



**BUSITEMA
UNIVERSITY**
Pursuing excellence

**FACULTY OF NATURAL RESOURCES AND
ENVIRONMENTAL SCIENCES
DEPARTMENT OF NATURAL RESOURCE ECONOMICS**

**THE POTENTIAL IMPACTS OF CLIMATE CHANGE AND CLIMATE
VARIABILITY ON ARABICA COFFEE PRODUCTION: A CASE STUDY OF
TINGEY COUNTY IN KAPCHORWA DISTRICT, UGANDA**

By

KATO PHILLIP
(BU/GS16/MCC/27)



SUPERVISORS

Dr. Isabirye Moses (PhD)

Mr. Taako George Edema

**Dissertation submitted to the Faculty of Natural Resources and Environmental Sciences
in partial fulfilment of the requirements for the award of the Degree of Master of
Science in Climate Change and Disaster Management of Busitema University**

OCTOBER, 2020

ABSTRACT

The study was conducted in the Tingey county Kapchorwa district in Uganda aimed at assessing the effect of climate change and climate variability on Arabica coffee production. The objectives of the study were to assess the effect of climate change and climate variability on coffee production under the current and predicted climatic conditions of precipitation and temperature; to assess the adaptation techniques that farmers are applying and to assess the determinants of farmer's choice of adaption techniques.

To achieve these objectives, the study assessed the historical and forecasted precipitation and temperature patterns under the three emission scenarios of RCP 2.6, RCP 4.5 and RCP 8.5. Questionnaires and key informant interviews were employed to gather information on farmer's adaptation techniques to the impacts of climate change and determinants of farmer's choice of adaptation techniques.

Gridded datasets of observed and modelled rainfall and temperature data from Climate Research Unit (CRU) and Coordinated Regional Climate Downscaling Experiment (CORDEX) were used to assess the historical and forecasted patterns of rainfall and temperature.

The research findings reveal that climate change will negatively affect coffee production. Temperature will increase by 0.5^oC for RCP 2.6, 1.7^oC for RCP 4.5 and 4.6^oC for RCP 8.5. Such temperature changes will lead to coffee flower abortion, early ripening of coffee beans and areas suitable for the growth of coffee will reduce. Arabica coffee farmers could be forced to move up the mountains for favourable temperatures and this will in turn affect the quality of Arabica coffee and farmers could also be forced to switch to the production of other cash crops.

Results also indicate that farmers are employing different techniques to adapt to climate change. 41.07 percent of the respondents use intercropping as an adaption technique followed by agroforestry at 34.40 percent.

In conclusion, climate change and climate variability will negatively affection Arabica coffee production in Tingey County, Kapchorwa District.

DECLARATION

I, Kato Phillip declare that this research is my own original work done within the period of registration and that it has never been submitted for a degree award in any other institution.

Signed: 

Date: 

Kato Phillip

CANDIDATE



APPROVAL

This is to confirm that this research report is original and has only been through the efforts of **Kato Phillip** after pursuing a Master of Science in Climate change and Disaster Management of Busitema University. He has therefore fulfilled part of his requirements for the Award of the Master's Degree in Climate change and Disaster Management of Busitema University, Uganda.

Dr. Moses Isabirye (PhD)
Department of Natural Resource Economics
Faculty of Natural Resources and Environmental Sciences
Busitema University

Signed:



Date:

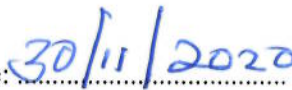


Mr. George Taako Edema
Lecturer,
Department of Natural Resource Economics,
Faculty of Natural Resources and Environmental Sciences

Signed:



Date:



DEDICATION

This dissertation is dedicated to my family for they gave me conducive time at home that enabled me give time to my studies.

To my father Joshua Baino-Komire (RIP) and my mother Nalongo Amoofti Regina.

ACKNOWLEDGEMENTS

I express my deepest and great gratitude to the Almighty God for both spiritual and physical strength and wisdom.

My sincere appreciation and thanks to my supervisors, Dr. Moses Isabirye and Mr. Taako Edema George for their guidance and valuable support throughout this research.

Appreciation also goes to staff and colleagues of Busitema University, Department of Biophysical and Geo Information Sciences, Natural Resource Economics, Faculty of Natural Resources and Environmental Sciences:

Appreciation to the management of Kyagalanyi coffee Ltd for the support rendered to me in data collection.

Special thanks to the management of National Environment Management Authority (NEMA) for the favourable environment to enable me undertake my research.

