Consolidated Report for October 2012 – March 2018

West African Science Service Centre on Climate Change and Adapted Land Use Master Research Programme on Climate Change and Adapted Land Use (WASCAL MRP CC and ALU)

WASCAL
West African Science Service Centre on Climate Change and Adapted Land Use

SPONSORED BY THE
Federal Ministry of Education and Research

FEDERAL UNIVERSITY OF TECHNOLOGY

CONSOLIDATED REPORT
FOR
OCTOBER 2012 – MARCH 2018

JUNE 2018

CONTRIBUTORS:
Professor Appollonia A. OKHIMAMHE
Dr Saratu Usman IBRAHIM
Dr Julia EICHIE
Mr Isaiah SULE
Lucy PETER
Edward Stephen SUNDAY
Engr Raphael AGBOOLA

EDITOR:
Professor Appollonia A. OKHIMAMHE

DESIGN, LAYOUT AND COVER DESIGN:
Professor Appollonia A. OKHIMAMHE

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EXECUTIVE SUMMARY

West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) is a capacity building and research collaboration between Germany (Federal Ministry of Education and Research) and ten (10) West African countries namely Nigeria, Ghana, Benin, Mali, Cote d'Ivoire, Burkina Faso, Niger, Togo, The Gambia and Senegal. Each of these host countries was initially represented by a Task Force member nominated by focal Ministries during the pre-operational phase (late 2010 – early 2012) of WASCAL. Cape Verde is now a part of this network. WASCAL CCALU, one of the centres in this network, has graduated thirty (30) MTech Degree students in Climate Change and Adapted Land Use in October 2012 to March 2018 spanning three academic sessions or a period of approximately six years. Within the period of their stay in Minna, the students undertook field visits to Busugi, Chikodna and Kataeregi communities in order to get familiar with the environment of the local communities and to determine the communities' responses to climate change. On concluding the lecture phase, the field visit and research phase of all three (3) Batches of students commenced after the International Advisory/Academic Board and the Major Supervisors. Each of the students' full proposal was assessed and recommendations made concerning the topics, scope and the budget of the proposed research on the 2nd and 3rd of February 2017. The Centre implemented the decisions of the Board for each student during the course of their work. Specifically, for Batch "C", the Board and Centre ensured that maximum use of the budget was recommended to the benefit of WASCAL. On participation in workshops/conferences during their programme, Batch "C" students were the first of the Batches to participate in a workshop on academic publishing and manuscript writing organized by the Academic Publishing Unit of Federal University of Technology, Minna. Due approval was granted to the Director for the savings from their research grant to be utilized for this purpose because of its significance to their research reports preparation, paper writing and presentation. In terms of community service, amongst the communities studied by the students (Busugi, Chikodna and Kataeregi), Busugi community's one block with two classrooms was selected as a community development project. This was achieved through voluntary contributions from Batch C students, WASCAL CCALU staff and some International Advisory Board members. This would help to minimize the exposure of developing young brains to climate change induced high temperature during classes. In terms of publicity, the campus radio (Search FM on 92.3 MHz), which has a signal coverage over the whole of Minna, some parts or Kaduna and Abuja, aired its interview with the Executive Director, Dr Moumini SAVADOGO, when he visited the University on 1st August 2018. This particular visit was unique and most welcomed being the only visit from the Headquarters between 2015 and 2018; and the maiden visit of the incumbent ED within a year of his appointment. Some of the students also published papers from their research work as valuable contribution to existing literature on climate change. During this period of reporting, the International Advisory/Academic Board, the Dean of the Post Graduate School and Director of Academic Planning Unit worked intensively to develop the curriculum for the new PhD programme in Climate Change and Human Habitat, that has already been subjected to the necessary academic procedures. One very important component of WASCAL is the 'buy in' of the host countries through their focal Ministries that are expected to contribute financially to the programme. As at the time this report was prepared (February 2019), WASCAL MRP on CC&ALU had received funds amounting to eight hundred and forty eight thousand, two hundred and four euros and twenty one cents (€848,204.21), which was used for running the programme from October 2012 to February 2019. So far, the Federal University of Technology, Minna has made in kind contributions estimated at approximately sixty seven thousand euros (€67,000.00) and numerous administrative concessions to ensure the success of the programme.

From the Director's Desk: Prof A. A. Okhimamhe 

INTRODUCTION

1.1 APPROVAL OF WASCAL CC AND ALU

West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) is a capacity building and research collaboration between Germany (Federal Ministry of Education and Research) and ten (10) West African countries namely Nigeria, Ghana, Benin, Mali, Cote d'ivoire, Burkina Faso, Niger, Togo, The Gambia and Senegal. Each of these host countries was initially represented by a Task Force member nominated by focal Ministries during the pre-operational phase (late 2010 – early 2012) of WASCAL. Cape Verde is now a part of this network. Nigeria's interest in WASCAL was signified through a position paper and a letter of request to host at least a WASCAL Centre as well as a task force meeting during the tenure of Mr John Odey, a former Minister for Environment. Thus, the Ministry is regarded as WASCAL's host in Nigeria and Prof A. A. Okhimamhe, was nominated by the Ministry to represent Nigeria during her tenure as the Director, Centre for Climate Change and Freshwater Resources (CCFR), FUT Minna, an erstwhile linkage Centre to the Ministry. The different phases of WASCAL spanned across the tenures of four Federal Ministers of Environment and a Minister of State for Environment.

During the pre-operational phase, some member countries including Nigeria, hosted meetings that deliberated on the concept of WASCAL as presented by the proponent, Professor Paul Vlek, formerly of the University of Bonn, on behalf of German Ministry of Education and Research (BMBF). Additionally, during the meetings the constitution and cooperation agreement of WASCAL were drafted. Prof Okhimamhe also participated in four Scientific meetings that were organized to select WASCAL host Universities, one of which she formally presented Nigeria's interest in hosting Land Use thematic area in FUT Minna. ***Consequently, when Nigeria hosted one of the meetings, the Task Force and German partners were not only hosted by a former Honourable Minister for Environment, Mr John Odey, but also visited the Federal University of Technology, Minna for the first time. They were warmly received by Professor M. S. Audu, a former Vice Chancellor, who reiterated the interest of FUT Minna to host one of the Centres being proposed by WASCAL.*** In February 2012, Ministers (representing the Ministerial Board) from WASCAL host countries and Germany signed the cooperation agreement that ushered in the operational phase of WASCAL and the Task Force was replaced by a Governing Board. ***The signature ceremony that launched WASCAL as an international organization of repute, with ECOWAS as observer, occurred during Hajiya Hadiza Mailafia's tenure as Honourable Minister for Environment.*** A Scientific Board that reports to the Governing Board was also constituted.

WASCAL programme covers three (3) major activities: Graduate Study Programme, Competence Centre and Research component. Nigeria is fully involved in the Graduate Study Programme and hosts two postgraduate programme. This novel approach to capacity building in Africa is one of its kind in FUT, Minna. The participation of FUT Minna in WASCAL as the Master Research Programme (MRP) on Climate Change and Adapted Land Use was finally accepted during the Task Force meeting hosted by Senegal in 2011. It passed through three stages:

(a) **The submission of a proposal to WASCAL**: Since no concept paper was prepared for this programme, a proposal for the hosting a Master degree in Climate Change Management was submitted by Prof A. A. Okhimamhe, on behalf of the University. This was subsequently modified to M.Tech in Climate Change and Adapted Land Use by the International Board for CC&ALU comprising representatives from WASCAL host/partner universities in Nigeria, Ghana, Benin, Germany, Togo and representative of the Department of Capacity Building in

WASCAL, Accra. The modified curriculum is cross-disciplinary and comprises core courses that focus on climate science, geospatial techniques, geostatistics and research methodology; while the elective (specialized) courses emphasized courses related to land use. Under the supervision of Academic Planning Unit (APU) of the University, the curriculum was finalized to ensure the requirements of National University Commission (NUC) were adhered to and then the curriculum was subjected to all the necessary academic procedures in Federal University of Technology, Minna.

(b) **Approval by Senate of FUT Minna:**
On the 7th September 2012, the then Director of Academic Planning Unit, Professor Bamidele Awojoyegbe presented the curriculum during the 364th senate meeting. He secured the approval of M.Tech Climate Change and Adapted Land Use as an academic Master degree programme with duration of 24 months to be coordinated by WASCAL CC & ALU.

(c) **Signing of MoU**:
In October 2012, the implementation of this programme commenced after the University signed a Memorandum of Understanding (MoU), with the University of Bonn, Germany, which coordinated the implementation of WASCAL in West Africa. The MoU required that WASCAL CC & ALU should be administered by a Director, who reports directly to the Vice Chancellor and also interacts closely with the Director of Graduate Studies in WASCAL Accra; staff that are either seconded to or employed directly by WASCAL and a University-based academic and advisory board.

To ensure that we have an appropriate structure on ground for a smooth take off for the programme, an Implementation Committee was constituted under the chairmanship of Prof. (Mrs.) Stella N. Zubairu, the then Dean of Postgraduate School, with membership drawn from Deans of relevant schools to the programme. The committee metamorphosed into the Academic/Advisory Board for the programme on academic and other related matters.

The Phase One of WASCAL commenced in October 2012 with the admission of ten students from eight countries. WASCAL CC&ALU operated from Bosso Campus in a structure that was renovated and furnished by the University. However, funds from the German Ministry of Education and Research were used for the construction and commissioning of WASCAL CC&ALU building in Gidan Kwano Campus; provision of equipment, books, furniture, 12-seater executive bus, among others. ***WASCAL CC&ALU building was commission by a former Honourable Minister for Environment, Mrs Laurentia Mallam.*** Prof. A.A. Okhimamhe became the Director of WASCAL CC & ALU in October 2015. Prior to that, she coordinated WASCAL CC & ALU (February 2012 – September 2015) during her tenure as Head of Department of Geography.

1.2 EVOLUTION OF WASCAL CC AND ALU IN FUT MINNA

It suffices to mention that the first Executive Director of WASCAL, Prof Paul Vlek, visited the University, just before the operational Phase commenced, alongside, Dr Mamadou Ouattara, the first Director of the GSPs. The first operational phase of WASCAL CC and ALU led to the graduation of two sets of students within four years of existence in FUT Minna: Batch A (2014) and Batch B (2016). During graduation ceremony of Batch "A", WASCAL was represented by the 1st Chairman of the Governing Board, Late Professor Modibo Haidara and Nigeria's Board member, Prof Niyi Osuntogun; and top management of WASCAL Headquarters, namely, the 2nd Executive Director

of WASCAL, Dr L. Sedego; the Director of GSP, Dr M. Ouattara and the Finance Manager, Mr Daniel Ofori.

In total, CC & ALU graduated 20 students on schedule during the tenure of Professor M. A. Akanji, who ensured that all the necessary support was accorded the Centre. The second operational phase of WASCAL programme commenced in March 2016 after an MoU was signed between FUT Minna and WASCAL Accra. It ushered in a number of reforms recommended by the sponsors, based on lessons learnt from the previous phase. These reforms are being implemented in all the ten existing WASCAL centres and these include:

(a) Adjustments to the legal framework of WASCAL: MoUs were signed first, between WASCAL Accra and University of Bonn to reflect its status as an international organisation; and secondly, between WASCAL Accra and Lead Universities (e.g. FUT Minna);
(b) Implementation of new rules for financial management: Manual on the new rules have been received by the MRP and is being adhered to strictly;
(c) Students' enrolment that now involves "face to face" interviewing shortlisted students at country level by the International board, approval by WASCAL of selected students before presentation to Postgraduate Board of Universities for scrutiny and admission; review of students' research budget; rigourous process of selecting lecturers and thesis supervisors; preparation of WASCAL research agenda for West Africa that students to guide the choice of research topics; review of previously existing curriculum etc;
(d) Approval of the appointment of Deputy Directors for each of the Centres; and
(e) Enhancement of WASCAL corporate image that encourages uniformity in all WASCAL procedures and processes e.g. uniform calendar, corporate emails for staff and students etc.

The reforms on quality assurance (item "c") became effective with the admission of Batch C students in March 2016. After participating in the language and common courses programme in Accra (Ghana) and Lome (Togo), they resumed fully in June 2016. Comprising of ten students from nine countries, Batch C students completed their programme in March 2018. During this period, WASCAL Research Action Plan 2019-2022 (WRAP 2.0) was developed by member countries with the assistance of German partner Universities with funding from the Federal Ministry of Education and Research (BMBF). ***Nigeria's consultations were jointly organized by WASCAL Graduate Schools in the Federal University of Technology, Minna (MRP CC&ALU) and Federal University of Technology, Akure (DRP WACS), and hosted by the Federal Ministry of Environment with the former Honourable Minister, Mrs Amina Mohammed declaring the workshop open in Abuja.*** The Master degree programme has transformed into a PhD in Climate Change and Human Habitat (CC and HH) and the programme is expected to commence in 2019. In the meantime, WASCAL is working towards ensuring the sustainability of all her centres across West Africa. Currently, the modus operandi of these are being discussed in various meetings. ***One very important component of WASCAL is the 'buy in' of the host countries through their focal Ministries, who are expected to contribute financially to the programme.*** So far WASCAL MRP on CC&ALU has benefitted from BMBF to the tune of eight hundred and forty-eight thousand, two hundred and four euros and twenty-one cents (€848,204.21) as at 28th February 2019, which was used in running the programme from October 2012 to February 2019, when this report was prepared. So far, the Federal University of Technology, Minna has made in kind contributions to the tune of approximately sixty-seven thousand euros (€67,000.00).

1.3 PHILOSOPHY:

The Master of Technology degree in Climate Change and Adapted Land Use was designed to encourage cross-border collaboration in education and research aimed at addressing the impacts of climate change in West Africa in an integrated, cross-disciplinary and multi-sectoral manner. State-of-the-art modelling tools will be used for innovative analysis of environmental and socio-economic datasets to produce quantitative results for predicting and assessing the impacts of climate change with the view towards proffering the most suitable adaptation measures to minimize these impacts. The general philosophy of the course is to produce highly skilled graduates with a broad and deep knowledge of climate change who can effectively apply this knowledge to at least, five climate change impact areas namely, Land Management, Agriculture, Water Resources, Economic resources and West African Climate System that have been identified as being very critical to the sustainable development of the West African sub-region.

1.4 VISION:

To become the leading postgraduate degree programme for educating vibrant young scientists and conducting cross-disciplinary, multi-sectoral and innovative research on Climate Change that aims at bridging the gap in knowledge on the land use changes, climate stress and possible feedbacks.

1.5 MISSION:

To produce graduates equipped with the highest quality education and training in the use of innovative research methodologies and application of state-of-the-art digital technologies and modelling tools for assessing climate change impacts with the view of deriving useable climate change scenarios that can guide policy formulation across the West African region.

1.6 OBJECTIVES:

The Master of Technology degree programme in Climate Change and Adapted Land Use was administered within the framework of WASCAL International capacity building effort which entailed collaboration with University of Bonn, Germany with funding support for faculty, students, infrastructural and equipment needs. Students were admitted from the participating countries and ten (10) of the best applicants were sponsored by the Federal Government of Germany. As with all other WASCAL International-level GRPs/MRPs, with the completion of the programme, the participants are expected to:

a) Form the critical mass of young scientists on Climate Change and Adapted Land Use in their various countries with the greatest prospects for seeking admission to commence their PhD in any of the GRP thematic areas;
b) Be able to place the profession in the broad social, economic and environmental perspective of climate change and adapted land use with emphasis on problems in West Africa;
c) Be exposed to the requisite knowledge and skills in the five thematic areas of WASCAL. These thematic areas are West African Climate Systems, Water Resources, Land Management, Agriculture and Economic Resources; and
d) Be able to contribute to the development of innovative approaches to managing natural resources in relation to climate change.

2.0 ACADEMIC ACHIEVEMENTS

2.1 GRADUATION

The WASCAL CCALU has graduated three batches of 10 students each for M.Tech Degree in Climate Change and Adapted Land, totaling thirty (30) students in all. The three batches (A, B and C) graduated during the 2013/2014, 2014/2015 and 2017/2018 Academic Sessions respectively. The final results of the ten (10) Batch "A" Students were approved by the Senate of the University on 25th October, 2014 (Set of 2014); which also marked the effective date of the students' graduation. Amongst them were three (3) female students; AKPEOKHAI Agatha Ochuware (Nigeria), KIMA Sophie Agnes (Burkina Faso) and DAH-GBETO Afiavi Pelagie (Benin Republic). Figure 2.1 shows Batch A students and WASCAL CCALU staff, while Table 2.1 shows the comprehensive list of the 30 Batches A, B and C graduates from the University.

Figure 2.1 Batch "A" (SET of 2014), dignitaries and staff members at their graduation ceremony

The final results of the eight (8) Batch "B" Students were approved by the Senate of the University on 28th October, 2015; while those of two (2) other students, who were late in submitting their corrected reports, were approved on 25th November, 2015. These dates also marked the effective dates of the students' graduation. Amongst them were two (2) female students; OKAFOR, Gloria Chinwendu (Nigeria) and ALLAKONON, Marsanne Gloriose Bignon (Benin Republic). Figure 2.2 shows Batch B students (Set of 2016) displaying their certificates.

Final results of the ten (10) Batch C Students were approved by the Senate of the University on 28th March 2018. This date also marked the effective date of the students' graduation. Amongst them were two female students; SIMON, Susan Ojochide (Nigeria) and ADET, Lucette (Cote D'Ivoire). Figure 2.3 show Batch C students (Set of 2018) displaying their Statement of Results.

