composition and biomonitoring of substances of abuse in the Northern region of Nigeria"**.** The focus of this research is to establish the current state of art of drugs of abuse in the Northern region of Nigeria; to elucidate the chemical composition and active ingredient of new psychoactive substances (NPS); to modify validated analytical methods for the detection of new psychoactive substances in blood, urine and hair.

In last 5 years, 6 research projects were granted with funding from NRF, South Africa and TETFUND, Nigeria. He is a member of Mycotoxicology Society of Nigeria (Vice President (North), Experts on Mycotoxins in Food, Food Hygiene, Food Import/Export Inspections and Certification System of the National Agency for Food and Drug Administration and Control (NAFDAC) of Nigeria, National Codex Committee of Nigeria, African Union Expert Committee on Contaminants in Food (2011 to date) and Joint FAO/WHO Expert Committee on Contaminants in Food (JECFA) (2012-2016). He coordinated the writing of the "discussion paper on fungi and mycotoxins in Sorghum" which was adopted as a document of the Joint FAO/WHO Experts Committee on Food Additives (JECFA) in 2012 and participated in the writing of "Proposed draft annex for "prevention and reduction of aflatoxins and ochratoxin A in sorghum" in the existing code of practice for the prevention and reduction of mycotoxin contamination in cereals (CAC/RCP 51-2003)".

Prof Makun has 57 publications, mostly on mycotoxins in peer review journals, technical papers and books and is currently the Director of Research, Innovation and Development, Federal University of Technology, Minna.

Dr. Appollonia A. OKHIMAMHE
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Dr A. A. Okhimamhe is the Director of the Masters Research Programme on Climate Change and Adapted Land Use (MRP CC & ALU) of the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL), a German sponsored graduate research programme with its Headquarters in Accra, Ghana.

In collaboration with colleagues, 20 West African students from Nigeria, Ghana, Benin, Togo, The Gambia, Cote D'Ivoire, Mali, Niger and Burkina Faso graduated with Master of Technology (M.Tech) in Climate Change and Adapted Land Use from the University. Another Batch of 10 students are expected to commence their programme in mid 2016. Aside from her academic qualifications, her participation in various training activities organized by the United Nations in Regional Centre for Mapping of Resources for Development in Nairobi, Kenya (1992); University of Stockholm, Sweden (1994); Harare, Zimbabwe (1995); and European Space Research Institute in Frascati, Italy (1997, 1998) had prepared her professionally for her career. Additionally, in 2000, she secured a 6 months fellowship-traineeship for a colleague in the Department and herself at the European Space Research Institute in Frascati, Italy. Dr Okhimamhe is an alumni of the International Visitor Leadership Programme (IVLP), U.S. Department of State's Bureau of Educational and Cultural Affairs' (ECA) premier professional exchange program. Currently, she is an Associate Professor of Geography with a research focus on application of remote sensing and GIS in geographical sciences including climate change.

Dr Okhimamhe has served her country as a Technical Delegate at the UNFCCC COP in Cancun, Mexico (2010), Durban, South Africa (2011), Doha, Qatar (2012) and Warsaw, Poland (2013). She has supervised more than 30 postgraduate students and has several publications and is still publishing. In collaboration with her students in the last 3 years, she has focused on urban climate change studies using geospatial techniques.

Prof. Abiodun Musa AIBINU

Federal University of Technology, Minna

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Abiodun Musa AIBINU (PhD), is a highly motivated career driven achiever with over Eighteen (18) years working experience in the field of: Mechatronics Engineering; Telecommunication Engineering; Spectrum Management; Industrial Automation; Teaching; Research and Project Development.

He received: National Diploma award from The Polytechnic, Ibadan, Nigeria; B.Sc degree from Obafemi Awolowo University (OAU), Ile-Ife, Nigeria; M.sc degree from Blekinge Institute of Technology (BTH), Sweden and Doctoral degree award from International Islamic University Malaysia, (IIUM), Malaysia. He has been actively involved in teaching and research activities at various universities since the completion of his post-graduate studies. However, prior to that he has worked with: MTN Communication (Nigeria) Limited; GS Telecom (Nigeria) Limited; DCC Satellite and Networks Limited; Oganla Consulting and Investment (OCI) limited; Communications Associates (COMSAC) (Nigeria) Limited just to mention but a few.

Engr. Aibinu has participated and won several awards at various international and national exhibitions and was nominated for 2012 promising researcher award and best teacher award at IIUM Malaysia. He has also won several research grant awards in and outside Nigeria and has authored/co-authored several publications in both local and international journals and conferences.

He is presently, the Head of Department, Mechatronics Engineering Department, Federal University of Technology, Minna and the Director, Center for Open Distance and e-Learning (CODeL), Federal University of Technology, Minna.