TABLE OF CONTENTS

ABSTRACT	i
DECLARATION	ii
APPROVAL.....	iii
DEDICATION.....	iv
ACKNOWLEDGEMENTS	v
LIST OF TABLES	ix
LIST OF FIGURES	x
ABBREVIATIONS	xi
CHAPTER ONE: INTRODUCTION.....	1
1.0 Introduction	1
1.1 Background to the Study	1
1.2 Objectives of the Study	3
1.2.1 Main Objective.....	3
1.2.2 Specific Objectives.....	3
1.3 Research Questions	3
1.4 Statement of the problem	3
1.5 Justification of the Study	4
1.6 Significance of the Study	4
1.7 Conceptual framework	5
CHAPTER TWO: LITERATURE REVIEW	7
2.0 Introduction	7
2.1 History of coffee Production in Uganda.....	7
2.2 Climatic factors that favour growth of Arabica coffee.....	9
2.3 Climatic Condition changes in Uganda.....	11
2.4 Influence of climate variation on Arabica Coffee production.....	14
2.5 Global climate models and downscaling.....	17
2.6 Representative Concentration Pathway	18
2.7 Adaptation to climate change	20
2.7.1 Climate change adaptation techniques for Arabica coffee farmers	21
2.8 Conclusion.....	23
CHAPTER THREE: MATERIALS AND METHODS.....	24
3.0 Introduction	24
3.1 Scope of the Study	24

3.2	Study site	24
3.2.1	Administrative Units and the population size	25
3.2.2	Relief and Climate.....	26
3.2.3	Vegetation	26
3.2.4	Economic Activities.....	26
3.3	Research design.....	26
3.4	Target Population.....	27
3.5	Sampling method.....	27
3.5.1	Study Population sample	28
3.5.2	Sample size determination	28
3.6	Data collection.....	28
3.6.1	To assess the effect of climate change and climate variability on Arabica coffee production using the current and predicted climatic conditions.....	28
3.6.2	Assessing adaptation methods to climate change by Arabica coffee farmers	29
3.7	Data management.....	30
3.8	Data analysis.....	30
3.9	Precipitation and Temperature Projection.....	31
3.9.1	Representative Concentration Pathway 2.6 (RCP2.6)	31
3.9.2	Representative Concentration Pathway 4.5 (RCP4.5)	32
3.9.3	Representative Concentration Pathway 8.5 (RCP 8.5)	32
3.10	Assessing farmers choice of adaptation techniques to climate change	32
3.11	Data Preparation	34
CHAPTER FOUR: RESULTS AND DISCUSSIONS		35
4.0	Introduction	35
4.1	Assessment of Arabica coffee production under current and predicted climatic conditions	35
4.1.1	Variability in precipitation for observed and modelled data.....	35
4.1.2	Variability in Temperature for observed and modelled data	36
4.1.3	Temperature and Rainfall forecast for Tingey County in Kapchorwa District based on representative concentration pathways	37
4.1.4	Spatial representation of temperature changes.....	45
4.1.5	Spatial representation of changes in rainfall	46
4.1.6	Arabica coffee production / yield based on temperature and rainfall	47
4.2	Assessment of climate change adaptation methods.....	50
4.2.1	Age of the respondents.....	50

4.2.2	Sex of the respondents	50
4.2.3	Household size	51
4.2.4	Land available for agriculture.....	51
4.2.5	Coffee land	51
4.2.6	Number of bags of coffee harvested	51
4.2.7	Home major decisions.....	51
4.2.8	Source of Income	51
4.2.9	Level of Education of respondents.....	52
4.2.10	Experienced Coffee Loss	53
4.2.11	Causes of coffee loss.....	53
4.2.12	How to overcome coffee losses.....	54
4.2.13	Access to information on coffee market	56
4.2.14	Access to information on weather forecast.....	56
4.2.15	Benefits from Member Groups	56
4.3	Adaptation techniques.....	60
4.4	Determinants of farmers choice of adaptation methods to climate change.....	62
CHAPTER FIVE: CONCLUSSIONS AND RECOMMENDATIONS.....		65
5.0	Introduction	65
5.1	Summary	65
5.2	Conclusions	65
5.2.1	To assess the effect of climate change and climate variability on Arabica coffee production.....	65
	Variability in Temperature.....	65
5.2.2	To identify the different methods used by farmers to adapt to climate change	65
5.2.3	To study the determinants of farmers' choice of adaptation methods to climate change	66
5.3	Recommendations	67
5.3.1	Recommendations to government.....	67
5.3.2	Recommendations to farmers.....	68
5.4	Further research.....	69
REFERENCES.....		70
ANNEXES		74
ANNEX 1: QUESTIONNAIRE.....		74