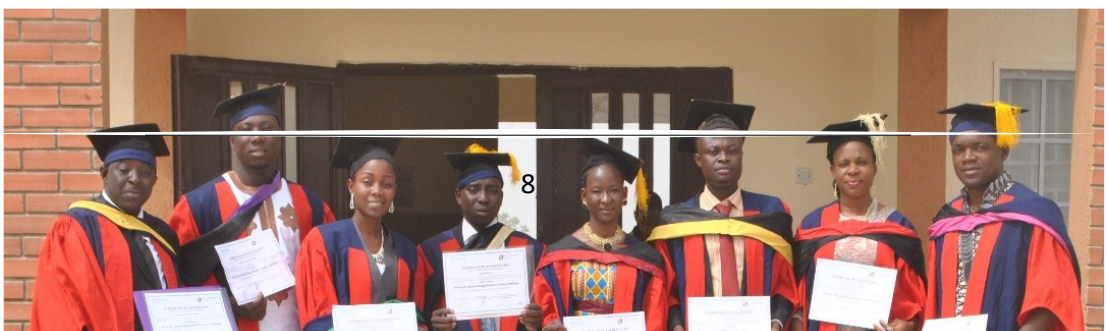

Figure 2.2 Batch "B" (Set of 2016) graduates displaying their certificates

Figure 2.3 Batch C (Set of 2018) graduates displaying their Statement of Results

Table 2.1 Graduates of Batches A, B and C

SN	REGISTRATION NUMBER	NAMES (SURNAME FIRST)	COUNTRY OF ORIGIN
BATCH A WASCAL CC & ALU GRADUATES			
1	MTech/SNAS/2013/3439	NYADZI Emmanuel	Ghana
2	MTech /SNAS/2013/3440	DAH-GBETO Afiavi Pelagie	Benin Republic
3	MTech /SNAS/2013/3441	AKPEOKHAI Agatha Ochuware	Nigeria
4	MTech /SNAS/2013/3442	BESSAH Enoch	Ghana
5	MTech /SNAS/2013/3443	KIMA Sophie Agnes	Burkina Faso
6	MTech /SNAS/2013/3444	AKAMAH Abel Kokouvi	Togo
7	MTech /SNAS/2013/3445	SONKO Ebrima	Togo
8	MTech /SNAS/2013/3446	GARBA HIMA Mamane Bello	Niger Republic
9	MTech /SNAS/2013/3447	SANOGO Karamoko	Mali
10	MTech /SNAS/2013/3448	ADENLE Ademola Andrew	Nigeria
BATCH B WASCAL CC & ALU GRADUATES			
11	MTech /SNAS/2014/4210	ASONIBARE, Femi Oluwatosin	Nigeria
12	MTech /SNAS/2014/4211	COULIBALY, Gnenakantanhan	Cote D'Ivoire
13	MTech /SNAS/2014/4212	OKAFOR, Gloria Chinwendu	Nigeria
14	MTech /SNAS/2014/4213	MOUSSA, Soulé	Niger Republic
15	MTech /SNAS/2014/4214	BISSADU, Kossi Dodzi	Togo

16	MTech /SNAS/2014/4215	ALLAKONON, Marsanne Gloriose Bignon	Benin Republic
17	MTech /SNAS/2014/4216	KOGLO, Yawovi Séna	Togo
18	MTech /SNAS/2014/4217	DAOU, Assitan	Mali
19	MTech /SNAS/2014/4218	GBANGOU, Talardia	Burkina Faso
20	MTech /SNAS/2014/4219	LARBI, Isaac	Ghana
BATCH C WASCAL CC & ALU GRADUATES			
21	MTech/SPS/2015/6065	SIMON, Susan Ojochide	Nigeria
22	MTech/SPS/2015/6066	ADET, Lucette	Cote D'Ivoire
23	MTech/SPS/2015/6067	SANI ISSA, Mahaman Sanoussi	Niger
24	MTech/SPS/2015/6068	RAGATOA, Dakega Saberma	Togo
25	MTech/SPS/2015/6069	SANOU, Charles Lamoussa	Burkina Faso
26	MTech/SPS/2015/6070	GUIDIGAN, Gildas Landry Mèminvègni	Benin
27	MTech/SPS/2015/6071	SIDIBE, Mohamed	Mali
28	MTech/SPS/2015/6072	IBOKO, Maduabuchi Paul	Nigeria
29	MTech/SPS/2015/6073	CHAM, Fafa O.	The Gambia
30	MTech/SPS/2015/6074	ODOOM, Peter Rock Ebo	Ghana

Batch A produced five (5) students with First Class Upper Division results i.e. cumulative grade point average (CGPA) above 4.50 out of a maximum of 5 points, two of whom are female students. The overall best graduate was ADENLE Ademola Andrew with a CGPA of 4.90. The remaining five students graduated with Second Class Upper Division (CGPA greater than 3.50 but less than 4.50). Three out of the five of them had CGPA of between 4.12 and 4.3.1 Table 2.2 shows the cumulative grade points of the graduates in Batches A, B and C.

Batch B produced two (2) students with First Class Upper Division results. The overall best graduate of Batch B was BISSADU, Kossi Dodzi (4.88) followed by KOGLO, Yawovi Séna (4.53). Five of the remaining eight students graduated with Second Class Upper Division with CGPA of between 4.24 and 4.49. The last set of students graduated with Second Class Lower Division with their CGPA ranging from 3.23 to 3.31 (See Table 2.2).

Batch C produced four (4) students with First Class Upper Division, one of whom is a female student. The overall best graduate was ODOOM, Peter Rock Ebo with a CGPA of 4.65. The remaining six students graduated with Second Class Upper Division (CGPA greater than 3.50 but less than 4.50). Four out of the six of them had CGPA of between 4.00 and 4.40. Table 2.2 shows the cumulative grade points of the graduates.

Table 2:2 Cumulative Grade Point Average (CGPA) of Batches A, B and C Students

S/N	NAME	CGPA
BATCH A WASCAL CC & ALU GRADUATES' GRADES		
1.	ADENLE Ademola Andrew	4.90
2.	AKPEOKHAI Agatha Ochuware	4.84
3.	BESSAH Enoch	4.80
4.	KIMA Sophie Agnes	4.76
5.	NYADZI Emmanuel	4.65
6.	DAH-GBETO Afiavi Pelagie	4.31

7.	AKAMAH Abel Kokouvi	4.27
8.	GARBA HIMA Mamane Bello	4.12
9.	SONKO Ebrima	3.96
10.	SANOGO Karamoko	3.84
BATCH B WASCAL CC & ALU GRADUATES' GRADES		
11.	BISSADU, Kossi Dodzi	4.88
12.	KOGLO, Yawovi Séna	4.53
13.	ALLAKONON, Marsanne Gloriose Bignon	4.49
14.	ASONIBARE, Femi Oluwatosin	4.48
15.	OKAFOR, Gloria Chinwendu	4.48
16.	LARBI, Isaac	4.47
17.	GBANGOU, Talardia	4.24
18.	MOUSSA, Soulé	3.31
19.	COULIBALY, Gnenakantanhan	3.27
20.	DAOU, Assitan	3.23
BATCH C WASCAL CC & ALU GRADUATES' GRADES		
21.	ODOOM, Peter Rock Ebo	4.65
22.	SANOU, Charles Lamoussa	4.63
23.	IBOKO, Maduabuchi Paul	4.55
24.	SIMON, Susan Ojochide	4.51
25.	CHAM, Fafa Oggo	4.40
26.	RAGATOA, DakegaSaberma	4.09
27.	ADET, Lucette	4.00
28.	SIDIBE, Mohamed	4.00
29.	SANI ISSA, Mahaman Sanoussi	3.68
30.	GUIDIGAN, Gildas Landry Mèminvègni	3.67

2.2 EVENTS

Batch A, B and C students undertook field studies in Busugi, Chikodna and Kataeregi local communities in Niger State to get familiarized with their local environment; and to determine the communities' responses to climate change. The visit was part of the requirements for the course Community Based Field Work (CCA 712). Each student prepared a report on the perception of the community on climate change and its impact on their livelihood. The reports were graded by the Field Course Coordinator Late Prof. J. M. Baba, a specialist in Geography of Rural Economy.

Additionally, by special concession granted by the Headquarters in Accra, Batch B students were able to participate actively in their Convocation Ceremony. Furthermore, Batch C students participated in a workshop on academic publishing and manuscript writing organized by the Academic Publishing Unit of Federal University of Technology, Minna. Their participation was sponsored by BMBF through their research grant courtesy approval from Accra.

Regarding extracurricular activities, outside the usual busy academic events, the students embarked on an educational visit to locations in Nigeria outside the normal learning environment. Some Batch A students took a tour to some tourist locations (Ikogosi Warm Stream, Idanre Hill, Osun Grove, and Erin Ijesha Falls) in South-West Nigeria. Figure 2.4 shows Batch B students upstream of Shiroro Dam

during their educational visit to the dam. Batch C graduates also visited the Dam. Figure 2.5 shows Batch C students upstream of Shiroro Dam.

Figure 2.4: Some WASCAL CC and ALU Staff with Batch B graduates on the Shiroro Dam during their educational visit to the dam

Figure 2.5: Some Batch C graduates on the Shiroro Dam during their educational visit to the dam

2.3 FIELD TRIPS/RESEARCH

Batch A students conducted their Master degree research in their home countries. This was viewed as an anomaly by the Pioneer Executive of WASCAL because the programme is meant to provide multicultural research experience for the students. This was rectified with Batch B as they chose topics relevant to the "food basket" of Nigeria, the North Central States of Niger, Kogi, Kwara and Nasarawa States. It suffices to mention that research topics were chosen by the students, with slight modifications made by the International Advisory/Academic Board. However, prior to the commencement of Batch C's programme, WASCAL developed its Research Agenda and this served as a guide for the research topics selected by the students. The topics, scope and their associated budgets were moderated by the International Advisory/Academic Board of CC and ALU on the 2nd and 3rd of February 2017. The Centre implemented the decisions of the Board for each student during the course of their work. The students spent between four and five months in their respective field locations spanned across six countries. While five students worked in Nigeria, the other students conducted their field work in The Gambia, Benin Republic, Niger Republic, Burkina Faso and Mali.
For all the students, their scores and concise details of the study are contained in their respective abstracts in Chapter five.

2.3.1 BATCH "A" STUDENTS' RESEARCH

KIMA, Sophie Agnès assessed the impact of climate and land use changes on pastoral livestock farming in Boulgou Province, South-Eastern Burkina Faso. She utilized annual rainfall and temperature data from 1980 to 2012, Landsat satellite images of 1989, 2001 and 2013 as well as socio-economic data from 248 respondents in the province. Her efforts earned her 83% and 70% scores during the internal and external oral defense respectively. Her effort also earned her two publications in reputable international journals.

DAH-GBETO, Afiavi Pelagie examined gender and land use decision making in response to climate variability in Dassari Watershed (Materi), Benin Republic. The study utilized role playing game (RPG) tool and focused group discussions to identify gender specific strategies to cope with climate change. The output of the research earned her 74% and 65% scores during the internal and external oral defense respectively.

NYADZI, Emmanuel assessed soil organic Carbon stocks and trace gas emissions from burnt lands under different types of vegetation in the Guinea Savanna of Northern Ghana. He generated his data from six experimental plots of 50 m x 50m on four different vegetation and soil samples taken from five sampling points at 0-10 cm, 10-20 cm and 20-30 cm depths. His efforts earned him 70% and 80% scores during the internal and external oral defense respectively as well as a journal publication.

GARBA HIMMA, Mamane Bello assessed the impact of rainfall and temperature variability on agriculture in Dosso and Maradi Regions of Niger Republic using a Ricardian Approach. It utilized data collected from over 200 farmers, annual crop net revenue, climate and other socio-economic variables. The output of the research earned him 67% and 63% scores during the internal and external oral defense respectively.

SONKO, Ebrima studied seasonal variation of soil nutrient availability for plant use and farmers' adaptation strategies in North Bank Region of the Gambia. He used soil samples collected in three upland fields at a depth of 0-15cm to analyze pH, Soil organic carbon (SOC), total nitrogen (TN) and soil moisture content. The study used socio-economic data obtained from 105 respondents through household interview and rainfall data obtained from Water Resources of The Gambia. His efforts earned him 68% and 60% scores during the internal and external oral defense respectively.

SANOGO, Karamoko evaluated climate variability and land use change on vegetation dynamics in Fina Reserve, Mali. The study utilized climate data, remotely sensed data, farmers' perception and adaptation measures as well as Geographic Information System (GIS). The output of the research earned him 78% and 71% scores during the internal and external oral defence respectively. He has a publication to his name.

AKPEOKHAI, Agatha Ochuware evaluated the impact of tillage and fertility management on soil carbon sequestration at Minna in the Southern Guinea Savanna of Nigeria. The study quantified the vertical distribution of soil organic carbon (SOC) under different tillage systems and various nutrient sources. It also utilized data from a socioeconomic survey as well as Farmers' observation of climate change parameters. The effort earned her 75% and 68% scores during the internal and external oral defence respectively.

BESSAH, Enoch assessed soil organic carbon stocks under various land use andland cover types in the Kintampo North Municipal, Ghana. The study utilized data obtained on Soil bulk density, pH, particle size distribution and SOC from random field sampling on 34 plots and 24 sample points at depths: 0 - 10 cm, 10 - 20 cm and 20 - 30 cm per plot. It also integrated two Landsat images (Landsat 8 & 5) and interview data of 120 farmers with soil corer. Soil bulk density, pH, particle size distribution and SOC were determined using standard laboratory procedures and computations interview with 120 farmers. His efforts earned him 81% and 65% scores during the internal and external oral defense respectively as well as two journal publications in quality journals.

AKAMAH, Abel Kokouvi appraised the trends in land use and cover change following climate variability in Ogou District, Togo. Data used for the study include climate data collected from *Direction du Service National de la Meteorologie du Togo*, downloaded Landsat images from GLCF, as well as household survey of two hundred and forty seven (247) farming households. His effort earned him 65% and 55% scores during the internal and external oral defense respectively.

ADENLE, Ademola Andrew assessed the sustainability of fadama farming system as an adaptive response to climate change and variability in Southern Guinea Zone of Nigeria. Primary data for the study were collected through the administration of a structured questionnaire and Focus Group Discussions (FGD) involving Fadama farmers and scientists at National Cereal Research Institutes (NCRI) Badeggi, Niger state. Other datasets include remote sensing data obtained from United States Geological Survey (USGS) and Meteorological data downscaled from Era interim. His efforts earned him 75% and 65% scores during the internal and external oral defense respectively as well as journal publications.

2.3.2 BATCH "B" STUDENTS' RESEARCH

GBANGOU, Talardia analysed climate change projection on water availability for rainfed agriculture in Awun Basin, Kwara State, Nigeria. The study utilized RegCM4 for two scenarios (RCP4.5 and RCP8.5) driven by two GCMs (MPI and GFDL) collected at WASCAL competence centre, Burkina Faso, and synoptic weather observation of Ilorin (1985-2014) collected at NIMET, Abuja. His efforts earned him 69% and 70% scores during the internal and external oral defense respectively as well as a journal publication in a high profile journal.

DAOU, Assitan assessed the impact of climate change on land use/land cover in Kogi State, Nigeria. The data used for the study include forty years rainfall and temperature data (1975-2014) obtained from NIMET, Landsat images (1987, 2001 and 2014) and questionnaire on farmer's perception. The output of the research earned her 67% and 65% scores during the internal and external oral defence respectively.

OKAFOR, Gloria Chinwendu examined household vulnerability and adaptation to water stress induced by climate variability on downstream Kaduna River Basin. The data used for the study include historical records of hydro-climatic data obtained from NIMET and Shiroro Hydro-electric Power Station, and 200 randomly sampled households chosen for a qualitative stakeholders' participatory survey for exploring vulnerability. Her efforts earned her 70% and 70% scores during the internal and external oral defense respectively.

ALLAKONON, Marsanne Gloriose Bignon assessed the vulnerability of scattered agroforestry tree species to climate change in Niger State, Nigeria. The primary data used was questionnaire

administered to 340 farmers, heads of households, across seven (7) Local Government Areas (LGAs) of the state, which enabled the identification of the most used species, and the assessment of their ethno-botanic, edible cultural and economic importance. The final output of the research earned her 78% and 70% scores during the internal and external oral defense respectively.

KOGLO, Yawovi Séna studied the effect of pre - wetted technique on soil temperature, moisture content, organic carbon and greenhouse gas emissions in Niger State, Nigeria. The primary data used was the outcome of an experiment conducted at Edozhigi on integrated formulations of rice straw and urea at different rates respectively: 2, 3 and 4 t/ha and 25, 50 and 75 kg/ha with one check plot. Final result of the study earned him 74% and 71% scores during the internal and external oral defense respectively.

BISSADU, Kossi Dodzi carried out remote sensing and gis-based assessment of land degradation driven by climate and land use changes in Nasarawa State, Nigeria. Temperature and rainfall data were collected for a time period of 34 years for two meteorological stations of Nasarawa State. Landsat satellite images of the years 1986, 1999 and 2015 were classified using maximum likelihood to produce LULC maps. The final output of the research earned her 75% and 67% scores during the internal and external oral defense respectively.

ASONIBARE, Femi Oluwatosin worked on site selection for urban forestry development as a mitigant of climate change in Ilorin Area, Southern Guinea Savannah of Nigeria. The study employed a geographic information system (GIS) for analysis and presentation of the spatial data. The maps were prepared, reclassified and standardized within the GIS environment. Image classification was used to generate land use, land cover map of the study area for 2015 from Landsat 8 image. His efforts earned him 65% and 73% scores during the internal and external oral defense respectively.

COULIBALY, Gnenakantanhan examined the effects of climate change on groundwater resources in Kogi State, Nigeria using Water Balance Method. Data utilized include historical climate data, questionnaires, and soil samples. Questionnaires were used to assess inhabitants' perception about climate change and its potential impact on groundwater. The final product of the research earned him 50% and 66% scores during the internal and external oral defense respectively.

MOUSSA, Soulé assessed the impact of land use and climate change on vegetation dynamics of Doma Forest Reserve in Nasarawa State, Nigeria. The study used Land satellite images for 1984, 1999 and 2015 downloaded from GlOVIS, field data obtained from Doma forest inventory and questionnaire. The final product of the research earned her 67% and 60% scores during the internal and external oral defense respectively.

LARBI, Isaac evaluated root and tuber crops yield under the changing climatic conditions in Kwara State, Nigeria. The data used were Rainfall data (1975-2014), minimum and maximum temperature (1985-2014) and yield data of cassava and yam covering a period of twenty years (1995-2014). Questionnaires were also administered. The final results earned him 62% and 70% scores during the internal and external oral defense respectively.

2.3.3 BATCH "C" STUDENTS' RESEARCH

ODOOM, Peter Rock Ebo assessed climate change impacts on streamflow and energy production in Shiroro Hydro power dam located in Central Nigeria using Rainfall, streamflow and temperature

(minimum and maximum) data collected from Nigeria Meteorological Agency (NIMET), climate model output data from the output of the Coordinated Regional Downscaling Experiment (CORDEX) atmospheric model simulations from WASCAL WACS in Akure, as well as Climate Forecast System Reanalysis (CFSR) and Remote Sensing datasets such as Digital Elevation Model, FAO soil map and Moderate Resolution Imaging Spectroradiometer (MODIS) land cover. His efforts earned him 77% and 62% scores during the internal and external oral defense respectively.