Prof. MORENIKEJI, Olakanmi Oluwole

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Morenikeji, Olakanmi Oluwole joined the services of the Federal University of Technology, Minna in 1990 as an Assistant Lecturer and rose to become a Professor of Urban and Regional Planning in 2006. He obtained his B. Sc in Geography and Regional Planning from the University of Calabar in 1983 and M. Sc Urban and Regional Planning from the University of Benin in 1998. He enrolled for his Ph.D in Transport Planning in 1992 at FUT Minna and won a Nigerian-Italian Ph.D scholarship which enabled him to do part of his Ph.D work at the University of Trieste, Italy. He bagged his Ph.D in 1998 and utilized his post-doctoral Commonwealth Fellowship at the Instrumented City, Institute for Transport Studies, University of Leeds, UK (2004/2005).

Morenikeji served as the Head of Department of Urban and Regional Planning from 1995 – 2002 and later, Director of the Centre for Human Settlements and Urban Development established in collaboration with the UN-Habitat in FUT, Minna. He was also the Dean of the School of Environmental Technology from 2008-2012. He has also participated in a number of internationally funded research projects and published several papers in learned journals. His areas of interest include transportation planning, human development studies, spatial analysis and Research Methods.

He is currently participating in a collaboratory research between The Construction and Property Research Centre, University of the West of England (CPRC-UWE), Bristol, UK and the Federal University of Technology (FUT), Minna being funded by DFID. He has been appointed by the West African Science Centre on Climate Change and Adapted Land Use (WASCAL) as a visiting Lecturer at the Joint Facility for Language and Common Courses (JFLCC) 2016 which is a collaborative programmes for Masters (MRP) and Doctoral Research Programme (GRP) students from 10 participating Universities.

He is currently the Deputy Vice-Chancellor (Academics) Federal University of Technology, Minna, Niger State, Nigeria.

Prof. Mustapha ZUBAIRU

Federal University of Technology, Minna

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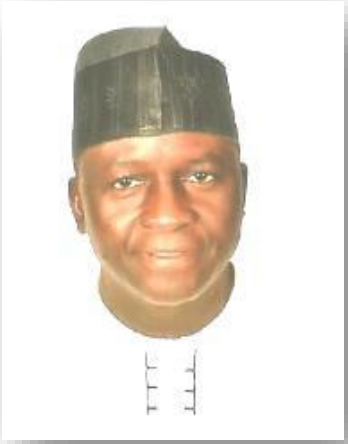
Mustapha Zubairu is currently a Professor in the department of Urban and Regional Planning and the Director Centre for Human settlement and urban development (CHSUD) in the Federal University of Technology, Minna. He received his B.Sc. and M.Sc. degrees in architecture from the Ahmadu Bello University Zaria, Nigeria, in 1975 and 1977 respectively. He also holds M.Sc. and Ph.D. degrees in urban and regional planning from the University of Strathclyde, Glasgow, Scotland 1983 and 1990. He is a Member of the Royal Planning Institute, Member, Nigerian Institute of Architects, Fellow, Nigerian Institute of Town Planners and a Member, Nigerian Institute of Management.



Prof. M. Zubairu was amongst others, a principal architect in the Ministry of Works and Housing, Minna, Niger State from 1979-1981, a Chief Architect/Planner in the Niger state housing corporation between 1983 – 1984 after which he became the general manager Niger State Housing Corporation, Minna between 1984 and 1992. He eventually became the General Manager, Urban Development Bank of Nigeria PLC, in charge of the Lagos Regional Office from 1992 to 1999 were he was trained by World Bank on Project development and appraisal.

In 1999 he was appointed the position of Managing Director/Chief Executive, Federal Housing Authority, Abuja where stayed until 2001. Through a large portion of his tenure (1995 till date) to be exact, he established and was also involved in private practice as principal partner in an architecture and urban planning consultancy firm. In 2003, he was appointed as director, Centre for Human Settlements and Urban Development in the Federal University of Technology, Minna and has retained this position till date. Since his appointment he has been servicing the department of urban and regional planning and architecture as mentor, supervisor and all round resource person.

His area of specialization includes; Housing, Urban design, Urban Management and Slum upgrading.

Professor Yekeen A. SANUSI

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Yekeen A. Sanusi is a Professor of Urban and Regional Planning at the Federal University of Technology, Minna. His lecturing experiences span over 20 years and has lectured at both undergraduate and postgraduate classes. His academic works cover issues on urban environmental quality, urban dynamics, urban governance and green economy (poverty, service delivery and deprivations, water and sanitation, energy and climate change).

He also has studies and reports sponsored by international bodies and Research Board of the Federal University of Technology, Minna. His teaching areas cover planning theory, development control and settlement of disputes, urban governance, project planning and evaluation, energy planning, environmental impact assessment and tourism planning. He has successfully supervised many postgraduate theses (PhD, Master and Postgraduate Diploma). On administrative front,

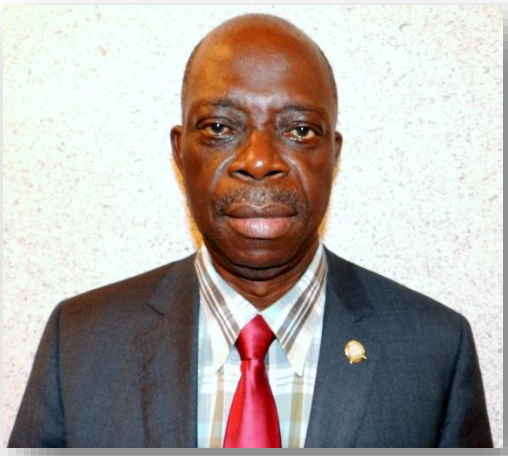
He was Deputy Dean, School of Environmental Technology of the Federal University of Technology, Minna between 2006 and 2008 and the Head of Department, Urban and Regional Planning between 2008 and 2012. Since 2012, he has been the Dean of the School of Environmental Technology. He is a Registered Town Planner (RTP) and a member of Nigerian Institute of Town Planners (NITP).