LIST OF TABLES

Table 2-1: Climatic requirements for growth of Arabica coffee (Beernaert F et al., 1993)	11
Table 2-2: Representative concentration pathways under different scenarios	20
Table 2-3: Adaptation to climate change	22
Table 3-1: Population of Tingey County (UBOS, 2014)	27
Table 3-2: Sampled households	28
Table 3-3: Description of dependent variables	33
Table 3-4: Description of independent variables	33
Table 4-1: Estimated Arabica coffee yield reduction for Tingey County based on RCPs	47
Table 4-2: Estimated Arabica coffee yield percent for Tingey County based on RCPs in relation to rainfall	48
Table 4-3: Age of the Respondents ($N=352$)	50
Table 4-4: Sex of the respondents ($N=352$)	50
Table 4-5: Household size, bags of coffee harvested, land available for coffee growing and total available land for agriculture ($N=352$)	50
Table 4-6: Major decision makers at home ($N=352$)	51
Table 4-7: Source of Income and Level of Education Cross tabulation ($N=352$)	52
Table 4-8: The causes of coffee losses ($N=352$)	53
Table 4-9: Climate change adaptation techniques ($N=352$)	55
Table 4-10: Access to information on coffee markets ($N=352$)	56
Table 4-11: Access to information on weather forecast ($N=352$)	56
Table 4-12: Benefits of being a member of a farmer group ($N=352$)	57
Table 4-13: Relationship between land available for coffee growing and the bags of coffee harvested ($N=352$)	58
Table 4-14: Access to weather forecast information to number of bags of coffee harvested ($N=352$)	59
Table 4-15: Access to market information to number of bags of coffee harvested ($N=352$)	59
Table 4-16: Relationship between Tree shades and volume of coffee harvested ($N=352$)	60
Table 4-17: Relationship between use of pesticides and volume of coffee harvested ($N=352$)	60
Table 4-18: Relationship between mulching and volume of coffee production ($N=352$)	61
Table 4-19: Relationship between fertilizer and volume of coffee production ($N=352$)	61
Table 4-20: Relationship between stumping and volume of coffee production ($N=352$)	62
Table 4-21: Group membership and volume of coffee production ($N=352$)	62
Table 4-22: Parameter estimates of the multinomial logit climate change adaptation model	63

LIST OF FIGURES

Figure 1-1: Impacts of climate change & climate variability on Arabica coffee production and adaptation measures (REMA, 2011)	6
Figure 2-1: Arabica Coffee export trends for Uganda from 1991 to 2017 (UCDA, 2019) ..	8
Figure 2-2: Trends of the value of Arabica Coffee for Uganda from 1991 to 2017 (UCDA, 2019)	9
Figure 2-3: Average monthly temperature of Uganda from 1901 to 2016 (World Bank, 2016)	12
Figure 2-4: Average monthly Rainfall of Uganda from 1901 to 2016 (World Bank, 2016)	13
Figure 2-5: Key Natural hazards statistics in Uganda from 1985 to 2018 with the number of people affected (World Bank, 2018).....	14
Figure 2-6: The impacts of temperature on robusta coffee production (Smonett, O, 1989)	16
Figure 2-7: Atmospheric CO2-equivalent concentrations (IPCC, 2014).....	18
Figure 3-1: Map of Tingey County in Kapchorwa District.....	25
Figure 4-2: Average Temperature for Tingey County, Kapchorwa from 1971 to 2000 using observed and modelled data (CRU, 2019).....	36
Figure 4-3: Temperature projection for Tingey County in Kapchorwa district from 2006 to 2100 based on RCP2.6.....	37
Figure 4-5: Average temperature projection for Tingey County from 2006 to 2100 based on RCP8.5	39
Figure 4-6: Rainfall projection for Tingey County in Kapchorwa district from 2006 to 2100 based on RCP2.6	40
Average rainfall deviations based on RCP2.6	41
Figure 4-7: Average rainfall deviations based on RCP2.6.....	41
Annual Rainfall forecast from 2006 to 2100 based on RCP4.5	41
Figure 4-8: Rainfall projection for Tingey county, Kapchorwa district from 2006 to 2100 based on RCP4.5	42
Figure 4-9: Annual rainfall deviations based on RCP4.5	43
Figure 4-10: Annual rainfall projection for Tingey County, Kapchorwa district from 2006 to 2100 based on RCP8.5.....	44
Figure 4-11: Annual rainfall deviations based on RCP8.5	45
Figure 4-12: Temperature projections based on RCP 2.6, 4.5 and 8.5	46
Figure 4-13: Rainfall projections based on RCP 2.6, 4.5 and 8.5.....	46
Figure 4-14: Arabica Coffee yield / production with increased average temperature	49
Figure 4-16: Level of Education of the respondents.....	52