CHAM, Fafa Oggo undertook a study to determine the relationship between variability in climate parameters and the occurrences of common cattle diseases in Upper River Region using monthly minimum and maximum temperature, rainfall and humidity meteorological data from Basse and Fatoto Stations, wind speed data from the Department of Water Resources, veterinary clinical records from the Regional Veterinary office in Basse as well as research questionnaires and focus group discussions from three selected districts. The output of the research earned him 72% and 70% scores during the internal and external oral defense respectively.

RAGATOA, Dakéga Saberma investigated the heat wave characteristics in different climatic zones in Nigeria over a long period using daily minimum and maximum temperature for 17 stations across the country acquired from NIMET, ERA-INTERIM reanalysis daily minimum and maximum temperature data from 1981 to 2016 collected from ECMWF data base, and CORDEX-AFRICA Weather Research and Forecast (WRF) model outputs from 2018 to 2100 obtained from GSP WACS Akure, where most of his analysis were run. His work provided national outlook of heatwave situation in Nigeria. The output of the research earned him 75% and 75% scores during the internal and external oral defense respectively. His effort also earned him a publication in a reputable international journal in 2018.

IBOKO, Maduabuchi Paul predicted the impact of rainfall variability on water erosion intensity under four soil management practices in Nsukka Local Government Area, He also utilized data acquired from NiMet. Nigeria using Soil samples collected from profile pits dug on four different land uses; Water Erosion Prediction Project (WEPP) model, as well as CORDEX Weather Research and Forecast (WRF) model outputs from 2041 to 2170 obtained from GSP WACS Akure. His efforts earned him 68% and 65% scores during the internal and external oral defence respectively.

GUIDIGAN, Meminvegni Landry Gildas studied climate and land use impacts on the geographic distribution of Kigelia africana (Bignoniaceae) in Republic of Benin using current and future (CNRM-CM5 and HadGEM2-ES model) climate data retrieved from WorldClim, Soil layer from World Soil Database version 1.2 and Climate Change Initiative Land Cover (CCI_LC) maps of 1992, 2003 and 2015 from the European Space Agency (ESA), MaxEnt species distribution modelling (SDM) as well as households interviews using a semi-structured questionnaire. The output of the research earned him 90% and 74% scores during the internal and external oral defence respectively. His effort earned him two publications in Springer Journal in 2018.

ADET, Lucette assessed climate change and its impacts on occurences of sargassum natans and sargassum fluitans on coastline of Lagos and Environs, Nigeria using salinity, wind speed and sea surface temperature from Pilot Research Moored Array in the Tropical Atlantic (PIRATA) website, precipitation data from NOAA database and ocean current data from NASA Ocean Ocean Surface Current Analysis Real Time (OSCAR), remotely sensed images to map Sargassum distribution from 2011-2016 and questionnaires on household perceptions on Sargassum natans and Sargassum fluitans

in Lagos State. She also benefitted from the NIMET data that was acquired by the Centre from the students' research budget. Her efforts earned her 76% and 72% scores during the internal and external oral defense respectively.

Table 2.3: The scores of Batches A, B and C students from their projects

S/N	Name of Graduate	Internal Examiner's Score	External Examiner's Score	Average Score
BATCH A WASCAL CC & ALU GRADUATES' PROJECT GRADES				
1.	ADENLE Ademola Andrew	75	65	70
2.	AKPEOKHAI Agatha Ochuware	75	68	72
3.	BESSAH Enoch	81	65	73
4.	KIMA Sophie Agnes	83	70	77
5.	NYADZI Emmanuel	70	80	75
6.	DAH-GBETO Afiavi Pelagie	74	65	70
7.	AKAMAH Abel Kokouvi	65	55	60
8.	GARBA HIMA Mamane Bello	67	63	65
9.	SONKO Ebrima	68	60	64
10	SANOGO Karamoko	78	71	75
BATCH B WASCAL CC & ALU GRADUATES' PROJECT GRADES				
11.	BISSADU, Kossi Dodzi	75	67	71
12.	KOGLO, Yawovi Séna	74	71	73
13.	ALLAKONON, Marsanne Gloriose Bignon	78	70	74
14.	ASONIBARE, Femi Oluwatosin	65	73	69
15.	OKAFOR, Gloria Chinwendu	70	70	70
16.	LARBI, Isaac	62	70	66
17.	GBANGOU, Talardia	69	70	70
18.	MOUSSA, Soulé	67	60	64
19.	COULIBALY, Gnenakantanhan	50	66	58
20.	DAOU, Assitan	67	65	66
BATCH C WASCAL CC & ALU GRADUATES' PROJECT GRADES				
21.	ODOOM, Peter Rock Ebo	77	62	70
22.	SANOU, Charles Lamoussa	72	70	71
23.	IBOKO, Maduabuchi Paul	68	65	67
24.	SIMON, Susan Ojochide	72	72	72
25.	CHAM, Fafa Oggo	72	70	71
26.	RAGATOA, Dakega Saberma	75	75	75
27.	ADET, Lucette	76	72	74
28.	SIDIBE, Mohamed	70	72	71
29.	SANI ISSA, Mahaman Sanoussi	56	73	65
30.	GUIDIGAN, Gildas Landry Mèminvègni	90	74	82

SIMON, Ojochide Susan assessed the response of land surface temperature to land use and land cover in Kano Metropolis and its Suburbs, Nigeria using ground truth training samples from the field; Landsat 8 Operational Land Imager and Thermal Infrared Sensor (OLI/TIR), multi-temporal remote sensing satellite data of 2015 and 2016 for retrieving LST and deriving land use and land cover classification, various land cover indices such as Normalised Difference Vegetation Index (NDVI), Normalised Difference Built Index (NDBI) and Modified Normalised Difference Water Index

(MNDWI) derived using R-statistics software. Part of her analysis were done in University of Wurzburg. Her efforts earned her 72% and 72% scores during the internal and external oral defense respectively.

SANOU, Lamaoussa Charles assessed the implications of climate change and land use/land cover changes on pastoral resources and practices within Kompienga Province, Burkina Faso. He utilized rainfall, temperature, relative humidity and potential evapotranspiration data from the National Office of Meteorology; training samples from the field, Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI from USGS website, and Survey data collected from 271 respondents (pastoralists, agro-pastoralists) in the province. The output of the research earned him 72% and 70% scores during the internal and external oral defense respectively.

SIDIBE, Mohamed assessed and predicted climate variability impact on land use land cover change in Sikasso Region, Mali with focus on agricultural lands. The data used comprised time series satellite images from Moderate Resolution Imaging Spectroradiometer (MODIS) Terra for the years 2000, 2008 and 2016, monthly rainfall and temperature from 1981 to 2016 for the four main meteorological stations across the study area acquired from the National Meteorological Services, Mali-Meteo, as well as and socioeconomic information. The output of the research earned him 70% and 72% scores during the internal and external oral defense respectively.

SANI ISSA, Mahaman Sanoussi worked on soil nutrient dynamics under long term application of mineral fertilizer micro-dosing to pearl millet on a Sahelian Sandy soil of Niger Republic. The output of the research earned him 56% and 73% scores during the internal and external oral defense respectively.

At least papers have been published from various research carried out by graduates of the Centre, the most unique being a national case study that utilised climate data acquired from Nigerian Meteorological Agency (NIMET) published in an international journal of repute by RAGATOA, Dakega Saberma, within 6 months post-graduation. Worthy of mention are three papers from Batches “A” (BESSAH, Enoch), “B” (TALARDIA, Gbangou) and “C” (GUIDIGAN, Gildas Landry Mèminvègni) graduates that were published in 2018. These publications are listed in the publication section of the report.

3.0 SUCCESS STORIES

3.1 AWARDS AND INTERNATIONAL RECOGNITION

In 2014, the best student of Batch A, with a CGPA of 4.90, was employed by the University in the Department of Geography and he is currently on study fellowship for a PhD programme in the Institute of Geography, University of Bern, Switzerland; and he recently secured Rufford Small Grant to conduct field work in his home country, Nigeria. One of the Batch A student, Agatha Ochuware Akpeokhai, was a research fellow of Alexander von Humboldt (AVH) foundation on Climate Protection and Climate-Related Resource Conservation, Germany (2014 – 2016).

In 2018, a Batch A student, Enoch Bessah, had a UNEP/UNESCO/BMU short course fellowship award from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety to attend "SC 76" Renewable Energy Sources and Energy Efficiency course for 4 weeks at the Centre for International Postgraduate Studies of Environmental Management (CIPSEM), Technische Universität Dresden, Germany.

Femi Asonibare, a batch B student, got a Global Environment Facility, Small Project Grant (GEF-SPG) in 2018. He also got a consultancy job with International Fund for Agricultural Development (IFAD) CASP on participatory Land Use Planning in 7 northern Nigeria states. Some of the Centre's graduates are currently on study fellowship for PhD. programme as listed in Table 3.1.

Table 3.1: Graduates on Study Fellowship

Name	Study Fellowship	Since
Enoch Bessah	PhD at University of Ibadan, Nigeria (UNESCO)	2016
Abel Kokouvi Akamah	PhD at Federal University of Technology, Akure (WASCAL)	2016
Ebrima Sonko	PhD at KNUST (WASCAL)	2016
Mamane Bello Garba Hima	PhD at Senegal (WASCAL)	2016
Emmanuel Nyadzi	PhD at Wageningen University, The Netherlands	2016
Gloria Okafor	PhD at KNUST (WASCAL)	2016
Soulé Moussa	PhD at KNUST (WASCAL)	2016
Asitan Daou	PhD at Mali (WASCAL)	2016
Coulibaly Gnenakantanhen	PhD at 2iE, Ouagadougou, Burkina Faso	2016
Andrew Ademola Adenle	PhD at Institute of Geography, University of Bern, Switzerland	2017

3.2 COMMUNICATION AND VISIBILITY ACTIVITIES

In 2014, WASCAL CC&ALU (now WASCAL CC&HH) had the commissioning of her building, located in the Gidan Kwano Campus of the University, and also celebrated the graduation of her first set of students. During the ceremony, the Vice Chancellor, Prof Akanji, and his team of Principal Officers received guests such as the Minister of Environment (represented by Dr Samuel Adejuwon, Director of Climate Change Department in the Ministry), German Ambassador to Nigeria (represented by Mr Dirk Schulz); Chairman of WASCAL Board (Prof Modibo Haidara), WASCAL Board member representing Nigeria and Second Vice Chairman (Prof Adeniyi Osuntogun), as well as the Executive Director and his team (Dr Sedogo, Ouattara and Mr Ofori).

Other esteemed guests at the event were: the Vice Chancellor of FUTA represented by Prof Bayo Omotosho; representatives of our two German Partner Universities (Dr Michael Thiel and Mrs Mini Boutros); members of WASCAL CC&ALU International Regional Advisory Board comprising Prof Bayo Omotosho, Dr Eric Forkuo (representing KNUST), Dr Georges Abbey (representing University of Lome), Mrs Christine K. (from **Heinrich Böll Foundation, Nigeria**, representing the Civil Society) and Dr Adejuwon (representing Focal Ministry); members of FUT Minna Advisory Board led by the Dean of Postgraduate School, Prof (Mrs) Stella Zubairu; as well as staff and students of WASCAL CCALU. The graduating students also showcased their research in a poster exhibition that was declared open after the WASCAL CC&ALU building was commissioned.

Figure 3.1 Batch "A" graduates with some of the dignitaries in their graduation ceremony

In 2016, a member of the Governing Board of WASCAL, Prof. Brice Sinsin, was invited by the University to give the 25th convocation lecture. Batch B graduates, were brought back from their respective countries by WASCAL to participate in the convocation ceremony, where they witnessed the pomp and pageantry of such an occasion in a Nigerian University. Batch C students, in 2018, attended and made presentation of their research in conferences within the country (Lapai, Port Harcourt and Kano).

During his familiarization visit to the University, the Chancellor, His Eminence, Eze (Dr) Eberechi N. Dick (JP), the Eze Udo 1 of Mgboko Ngwa Amaise Autonomous Community, Obingwa Local Government Area and Chairman, Abia State and South East Council of Traditional Rulers, honoured the Centre with his presence, where he encouraged the staff to keep up their good work.

The campus radio (Search FM on 92.3 MHz), which has a signal coverage over the whole of Minna, some parts or Kaduna and Abuja, aired its interview with the Executive Director during his first visit

to the University in August 2018. Additionally, the visit was publicised via the University's weekly online Newsletter and Quarterly magazine. Both of these have a wide coverage beyond the shores of Nigeria. A video clip of the visit was sent to the Publicity Department of WASCAL Accra for record purposes and dissemination. Figure 3.2 shows the Vice Chancellor, Prof Abdullahi Bala and Executive Director of WASCAL, Dr Moumini Savadogo during the courtesy call on the VC.

Figure 3.2 The Vice Chancellor, Prof Abdullahi Bala and Executive Director of WASCAL, Dr Moumini Savadogo during the courtesy call on the VC

Amongst the communities studied by the students (Busugi, Chikodna and Kataeregi), as part of the requirements for the course Community Development Project (CCA 712), Busugi community was selected for community development project sponsored by Batch C students, WASCAL CCALU staff and some International Advisory Board members, due to the debilitating state of the classrooms in the community primary school that exposes developing young brains to climate change induced high temperature. The primary school classrooms were renovated. Also, the batch C students developed a monograph of Kataeregi village, which is awaiting publication.

The Dean of Post Graduate School, Prof. M. G. M. Kolo, who represented the Vice Chancellor, the Director (Prof. A. A. Okhimamhe), the Deputy Director (Dr. Mrs Saratu Usman Ibrahim) and the representative of German partner University, Dr. Michael Thiel, were interviewed during the commissioning of the Busugi project and streamed live on the campus FM radio and also published online in the University's Newsletter. Figures 3.2 and 3.3 show clips from the commissioning of the renovated building.

Figure 3.3 The representative of the Vice Chancellor, Prof. M. G. M. Kolo (Dean of Postgraduate School) commissioning the renovated building.

Figure 3.4 Members of the International Advisory Board, Staff of WASCAL and Busugi Primary School staff and pupils, their parents and other members of the community at the commissioning.

3.3 ALUMNI TESTIMONIES

Graduates of the Centre are undertaking various PhD programmes within Nigeria, West Africa, Netherlands and Switzerland. The best graduating student in Batch A was immediately employed by the University and is currently an Assistant Lecturer in the Department of Geography. Other graduates are currently formally employed as Head of the Division of Programming the Energy Sector at the

Ministry of Planning, Niger (**Mr Mamane Garba**); PACJA-Gabon,Panafrican Alliance for Climate Justice under the Gender-Agriculture and Sustainable Development committee (**Miss Dah-Gbeto**); Range Management Specialist on the Sahel Sustainable Pastoralist Development Program (SSPDP), Burkina Faso (**Miss Kima**); Head of Section-Environmental Monitoring at the Rural Development Office of Selingué (ODRS), Mali (**Mr Mohamed Sidibe**).

4.0 FUNDING SUPPORT

4.1 CONTRIBUTION OF THE UNIVERSITY

The host University (Federal University of Minna, Niger State, Nigeria) has contributed the following to WASCAL CC and ALU since its inception:

1) WASCAL CC & ALU Complex, which had been in use since 2014, was built on land that costs six million, seven hundred and twenty-six thousand, seventy-one naira, five kobo (₦6,726,071.05), an equivalent of thirty-one thousand, seven hundred and eighty-seven euros seventy cent **(€31,787.70)**. Additionally, the primary supply of electricity to this complex is paid for by the University. This amount is estimated at one million, seven hundred and fifty-three thousand, nine hundred and twenty-six naira, eighty-four kobo (₦1,753,926.84), an equivalent of four thousand, three hundred and eighty-four euros, eighty-two cent. **(€4,384.82)** from October 2012 to February 2018.

2) The University deployed four security personnel to WASCAL CC & ALU Complex on shift basis from inception till to date. Their salaries are being paid fully by the University and this amounts to seven million, seven hundred and thirty-three thousand, eight hundred and eight naira (₦7,733,808.00), an equivalent of nineteen thousand, three hundred and thirty-four euros fifty-two cent **(€19,334.52).**

3) The University provided some furniture for the students' accommodation and WASCAL Office Complex and some of these are still in use. Consequently, this investment by the University amounted to two million, one hundred and sixty-three thousand naira only (₦2,163,000.00) an equivalent of ten thousand, seven hundred and eighty-seven euros, ninety-seven cents **(€10,787.97).** Most of these have been in use since October 2012. These constitute the in-kind contributions to the tune of approximately sixty seven thousand euros **(€67,000.00**). Additionally, the University charged WASCAL highly subsidized school fees of five thousand, seven hundred and fourteen euros and ninety one cents **(€5,714.91)** for all ten Batch C students. This amount is approximately **29%** of the amount budgeted for this sub-head in the spirit of collaboration with WASCAL, with the intention that the balance be utilized in shoring up underfunded items in the budget.

4.2 CONTRIBUTIONS FROM THE SPONSOR (FEDERAL MINISTRY OF EDUCATION AND RESEARCH, BMBF) THROUGH WASCAL

Funds from the Federal Ministry of Education and Research (BMBF), Germany through WASCAL in Accra, Ghana has provided funds amounting to eight hundred and forty eight thousand, two hundred and four euros and twenty one cents **(€848,204.21**), which was used in running the programme from **October 2012 to February 2019**. This amount covered infrastructure/building; students' tuition, language courses, stipend and research grant; staff and faculty honoraria, travel and incentives; internet access, books and journals; teaching aid, office and laboratory equipment; advisory board meetings, two (2) vehicles and operational funds.