He is a member of many international research networks. Among these are Environment, Health and Development Network and Renewable Energy Policy Network for the 21st Century.

PROF Johnson Bade FALADE

Executive Director of the Foundation for Development and Environmental Initiatives (FDI)

He is currently the Managing Director/Chief Executive Officer of Gotosearch.Com Ltd and Executive Director of the Foundation for Development and Environmental Initiatives (FDI) from July 20012-date. He is currently a Senior Programme Advisor for the Urbanisation Research Nigeria Project.



Prior to this appointment, Prof Falade was the first Country Director of UN-HABITAT Programme Support office for Nigeria (2003-2012); UNDP (Programme Analyst in the Governance Team (2000-3), UNDP Zonal Officer for the North-West Zone of Nigeria (1998-2000); Programme Officer for Economic Management Team (1994-98); Programme Officer for Water and Sanitation (1992-94).

He was appointed Pupil Town Planner, County Planning Department, County Durham, Durham, UK (1977-78) and Air Mapping Assistant with the Photogrammetry Department, Ministry of Lands and Housing, Ibadan, Nigeria (1968-1970).

Professor Falade has a vast teaching and research experience. He was appointed Assistant lecturer (1982-83), Lecturer 1 (1985-87), Senior Lecturer (1987-91) with the Faculty of Environmental Design and Maanfgement fo the Obafemi Awolow University Ile-Ife. He was a Visiting Professor, Department of Geography and Regional Planning, Adekunle Ajasin University, Akungba, Akoko, Ondo State (2005-7); He was Visiting Associate Professor, Department of Urban and Regional Planning University of Lagos, Lagos (1998-90); Visiting Lecturer Department of Geography and Regional Planning Lagos State University, Ojoo (1998).

Professor Falade is member of several Professional Bodies: namely Nigerian Institute of Town Planners (1984-till now), Fellow of the Institute (1999-till date); Town Planners Registration Council (1986-till date); Nigerian Construction Industry Academy (1986-to-date); Nigerian Institute of Management (NIM) and International Union on Parks and Recreational (2004-to-date).

Professor Falade has been awarded many national and international awards. He has several publication to his credit in the areas of urban planning, landscape design and conservation and urbanization and urban governance.

ASSESSMENT OF THE IMPLICATIONS OF URBAN GROWTH IN SULEJA BETWEEN 1987 AND 2014

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Cities in developing countries are often characterized by uncoordinated growth. Accompanying this growth are various problems which include traffic congestion, emergence of slum, flooding, uncollected solid waste and poor sanitation. These problems pose a critical challenge to cities in developing countries. Suleja which is one of the most urbanized local governments in Niger State and also proximate to Abuja the Federal Capital Territory is experiencing the identified problems.This study therefore examines the extent and implications of urban growth in Suleja between 1987 and 2014. Spatial analysis of the city for the period understudy (1987 - 2014) and implication of the growth on the residents and environment were determined.Primary and secondary data as well as Geospatial techniques were used for the study.Two sets of satellite imageries were used for the study that is,Thematic Mapper for 1987 and Enhance Thematic Mapper for 1997, 2007 and 2014. The findings of the geo-spatial analysis were corroborated with the findings of the primary and secondary data sources.The analysis reveals that Built-up area in Suleja increased from 10.91km^2 in 1987 to 46.25km^2 in 2014. While the 35% of the building plans submitted for approval to Niger State Urban Development board, Suleja are approved annually. The study also revealed that the pollution level of Suleja which was consequential to the increase in growth recorded a high value of 15.97 ppm for CO, 0.67 ppm for NO_2 and 1.33 ppm for SO_4.The study recommends that the planning and management of Suleja should be based on inclusive planning approach more so, infrastructure should be systematically expanded at a rate equal to the rate of the urban growth in Suleja.

Keywords: Pollution, Slum, Solid waste, Spatial growth, and Urban growth

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INTRODUCTION

In less developed countries of the world before 1950 the pace of urbanization was very slow, however, after this period the rate of urban growth increased substantially (McCatty, 2014). Most of the world's urban centres are rapidly urbanizing at an alarming rate this assertion was proven by Donk (2006), who believes that the world is increasingly becoming urbanized and the rate at which city populations and urban centres grows is an indication of the pace of social and economic change. In recent times rural-urban drift has led to an increase in urban growth in most developing countries. This growth is attributed to the "Push" of the rural areas and the "Pull" of urban centres (Aluko, 2010). The push and pull in this regard are with respect to the population, which can be traced to the effects of regional imbalances (Oyeleye, 2013) in other words regional imbalance and urban drift has led to increase in population in urban centres. According to Tibaijuka (2006), it has been estimated that one third of the world's population lived in cities In 1976 and 30 years later (2006), this population rose to one-half of the entire humankind and by the target year for the Millennium Development Goals (MDGs); cities in the world are estimated to grow to two third that is, 6 billion people by 2050 (UN- Habitat 2006).