ABBREVIATIONS

°C	Degrees Celsius
CCKP	Climate Change Knowledge Portal
CH ₄	Methane
CO ₂	Carbon dioxide
CORDEX	Coordinated Regional Climate Downscaling Experiment
CRU	Climate Research Unit
CW	Climate Wizard
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gases
GIS	Geographic Information Systems
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IRI	International Republican Institute
LDC	Least Developed Countries
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
Masl	Meters above sea level
MNL	Multinomial logit model
MWE	Ministry of Water and Environment
NAPA	National Adaptation Programme of Action
NEMA	National Environment Management Authority
OWC	Operation Wealth Creation
Ppm	Parts per million
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
UBOS	Uganda Bureau of Statistics
UCDA	Uganda Coffee Development Authority
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

CHAPTER ONE: INTRODUCTION

1.0 Introduction

In this chapter, we present background to the study, the major and specific objectives, research questions, statement of the problem, justification and significance of the study and the conceptual framework.

1.1 Background to the Study

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a variation between normally experienced climate conditions and a different, but recurrent, set of climate conditions over a given region of the world over a period of 30 (thirty) years (IPCC, 2001). The key cause of climate change is the burning of fossil fuels, these lead to the increase in greenhouse gases (GHG) such as carbon dioxide (CO₂) and Methane (CH₄) content of the atmosphere that weaken the ozone layer leading to global warming (IPCC, 2001).

There is strong evidence that suggests that climate is changing such as increase in global land surface temperatures, melting of ice on mountain Rwenzori, more frequent droughts, unpredictable rainfall patterns, and many more. Agriculture which is a backbone of Uganda's economy is predominantly rain fed and is highly vulnerable to climate change and climate variations. Over 80% of Uganda's population is rural and 73% of the working population are employed in agriculture and related activities (MAAIF, 2010).

Studies by the International Food Policy Research Institute (IFPRI) have showed that increased floods and droughts increase the likelihood of short-run crop failures and long-run production declines in both crops and animals (IFPRI, 2009). If left unchecked, climate change is expected to lower global per capita Gross Domestic Product (GDP) by 20% by 2200, threatening global food security (Stern, 2010).

High yields in Arabica Coffee is linked to climate, and is thus strongly influenced by changes in climate (Sys et al., 1993). The stated optimum mean annual temperature range for Arabica is 16–22 degrees Celsius. At temperatures above 22 degrees Celsius, development and ripening of fruits are accelerated, often leading to the loss of beverage quality (Carmago, 2010) although in some locations higher temperatures 24 to 25 degrees

REFERENCES

- Abbas Tashakkori, C. T. (2003). *Handbook of Mixed Methods in Social & Behavioral Research*.
- Agegnehu, E., Thakur, A., & Muluaalem, T. (2015). Potential Impact of Climate Change on Dynamics of Coffee Berry Borer (*Hypothenemus hampei* Ferrari) in Ethiopia. *Open Access Library Journal*, 2: e112.
- Brown, M., & Funk, C. (2008). 8. Brown, M. and Funk, C *Climate: Food security under climate change*. *Science*, 319: 580-581.
- Carmago, A. (2010). *The impact of climatic variability and climate change on Arabic coffee crop in Brazil*. *Bragantia* 69: 239–247.
- CRU. (2019, May 05). <http://www.cru.uea.ac.uk/data>. Retrieved from Climate Research Unit: <http://www.cru.uea.ac.uk/data>
- CTA. (2006). *Coffee Executive brief, Agritrade News and analysis of events affecting the Africa Caribbean and Pacific (ACP) agricultural trade, September, 2006*.
- DaMatta, F. (2004). *Exploring drought tolerance in coffee: a physiological approach with some insights for plant breeding*. *Braz. J Plant Physiol* 16: 1–6.
- Danielsen, S., Matsiko, F. B., & Kjaer, A. (2014). "Implementing Plant Clinics in the Maelstrom of Policy Reform in Uganda." *Food Security* 6: (6): 807-818.
- Davis, A., Aron, P., Tadesse, G. W., Baena, S., & Moat, J. (2012). *The Impact of Climate Change on Indigenous Arabica Coffee (Coffea Arabica): Predicting Future Trends and Identifying Priorities*. *PLOS ONE*, Vol. 7, No. 11, pp. 1-
- Deressa, & Temesgen, T. (2007). *Deressa, Temesgen Tadesse (2007). Measuring the Economic Impact of Climate Change on Ethiopian Agriculture: Ricardian Approach*. *World Bank Policy Research Working Paper No. 4342*.
- Enomoto, R. (2011). 15. *Enomoto R (2011). Climate-friendly and Productive farming Guide for Coffee smallholders in Africa*.
- Eshetu, A., Ashok, T., & Tewodros, M. (2015). *Potential Impact of Climate Change on Dynamics of Coffee Berry Borer (Hypothenemus hampei Ferrari) in Ethiopia*. *future changes*. (2020, September 1). Retrieved from IPCC Home: https://ar5-syr.ipcc.ch/topic_futurechanges.php
- Given, L. M. (2008). *The Sage Encyclopedia of Qualitative Research Methods*.
- Given, L. M. (2008). *The Sage Encyclopedia of Qualitative Research Methods: Volume 1 and 2*. London: SAGE Publications.
- Hagger, J., & Schepp, K. (2011). *Coffee and climate change. Desk study: impacts of climate change in four pilot countries of the coffee and climate initiative*. Hamburg: *Coffee and Climate*.