	Description	Assigned To	Date Acquired	Purchase Cost/ Prix D'achat			Observations
				Local Currency	Exchange Rate	Euro Equivalent	
	(Model, Manufacturer, Serial No. etc.)	(Location/ Person)	(Month/ Year)				
1	Armless Study Chairs	WASCAL Office	10/5/2012	165,000.00	202.04	816.67	6 Bad and 9 Good
2	File Cabinets	WASCAL office	10/5/2012	110,000.00	202.04	544.45	Good
3	Split ACs	Board Room	10/5/2012	140,000.00	202.04	692.93	Should be replaced
4	Haier Thermocool Fridge	WASCAL Office	10/5/2012	120,000.00	202.04	593.94	1 Bad and 2 Good
5	Set of Dinning table and chairs	Board Room	6/11/2012	150,000.00	198.91	754.11	Good
6	Haier Thermocool Fridge with Freezer	Students Lodge	6/11/2012	90,000.00	198.91	452.47	Good
7	LG Plasma TV	Board Room	10/5/2012	79,000.00	202.04	391.01	Good
8	Gas Cooker	Students Lodge	6/11/2012	45,000.00	202.04	222.73	Should be replaced
9	6.5KVA TEC Generator	Students Lodge	6/11/2012	130,000.00	198.91	653.56	Good
10	Mattresses	Students Lodge	6/11/2012	145,000.00	198.91	728.97	Good
11	Beds	Students Lodge	6/11/2012	450,000.00	198.91	2,262.33	Should be replaced
12	Water Dispenser	WASCAL Office	10/5/2012	60,000.00	202.04	296.97	Good
13	Water Storage Tanks	WASCAL Office	6/11/2012	90,000.00	198.91	452.47	Good
14	Library Partitioned Reading Tables	Library	10/5/2012	115,000.00	202.04	569.19	Should be upgraded
15	Board Room Conference Table	Board Room	10/5/2012	274,000.00	202.04	1,356.17	Good
	Total			**2,163,000.00**		**10,787.97**	

Table 4.1: The current status of assets provided by the University

5.0 PUBLICATIONS

5.1 STUDENTS' THESES

Table 5.1 Batch "A" Theses

S/N	TITLE	AUTHOR
1	An Evaluation of the Impact of Tillage and Fertility Management on Soil Carbon Sequestration at Minna in the Southern Guinea Savanna of Nigeria.	AKPEOKHAI, Agatha Ochuware
2	Seasonal Variation on Soil Nutrient Availability for Plant Use and Farmers Adaptation Strategies in North Bank Region of the Gambia	SONKO, Ebrima
3	Assessment of Soil Organic Carbon Stocks under Various Land Use/Land Cover Types in the Kintampo North Municipal, Ghana	BESSAH, Enoch
4	Assessment of the Impact of Climate and Land Use Changes on Pastoral Livestock Farming in Boulgou Province, South-Eastern Burkina Faso	KIMA, Sophie Agnes
5	Assessment of Soil Organic Carbon Stocks and Trace Gas Emissions from Burnt Lands under different Vegetation in Northern Ghana	NYADZI, Emmanuel
6	Gender and Land Use Decision-making in Response to Climate Variability in Dassari Watershed (Matteri), Benin Republic.	DAH-GBETO, Afiavi Pelagie
7	Sustainability of Fadama Farming System as an Adaptive Response to Climate Change and Variability in Southern Guinea Zone of Nigeria	ADENLE, Ademola Andrew
8	Impact of Rainfall and Temperature Variability on Agriculture in Dosso and Maradi Regions of Niger Republic: A Ricardian Approach.	GARBA, Hima Mamane Bello
9	Evaluation of Climate Variability and Land Use Change on Vegetation Dynamics in Fina Reserve, Mali	SANOGO, Karamoko
10	An Appraisal of the Trends in Land Use /Cover Change following Climate Variability in Ogou District, Togo	ABEL, Kokouvi Akamah

Table 5.2 Batch "B" Theses

S/N	TITLE	AUTHOR
	Assessment of Vulnerability of Scattered Agroforestry Tree Species to Climate Change in Niger State, Nigeria	Allakonon, M. Gloriosse Bignon
	Analysing Climate Change Projection on Water Availability for Rainfed Agriculture in Awun Basin, Kwara State, Nigeria	Gbangou, Talardia
	Effects of Climate Change on Groundwater Resources in Kogi State, Nigeria Using Water Balance Method.	Coulibaly, Gnenakantanhan
	Evaluation of Root and Tuber Crops Yield under the Changing Climatic Conditions in Kwara State, Nigeria	Larbi, Isaac
	Assessment of the Impact of Climate Change on land Use/Land Cover in Kogi State, Nigeria	Daou, Assitan
	Impact of Land Use and Climate Change on Vegetation Dynamics of Doma Forest Reserve in Nasarawa State, Nigeria	Moussa, Soule
	Site Selection for Urban Forestry Development as a Mitigation of Climate Change in Ilorin Area, Southern Guinea Savanna of Nigeria	Asonibare, Femi Oluwatosin
	Household Vulnerability and Adaptation to Water Stress Induced by Climate Variability on Downstream Kaduna River Basin	Okafor, Gloria Chiwendu
	Remote Sensing and GIS-Based Assessment of Land Degradation Driven by Climate Land Use/ Change in Nassarawa State, Nigeria	Bissadu, Dodzi Kossi
	Effect of Pre-Wetted Technique on Soil Temperature, Moisture Content, Organic Carbon and Greenhouse Gas Emissions in Niger State, Nigeria	Koglo,Yawovi Sena

Table 5.3 Batch "C" Theses

S/N	TITLE	AUTHOR
	Assessment of the Response of Land Surface Temperature to Land Use and Land Cover in Kano Metropolis and its Suburbs	SIMON, Susan Ojochide
	Climate Change and Occurrence of *Sargassum Natans* and *Sargassum Fluitans* on Nigeria's Coastal Landscape and Their Impact on People's Livelihood	ADET, Lucette
	Soil Nutrient Dynamics under Long Term Application of Mineral fertilizer Micro-dosing to Pearl Millet on a Sahelian Sandy Soil of Niger Republic	SANI ISSA Mahaman Sanoussi
	Spatial and Seasonal Variations of Heat Wave Characteristics over Nigeria	RAGATOA Dakega Saberma
	The Implications of Climate and Land use/Land Cover Changes on Pastoral Resources and Practices in Kompienga Province, Burkina Faso	SANOU, Charles Lamoussa
	Future Climate and Land Use Impact on the Geographic Distribution and Conservation of Kigelia Africana in Benin, West Africa	GUIDIGAN, Gildas Landry Meminvegni
	Assessment and Prediction of Climate Variability Impact on Land Use Land Cover Change in Sikasso Region, Mali	MOHAMED, Sidibe
	Prediction of Rainfall Variability Impact on Water Erosion Intensity under Four Soil Management Practices at Nsukka, Nigeria	IBOKO, Maduabuchi Paul
	The Impact of Climate Variability on the Occurrence of Common Cattle Diseases in Upper River Region, the Gambia	FAFA, O. Cham
	Impact of Climate Change on Hydropower Generation: A Case Study of Shiroro Dam, Nigeria	ODOOM, Peter Rock Ebo

5.2 ABSTRACTS

5.2.1 BATCH "A" ABSTRACTS

1) Thesis Title: "*Gender and Land Use Decision Making in Response to Climate Variability in Dassari Watershed (Materi): Benin Republic"* By DAH-GBETO, Afiavi Pelagie

ABSTRACT

This study examines gender perspective when addressing responses to climate variability/ change and addresses some of the gaps in understanding how men and women farmers cope with climate variability in Dassari watershed. It investigated how coping strategies are shaped by gender dimensions of power relations, access to resources and equity in decision-making. While the role playing game (RPG) tool helped identify gender specific strategies to cope with climate change, by demonstrating men's and women's abilities to react to changes in the climate; a household survey was conducted to assess household characteristics, farmers' opportunities and constraints at farm and household level. Two workshops were held respectively with the men and women involved in farming activities. The Focus Group Discussions engaged 8–10 individuals to generate qualitative information on the study variables and captured how men and women in farm households perceive and experience climatic shift. Results showed that farmers' interviewed are very knowledgeable about climate variability/change events. They are aware of changing climate causes and consequences on their daily life especially their farming activities and majority of them; about 86.6 % have started adaptation. Majority of the respondents 87.3 % agreed that there have been increased in temperature trend in the watershed. The farmers observed also that there have been changes in the rainfall patterns too. Over 53.3 % observed the rainfall to have decreased while 43.1 % observed an unpredictable and poor distribution pattern. They highlighted unpredictable rainfall patterns, rising temperatures and the occurrence of strong winds as major climatic changes. From the RPG data, a clear difference was observed between male and female styles of decision making, and coping strategies under climate variability. The game result showed that, while access to information lead the decision-making

process of both female and male farmers; access to credit and household level food security determine land use decision making for male and female respectively. Farmers in Dassari watershed have been adapted in different ways from intensification of fertilizer used to prayers to the gods. However, they also identified some limitations to the adaptation measures undertaken before listing their recommendations on how to improve things for the benefit of the farmer and for everybody. From these findings, advices have been given that more opportunity should be given to the women in this area to participate in (natural) resources management and decision making process; in order to help the community with regards to poverty alleviation and sustainable management of resources.

2) **Thesis Title: "*Assessment of Soil Organic Carbon Stocks and trace Gas Emissions from burnt Lands under different vegetation in Northern Ghana*" By EMMANUEL, Nyadzi**

ABSTRACT

To determine the contributions of human activities on a changing climate do not only call for the assessment of main greenhouse gases but also trace gases emissions as well as variations of carbon sink in the soil. This study examined the dynamics of soil organic carbon stocks (SOCS) and estimated trace gas emissions using Intergovernmental Panel on Climate Change (IPCC) published guidelines. The study was conducted in the guinea savannah of Northern Region of Ghana. Six (three on burnt and other three on unburnt lands) experimental plots of 50 m x 50m were marked out on four different vegetation and soil samples taken from five sampling points at 0-10 cm, 10-20 cm and 20-30 cm depths. Carbon concentration and bulk density were determined using Wakley Black and core method respectively. Another Five sampling plots (1m x 1m) on each vegetation cover were marked out to sample above-ground biomass for carbon content determination, before carbon release and trace gases (CH4 and CO) were further estimated. Findings of the research showed that while Carbon and bulk density differed significantly ($P<0.05$) across depth. A significantly strong negative correlation existed between them. Fire significantly ($P<0.05$) increased SOCS on burnt lands. SOCS insignificantly ($P>0.05$) varied under the vegetation types with close savanna woodland (CSW) recording the highest stock of organic carbon of ~16.7t/ha on unburnt sites and ~19.43 t/ha on burnt sites while Grass/herbs with scattered trees and shrubs (GHST) recoded ~7.9 t/ha and ~9.42 t/ha on unburnt and burnt sites respectively. Above-ground biomass density was highest on OSW with a density of ~4.8t/ha, while CSW recorded the least biomass density. GHST contained the highest organic carbon of 45.46% while CSW recorded 29.28% as the lowest carbon content. A significantly positive correlation existed between above-ground biomass density and carbon released. CH_4 and CO emitted differs significantly ($p<0.05$) under all the vegetation cover types and were perfectly correlated ($r=1.00$) with the quantity of above ground biomass density and carbon release. Results also showed that irrespective of the vegetation type, more CO were emitted than CH_4 during burning and this variation differed significantly ($P<0.05$) under the different vegetation types. The average amount of CH_4 and CO emitted per hectare of area burnt made Open savanna woodland (OSW) the highest CH_4 and CO emitter with 0.001719 tons and 0.045119 tons respectively while closed savanna woodlands (CSW) recorded the least emission of 0.000268 tons of CH_4 and 0.007043 tons of CO. The ratio of Dead and live at the time of burning on each vegetation type was the main reason for variations in emissions under the different vegetation covers. The results imply that, soils in the study area are generally low in SOCS and in the face of a changing climate (increasing temperature and unreliable rainfall) soils of this kind can barely support plant growth. Also the emissions may directly and indirectly contribute to global warming, impact negatively on both plant and animals, reduce visibility, cause health problems as well as increased human mortality especially if locally significant, especially when the release are annual, and concentrated during the dry season.

3) **Thesis Title: *"Impact of Rainfall and Temperature Variability on Agriculture in Dosso and Maradi Regions of Niger Republic: A Ricardian Approach"* By GARBA HIMA, Mamane Bello**

ABSTRACT

This study assesses the impact of climate variability on crop agriculture in Maradi and Dosso regions of Niger Republic. It is based on farm data collected from over 200 farmers. Annual crop net revenue is regressed on climate and other socio-economic variables. The results are then applied to possible future climates. Marginal impacts of the climate variables on crop net revenues show different results for precipitation and temperature and also for adaptation and without adaptation models. This analysis indicates that if temperature increases by 1°C annually, the annual crop net revenues for both models will decrease: up to 582170.7 FCFA for model one (M1) and up to 1316 FCFA for model two (M2). But, the marginal impact of increasing precipitation of 1mm/month will increase crop revenue for the models: up to 721917 FCFA for M1 and 1,861,455 FCFA for M2. The study examines also the impact of uniform climate scenarios on the net revenue per hectare. They are the Intergovernmental Panel on Climate Change (IPCC) scenarios: decreasing precipitation by 7% and 14% and increasing temperature (RCP 4.5 & RCP 8.5). The crop net revenue will fall between 10 and 26% if the scenarios happened. Another finding of this thesis is that: Each farmer who is practicing adaptation is able to cover the potential loss from climate change. For instance, farmer from Maradi and Dosso can respectively compensate the potential adverse impact of climate variability up to 8.95% and 12.71% per ha. How farmers perceive climate change and how they adapt were captured in this study. It also gives constraints on adaptation mechanisms. Farmers of these regions are aware of climate changes. The majority of them remarked a decrease in precipitation and an increase in temperature, and that some have taken adaptive measures. The analyses on top more or less testify the size and direction of the impact of climate change on crop net revenue. In general, the results provide an opinion about decreasing precipitation and increasing temperature that are harmful to the agricultural productivity. Maradi region is more affected by climate change negative impacts comparing to Dosso region. These results propose that Niger Republic should start planning measures for unexpected events of climate conditions. There is need to encourage irrigated systems in order to minimise the vulnerability of the agricultural sector.

4) **Thesis Title: *"Seasonal Variation on Soil Nutrient Availability for Plant use and Farmers Adaptation Strategies in North Bank Region of The Gambia"* By SONKO, Ebrima**

ABSTRACT

This study examined seasonal variation on soil nutrient availability for plant use and farmers' adaptation strategies in North Bank Region of The Gambia. The aim was to evaluate nutrient levels in the soil interface by determining changes in soil nutrient availability for plant use during wet and dry season. Soil samples were collected in three upland fields at a depth of 0-15cm and analysis were done on this variables: pH, Soil organic carbon (SOC), total nitrogen (TN) and soil moisture content. Soil pH was measured using the glass electrode method with a soil-to-water ratio of 1:2. Soil total nitrogen was determined using the micro Kjeldahl distillation and titration method. Soil organic carbon (SOC) was determined by a modified Walkley-Black procedure. The gravimetric method of moisture estimation was used to dry the soil samples on the oven at 105 °C and dried to a constant weight. Plant tissue (groundnut) was collected within $1m^2$ wooden frames and prepared for routine analysis of total nitrogen (TN), total carbon (TC) and moisture content. Socio-economic data was obtained from 105 respondents through household interview. Rainfall data was obtained from Water Resources of The Gambia to determine the trends in the study area. The result show that soil moisture

content, soil total nitrogen and soil pH were found to be significant (P<0.05) in different seasons indicating variation in nutrient content in the productive soil depth due to the influence of moisture deficiency except soil organic carbon which shows no significant difference. In addition, variation of available plant nutrients content within the communities showed that higher plant total nitrogen was received during wet season in Nuimi Lamin 3.18 % followed by Jokadu Dasilami with 2.84 % while Njaba Kunda is having the least 2.20 %. During dry season there was no significant (P<0.05) different of plant total nitrogen among communities. Meanwhile Plant total carbon also showed a significant (P>0.05) difference within the communities during wet season, Nuimi Lamin having the highest percentages (53.11% followed by Jokadu Dasilami with 51.12% while Njaba Kunda recorded the least 36.88 %). During dry season there was no significant (P<0.05) difference in plant total carbon. It is establish that majority of the farmers are between 40-60 years of farming experience and have limited knowledge of farm management practices. Farmers use both chemical and organic fertilizers mostly to manage their soils as adaptation strategies. Rainfall trend in the study area was found to be 35 % lower (425 mm) than normal 1200 mm. The study also concluded that soil degradation and drought in the region is a challenge, therefore it is recommended that farmers should be encouraged to practice organic farming and avoid harvesting the entire crop biomass which can conserve moisture and increase soil fertility.

5) **Thesis Title: *"Assessment of the Impact of Climate and Land Use Changes on Pastoral Livestock Farming in Boulgou Province, South-Eastern Burkina Faso"* BY KIMA, Sophie Agnès**

ABSTRACT

In Burkina Faso, climate change and conversion of grazing area to cropland are the main challenge of pastoral livestock. This study seeks to examine the impact of climate and land use/cover change on pastoral livestock farming in Boulgou province between 1980 and 2013. In order to achieve this, annual rainfall and temperature data from 1980 to 2012 were statistically analysed using a simple linear regression model and standardized anomaly index (SAI) to show the long-term annual trends, and to evaluate the inter-annual fluctuations of rainfall in the study area over the period of study. In addition, onset and cessation dates were computed from daily rainfall data because of their importance to agriculture and water resources management. Also, Landsat satellite images of 1989, 2001 and 2013 as well as socio-economic data from 248 respondents were analysed. Within the period of study, annual rainfall was highly variable and this was depicted as positive or negative anomalies with standardized anomaly index (SAI) greater or less than 1.5 times the standard deviation below the 33 years mean of 818.9mm. Conversely, the annual minimum and maximum temperature show a statistically significant upward trend with a rate of change of 0.25°C and 0.24°C per decade respectively which reflects an increase 0.82°C and 0.76°C from 1980 to 2012. Although substantial increase in rainfall occurred in 1989, 1994, 2007, 2008 and 2009, such anomalies occurred only 42.4% of the time, implying that there were more dry years than wet years. In addition, the analysis of daily rainfall data showed that, on the average, the onset and cessation dates were 9th June and 7th October, depicting a delay, in comparison to the long term average of mid-May and October. The interpretation of the classified Landsat images revealed an increase in cropland from 20.5% to 36.7% in 1989 and 2013 respectively. This resulted mainly from the conversion of woody savannah and shrub and grass savannah. The socio-economic survey suggests that most of the agro-pastoralists (about 73.4%) had observed that temperature had changed compared with rainfall amount (1.2%). In addition, 95.2% of the respondents observed that the frequency of the rains had decreased. The survey corroborated the results obtained from the analyses of climate and Landsat data used for the study.

The respondents believe that climate is changing for the worst and is having negative impacts on crop and pastoral livestock through reduction in crop yield, fodder quantity and quality, water availability, animal production and reproduction, increasing of animal morbidity and mortality. Consequently, in order to tackle the combined impacts of climate variability /change and land use change, they practise local adaptation measures that include the use of crop residue (98.4%), vaccination (91.9%), the adoption of agro-pastoralism (89.5%), using concentrated livestock feed (80.6%), herd destocking (44.8%) and use of woody forage (42.3%). In addition to these, improvement of grazing areas, availability of information and technical training on new adaptation technologies acquired from the NGOs and government agencies can successfully reduce the vulnerability of agro-pastoralists.