Africa is presently ranked among the least urbanized continent of the world, it is, however, prominent for its highest rates of urbanization. According to the United Nation's projection, it is expected that 61% of the world population will be urban by 2030 and over half the population in Africa will be urban by 2020 (UN, 2004; Ajala, 2005). Jiboye (2005), Osasona et al (2007) opined that, this phenomenal growth anticipated for cities can be attributed to the incidence of globalization, industrialization and population explosion. Urban growth can be refer to the rate of growth of an urban population or a growth that makes intensive use of land for the location of buildings and impermeable surfaces (Oyeleye, 2013). On the other hand Ioannides, et al (2008) referred to urban growth as the process of growth and decline of economic agglomerations. UNICEF (2012), in her report defined urban growth as an absolute increase in the number of people who live in towns and cities, and believes that the pace of urban population growth depends on the natural increase of the urban population and the population gained by urban areas through both net rural-urban migration and the reclassification of rural settlements into cities and towns.

The effects of this population changes in African cities in particular has produced miseries that are often difficult to understand because most of the African primate cities including those in Nigeria are faced with the problem of deteriorating physical and living conditions. The deterioration manifests itself in form of slums, urban sprawl and squatters' settlements, increasing traffic congestion, flooding and erosion and deteriorating infrastructures (Olurin 2003 and Olujimi 2009). Urbanization has enormous negative consequences in Nigeria and other developing countries, Population increase as index of urbanization in Nigeria is driven by rural-urban migration and not by natural increase (Oyeleye, 2013). Many scholars see rural-urban migration in urbanization process as the genesis of urban problems in different part of the world (Wahab, 1990; Agbola, 2004; Olujimi 2009). In order to achieve sustainable urban planning in our cities, it is imperative for planners to monitor the ongoing changes in land use/land cover pattern of an area over a period of time. Against this

background, every bit of the available land will be used in most rational and best possible way so as to ensure orderly development.

Aim and Objectives of the Study

This study aims at examining the nature and consequences of urban growth in Suleja with a view to achieving sustainable development. In executing this study, the trend of physical growth of Suleja between 1987-2014 was analysed and the implications of the growth on the residents and the environment was examined.

Nature of Urban Growth in Nigeria

Urban growth and physical expansion of urban settlements is not peculiar to Nigerian states alone, but a global phenomenon which has occurred significantly all over the world. In recent times, urban growth has had an intense drive in the third world regions (Aina, 1992 as cited by Abiodun et al., 2011). This assertion is also supported by the UN (2012) who professed that the population of the world is expected to be concentrated in the third world countries whose population is projected to increase from 2.7 billion in 2011 to 5.1 billion by the year 2050. Over the years, population growth in Nigeria has been growing at an alarming rate and Olujimi (2009) opined that the Urban population growth in Nigeria in the last thirty years is 5.8 percentage per annum and this is amongst the highest urban growth rate in the world. The rate of urban growth in Nigeria can be tied to three major processes which are natural increase in the population; rural-urban migration and city annexation into the surrounding rural areas (Agbola, 2006).

It is noteworthy that urban growth processes in Nigeria and most developing countries are expanding without significant urban planning. Celik et al. (2009) noted that physical manifestations of rapid urbanization in third world countries like Nigeria are often chaotic and shows far-reaching demographic, social and economic transformations. Regrettably, the opportunities tied to urbanization in these countries are lost due to inadequate resources, basic infrastructure, services and well-conceived planning (Celik et al., 2009). These occurrences are responsible for millions of people in Nigeria, living in environment overwhelmed by slums, filth and squalor having grossly inadequate social amenities (Bankole and Bakare, 2011). The nature of urban growth experienced in Nigeria is evident in the conversion of land from nonurban area to an urban area, or expansion of urban areas into adjoining neighbourhoods, agricultural land, forest area, wetland and other nonurban lands.

Ndabula et al., (2014) opined that urban expansion in itself may not be a problem, but rather the nature and patterns of the urban growth, which may be characterized based on urban land use pattern and its associated impact on the urban spatial form, the rate of land conversion and land use intensity. The concept of urban growth includes spreading outwards of a city and its suburbs to its outskirts, auto-dependent development on rural land, excessive,

ineffective urban space consumption, poor distribution of open spaces, scattered development away from the central city and existing infrastructure (Hasse and Lathrop, 2003).

