

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND
TECHNOLOGY KUMASI GHANA

Multi-Agent Simulation Approach on the Impact of Agricultural Land-use
Change Adaptation Towards the Effect of Changing Climate in
Semi-Arid Ghana

By

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(BAgric. Crop Protection and Environmental Biology;
MSc. Land / Natural Resources Management)

A Thesis submitted to the Department of Civil Engineering,
College of Engineering
in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Climate Change and Land Use

APRIL 2015

CERTIFICATION

I hereby declare that the submission of this thesis synopsis is my own work towards the Doctor of Philosophy in Climate Change and Land-use, and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

This research adapted the Land-Use Dynamic Simulator (LUDAS) framework to develop a multi-agent simulation model (Vea-LUDAS) that captured the impact of agricultural land-use change adaptation options in Vea catchment, Ghana. Sub-models on the maize credit acceptance and soil loss were developed as adaptations to the LUDAS framework. The Vea-LUDAS model simulated the impact of maize credit scenario - MCS (an agricultural land-use change adaptation strategy) on: (i) Agricultural land-use, (ii) Farm household livelihood and (iii) Soil loss potential, and the impact of MCS was compared with the baseline scenario (BS) i.e. business-as-usual for a 20 year simulation period (2012 - 2032). This research also determined the association between heterogeneous farm households and their climate change perception. Further, the underlying factors for agricultural land-use change (ALUC) options in the study area were identified. Mixed method was used for data collection and this included a household survey, farmer and key informant interviews, field measurements, focus group discussion, scenario exploration exercise and role playing games..

The perception of heterogeneous household shows similarities and differences. The endowments of households have influence on their perception about climate change. Identified factors influencing ALUC options in the study area includes water (rainfall) availability, tradition and land suitability.

From the simulation result, the number of maize adopters increased from about 20 % to about 50 % and the area put under maize cultivation increased by

about 266 %. MCS influenced the conversion of some agricultural lands into maize cropland. Average annual aggregated crop yield was 6.3 % higher under MCS compared to BS. Soil loss under BS and MCS showed no statistical difference, but the simulation result shows that cultivation on cropland with high erosion risk has implication for soil loss.

In conclusion, this study shows that MCS can improve farm household livelihood in the face of changing climate. However, an encompassing policy strategy will boost crop production and household resilience towards the impact of climate change and variability. Some farmer adaptation strategies should include improved fertiliser subsidy scheme, better access to irrigated farming, accessibility to improved land preparation equipment and improved seed varieties.



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LIST OF ABBREVIATIONS

ABM	Agent based model
AfDB	African Development Bank
ALUC	Agricultural Land-use Change
CCLU	Climate Change and Land Use
CEC	Cation Exchange Capacity
DEM	Digital Elevation Model
DfID	Department for International Development
DLR	Deutsches Zentrum für Luft- und Raumfahrt
ECA	Economic Commission for Africa
ENSO	El Nino Southern Oscillation
ES	Ecosystem services
ESRI	Environmental Systems Research Institute
FAO	Food and Agriculture Organisation
GCM	Global Circulation Model
GHG	Greenhouse gases
GIS	Geographic Information System
GPS	Global Positioning System
GRP	Graduate Research Programme
IBM	Individual-Based Models
ICOUR	Irrigation Company of the Upper Region
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
KCA	K-means Cluster Analysis
LUCC	Land-use/cover change
LUDAS	Land Use Dynamic Simulator
MA	Millennium Ecosystem Assessment
MAS	Multi Agent Simulation
MDG	Millennium Development Goals

MoFA	Ministry of Food and Agriculture
NEPAD	New Partnership for Africa's Development
ODD	Overview, Design concepts and Details
PCA	Principal Component analysis
PSEE	Participatory Scenario Exploration Exercise
SES	Socio Ecological Systems
SRTM	Shuttle Radar Topography Mission
TERI	The Energy and Resources Institute
UER	Upper East Region
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
U.S.EPA	U.S. Environmental Protection Agency
USLE	Universal Soil Loss Equation
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
WRC	Water Resources Commission