6) **Thesis Title: "*Evaluation of Climate Variability and Land Use Change on Vegetation Dynamics in Fina Reserve, Mali*" By SANOGO Karamoko**

ABSTRACT

The sustainable management of biodiversity and productivity in forested lands requires an understanding of main interactions between socioeconomic, biophysical factors and their response to environmental change. Fina reserve is located between $13°10^{1}$ - 40^{1} North latitude and $9°30^{1}$ - 50^{1}West longitude. The study evaluated the effect of climate variability and land use change on the vegetation dynamic in Fina reserve, Mali from 1983 to 2013 using times series analysis, lag-correlation, application of remote sensing (intensity change), farmers' perception and adaptation measures as well as Geographic Information System (GIS). The result confirms a positive correlation between inter-annual rainfall variability and vegetation since the deficit phase of rainfall correspond to the vegetation deficit phase. Similarly, there is a positive correlation between inter-annual rainfall and Normalised Difference Vegetation Index (NDVI) of 66% significance at 1% level. NDVI values changed in relation to different amount of rainfall and maximally respond to variation of rainfall with a lag-correlation at about two biweekly with a coefficient of 91%. The temperature is positively correlated with NDVI at the onset and cessation of the season, but negatively correlated during dry and rainy season. Also, the result of land use change detection shows that from 1985 to 2013 there was an increase of agriculture land and decrease in savannah wood land. By implication, the main factors for these changes were natural factors such as deficiency of rainfall and climatic variation since the change in the first interval (1985to1999 was 78.49%) higher than the second interval (1999 to 2013) which was 67.51% even though human population is on increase in second period. Furthermore, the result of transition to forest shows that, savannah woodland and steppe in both time intervals are consistently targeting the forest while bare land and Savannah woodland are consistently targeting agriculture land. The farmers in Fina reserve are aware of the effect of climate change through increase variability of rainfall, higher temperature, shorter length of rainy season, late onset and earlier cessation and increase flooding. Generally, land use and land cover dynamics have local and regional scale effects because its impacts do not have limited boarders and rainfall is the major driver of vegetation dynamics in Fina reserve. Therefore, it becomes necessary to local land use planning and design with protection practices for improved sustainability of the Fina reserve.

7) **Thesis Title: "*An Evaluation of The Impact of Tillage and Fertility Management on Soil Carbon Sequestration at Minna in the Southern Guinea Savanna of Nigeria"* By AKPEOKHAI, Agatha Ochuware**

ABSTRACT
The impact of agronomic activities on soil carbon sequestration as an adaptation to the impacts of climate change was assessed in Niger state, southern Guinea savanna of Nigeria. Farmers' observation of climate change parameters was evaluated and the various tillage and fertility methods used by farmers to cultivate maize were verified. The quantification of the vertical distribution of soil organic carbon (SOC) and its fractions as indicators of SOC sequestration under different tillage systems amended with various nutrient sources were also done. Results from the socioeconomic survey showed that 97.5% of the respondents were aware of climate change and variability. The tillage methods used included mechanized tillage practiced by 57%, manual tillage practiced by 37% and other types practiced by 1%. Based on these findings, the field trial was designed to investigate the effect of tillage and nutrient amendments on soil carbon sequestration using maize as a test crop. Treatments consisted of zero tillage, mechanized tillage and manual tillage amended with an equal amount of nitrogen (120 kg ha^{-1}) supplied as poultry droppings (organic source), Nitrogen, Phosphorus and Potassium (NPK) + Urea (inorganic source) and a combination of poultry droppings and NPK + Urea (integrated source). After harvest, soil samples were collected at 0–5 cm, 5-15 cm, 15-25 cm, 25-50 cm and 50-75 cm depths and analysed for SOC and its fractions. Results showed that manual tillage and integrated nutrient source had highest plant height values. All carbon fractions significantly ($P<0.05$) decreased vertically down soil depths. Water soluble organic carbon fraction (WSOC) and the particulate soil organic carbon fraction (PSOC) were most affected by treatments, highest significant decrease ($P<0.05$) was recorded at 0-5 cm, 5-15 cm and 15-25 cm depths. Highest significant variation in the non-hydrolysable organic carbon fraction (NHOC) occurred at 25-50 cm depth. Residual soil NPK, plant NPK and plant carbon concentration were not significantly affected by tillage and nutrient sources. Results from the study provided empirical evidences and gave an understanding of the trend at which SOC and its fractions change with land manipulation and land management. The study concluded that manual tillage and organic nutrient source were best land management practices that could be adopted for increased soil carbon sequestration and adaptation to climate change.

8) Thesis Title: *"Assessment of Soil Organic Carbon Stocks under Various Land Use/Land Cover Types in the Kintampo North Municipal, Ghana"* By BESSAH, Enoch

ABSTRACT
Climate change adaptation and mitigation in soils has gained much attention recently with the introduction of sustainable agriculture and land use management (SALM) practices by the World Bank. SALM enhances the ability of the soil to sink more carbons. This study was to assess soil organic carbons stocks under the major landuse/cover types in Kintampo North Municipal which is located in the Guinea savanna through the transition agro-ecological zone of Ghana. Two LANDSAT images (Landsat 8 & 5) were classified using maximum likelihood to produce LULC maps for 1986 and 2014 in ENVI 4.7 and change detection done in IDRISI 17. Cluster sampling was used for picking ground control points. Random field sampling was done on 34 plots and 24 sample points at depths 0 - 10 cm, 10 - 20 cm and 20 - 30 cm per plot with soil corer. Soil bulk density, pH, particle size distribution and SOC were determined using standard laboratory procedures and computations. Results were subjected to both statistical (ANOVA, Correlation) and Geo-statistical (Kriging) analyses. The soil organic carbon stocks in each land use decreased with depth. The mean SOC for the five (5) land-use systems studied were 11.33 t/ha, 7.95 t/ha and 6.08 t/ha at 0 - 10 cm, 10 - 20 cm and 20 - 30 cm respectively. The vertical variability in SOC distribution across all considered land use/cover types was statistically significant ($p < 0.05$) but the statistical difference amongst land

use/cover types was not significant. The determined mean SOC stocks in descending order at depth 0 - 30 cm were 30.02 (±13.20) > 25.73 (±8.95) > 25.70 (±9.41) > 24.31 (±7.74) > 22.01 (±8.92) t/ha for Savanna woodland/forest > crop land > mango plantation > teak plantation > cashew plantation respectively. The spatial distribution of SOC stocks ranged between 12 t/ha to about 33 t/ha at 30 cm depth by kriging. Available farmers on the sampled farms were interviewed on their land use management practices. Residue use as cover crops was the largest management practice (90%) by farmers especially the plantation farmers. There is no proper management procedure aside crop residue, which call for the introduction of sustainable agriculture and land use management practices to raise SOC stocks thereby increasing yield through better soil fertility and contributing to climate change adaptation. Out of the 120 farmers interviewed on land use decisions, 74.17% had no future plans to change current land use. Only 10.83% will change to mixed cropping which has a capacity of increasing its storage under the SALM project. Both crop and tree plantation was the future plans of 12.5% of the respondents and remaining 2.50% opted for agro forestry and mono cropping in the future. None of the interviewed farmers was aware of climate change and its relation to land use, and the Clean Development Mechanism (carbon credits) since it is not operational in the Municipal. A national carbon inventory will contribute to the monitoring of carbons and proper estimations using any accepted method to determine SOC stocks.

9) Thesis Title: "*An Appraisal of the Trends in Land Use/Cover Change Following Climate Variability in Ogou District, Togo*" By AKAMAH, Abel Kokouvi

ABSTRACT

This study conducted in Ogou District (Togo, West Africa) attempted to bring out scientific evidence of climate variability/change in the study area which is the major food crops production zone for the Plateaux Region, the 'food reservoir' for the whole country. Data for this study were collected from *Direction du Service National de la Meteorologie du Togo*, Landsat downloaded images and sourced through household survey by individual interviews among two hundred and forty seven (247) farmer households stratified and randomly selected in the study area. The study had three (3) specific objectives namely; firstly, analysis of rainfall, minimum and maximum temperature data, secondly satellite image analysis and finally questionnaire administration to farmers on their perception of climate variability/change. Analysis of variance at 95% confidence level was ran in SPSS 20.0 version to confirm trends and differences observed over the two climate variables. ENVI 5.1 and Idrisi 17.0 (The Selva Edition) were used for satellite image processing and future land use/cover change predictions. Arc Map 10 was used in mapping land use/cover of different years and EpiData 3.1 and Microsoft Excel 2013 were used for questionnaire results computation and processing. Results showed that minimum temperature in Ogou District significantly (P<=0.05) increased from 21.5˚C to 22.0˚C and maximum temperature from 31.0˚C to 31.8˚C, both over 40 years (1974-2013). Mean annual rainfall distribution shows a bimodal rainfall pattern with two peaks: July with 197.8mm and September with 203.5mm. The break in rainfall in August with 183.2mm indicates little dry spell over Ogou District. The main challenge today to farmers in the district is rainfall distribution over the growing season and not the amount of total annual rainfall. Land use/cover change is in a dynamic transition at relatively high rates from natural vegetation (forest and savanna) to farmlands and to buil-up areas. If this changing trend is maintained, only 44.93% natural vegetation, 30.22% farmlands and 24.30% built-up area are expected to persist at the end of the next ten years (2014-2023). Most respondents (61%) to the questionnaire were fairly informed about climate variability/change causes and impacts on their economic activities. However, they were not able to link their farming practices to any of the causes of climate variability/change. Furthermore, land tenure system did not facilitate

reforestation of semi-degraded agricultural lands in the district. The study therefore recommends that appropriate strategies to mitigate effects of climate change, enhance sustainable productivity, balance the land use/cover types against irrational expansion trends and protect the environment, need to be advanced in Ogou District to maintain a planned rate of migration of farmlands into forests or marginal areas, or built-up areas into farmlands or forests. In addition, more research need to be conducted on the underlying causes of the uneven and unpredictable yearly distribution of rainfall in the study area in order to help farmers adapt their cropping practices to this new rainfall patterns in Ogou District.

10) Thesis Title: *"Sustainability of Fadama Farming System as an Adaptive Response to Climate Change and Variability in Southern Guinea Zone of Nigeria*" By ADENLE, Ademola Andrew

ABSTRACT

Over the centuries, the use of Fadama particularly for dry season farming has been of significance in many parts of Nigeria. The aim of this study is to assess the present state of Fadama land in the study area as a strategy to making it sustainable so that it can become an effective climate change adaptation tool in small holding agriculture. The specific objectives of the study are to characterize the Fadama sites in the study area in terms of its dominant adjoining land uses, evaluate the ecological changes and its implications relating to the adaptive use of Fadama for farming, to and determine the relationship between changes (soil moisture change) Fadama land and rainfall amount in dry season as well as to propose a plan for the protection and preservation of Fadama. The study adopted geospatial techniques to characterize the Fadama sites in terms of its dominant adjoining land uses and the ecological changes over a period of last 41years between 1973 and 2014.The relationship between observed changes in Fadama sites with climatic rainfall was assessed and plan for the protection and preservation Fadama that was proposed. Primary data for the study were collected through the administration of a structured questionnaire and Focus Group Discussions (FGD) involving Fadama farmers and scientists at National Cereal Research Institutes (NCRI) Badeggi, Niger state. The data sets obtained were analysed with simple statistical procedures. Remote Sensing data were also employed in this study and were obtained from United States Geological Survey (USGS) and Meteorological data were downscaled from Era interim site using the multidimensional data format. Standard spatial operations (Image classification, reclassification, overlay, and zonal analysis) were carried out using geospatial tools (IDRISI, ArcGIS.10.0). Fadama sites from Garmin Map Source 6.12 for Nigeria helped in the classification operation. Also Excel embedded Intensity Analysis codes was used in determining the changes in Fadama ecosystem that affects food security, environmental sustainability and poverty reduction in the area. The study shows that the rate of landuse/landcover in the faster and is telling on Fadama land; Fadama is undergoing some pressure from other land uses. Although building around the Fadama is minima, its vegetation cover have been severely degraded,Temparature rise is occuring in Fadama and the soil moisture which makes Fadama a possible adaptation to climate change and variablity is decreasing. The study also provided the weak positive correaltion between rainfall and soil moiture in Fadama during dry season and proposed likely plans for Fadama conservation and protection based on peoples's reponses and remote sensing resultss.The outcome of the research craved for the adaptive management and restoration of Fadama landscape and programmes by government, public,private and other stakeholders as response to climate change

5.2.2 BATCH "B" ABSTRACTS

1) Thesis Title: "*Analysing Climate Change Projection on Water Availability for Rainfed Agriculture in Awun Basin, Kwara State, Nigeria*" By GBANGOU, Talardia

ABSTRACT

This study investigates the impact of climate change projections on water availability for rainfed agriculture in Awun basin, Kwara State, Nigeria using high resolution (25 km spatial resolution) RegCM4 simulations. The study was guided by four (4) specific objectives which are (i) assessment of crop types, cropping patterns and farmers' perception of water availability, (ii) downscaling/bias correction of climate scenarios, (iii) evaluation of rainfall characteristics (onset, seasonality index, and hydrologic ratio), and (iv) assessment of the crops water requirements. RegCM4 runs for the control period and for two scenarios (RCP4.5 and RCP8.5) driven by two GCMs (MPI and GFDL) were collected at WASCAL competence centre, Burkina Faso. The simulations provided are rainfall, minimum and maximum temperature and relative humidity for the control period (1985-2004) and the scenario period (2080-2099). The observations (1985-2014) for the same parameters from the synoptic station of Ilorin were collected at NIMET, Abuja. A focus was made on major food crops (maize, sorghum, cassava, and yam) in the area. Onset of growing season was determined using Benoit method tested with HS and BMN ET models. BMN model was also used to compute ET0. The study showed that mean rainfall depth for the realistic scenario RCP4.5 will decrease by 9.6% and 13.1 % for MPI and GFDL driven runs while under the pessimistic scenario RCP8.5 the expected decreases in the mean rainfall depth are 15.2 % and 17.7 % for MPI and GFDL driven runs respectively. Minimum and maximum temperatures will increase from 1.5 ^{0}C to 2 ^{0}C for the realistic scenarios RCP4.5 and from 3.1^{0}C to 4.0^{0}C for the more pessimistic scenario RCP8.5 respectively. However, the mean relative humidity will decrease by 10% by 2100s. The start of the growing season, independently of the ET model used, is projected to be late in the future. In fact, the onset date is 5th May for baseline (1995-2014) while under RCP4.5 the dates are 23rd May and 2nd June for MPI and GFDL driven runs respectively and under the RCP8.5 the dates are 14th June and 9th June for MPI and GFDL respectively. A seasonality index (SI) included between 0.80 and 0.99, and a hydrologic ratio (HR) < 0.74 for all scenarios were found, meaning respectively that (i) the rainy season will get shorter and (ii) the area will get drier in the future. Results showed that the crop water need for the growing season of maize and sorghum will be satisfied while that of cassava will not. It showed that cassava could not be planted conveniently within its growing season without irrigation in Awun Basin. The present study might be helpful in explaining the plausible effects of present and future climate on crop water needs and better planning of agricultural water resources in Awun Basin.

2) Thesis Title: *"Assessment of the Impact of Climate Change on Land Use/Land Cover in Kogi State, Nigeria"* By DAOU, Assitan

ABSTRACT

Climate change and variability pose serious risks to rain-fed agricultural land use in the semi-dry agro-ecological zones of Nigeria. Kogi State, is not an exception. Rainfall is becoming more unpredictable and unreliable both in its timing and its volume and growing seasons are changing, ecological zones are shifting. Therefore, this study was conducted to find out the impact of climate change on agricultural land use in Kogi State in order to implement better adaptation strategies for smallholders. For this purpose, forty years (1975-2014) rainfall and temperature data from NIMET, Landsat images (1987, 2001 and 2014) and questionnaire on farmer's perception were used. Focused

variables calculated were: Standardized anomalies, means for both temperature and rainfall. Landsat images were used to assess Land Use/Land Cover (LULC) types between 1987 and 2014. A questionnaire was administrated to investigate farmer's perception on climate change and agricultural land use. Data collected were analysed using SPSS 20. Excel 2013 and Envi5.1. The magnitude of the change rate between 1987 and 2001, 2001 and from 2987 to 2014. It obvious that only water body did not experience a major change. It was observed that a decrease in natural vegetation within the period of 1987-2001 (15) and from 1987 to 2014 (29). This indicate the practice of deforestation in the study area for residential purpose and farming. Binary Logit Model was used to determine the significant factor that affects farmer's decision to change land use under cultivation. Results show a slight increase in both temperature and rainfall up to 0.4 and 0.10 respectively. Lowest and highest temperatures were recorded in 1989 and 2005 respectively with values of 27.30C and 29.20C. The period of 1975 to 1997 is characterized as the cool years as the values were below the normal (zero) except years 1980, 1983, 1987, 1990 and 1996, while from 1998 to 2013 mean annual temperature was above the normal. The average rainfall is 1218.5 mm. The study area has experienced successive dryness years from 1975 to 1985 with a wet year occurring in 1978. The dry year was 1977 while the wetness was 1999 with respective standardized value of -1.82 (moderate dryness) and +2.23 (extreme dryness). The statistic of land use and land cover map shows that between 1987 and 2001 (15 years), the built up area had increased by 41.565 hectares. While farmland decreased by -27577 hectares between 1987 and 2001. Between 2001 and 2014 only built up area increased tremendously by 10.68% within the period. In terms of adaptation strategies, seven (7) adaptation strategies were employed by farmers, viz: changing planting dates, implement soil conservation schemes and change crop variety at 31%, 22% and 21% respectively in response to change in rainfall. Logit regression model reveals that change in rainfall patterns (Fpr. = 0.122) has no significant impact on farmers' decision to change land use under cultivation at 5% level of significance. However, number of family member schooling (Fpr. = 0.01), household farming experience (Fpr. = 0.00) and access to credit (Fpr. = 0.00) have significant impact on farmers' decision to change land under cultivation. These results will be useful for agricultural planning in the study.