Methodology

The longitudinal design method was adopted in this study. Data for the study was generated from two main primary sources and secondary sources. Since this study involved change detection, the use of imageries taken at different times were adopted. Data for the secondary sources were obtained from journals and other materials from the internet; Solid waste data were obtained from Niger State Environmental Protection Agency, lists of building plan approvals were obtained from Niger State Urban Development Board while crime reports were obtained from the Nigerian Police Force Suleja. Four sets of satellite images for Suleja for 1987, 1997, 2007 and 2014. All the imageries are the American Land-sat series Thematic Mapper (TM) and Enhance Thematic Mapper (ETM^+). All the satellite imageries were obtained from the National Centre for Remote Sensing, Plateau State (table1. 1). Data for the primary sources were acquired from Oral interview and the use of "Rasi 700" gas meter which was used to measure the level of Pollution in Suleja.

Table 1.1: Image Properties

S/No	Image Year	Path and Row	Data Set	Image Captured Date
1	Suleja 1987	P189 R53	TM	21/12/1987
2	Suleja 1997	P189 R53	ETM^+	27/12/1997
3	Suleja 2007	P189 R53	ETM^+	09/12/2007
4	Suleja 2014	P189 R53	ETM^+	04/3/2014

Source: Fieldwork, 2014

The data generated were processed; tabulated and analysed using the Statistical Package for Social Science (IMB SPSS) ver.20. The software package used for images analysis was the Integrated Land Water Information System (ILWIS 3.3 Academic). The ILWIS Academic was used for Image Classification and Post Processing. A supervised classification was carried out on all the imageries using three parameters which are, Built-up Area, Bare Surface and Vegetation. Geospatial techniques were employed in determining the spatial growth of Suleja between 1987 and 2014. In order to make this research scientific, four imageries of ten years intervals were processed that is, Thematic Mapper for 1987, the Enhance Thematic Mapper for 1997, 2007 and 2014.

The images obtained were "sub-set" on ILWIS 3.3 Academic so as to determine the Area of interest which is Suleja. Band combination of 4, 3, 2 were used to develop a "false colour composite" for the study area. The 4, 3, 2 bands have a potential of being used for urban studies, on this colour composite Vegetation appears in shades of red, urban areas in cyan blue, soils vary from dark to light browns. "Training sets" were created on all the imageries

and these "Training sets" include: Built-up area, Vegetation and Bare Surface. These training sets were subjected to a supervised (full Gaussian) maximum likelihood classification; this was done using the "classifier" tool on the operation list of ILWIS 3.3 Academic software.

Study Area

Suleja Local Government Area (fig 1) lies between latitude 9º6'13.8'' and 9º17'49.35'' north of the equator and longitude 7º6'58.6' and 7º12'18.41' east of Greenwich Meridians. Suleja local government has a population of 216,578 in 2006 (NPC, 2006). In the year 2014, the population figure increased to 278,735 (projected figure).

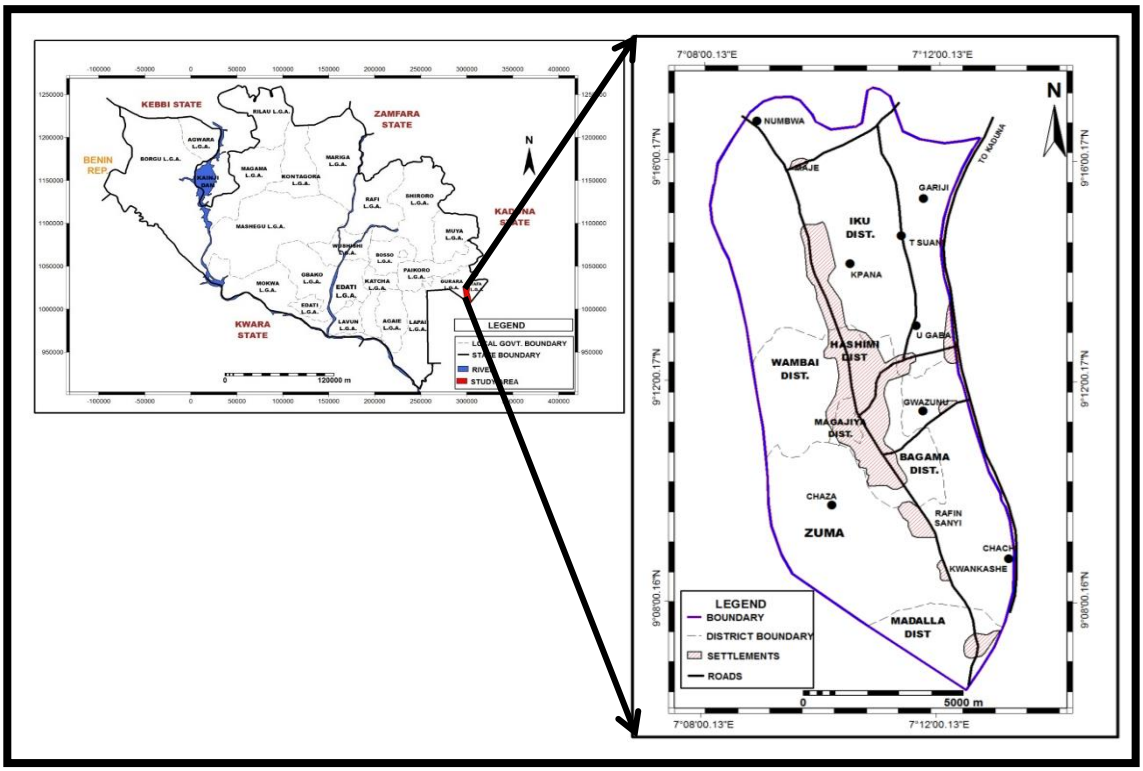

Figure 1: Administrative Map of Suleja highlighted in Map of Niger
Source: Department of URP FUT Minna.