ACKNOWLEDGEMENT

I am ever grateful to my Creator, and to whom I owe my very existence. I sincerely appreciate my Supervisors, Professor Sampson Agodzo and Professor Samuel Odai for their professional and technical advice, constant support, motivation and moral encouragement from the beginning of my doctoral degree programme to the research stage and up till this moment. My sincere appreciation also goes to my doctoral research science adviser, Dr. Grace Villamor, who stood by me from research design to the implementation phase. I appreciate your advice and constructive criticisms and I thank you for sparing part of your tight schedule to provide technical and theoretical support. I thank Federal Ministry of Education and Research (BMBF) Germany for providing the research fund through West African Science Service Center on Climate Change and Adapted Land Use (WASCAL).

Special thanks to WASCAL GRP CCLU Coordinator, Dr. Wilson Agyare, the local board members (Prof. Eric Forkuo, Dr. Leonard Amedkudzi and Dr. Kyere Boateng) and the international board members. I express thanks to Dr. Tinuke Adebajji for statistic advice, Dr. Quang Bao Le and other Lecturers who taught me. To my course mates, Bernard, Boundia, Demba, Halima, Laouali, Lucette, Maurice, Nat and Solo, you are wonderful. I thank the administrative staffs of Steven Paris hostel and my hostel mates (Kobby, Oxford, Pep, Charles, Sidik and others). I am grateful to the staffs of Water Resources Commission, Bolgatanga (Liza, Abongo, Justice and Comfort), the staffs of Ministry of Food and Agriculture (MoFA) at the regional office, Bongo and Bolgatanga district office, and the staffs of Irrigation Company for the Upper region (ICOUR). I thank Mr. Joachim Abunga and his family for the assistance on and off the field in

Bolgatanga. To WASCAL team in Bolgatanga (Aaron, Sammy, Akwesi, Rita, Monica, Ben, Monica, Ben and Francis), I thank you all. Special thanks to Mr. Aaron Aduna and Mr. Guug. To my field assistants (Tomas, John, Chris and others) and my housemates (Aline, Vivian, Ernest) in Bolgatanga, I value you all.

I attribute my remarkable stay at the centre for development research University of Bonn Germany to Minnatallah Boutros, Dr. Gunter Manske, Haik, Dr. Domonik Wissner, Jelana, Maike Retat-Amin, Sabine Aengenendt-Baer, Elena and other people at the centre. I am grateful to Ismael Akinpelu and family, Samson-Tobi, Richard-Appiah Otoo, Ayodele Mesele, Lukmon, Fadesere, Bayo Olugbile, Biola Kamar, Lanre, Hammed, Ismahil salawu, Fashogbon, Madam Onawunmi, Madam Dorcas, Femi Lawal, Grivin Chipula, Frank Annor, Gerald Forkuo, Jerry-Gavu. To my undergraduate degree Lecturers (Prof. Omoloye, Prof. Atiri, Prof. Awodoyin, Dr. Ilori, Prof Ewete, Dr. Cole, Dr. Olubode) and my Master's degree Supervisor (Dr. Ruben Sakrabani), I thank you all for staying in touch. I thank Dr. Ademola Braimoh for his advice.

Finally, I thank my Parents (Mr. and Mrs. Badmos) for giving me a very good start and for their encouragement all the way. I thank Mrs. Bola Badmos, Mrs. Nike Badmos, Mr. Alase and Mrs. Alase and family, Bolaji Badmos and family, Biodun Badmos and family, Bimpe, Bisi, Bayo Badmos and family, Bode, Banji, Badmidele, Bisola, Yetunde Badmos, Barister Tijani Ishola and family, Mr Gbolagade Dada and family, Mr Sadiku and family, Kola Diekola, Toba, Capello and Kenny. Lastly, I want to express sincere appreciation to Oziohu for standing by me all the way. My special thanks to other not mentioned for their support.