3) Thesis Title: *Household Vulnerability and Adaptation to Water Stress induced by Climate Variability on Downstream Kaduna River Basin*. By OKAFOR, Gloria Chinwendu

ABSTRACT

Water stress is one of the risks climatic variations poses to livelihoods and challenge that is confronting all continent of the World. This study aimed at investigating household vulnerability and adaptation to water stress induced by climate variability on Downstream Kaduna river basin. The study sites; Shiroro, Gbako and Lavun LGA were selected purposively while random sampling was adopted to select 200 households. Historical records of hydro-climatic data were collected from NIMET and Shiroro Hydro-electric Power Station. The research employed qualitative data collected through stakeholders' participatory survey to explore vulnerability through its three determinants: exposure to a stressor (water stress and climate variability), sensitivity to stress, and adaptive capacity of households. Interviews at the household levels, focus group meetings and site visits were conducted to assess the prevailing conditions in six communities and to develop a profile of water stress and how this was altered by climatic variations. Statistical tests were used to assess the significance of trends and questionnaire data were analysed using SPSS IBM 20 and MS Excel 2013. The results indicate that for the period 1975 to 2014 at 95% significance level, rainfall in the Kaduna river basin has no distinctive significant trend at annual and seasonal scale, but the temperature in the basin show obvious upward trends particularly during the rainy season. An overall increasing trend is

prevalent in runoff series into the Shiroro reservoir which are the result of the combined effects of rainfall and temperature changes in the basin. In addition, the survey in six communities suggests that households are vulnerable to climate variability induced water stress with low current coping capacity. The study revealed that households have both individually and collectively employed strategies to minimize water-related vulnerabilities such as soil and water conservation practices, diversification and migration to nearest towns. Household adaptation techniques to water stress induced by climate variability in the study area are temporal indigenous coping strategies usually adopted during periods of stress to offset growing vulnerability. The study demonstrated how an understanding of the local household vulnerabilities will enable the recognition of early indicators of water and food insecurity in addition to the occurrence of extreme events. In general, vulnerability of households has decreased across villages due to differences in sensitivity to stress, livelihood options and infrastructure. Therefore, there is the need to have robust coping and adaptation measures to deal with the variations in the climate system.

4) Thesis Title: "*Assessment of Vulnerability of Scattered Agroforestry Tree Species to Climate Change in Niger State, Nigeria*" By ALLAKONON, Marsanne Gloriose Bignon

ABSTRACT

Climate change-induced impacts on trees has gained much more attention during the past years. In the tropics, more information on trees sensitivity to climate change is still needed. This study has assessed the vulnerability of Underutilized Agroforestry Trees (UAT) to climate change in Niger State, Nigeria. An Integrated Assessment Approach, encompassing exposure, sensitivity and adaptive capacity, and relating nineteen (19) indicators, has been used as framework for the assessment. To overcome the non-availability of specific tree-related data, the vulnerability of Underutilized Agroforestry Trees (UAT) has been assessed using the vulnerability of rural communities relying on them as a proxy. Therefore, individual questionnaires have been administered to 340 farmers, heads of households, across seven (7) Local Government Areas (LGAs), namely, Bosso, Rafi, Lavun, Lapai, Mashegu, Kontagora and Borgu LGAs, in Niger State. This enabled the identification of the most used species, and the assessment of their ethno-botanic, edible cultural and economic importance. The identified species were also ranked according to their sensitivity level to climate change. The data analysis, performed in R software and Microsoft Excel, revealed *Adansonia igitate*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Vitex doniana* and *Tamarindus indica* as the five species mostly used by Nupe, Hausa, Gwari, Abewa, Kambari, Bussa and Kamuku ethnic groups. All the identified species are used as food by man. However, they are also implicated in different proportion in other uses such as animal feeding, medicine, firewood, art and craft, worshiping, building, cosmetics, and trade. Although the climatic conditions pertaining to Niger State totally lie within the tolerance range of each species, some species have been perceived to be more sensitive than others. In this sense, rural communities pointed out *V. doniana* as being highly sensitive to climate change compared to other species. A strong association between local knowledge of the rural communities and their perception of the vulnerability of the mentioned species to climate change, can therefore be established. Furthermore, the assessment of vulnerability highlights a disparity in natural and social assets among the Local Government Areas. Farmers in Lavun and Lapai LGAs are deemed to be more vulnerable whilst those in Mashegu LGA are the least vulnerable to climate change. The results consequently imply that intervention should be drawn towards rural communities in Lavun and Lapai LGA to enhance their resilience to climate change. To be more effective, intervention measures should take into account, among others, the cultural importance of the species with regard to their traditional uses.

5) Thesis Title: *"Effect of Pre – Wetted Technique on Soil Temperature, Moisture Content, Organic Carbon and Greenhouse Gas Emissions in Niger State, Nigeria*" By KOGLO, Yawovi Séna

ABSTRACT

Poor agricultural practices, depletion of croplands productivity and carbon pools have continued to exacerbate indirect greenhouse gas (GHGs) emissions subsequently aggravating malnutrition and food security issues in Nigeria. For this purpose, an experiment was conducted at Edozhigi, in Niger State on integrated formulations of rice straw and urea at different rates respectively: 2, 3 and 4 t/ha and 25, 50 and 75 kg/ha with one check plot © (without straw and urea). Pre-wetted technique of the integrated formulations was adopted under Randomized Complete Block Design with (04) replications of ten (10) plots. The effect of treatments on the following variables; Soil Temperature (ST,oC), Moisture Content (SMC, %), GHGs emissions (kg/ha), Soil Organic Carbon Density (SOCD, t/ha), Soil Organic Carbon Density Gain per Month (SOCDG/month, kg/ha) and SOCD versus ST and SMC under each treatment were determined in order to identify the best treatments. Data collected were analysed using GenStat 16.2 and CCAFS-MOT 1.0 for SOC balance. MATLAB 11.0 and Excel 2013 were also used for data plotting and regression graphs. Significance and Duncan's Multiple Range Test were performed at 95% confidence level. Results indicated significant difference of treatments on each parameter evaluated. ST reduction; SMC, SOCD and SOCDG increase is a function of the quantity of straw and urea incorporated (Fpr. <0.001). Moreover, the study revealed strong decrease of SOCD with ST (r= -0.801) and increase with SMC (r= 0.851), and three best treatments (T2, T4 and T5) were identified. Their responses (TR, %) to each variable were; Soil Temperature (ST, oC) reduction was up to 20 %, Soil Moisture Content (SMC, %) increased about 41%. Similarly, Soil Organic Carbon Density (SOCD, t/ha) and Soil Organic Carbon Density Gain per Month (SOCDG/month, kg/ha) have increased respectively to 40.3% and 43 %. Potential carbon sequestration was about 44.4 % for the improved practices identified with 0 % methane emission and scanty nitrous oxide emission up to 31.3 %. These results gave strong evidence concerning the use of pre-wetted technique as panacea to both mitigate climate change and enhance croplands productivity and resilience to these changes in Edozhigi.

6) Thesis Title: "*Remote Sensing and GIS-Based Assessment of Land Degradation Driven by Climate and Land Use Changes in Nasarawa State, Nigeria*" By BISSADU, Kossi Dodzi

ABSTRACT

Land degradation is one of the worldwide threats to the ecosystem, thereby reducing its capacity to provide the adequate ecosystem services. Sub-Saharan Africa is known as one of the most threatened regions by land degradation due to both the change and/or variability in the climate conditions and human activities. The impact of both climate and land use changes on land degradation was assessed in Nasarawa State, Nigeria. The focal points of this study were to assess how the climatic condition and land use changed in the study area and to appraise their impacts on land degradation, especially soil erosion by water. Temperature and rainfall data were collected for a time period of 34 years for two meteorological stations of Nasarawa State (Doma station representing the South and Kokona station representing the North. Rainfall and temperature patterns and trends were assessed using Standardized Precipitation Index, Thermal Anomaly Index, Innovative Trend Analysis, CUSUM test, and Sen and Man-Kendall rank test. For the climatic analyses, the software EXCEL 2013, XLSTAT 2015, SPSS 20.0 and MATLAB programming tools were used. Landsat satellite images of the years 1986, 1999 and 2015 were classified using maximum likelihood to produce LULC maps for 1986,

1999 and 2015 coupled with change detection in ENVI 5.1 and ArcGIS 10.0. Revised Universal soil Loss equation (RUSLE) model was used to model soil erosion for the periods 1981 and 2014 and soil erosion change trend and actuality were assessed based on multi-criteria rules methods with the help of ArcGIS 10.0, 3DEM, Global mapper and EXCEL 2013 analysis tools. The conservation priorities were then identified based on the erosion actuality and change trend. The mean temperature is increasing at the rate of 0.034°C/year (0.047°C/year in the South and 0.021°C/year in the North), the same significant increasing trend was observed in the minimum temperature at the rate of 0.098°C/year and 0.066°C/year in the South and North respectively. Only the maximum temperature did not change significantly in the study area. The rainfall equally increased at the rate of 6.39mm/year and 2.3mm/year in the South and North respectively. Land use/cover changed significantly from 1986 to 2015 and savannah shrub was the most depleted land cover (from a coverage of 78% of the landmass in 1986 to 53% in 2015) followed by savannah woodland (from 6% to 0.64%). However, agricultural land increased from 7.5% to 17%, settlements from 6.5% to 15% and degraded land or bare soil from 0.86% to 8%. The change in land use/cover pattern and climate conditions significantly impacted 27.47% of the total landmass of the study area with 15.45% and 12.02% observing improvement and deterioration status respectively. Thus, the soil erosion status improved in overall for the past 34 years. However, all the local government areas experienced some degree of deterioration of soil. About 99% of the total area need implantation of soil conservation strategies and 2% need an urgent intervention to prevent the area from the occurrence of disastrous erosion. Nasarawa, Keana, Karu, Akwanga, Lafia and Wamba are the regions of great concern for the degrading status of their land. It was concluded that changes in land use/cover and climate conditions contributed to the degradation of land (especially soil erosion by water) in Nasarawa State. Finally, implementation of sustainable land use management and mainstreaming erosion control practices in agricultural policy of the State were the major recommendations drawn up from the study.

7) Thesis Title: "*Site Selection for Urban Forestry Development as a Mitigant of Climate Change in Ilorin Area, Southern Guinea Savannah of Nigeria*" By ASONIBARE, Femi Oluwatosin

ABSTRACT

This study describes a site selection process for urban forestry development as a mitigant of climate change in Ilorin Area, Southern guinea savannah of Nigeria. Based on actual conditions of the study area and other related studies, constrains and factors were considered for the site suitability analysis for afforestation. Slope, elevation, roads, rivers and water bodies, settlements, land price/value and land use were considered. Criteria weights were calculated using the analytical hierarchy process (AHP) using pair-wise Comparison. The consistency ratio for the AHP of this study was 0.07, which was acceptable. A geographic information system (GIS) was used for analysis and presentation of the spatial data. The maps were prepared, reclassified and standardized within the GIS environment. Image classification was used to generate land use and land cover map of the study area for 2015 from Landsat 8 image. The classes generated for the classification are; bare surface 198,350.80 hectares (87.3%), water body 513.41 hectare (0.2%), settlement 7,858.79 hectare (3.6%) and vegetation 18,798.63 (8.9%). Land suitability map for afforestation location was generated using Weight Linear Combination method and the results of the analytical hierarchy process. The resultant map displayed four classes of suitability; high suitability, moderate suitability, low suitability and not suitable. The result of the suitability analysis showed that about 45,654.75 hectares (20.2%) fall under the category of high suitability. Moderate and low suitability covered an area of 74,559.73 hectares (33.1) and 66,869.07 hectares (29.7%) respectively while, not suitable areas accounted for 38.438.05 hectares,

about 17.0% of the study area for afforestation. By using the stated criteria, the suitable areas for afforestation site fall majorly on the North western part of the study area. Analyzing the results of the identified afforestation sites for carbon sequestration potentials, local species like *Azadirachta indica,Gmelina arborea, Parkia biglobosa and Anacardium occidentale* were used to estimate the amount of carbon dioxide that can be sequestered for the study area. The average numbers of trees were estimated to be 400 trees per hectare. *Azadirachta indica* and *Gmelina arborea* was estimated to sequester about 1,102.32 and 1,084.04 metric tons of carbon dioxide per hectare respectively The average carbon sequestration potential for a medium sized coniferous tree planted within the identified sites and allowed to grow for 10 years was estimated to be about 15.6 metric ton carbon dioxide. This study shows the ability of GIS, remote sensing and AHP as a veritable tool for analyzing criteria for land suitability. It highlights the potentials of abundance of land available for climate change mitigation by carbon sequestration through afforestation and reforestation.

8) Thesis Title: "*Effects of Climate Change on Groundwater Resources in Kogi State, Nigeria using Water Balance Method*" By COULIBALY, Gnenakantanhan

ABSTRACT

This study "Effects of Climate Change on Groundwater Resources in Kogi State using Water balance Method" was carried out to understand how change in climate condition affect the quantity aspect of groundwater. In order to achieve this goal, questionnaires, climate data and soil samples were collected during the field work. Questionnaires were used to assess inhabitants' perception about climate change and its potential impact on groundwater. Responses from questionnaire administered were used to calculate a percentage of answers and then bar charts were plot for each question. Historical climate data were analyzed to confirm population perception about the change in climate condition. Descriptive statistic, box plot, trend analysis and bar charts were used to visualize the data distribution characteristics and displays the direction of the change. From climate data, monthly and annual aquifer recharge were estimated using water balance equation and then correlation and regression statistic were performed among parameter used for recharge estimation. Soil analysis using dry sieve analysis technique was implemented to appraise natural soil hydraulic conductivity or the rate of aquifer recharge. The results reveals that hand dug wells, boreholes, stream and rivers were the water sources mostly used in the study area. Respondents estimate that the rainfall amount is becoming low over years with variations in the start and end of raining season. For some respondents, the rainy season is becoming shorter with large amount of rainfall. Respondents also notice that the sun is now very hotter (86.7%) than before. Most of respondents (80%) cannot explain what climate change is but they believe strongly (95.6%) that climate is changing. Those change in climate according to them affect the groundwater quantity and quality observed through change in taste (42%), odor (40%), and color (53%). General upward trend was found in annual rainfall data and also intensification in amount of rain from one decade to another. Minimum and maximum temperature data displayed increase in mean value over year shows by time series plots. Monthly aquifer recharge computation reveal that it occurred between April to October with high amount of water recharge during the month of June, July and August. Annual aquifer recharge amount was strongly dependent on the amount of rainfall. Hydraulic conductivity estimated from grain size distribution analysis was characterized by low natural capability of soil to let water flow through it.

9) Thesis Title: "*Evaluation of Root and Tuber Crops Yield under the Changing Climatic Conditions in Kwara State, Nigeria*" By LARBI, Isaac

ABSTRACT

This study evaluated root and tuber crops yield under the changing climatic conditions in Kwara State, located in the Guinea savannah Zone of Nigeria. Rainfall data (1975-2014), minimum and maximum temperature (1985-2014) and yield data of cassava and yam covering a period of twenty years (1995-2014) were used for the assessment. A questionnaire was administered to a sample of 150 tuber crops farmers in twelve villages from Ilorin East, Asa and Moro Local Government Areas of Kwara State. The questionnaire was formulated to collect information on farmers Socio-economic characteristics, awareness and Perception of climate change and the various adaptation strategies been used. Trend analysis and standardized anomaly were performed on rainfall and temperature. Modified Walter's method was used to determine rainfall onset, cessation and length of raining season. Co-integration and Error correction model test were the analytical tools employed in the analysis of effect of climate on cassava and yam yield. The results show that, there is an increased in annual rainfall of about 3.5mm/year from 1975 to 2014. Minimum and maximum temperature from 1985 to 2014 have also statistically increased at 95% confidence level with minimum temperature increasing at a faster rate compared to maximum temperature. In addition, the analysis of daily rainfall data showed that, on the average, the onset and cessation dates were 30th March and 12th October, depicting both an early onset and cessation of rainfall leading to a decrease in length of raining season. The results obtained from Co-integration and Error correction model test indicate that there are long-term relationships between the crop yield and annual rainfall, temperature and length of raining season. The output of yam was found to have a significant positive relationship with a coefficient of 0.00041 with the amount of rainfall. This shows that the production of yam irrespective of their increasing output was still dependent on the amount of rainfall. However, there was a negative relationship between cassava yield and rainfall though was not significant but temperature and length of raining season were significant in cassava model. Hence, increase in temperature and shortening of length of raining season will adversely affect the yield of cassava. The socio-economic survey revealed that majority of the respondents (91.3%) are aware of climate change with more than 92% of farmers indicating that temperature in the area had increased and about 56.2% of the respondents indicating that rainfall has also been on the increase. Moreover, the average adaptive capacity of the respondent was moderate (2.92), but majority of the respondents were highly adaptive to some individual adaptation strategies which are positively reflecting the trend of tuber crop yield in the area which shows an increasing trend. In conclusion, although there is a gradual decreasing in length of raining season over the last forty years, however, Kwara State is becoming wetter especially from 2003 to 2014.

10.0 Thesis Title: "*Impact of Land Use and Climate Change on Vegetation Dynamics of Doma Forest Reserve in Nasarawa State, Nigeria*" By MOUSSA, Soulé

ABSTRACT

Nigeria' forests reserve are reducing due to human activities. Forest reserves in Nigeria are depleted as a result of cropland expansion, pastureland and logging activities. A lot of studies have showed that deforestation is serious environmental problem in Nigeria with forest loss occurring at a highest world 'rate of 3.3% per year. The aim of this study is investigate the impact of land use and climate change on Doma forest reserve dynamics by combining Remote Sensing, GIS techniques and field data measurement. Land satellite images for 1984, 1999 and 2015 were downloaded from GlOVIS. The

field data were obtained from Doma forest inventory and questionnaire was used. The three years of satellites images were processed using ArcGIS 10, ENVI4.7 and IDRISI 17, for computerizing the maps of Normalized Vegetation Index (NDVI). Excel was used for statistical calculations. NDVI map comparison, NDVI differencing and descriptive statistic were used for the data analysis for Doma forest change detection. Floristic analysis was used to describe the woody flora of Doma forest reserve. Descriptive statistic was used to find out climate change perception of Doma forest reserve communities and their perception about the impact of climate change and land use affecting Doma forest dynamics. Doma forest reserve NDVI analysis revealed that high positive NDVI values of + 0.57 was recorded in 1999 while the lowest of -0.035 occurred in 1984 and followed by + 0.05 of 2015.But there was much reduction in Doma forest reserve greenness in 2015. As for Doma forest reserve woody flora description, the analysis showed that 36 woody species were recorded belonging to 16 botanical families and 36 genera within 10 plots but Fabaceae had the highest number of woody species (seven species) distributed in seven genera. All the recorded genera were monospecific. Questionnaire data analysis revealed that that 69 among 100 of the respondents were aware of climate change but only 31 respondents were not aware of climate change. Further, the analysis showed that 30% of the people perceived that climate change has impact on Doma forest reserve dynamics. Their feeling was that the impacts of climate change on Doma forest reserve dynamics were dryness of the forest and the long presence of Fulani men within the reserve due to the long delayed onset of rainfall. Nevertheless, 41% of Doma forest communities perceived that farming activities impacted more Doma forest dynamics followed by illegal logging and grazing. The study concluded there was substantial decrease in Doma forest reserve greenness from 1999 to 2015.Further, the study concluded that unsuitable land use practices such as the use of fire, cutting down the trees for land clearance, the collection for timber, the huts of Fulani men within the reserve were the land use of the depletion of Doma forest reserve.