Discussion and Findings

In analysing the images, three classes of landuse landcover were identified in Suleja, these classes are Built-up areas, Bare Surfaces and Vegetation. The built-up areas are represented in red colour, while bare surfaces and vegetation are represented in Grey and Green colour respectively (fig 2).

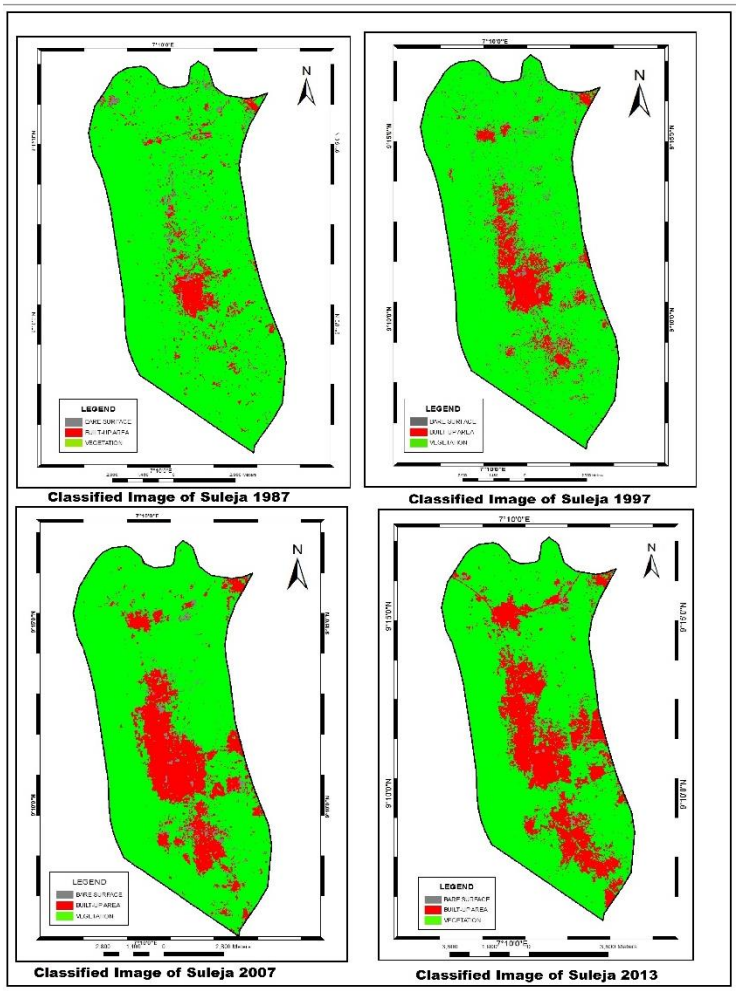

Fig 2: Composite Map for Suleja
Source: Author's Field Survey, 2014.

Table 1 shows the landuse landcover of Suleja in 1987, the table (table 1) reveals that the study area was forested in 1987 with vegetated area covering a total of 194.20 km^2 (91.77%) of the total land use. Built-up area and Bare Surface covers a land area of 10.91Km^2 (5.16%) and 6.51Km^2 (3.07%) respectively. Built up area increased from 10.91km^2 (5.16%) in 1987 to 17.46 km^2 (8.25%) in 1997. This increase led to a slight decrease in vegetated area from 194.20 km^2 (91.77%) in 1987 to 190.56 km^2 (90.60%) in 1997. Bare surface also decreased in the year 1997 with a total land area of 3.57 km^2 (1.69%). All these changes can be attributed to increase in human activities and increase in population (table 1).

In 2007 (table 1), there was a drastic increase in the size of built-up area in the study area. The built-up area increased to 30.52 km^2 (14.42%) as against 17.46 km^2 recorded in 1997. The Niger State Urban Development Board attributed the increase in growth to the influx of people moving into Suleja from Abuja as a result of "mass" demolition done within that period (2007) by Federal Capital Development Authority, Abuja. Increase in human activities in Suleja also gave rise to decrease in vegetation and bare surface in 2007. Vegetated area decreased to 178.15 km^2 (84.16%) while Bare Surface also decreased to 3.02

km^2 (1.43%) as against 190.56 km^2 (90.60%) and 3.57 km^2 (1.69%) recorded for vegetation and bare surface respectively in 1997.

Table 1 shows that the study area witnessed a considerable increase in socio-economic activities. The built-up area increase from 30.52Km^2 (2007) to 46.25 Km^2 in 2014, due to increase in human activities in Suleja more vegetal cover and Bare Surfaces were lost. The vegetal cover decreased from 178.15km^2 in 2007 to 164.02km^2 in 2013 as Bare Surface also decreased from 3.02km^2 in 2007 to 1.41km^2 in 2013. The change in landuse landcover (table 1) in this year can be attributed to increase in Population of Suleja. Between 1987 and 2014 the changes in built-up areas were progressive.

Table 1: Land use/Land Cover Change (1987-2014)

Sample Set	Land cover Area (Km^2)							
	1987	**%**	**1997**	**%**	**2007**	**%**	**2014**	**%**
Bare Surface	6.51	3.07	3.57	1.67	3.02	1.43	1.41	0.67
Built-up Area	10.91	5.16	17.46	8.25	30.52	14.42	46.25	21.85
Vegetation	194.20	91.77	190.59	90.07	178.15	84.16	164.02	77.48
Total	211.62	100	211.62	100	211.69	100	211.68	100

Source: Author's Field Survey, 2014.

Extent of Change between 1987 and 2014

The magnitude of change (table 2) from 1987-1997 is calculated by subtracting the area of each Landuses Landcover type for the year 1987 from 1997 that is, B-A. The annual frequency of change (D) is determined by dividing the magnitude of change of each of the Landuse landcover category by the number of years between the period, that is, 10 years for 1987 -1997, 10 years for 1997 to 2007 and 7 years for 2007 – 2014. The percentage of change (E) is calculated by dividing the magnitude of change C of each Landuse Landcover category by the figure of the base year that is, 1987 then multiplying the result by 100. This same process is done for the periods 1997 to 2007 and 2007 to 2014 where 1997 and 2007 are the reference year respectively. The results of the analysis show a tremendous change in the Landuse Landcover of the study area during the 27 years period from 1997-2014. It is noticed that the percentage change in the proportions of some Landuse sample sets increased while others decreased.

Table 2 also reveals that Bare Surface between 1987 and 1997 recorded an annual frequency of change of -0.29Km^2 with a percentage of change -45.16; this implies that 0.29km^2 is converted into built-up areas annually. This period (1987 - 1997) also recorded a decrease in vegetal cover. The analysis unveils that 0.36 km^2 of vegetal cover are lost annually due to human activities. Built-up area within this period (1987 -1997) gained a total of 0.66 km^2 annually. The dynamics indicate that there was an increase in spatial growth between 1987 and 1997.

Table 4: Extend and percentage of change between 2007 and 2014

Sample set	A Year 2007 (KM^2)	B Year2013 (KM^2)	C Magnitude of change (B-A)	D Annual Frequency of Change C/7	E Percentage of change C/A x100
Bare Surface	3.02	1.41	- 1.61	- 0.23	- 53.31
Built-up Area	30.52	46.25	15.73	2.25	51.54
Vegetation	178.15	164.02	-14.13	- 2.02	- 7.93
Total	211.69	211.68	- 0.01	- 0.01	-9.7

Source: Author's Field Survey, 2014.

The rate in crime was progressive between 2006 and 2014. The study reveals that a total of 905 cases were reported in the last 8 years in Suleja. The highest numbers of cases reported were in 2008 (31) and 2011 (124). The Nigerian Police Force in 2008 attributed the high crime rate recorded during that period to the influx of people from Abuja, a resultant effect of the Abuja mass demolition by the FCDA while that of 2011 was attributed to the Suleja Madalla bombing in which 113 people were arrested. As the population of the study area grew in 2013, 122 cases were reported and a total of 156 people were apprehended. This figure (156) marked the highest number of people apprehended in Suleja in the last eight years. 967 persons were apprehended in all the crimes committed in Suleja, 896 of which are males while 71 are females. This indicates that males are more involved in crime than their female counterpart. The prevalent crime record can be attributed to the spatial growth of Suleja, unemployment coupled with inadequate security arrangement for the city. Global standard for the ratio of a police to a person is 1:50 but in Nigeria, especially in a growing city like Suleja the ratio range between 1:600-1000. This gross shortfall encourages criminal activities to grow.

Environmental problems experienced in Suleja are Flooding, Erosion, Uncollected Waste and land Degradation. Fig 4.16 reveals that, 2.2% of the respondents are faced with the problem of flooding, 21.2% of the respondents are faced with the problem of Erosion. 57.6% and 19.1% of the respondents believed that uncollected waste and land Degradation respectively, are more pronounced in their area. The study reveals that Suleja has prevalent cases of uncollected waste and this occurrence can be attributed to increase urban growth. Table 5 shows that 62,928 cubic meters were collected in the year 2009. In the year 2010 123,120 cubic meters of solid waste were collected, 184,680 cubic meters, 247,152 cubic meters and 308,940 cubic meters were collected for the year 2011, 2012 and 2013 respectively. The increase in cubic meters of solid waste collected in the study area can be attributed to increase in population. A total of 926, 820 solid waste was collected between 2009 and 2014. The Niger Environmental Protection Agency believes that these statistics does not give a true record of waste collection in Suleja because lots of solid waste are left uncollected daily.