5.2.3 BATCH "C" ABSTRACTS

1) **Thesis Title: "*Climate Change and Occurrence of Sargassum Natans and Sargassum Fluitans on Nigeria's Coastal Landscape and Their Impact on People's Livelihood"* By ADET Lucette**

ABSTRACT

Climate change is an important emerging threat to every kind of life on earth, especially in the areas where populations are economically poor. West Africa is particularly vulnerable to the effects of climate change. Among those effects are the shifts of algae species from their native place to new more suitable areas. As a result of warming oceans, aquatic species shift their distribution. This is the case for two algae species identified as *Sargassum natans* and *Sargassum fluitans* which shifted from the Brazilian coast to West African coast. The occurrence of these algae along the Nigerian coast was the subject of this study. The species mostly affect food security and the economy of coastal population. This study aims at examining the impacts of climate change on spatial distribution of *Sargassum natans* and *Sargassum fluitans* along the coast of Nigeria by establishing a relationship between climatic variables and their spatial distribution. The study utilized remote sensed images to map *Sargassum* distribution from 2011-2016; evaluated the perception of coastal residents on the presence of S*argassum* on the coastline and their notion of climate change; and evaluated the past trend of the major variables that drive *Sargassum* phenomena along the Nigerian shores. To achieve these objectives, a combined quantitative and qualitative approach was performed to study coastal communities' perceptions among household heads in Lagos State; where a total of 206 household

heads were interviewed. The outputs were analysed using R software. The monthly images from MODIS Aqua GIOVANNI on normalized Fluorescence Line Height (nFLH) between 2011 and 2016 were displayed in Seadas software to highlight spatial algae blooms along the Nigerian coast. Principal Component Analysis (PCA) was performed in R software on key oceanic parameters namely: sea surface salinity, precipitation, sea surface temperature, wind and ocean current from 2011 to 2016. The trends of these oceanic parameters and the relationship between these parameters and *Sargassum* species distribution were also analysed. The results show limited knowledge (69.9%) about climate change and the reason of the occurrence of *Sargassum* due to low level of education and limitation of information access. The results also show that 77.7% of the respondents are of the view that climate change and the presence of *Sargassum* species have several consequences on their livelihood and activities. Moreover, the analysis of MODIS Aqua image reveals the past spatio-temporal patterns of *Sargassum* species along the Nigerian coast. The species fluorescence however does not fit with the monthly range trends reported by previous studies. The study further established that the principal variables involved in their motions are the wind patterns associated with the horizontal current velocity. The parameters such as v-velocity, salinity, precipitation, sea surface temperature, play important but indirect roles in the shift and the distribution of *Sargassum* species. Finally, the study reveals a temporal trend in the oceanic parameters which evolve together and lead to new *Sargassum* species distribution; as its events in Nigerian coast could be mostly explained by how long the oceanic parameters have reacted to the climatic changes. The study recommends the education of the coastal population on climate change, provision of necessary assistance to fishermen, as well as monitoring of winds and currents motions in order to predict *Sargassum* events.

2) **Thesis Title: "*The Impact of Climate Variability on the Occurrence of Common Cattle Diseases in Upper River Region, the Gambia*" By CHAM, Fafa Oggo.**

ABSTRACT

The study was conducted in Upper River Region, The Gambia. The study aimed at establishing relationships between climate variability and the occurrence of common cattle diseases, and determining the degree of climate variability in the study area. The study also aimed at comparing by gender cattle farmers' perception and understanding of climate variability, its impact and their coping strategies. One hundred and eighty-seven (187) structured questionnaire adopting face-to-face interviews of individual respondents were administered and six focused group discussions (3 for men and 3 for women) were separately held in three of the seven districts of the Region. In the focused group discussions, participatory rural appraisal tools including pairwise ranking and matrix scoring were employed. Spearman correlation and regression analysis was conducted to assess the relationship between climate variables and the selected diseases. To find out the difference between female and male cattle owners, frequency analysis and Pearson chi-square tests were done. Mann-Kendall and standardized anomaly tests were also conducted to assess the nature of climate variability. Results showed that the occurrence of each of the common cattle diseases is correlated to at least one of the climate variables, temperature being the most influential. For instance, monthly occurrence of reproductive and urinary tract infections was positively associated with minimum temperature ($r = 0.177$, $p = 0.027$), humidity ($r = 0.174$, $p = 0.038$), rainfall ($r = 0.265$, $p < 0.001$) and wind speed ($r = 0.166$, $p = 0.038$) in the Basse area at 0.05 alpha value. The study further revealed that there was no significant difference between gender and perceptions on questions relating to temperature, wind speed and rainfall trends. However, there were significant gender effects on most of the questions relating to impact and adaptation to climate variability. Only rainfall was found to be following a monotonic trend. However, the standardized anomaly demonstrated both monthly and

yearly variations in all climate variables. The study recommends the improvement of cattle management practices to minimise the impact of climate variability on cattle health. It also recommends that interventions to assist cattle owners cope with climate variability should be gender sensitive.

3) **Thesis Title: "*Future Climate and Land Use Impact on the Geographic Distribution and Conservation of Kigelia Africana in Benin, West Africa*" By GUIDIGAN, Meminvegni Landry Gildas**

ABSTRACT

*Kigelia africana (*Bignoniaceae) is a Non-Timber Forest Products (NTFPs) that makes major contribution to the subsistence of West Africa household through their multiple purposes (medicinal, nutritional, economic and socio-cultural). However, these ecosystem services are threatened by climate and land use change. Data collection and household survey were performed in Benin, West Africa, to assess the species distribution and use. In addition, current and future (CNRM-CM5 and HadGEM2-ES model base on RCP 8.5 by 2050 time horizons) climate data were retrieved from WorldClim, while soil layer data from World Soil Database version 1.2 and Climate Change Initiative Land Cover (CCI_LC) maps of 1992, 2003 and 2015 were retrieved from the European Space Agency (ESA). Additionally, MaxEnt species distribution modelling (SDM) was used to model species ecological niche in combination with a Geographic Information System (GIS). The modelled occurrence areas of *K. Africana* was implemented based on a total of 466 species records, from which 416 were collected on the field and 50 from the National Herbarium of Benin Republic. Seventy one (71) households were interviewed using a semi-structured questionnaire for ethno-botanical and socio-economic studies. The questionnaires were analysed using quantitative ethno-botanical methods. Principal Component Analysis (PCA) with R software was also applied to describe the value of the usage and the forms of *K. africana* used according to different tribes. The maps obtained from the model were overlaid on the existing protected areas network. The results established that 52% of the national area and 81 % of the national protected area network were found to be highly suitable for the cultivation and conservation of *K. Africana* and the greater part of the distribution of the species is expected to remain largely stable in Sudano-Guinean zone and Guinean zone, but there were some exception in the Sudanian zone. Despite the expansion and retraction in *Kigelia africana* species, the relationships with protected areas networks suggest that protected area networks of species distributions will also remain stable. All these corroborates with the assessment of CCI-LC map obtained. For the economic uses three categories were identified (medicinal, charcoal and firewood). The result reflects that for *K. africana* medicinal use is more cited. The economical use value of the different parts of the K. africana, showed that the fruits (50 %) are sold more than the bark (29.17 %) followed by the leaf 16.67 % while the root has the lowest percentage of 4.17 %. For the ethno-botanical Use Values (EUVt), the bark is more mentioned (100 %) by all the socio-cultural groups; the fruit 93%, leaf 86%, flower 14%, root 8% only for medicinal and magic uses, while contribution to yearly cash income ranges from 4.17 % to 50 %. The study recommends that further development and research on *K. Africana* should be enhanced in order to conserve the genetic diversity within and among the population and also to expand the market channels to provide more access to the economic value of *K. africana*.

4) Thesis Title: "*Prediction of Rainfall Variability Impact on Water Erosion Intensity under Four Soil Management Practices at Nsukka, Nigeria*" By IBOKO, Maduabuchi Paul

ABSTRACT

Anthropogenic activities and natural factors are largely responsible for soil degradation. These degradations are bound to increase with change in climate, thereby making some of the current soil management practices unsustainable in the future. Therefore, this study was aimed at predicting the impact of rainfall variability on water erosion intensity and to identify the most sustainable soil management practices in Nsukka Local Government Area of Enugu State, Nigeria. Water Erosion Prediction Project (WEPP) model was used to analyse four soil management practices. Soil samples were collected from profile pits dug on fallow land, range land, manually cultivated land and tractorized cultivation, at 0-20, 20-40 and 40-60cm depths with two replications each and the physical and chemical properties of the samples were analysed. Climate data of 1981 – 2010 collected from the Nigeria Meteorological Agency, Abuja were used as a baseline climate scenario while projected climatic data for Representative Concentration Pathways (RCP) 4.5 and 8.5 outputs scenarios from World Climate Research Programme (WRF) model were used as future (2041 to 2070) climate scenarios. The future and historical rainfall, minimum and maximum temperatures were tested for trends and also used to simulate mean monthly and annual soil losses and runoffs for the study area. The trend test (at 95 % confidence level) for the historical data set showed a significant trend for the mean monthly rainfall and a non-significant seasonal trend with Kendall S statistics of 119.00 and 6.00 respectively. The test also showed significant trend for future temperatures but was insignificant for both historical temperatures and future rainfalls for RCP 4.5 and 8.5 with high variations. The soil properties with climate data for historical and projected scenarios were incorporated into the WEPP model as inputs and ran for the different soil management practices. The model predicted highest runoff and soil loss of 1097.47 mm and 32.974 Mg ha-1 yr-1 under tractorized and fallow lands respectively while the lowest amount of runoff and soil loss of 594.92 mm and 0.005 Mg ha-1 yr-1 were recorded by rangeland. Highest runoff and soil loss were also predicted under the historical climate at 1190.92 mm and 38.294 Mg ha-1 yr-1 respectively while the projected RCP 8.5 produced the lowest amount of runoff and soil loss. The test of sustainability using Least Significant Difference (LSD) revealed that rangeland would be the most sustainable in the future. It also showed a statistically significant difference in the amount of soil losses and runoffs from the different land management practices and rainfall regimes (historical and projected climate conditions) with the historical climate posing the greatest threat to both runoffs and soil losses. The study concluded that range land would be the most sustainable land management in the future as its soil loss was less than the soil loss tolerance level (1.3 Mg/ha/yr) for Nsukka. Runoffs and soil losses from the future rainfall would generally be lower than that of the baseline and as such, the various management practices with little modifications are considered sustainable.

5) Thesis Title: "*Impact of Climate Change on Hydropower Generation: A Case Study of Shiroro Dam, Nigeria*" By ODOOM, Peter Rock Ebo

ABSTRACT

This study assessed the climate change impacts on streamflow and energy production in Shiroro Hydro power dam, located in a Guinean Savanna Zone in Niger State, Nigeria. Rainfall (1981-2015), streamflow (1990-2014), temperature (minimum and maximum) (1981-2015) data were collected from Nigeria Meteorological Agency (Nimet) and homogenisation test performed on the data using RHtestsV4. The trend in the data was evaluated using the Mann-Kendall and Sen's slope techniques.

Assessment of streamflow was done by utilising the Soil and Water Assessment Tool (SWAT). Remote Sensing datasets such as Digital Elevetion Model, FAO soil map and Moderate Resolution Imaging Spectroradiometer (MODIS) land cover were utilized in ArcSWAT to set up the watershed. Climate Forecast System Reanalysis (CFSR) was downloaded and served as the climate datasets for forcing the SWAT model. Streamflow data obtained were divided into two; the first part was used for calibration while the other part was used for validation of the watershed model. Downscaled NCC-NorESM1-M with WRF model output (precipitation, maximum and minimum temperature) under RCP 4.5 and 8.5 scenarios were extracted for the study area and streamflow simulated for the projected data in ArcSWAT. A stochastic dynamic model was employed to assess climate change impact on hydropower generation using the simulated output from the SWAT model. The results from the trend test showed existence of positive trend in both precipitation and temperature (average temperature) for Kaduna and Zaria whilst Minna and Jos revealed the presence of negative trend in average temperature. For precipitation, Jos showed no significant trend while precipitation series of Minna revealed a positive and significant trend. The calibration results of streamflow were unsatisfactory for R^2 = 0.51 and NSE=0.43 whilst PBIAS = -2 was very good. The uncertainty criteria of the model p-factor was 0.79 and r-factor 1.27 which were within the recommended range. The R^2= 0.79 and NSE= 0.77 and PBIAS = 15 values were good during the validation period with p-factor = 0.77 and r-factor = 0.77. Streamflow increased significantly from the baseline period (1990-2014) when compared with the projected future scenarios for both RCP 4.5 ad 8.5. Generally, energy production were observed to increase alongside revenue generation in the future but reliability of the plant was below the acceptable 0.75 reliability.

6) Thesis Title: "*Spatial and Seasonal Variations of Heat Wave Characteristics over Nigeria*" By RAGATOA, Dakéga Saberma

ABSTRACT

African countries are highly vulnerable to climate change, especially climate extremes. Heat Waves are projected to become very long and more intense in the upcoming decades and will therefore seriously affect health, infrastructures and especially agriculture that is the main economic activity. This study investigates the heat wave characteristics in different climatic zones in Nigeria over a long period considering the present and the future temperature conditions. Four objectives were specified which are to: analyse the temperature trend in Nigeria, analyse HWs occurrence from 1981 to 2016 in the different climatic zones (Coastal, Tropical Rainforest, Guinea Savannah, Sudan Savannah and the Sahel) in Nigeria, predict the future aspects of HWs to projected 2100 and evaluate the future trend of HW characteristics. ERA-INTERIM daily minimum and maximum temperature data from 1981 to 2016 were collected from ECMWF data base and used as the present time. Observation data were also obtained from NiMet in 17 stations across the country. CORDEX-AFRICA Weather Research and Forecast (WRF) model outputs from 2018 to 2100 were obtained with the same parameters from GSP WACS, F.U.T Akure under RCP4.5 and RCP8.5. Five heat wave characteristics namely: the heat wave number, duration, frequency, amplitude and magnitude were studied using four definitions; TX90 and TN90 that are temperature based 90th percentile thresholds; EHF; and HWMId. The trend analysis was performed on the observed daily minimum and maximum temperature for the 17 stations. The Modified Mann-Kendall trend test was performed because of the serial correlation in the data, and the results generally showed significant increasing trends. The slope was very low in many stations. The study of HW characteristics in different climatic zones revealed that from 1981 to 2016, HWs occurred and covered more zones in the last decades. The Sahel was really affected by the highest number of events and the highest number of days for the duration and the frequency. The

HWMId was used to quantify the intensity of HWs in the present time and revealed super extreme HWs in the Sahel and extreme HWs in the South. The prediction using WRF under the two scenarios RCP4.5 and RCP8.5 has shown a spatial increase in the frequency and magnitude of HWs during different periods. In the 2050s, there will be spatial increase and also an increase in the duration of HWs in almost the entire country. Even the Coastal zone will be having super extreme HWs. The RCP8.5 revealed more dramatic and dreadful HWs from 2073. The trend of each of the characteristics using the different definitions under the two scenarios from 1981-2100 revealed significant trends (p-value < 0.05) for many zones and the magnitude of the trends (Sen's slope) was revealed to be positively very low for some characteristics using some definitions and high (3.5) for other characteristics. Similarly, there are also negative slopes (-0.03). This study would help in agricultural decisions based on climatic zones and also in the infrastructures adjustments and mainly health domain considering that HWs will be more frequent and more intense in the near future time.

7) **Thesis Title:** ***Soil Nutrient Dynamics under Long Term Application of Mineral fertilizer Micro-dosing to Pearl Millet on a Sahelian Sandy Soil of Niger Republic*** **By SANI ISSA, Mahaman Sanoussi**

ABSTRACT

Low soil fertility and insufficient rainfall are the major constraints limiting pearl millet yields in Niger. Thus, to address these striking constraints, institutions working in Sahel joined forces through a collaborative research programme and developed an effective technique known as fertilizer micro-dosing (application of small doses of fertilizer in the hill of the target grain crop at planting) in order to tackle these issues. Reports from the implantation of the technology have shown up to 120% yield increase. However, the question is whether the application of this technology would not lead to soil nutrients mining in the long-term. A study was set at ICRISAT which aimed at evaluating the sustainability of the technology in the long-term with regard to pearl millet productivity and with emphasis on soil nutrient dynamics. As a long-term experiment, the study started since 2008 and was laid out in a randomized complete block design that involved two pearl millet varieties, three planting densities, and four nutrients management options. For this present study, a sub-set of the treatments from this long term experiment was used. The nutrient management options considered include the control, 2kg.ha^{-1} of DAP+ 1kg.ha^{-1} of Urea at elongation stem period, 30 kg. ha^{-1} of NPK and 60 kg. ha^{-1} of NPK. Soil survey was carried out in each of the corresponding plots, soil samples were collected both between and on the planting hills. A total of 36 soil samples were collected and analysed at Soil Lab of ICRISAT Sahelian Centre Sadore. The results showed significant decline in soil nutrient over years. The change in soil nutrient was markedly different on the planting hills and that from between hill spaces. The change in soil pH-H_2O values on the planting was -7.06% for the control plots and 9.57% for the plots treated with NPK. Hence, this negative change resulted in possible acidification of the experimental site. The total nitrogen content dropped in both the control plots and the plots that received NPK as micro dose. The percentage of change decreased with the application of NPK micro-dosing on the planting hills with -5.11% and -12.45% in the control plots and the plots receiving NPK respectively. Positive significant change in available P was observed (P≤0.05%) in soil between hill with 1.08% in the control plots and 15.97% in the plots where with NPK was applied. Whereas on the planting hills, the change was higher in plots treated with NPK compared to the control plots with respectively 88.19% and -6.27%. Further, the trend of the change observed in soil organic carbon content on the planting hills was -21.85% and -26.71% in micro-dosing plots and in the control plots respectively. Regarding pearl millet yield, both stover yield and total biomass showed similar trend in which decreased yield was obvious over the years. In 2009, an

average stover yield of 4053 Kg. ha^{1}, 5867 Kg. $ha^{-}1$, 6667 Kg. ha^{-1} and 5360 Kg. ha^{-1} was obtained respectively for the control plots, 2g DAP +1g Urea plots, 3g NPK plots and 6g NPK plots. Whereas in 2010, the stover yield decreased by 31%; 18.47%; 13% and 26.12% respectively for the control plots, the plots applied with 20Kg.$ha^{-1}$of DAP plus 10Kg. ha^{-1} of Urea, 30Kg.ha^{-1} of NPK plots and 60Kg.ha^{-1} of NPK. Grain yield also dropped in 2010 compared to 2009 by 36% for the control plots, 62.6% for the plots applied with 20Kg. ha^{-1} DAP plus 10 Kg. ha^{-1} Urea and 43.65% for the plots applied with 60Kg. ha^{-1} of NPK. These findings showed that in the Sahel low-input based millet cropping systems, for the micro-dosing fertilizer technology to be sustainable in the long term, the improvement and maintenance of soil fertility should be considered as the cornerstone.