Table 5: Volume of Waste Generated in Suleja per Population between 2009 and 2013

Year	Population	Volume of Solid Waste Generated (m^3)
2009	238,040	62,928
2010	245,664	123,120
2011	253,526	184,680
2012	261,626	247,152
2013	270,008	308,940
Total	**1,268,864**	**926,820**

Source: Author's Compilation, 2014.

Hypothesis:

H_0: the volume of waste generated in Suleja does not vary significantly with the annual population

H_1: the volume of waste generated in Suleja is directly proportional to increase in annual population

Based on the available data on the volume of solid waste generated between the five years period of 2009 and 2014, attempt was made to correlate the annual volumes of generated solid waste with the population figure for the corresponding years (table 6). The goal is to investigate if the volume of waste generated annually increases as the annual population increases. The result, as summarised in table 7, shows a perfect positive (1.0) correlation coefficient, which is significant at 99% confidence level. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted. This shows that, the volume of waste generated in Suleja is, actually, directly proportional to the annual population increase. The observed pattern is, therefore, real and not attributable to chance occurrence.

Table 6: Correlation between Volume of Waste Generated and Annual Population

		Population	Volume of Solid Waste Generated (m3)
Population	Pearson Correlation	1	1.000**
	Sig. (1-tailed)		.000
	N	5	5
Volume of Solid Waste Generated (m3)	Pearson Correlation	1.000**	1
	Sig. (1-tailed)	.000	
	N	5	5

**. *Correlation is significant at the 0.01 level (1-tailed).*

Source: Derived from Table 5

The Rasi 700 gas meter was used in collecting data on the quantity of Co, No_2 and So_2 concurrently and the emission level of Suleja 2014 was deduced.

Table 7: Level of Gas Emission in Suleja between 2012 and 2014.

	Standard	2012	2014
Gases	**Unit (PPM)**	**Unit (PPM)**	**Unit (PPM)**
CO	10	13.48	15.97
NO_2	0.04 -0.06	0.073	0.67
SO_2	0.01	0.0163	1.33

Author's Compilation 2014

Table 7 reveals the level of gas emission in Suleja in 2012, after the mean emission of the were recorded CO constitutes 13.48ppm, while No_2 and So_2 reads 0.073ppm and 0.0163ppm respectively (Gazali *et al*., 2013). The level of gas emission increased in 2014, 15.97ppm was recorded for CO, 0.0133ppm was recorded for SO_2 and 0.67ppm was recorded for NO_2. The value recorded in 2014 were higher than the stipulated value by the NESREA which state 10ppm for CO, 0.04 -0.06ppm for NO_2 and 0.01ppm for SO_2 (FEPA, 1999). The High pollution values can be attributed to urban growth and large concentration of Motorcycles.

Ineffective development control as a result of urban growth has led to emergency of Slum in Suleja between 1987 and 2014. According to the Niger State Urban Development Board only 35% of the building plans submitted to the Ministry are approved. The Board (NSUDB) noted that developers frequently go ahead with their development without having their plans approved and this contravention by developers often defaces Suleja. Table 8 shows the numbers of building plans approved between 1993 and 2013.

Table 8: Building plans approved from 1993 to 2013 in Suleja

Year	No. of Applications	No. of Plans Approved	No. Of Plans not Approved
1993	145	51	94
1994	150	53	97
1995	136	48	98
1996	90	32	58
1997	117	41	76
1998	134	47	87
1999	135	47	88
2000	79	28	51
2001	140	49	91
2002	108	38	70
2003	81	28	53
2004	82	29	53
2005	99	35	64
2006	174	61	113
2007	171	60	111
2008	227	79	148
2009	181	63	118
2010	129	45	84
2011	119	42	77
2012	79	28	51
2013	80	28	52
TOTAL	2656	932	1734

Source: NSUDB, 2014.

The number of building plans approved yearly, does not reflect the true population of Suleja. More so, the inability of the Niger State urban Development board to approve more than 35% of the applications made yearly has encouraged the erection of illegal buildings, contravention and chaotic planning in Suleja.

Conclusion

This study has effectively examined the implications of urban growth in Suleja between 1987-2014. It is important to note that crime, uncollected waste, pollution, land degradation, and slum emergence are consequential to urban growth in Suleja within the period under study. To accurately determine the extent of growth in Suleja within the 27 year study period, remote sensing tool was employed. This tool (remote sensing) provides an important catalyst in understanding of the way that urban areas grow and change over time.

Recommendations

On the basis of the findings of the study, recommendations are made to ameliorate the implications of urban growth in Suleja. Recommendations made are:

- The Niger State Government should partner with the National Centre for Remote Sensing and the Federal University of Technology, Minna for the training and capacity building of the staff of the Niger State Urban Development Board so as to bordering their knowledge in monitoring urban growth.
- The Niger State Urban development should give more attention to development control so as to check the emergence of unlawful development. More so, the process of building plan approval should be made less cumbersome by the planning board so as to encourage developers.
- The planning and management of Suleja should be based on the concept of Environmental Planning and Management (EPM). This is a bottom-up and community driven planning and management system, promoted by UN-Habitat.

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