8) **Thesis Title:** ***The Implications of Climate and Land use/Land Cover Changes on Pastoral Resources and Practices in Kompienga Province, Burkina Faso*** **By SANOU, Lamaoussa Charles**

ABSTRACT

The aim of this research work was to assess implications of climate and land use/land cover changes on pastoral resources and practices of herders in Kompienga province. Climatic data (1981-2016), Landsat images (1989-2015) and survey data were retrieved and analysed. Trend analysis using Mann-Kendall test, and Standardized Anomalies Index (SAI) analysis were conducted on rainfall, temperature, relative humidity and potential evapotranspiration data. Furthermore, rainfall onset, cessation, Length of Rainy Season (LRS) and Number of Rainy Days (NRD) were computed from daily rainfall data. In addition, deviations from a reference (climatology: 1981-2010), of each climatic variable were determined. Image classification was performed using Random Forest Algorithm in R-Software R 3.3.2. Changes detection and land use/cover prediction were done using MOLUSCE (Modules for Land Use Change Evaluation). Furthermore, survey data was collected from 271 respondents (pastoralists, agro-pastoralists). Results reveal that since 2011, annual rainfall amount was lower than that of the climatological record (877.8 mm), while temperature (minimum and maximum), RH and EPT of the other year were greater. An upward trend of temperature and the NRD were observed at 95 % confident level. The minimum temperature is evolving faster (0.50 °C per decade) than the maximum temperature (0.20 °C per decade). The period studied was characterized by more wet years (17 %) than dry years (14 %) while the normal years were predominant (69 %). Rain onset, cessation, LRS were highly variable compared to the average onset (15th June), cessation (15th October) and LRS (110.9 days) of the climatology. Land use dynamics was characterized by an increase in croplands at an average rate of 46.7 % per year, between 1989 and 2015. On the contrary a decline in grazeable areas was observed since 2001 at an average rate of 6.0 % per year. Generally, results of climatic and images analysis were corroborated by respondents' perceptions. Respondents similarly depicted an increase in cropping areas (98.5 % of respondents) to the detriment of pasture land (97.8 % of respondents). In addition, 93.4 % of respondents observed an increase in temperature while 97.8 % noticed a decreasing rainfall pattern. Climate change and land use/land cover (LULC) dynamics are negatively affecting forage availability (in quality and quantity); livestock production and reproduction performance; herders' practices, their livelihoods and the cohabitation of herding and crop farming. To adapt to these impacts, respondents adopt local adaptations strategies such as the use of crop residue (93.7 %), fodder trees (77.1 %), Fattening/Destocking (88.2 %), prayers and other rites (94.5 %), transhumance (97.0 %), feed supplement (99.3 %) and use of ground water (65.3 %). The LULC is likely to keep evolving to the detriment of pasture lands in the next 10 and 20 coming year (Kappa coefficient = 0.7). The vegetation is likely to decrease from 85.9 % in 1989 to 75.7 % and 74.7 % in 2025 and 2045. On the contrary cropland areas which accounted for 0.8 % of land area

in 1989 might increase up to 22.1 % in 2025 and slightly decrease in 2045 (21.9 %). This is consistent with respondents' perceptions on the future of pastoral herding in the province with a high probability to abandon this activity. Beyond, strategies adopted by respondents, urgent actions at both national and international level, need to be taken to tackle side effects of climate and lands use and cover dynamics. This might successfully reduce the vulnerability of pastoral communities in the study area.

9) Title of Thesis: *Assessment and Prediction of Climate Variability Impact on Land Use Land Cover Change in Sikasso Region, Mali* By SIDIBE, Mohamed

ABSTRACT

Climate change and variability are worldwide phenomena and their impact differ from one region to the other. In this context, this study focused on the assessment and prediction of climate variability impact on Land Use Land Cover Change (LULCC) in Sikasso region, Mali with focus on agricultural lands. The study assessed changes in LULC, examined climate variability and its impact on agricultural LULC and predicted future changes in LULC by 2030 and 2050. The dataset composed of time series satellite images from Moderate Resolution Imaging Spectroradiometer (MODIS) Terra for the years 2000, 2008 and 2016, monthly rainfall and temperature from 1981 to 2016 for the four main meteorological stations across the study area and socioeconomic information. The Savitzky-Golay (SG) filtering process (smoothing) was performed on Normalised Difference Vegetation Index (NDVI) time series images with TimeSat software and an ISODATA classification scheme adopted for four main classes: namely cropland, vegetation, water and others. Standardised anomaly, Coefficient of Variation (CV) and Modified Mann-Kendall (MMK) trend test were used to analyse rainfall and temperature data. Pearson's Chi-square test of association was performed on questionnaire data to determine whether climate variability has impact on LULCC and the prediction was carried out using Cellular Automata (CA)-Markov model. The LULCC analysis showed that agricultural lands increased by 4 % (129,665 ha) between the year 2000 and 2016 while the vegetation cover decreased by -1 % (30,000 ha) during the same period; water bodies increased and the class others decreased. The expansion of agricultural lands and decreases in vegetation cover are expected to continue. Furthermore, the mean temperature increased from 1981 to 2016 at the rate of 0.3 °C per decade and the minimum temperature recorded the highest rate of increase (0.44 °C per decade); on monthly basis, the highest deviations in the temperature were observed in the months of November (+1.24 °C), March (+0.69 °C) and October (+0.67 °C) while lowest was observed in the month of February (+0.15 °C). At 5 % significance level, an increasing trend was detected in the regional annual average rainfall and the amount of rainfall during the rainy season (for years after 2010) was considerably higher than the climatological mean-normal (1981-2016) except the years 2011 and 2013. The LULC model revealed that cropland will increase by 6.54 % (217,599 ha) between the period 2016-2030 and 18.58 % (618,179 ha) in 2016-2050. Vegetation will decrease by -11.14 % (-357,149 ha) between 2016 and 2030 and by -34.49 % (-1,105,814 ha) by 2050. Generally, the observed increment in annual and seasonal rainfall was not the primary factor for the expansion of agricultural lands as questionnaire analysis revealed that farmers' decisions to bring changes in their farms size was rather a function of market prices, changes in production systems, access to improved seeds and number of male workers. The intensification of LULCC as apparent from the model predictions and spatio-temporal climatic pattern signals the need for the development of mitigation and adaptation strategies that will minimize the sensitivity and exposure as well enhance the resilience of the Sikasso region to the anticipated changes.

10) Thesis Title: "*Assessment of the Response of Land Surface Temperature to Land Use and Land Cover in Kano Metropolis and its Suburbs*" By SIMON, Ojochide Susan

ABSTRACT

Kano State is faced with increasing air and surface temperature caused as a result of the continuous development activities, constructions and influx of people to the state. The study therefore analyses the development of land surface temperature (LST) on different land cover and land use categories and to determine the possible impact of the various class on LST. Landsat 8 Operational Land Imager and Thermal Infrared Sensor (OLI/TIR), multi-temporal remote sensing satellite data of 2015 and 2016 were used to retrieve LST and derive land use and land cover classification map using random forest machine learning algorithm. Various land cover indices such as Normalised Difference Vegetation Index (NDVI), Normalised Difference Built Index (NDBI) and Modified Normalised Difference Water Index (MNDWI) were derived using R statistics software. These land cover indices were used to examine the landscape attributes, characteristics and to further understand the cause-effect relationship between LST and LULC using a Pearson's correlation analysis and simple linear regression model. LULC classification map showed that using several multi-temporal satellite imageries for classification to extract biophysical information provide a more accurate result with a kappa coefficient of 1.017 and 1.013 and overall accuracy of above 85% which showed an excellent agreement between the map and ground truth data. The retrieved LST pointed out that land surface temperature could be as high as 38^{o}C to 40^{o}C in hot seasons and as low as 22^{o}C to 25^{o}C in wet seasons. LST values were extracted for the different land cover and land use class and result revealed that there is a decreasing trend of LST all through the season from built up areas (such as residential, commercial and industrial) which recorded a higher LST to water bodies (such as lakes, ponds, streams and rivers) which showed a low LST value. The correlation analysis generated between LST and the three land cover indices showed that for all time steps MNDWI showed a negative correlation with LST (-0.313 to -0.686 and -0.208 to -0.786 in 2015 and 2016 respectively). Likewise, NDVI showed a higher negative correlation of between -0.127 to -0.436 and -0.137 to -0.389 in 2015 and 2016 respectively. While, NDBI revealed a high positive correlation with LST of between 0.491 to 0.804 and 0.666 to 0.839 in 2015 and 2016 respectively. Urban Heat Island (UHI) effect was described by determining hot and cold spots areas with the core of the study area characterised as hotspot areas while the periphery and most notably the western part of the study area where irrigation fed agriculture are practiced characterised as cold spot areas and this explains why there is a decreasing trend of surface temperature as one moves from the core to the periphery. This study infers that vegetation plays a vital role in weakening LST and recommend that tree planting campaign should be carried out, landscaping should be done alongside road or bridge constructions. In addition, urban greening concept should be carried out by town planners and individuals to reduce the effect of UHI.

5.3 JOURNAL PUBLICATIONS

1. **D. Saberma Ragatoa**, K.O. Ogunjobi, A.A. Okhimamhe, N.A. Browne Klutse & B.L. lamptey "A predictive Study of Heat Wave Characteristics and their spatio-temporal trends in Climatic Zones of Nigeria: Modelling Earth Systems and Environment" *Modeling Earth Systems and Environment*, Vol. 4, No. 3, pp. 1125 - 1151, 2018.

2. **T. Gbangou**, A.A. Okhimamhe, M. Bamba Sylla, O.D. Jimoh "Assessment of Projected agro-climatic indices over Awun River Basin, Nigeria for the late Twenty-first century" *Climatic Change*, vol. 151, No. 3, pp. 445 -462, 2018.

3. **M.L.G. Guidigan**, Fortune Azihou, Rodrigue Idohou, Appollonia Aimiosino Okhimamhe and Adande Belarmain Fandohan "Modelling the current and Future Distribution of Kigelia africana under Climate Chgange in Benin, West Africa: Modelling Earth Systems and Environment *" Modeling Earth Systems and Environment*, Vol. 4, No 3, pp. 1225-1238, 2018.

4. **M.L.G. Guidigan,** F. Azihou, A.A. Okhimamhe, B. Sinsin, S.U. Ibrahim, L. Adet "Examining the Effectiveness of a Protected Areas Network in the Conservation of Kigelia Africana under Climatic Chjnge by 2050 in Benin" *Open Access Library Journal*. Vol. 5, No. 2, pp. 1-15, 2018.

5. **Enoch Bessah**, Abdullahi Bala, Sampson Kweku Agodzo, Appollonia Aimiosino Okhimamhe, Emmanuel Amoah Boakye, Saratu Usman Ibrahim (2019) "The Impact of crop Farmers Decision on Future Land use, Land Cover in Kintampo North Municipality of Ghana" International journal of Climate Change Strategies and Management' Vol. 11 issue: 1 PP 72-87, https://doi.org/10.1108/IJCCSM-05-2017-0114

6. **Enoch Bessah**, Abdullahi Bala, Sampson Kweku Agodzo, Appollonia Aimiosino Okhimamhe, Emmanuel Amoah Boakye and Saratu Usman Ibrahim "The Impact of Crop Farmers' Decision on Future Landuse Land-cover Changes in Kintampo North Municipality of Ghana" *International Journal of Climate Change Strategies and Management,* Vol. 11, No. 1, pp.72 – 87. 2016

7. **Karamoko Sanogo**, Abdulkadir Aishetu, A. A. Okhimamhe and Cheick H. Diakité (2015); Spatio-temporal Change in Land Use and Land Cover: Implications for Conservation of Fina Faunal Reserve in Mali; Nigerian Journal of Technological Reasearch, Vol.10/2: pp 34-42.

8. **Sophie Agnes Kima**, A. A. Okhimamhe, Andre Kiema, Nouhoun Zampaligre, Isaiah Sule (2015); Adapting to the impacts of climate change in the sub-humid zone of Burkina Faso, West Africa: Perceptions of agro-pastoralists; Pastoralism: Research, Policy and Practice 2015; Vol 5: pp 1-14.

9. **Nyazi, Emmanuel**, Ezenwa, I. S. Mathew, Nyarko, K. Benjamin, A. A. Okhimamhe, Bagamsah, T. Thomas and Okelola, O. Francis (2015); Assessment of Trace Gas Emissions from Wild Fires in Different Vegetation Types in Northern Ghana: Implications for Global Warming. Environment and Natural Resources Research; Vol. 5/2: pp 37-48.

10. **Sophie Agnes Kima**, A. A. Okhimamhe and Andre Kiema (2016) Assessing the impacts of land use and land cover change on pastoral livestock farming in South-Eastern Burkina Faso; Environment and Natural Resources Research; Vol. 6/1: pp 110-124.

11. Ebrima Sonko, Daniel N. Tsado, Sidat Yaffa, **Appollonia A. Okhimamhe** and Julia Eichie (2016); Wet and Dry Season Effects on Select Soil Nutrient Contents of Upland Farms in North Bank Region of the Gambia; Open Journal of Soil Science; Vol.6: pp 45-51.

6.0 OUR FUTURE

6.1 Our Prospects

WASCAL MRP on Climate Change and Adapted Land Use as sponsored by the German Ministry of Education and Research has run its course after graduating thirty Master Degree holders from ten West African Countries from October 2012 to March 2018. With the recent transformation of this Master Research Programme to a Doctoral Research Programme called Climate Change and Human Habitat (CC and HH), another chapter has commenced. Currently, issues on sustainability and climate change are on the front burner. West Africa has highly populated capital cities along its vast coastland, a number of which are at risk as sea level rises and coastal erosion and flooding increase. Similarly, key highly populated cities are located in the hinterland and are risk as less frequent rainfall events could lead to dry conditions, which make human comfort more expensive to maintain. The bleak picture does not end there, since cities in more habitable locations would become a "magnet" attracting a steady flow of humans in search of condusive environments to thrive in. **How do we transform our overcrowded cities into sustainable cities that mainstream climate change adaptation strategies into their operations? How do we improve on rural environments such that there is minimal push towards the overcrowded cities?** WASCAL Doctoral Research Programme on Climate Change and Human Habitat seeks to answer these questions and more, as it combines these two trending key foci of the research community, not only by providing a platform for young West African researchers to participate in global research through assessments and modelling of impacts of climate change on human habitat, and vice versa; with key target being rural and urban settlements; urban agriculture and forestry; urban and rural adaptation and mitigation strategies, rural and urban migration issues, among others.

6.2 Our Challenges

It is well known that most West African countries devote a meager amount of their resources on research and innovation. Educational institutions that should be the leading Centres for these are poorly funded and, in most cases, have many competing needs just to exercise a fraction of their mandate, which includes the provision of quality and affordable education to its teeming youths. Basic state of the art teaching aids, overloaded faculty, among others, are a bane of most institutions. However, with funding assistance from the Federal Ministry of Education and Research (BMBF), the sponsor of WASCAL, the capacity of FUT Minna has been enhanced to make tangible contribution in this field of climate change and adapted land use.

Beneficiaries of WASCAL Graduate Study Programmes comprise a network of Anglophone and Francophone host Universities with different modes of operation; and this has challenged the "status quo" in most of the host Universities in such a way that concessions have been made by the Federal University of Technology, Minna to accommodate WASCAL operational guidelines, which, among others, include:

(a) Senate approval of a curriculum developed collaboratively by the International Advisory/Academic Board of e.g. WASCAL CC and HH, with the Postgraduate School and Academic Planning Unit of the University;
(b) Inviting faculty from diverse environments (e.g. Nigeria, West Africa, Germany and others) as guest lecturers to maintain its international outlook;
(c) Having a multi-Departmental approach in engaging FUT Minna faculty, while retaining its link to the School (Faculty) with the most prominent scientific discipline promoted by WASCAL, i.e. Climate Change;

(d) Introducing course work during the first six months of the academic process of the students, as operated by ALL WASCAL DRPs;
(e) Accepting the promotion of WASCAL's unique identity for its GSPs e.g. headquarters in Accra under the leadership of an Executive Director, who is represented by the Director of Capacity Building Department on matters concerning the Graduate Study Programmes; Director of Capacity Building, who coordinates the activities of the graduate schools (MRPs and DRPs); Academic Centres run by Directors that report to the Vice Chancellors of their Universities; quality control procedures that include submission of progress reports; students, guest lecturers and supervisors assessment reports to Accra; inclusion of co-supervisors from partnering institutions in Germany or other West African Universities; and
(f) Admission procedure that includes "face to face" interviews of candidates shortlisted by the International Advisory/Academic Board competitively, using criteria that are familiar to the PGS; submission of the list to the PGS for approval and subsequent admission of the candidates as students of the University.

In addition to providing in-kind contribution, the host University has provided a conducive environment for the programme to thrive. However, sustaining the programme also requires the active participation of the main climate change country stakeholder and focal Ministry of WASCAL, the Federal Ministry of Environment and its Climate Change Inter-ministerial Committee, by securing the full 'buy in' of the Federal Government of Nigeria; and ensuring that country contributions are paid as at when due.

6.3 Our Plans

Ensuring sustainability and visibility will be given top priority by the CC and HH team. Various methods will be used in achieving these and it will involve active collaboration with partners in the WASCAL network, among others, under supervision of both WASCAL Headquarters in Accra and the host University. Specifics will be documented as the future unfolds. It suffices to mention that we are profoundly grateful for the strong push forward received through funding by the Federal Ministry of Education and Research (BMBF) in Germany; and collaboration with German partner Universities of WASCAL such as the University of Bonn and the University of Wurzburg. Consequently, WASCAL CC and ALU MRP has been able to successfully graduate 6 young Nigerians (3 females and 3 males); as well as other young West Africans from Benin (3), Burkina Faso (3), Cote D'Ivoire (2), Ghana (4), Mali (3), Niger (3), The Gambia (2) and Togo (4). We continue to count on the active support of the University Management, which has never been lacking since the commencement of the programme in the University; and the Federal Ministry of Environment and her partners.