- Harris, I., Jones, P., Osborn, T., & Lister, D. (2013). *Harris, I., Jones, P.D., Osborn, T.J., and Lister, D.H., 2013: Updated high-resolution grids of monthly climatic observations.*
- IFPRI. (2009). *Climate Change: Impact on Agriculture and Costs of Adaptation.* International Food Policy Research Institute Washington, D.C. Updated October 2009.
- IPCC. (2001). *Climate Change 2001: Impacts, Adaptations, Vulnerability". Contribution of Working Group II to the third assessment report of the IPCC.* Geneva: UNEP/WMO.
- IPCC. (2001). *Climate Change: " Impacts, Adaptations, Vulnerability". Contribution of Working Group II to the third assessment report of the IPCC.* UNEP/WMO. Geneva.
- IPCC. (2014). *The Intergovernmental Panel on Climate Change, Fifth Assessment Report.*
- Jaramillo, J., Muchungu, E., Fernando, E., Borgemeister, C., & Adenirin, C.-O. (n.d.). 'somelike It Hot: The Influence and Implications of Climate Change on Coffee Berry Borer (*Hypothenemus hampei*) and Coffee Production in East Africa,' *PLoS ONE* 6/9 (2011): e24528.
- Jassogne, Lawrence & Laderach, Peter & Van Asten, & Piet, J. (2013). *The Impact of Climate Change on Coffee in Uganda: Lessons from a case study in the Rwenzori Mountains.* Oxfam Policy and Practice: Climate Change and Resilience.
- Kasterine, A., Scholer, M., & Hilten, J. (2010). *Kasterine A, Scholer M, Hilten JH (2010). Climate Change and the Coffee Industry. Abstract for trade information services. International Trade Centre, Palais des Nations, 1211 Geneva 10, Switzerland.*
- Killeen, J., & Harper, G. (2016). *Coffee in the 21st century. Will Climate Change and Increased Demand Lead to New Deforestation?*
- Kumar, R. (1996). *Research methodology. A step-by-step guide for beginners.* Addison Wesley Longman.
- Laderach, P., Hagger, J., Lau, C., Eitzinger, A., Ovalle, O., Baca, M., . . . Lundy, M. (2010). *Mesoamerican coffee: Building a climate change adaptation strategy.* CIAT Policy Brief no. 2. Centro Internacional de Agricultura Tropical (CIAT). Cali, Colombia.
- Lavine, M. (2013). *Introduction to Statistical Thought.*
- MAAIF. (2010). *Agricultural Sector Development Strategy and Investment Plan, DSIP 2010/11-2014.*
- Masters, G., Baker, P., & Flood, J. (2009). *Climate Change and Agricultural Commodities.* CABI Position Paper.
- Mendoza, N. (2014). *Coffee and climate: The development imperative for smallholders.* Devex Impact.

- MWE. (2015). *Final study report on Economic Assessment of the Impacts of Climate Change in Uganda*.
- Nabikolo, D., Bashaasha, B., Mangheni, M., & Majaliwa, J. (2012). *51 Determinants of climate change adaptation among male and female headed farm households in Eastern Uganda*, *African Crop Science Journal*, 20 (2): 204-212.
- Noordzij M, T. G. (2010). *Sample size calculations: Basic principles and common pitfalls*. *Nephrol Dial Transplant*. 25:1388–1393.
- Oluwakemi, Obayelu & Oluwayemisi, Abimbola & Idowu, & Tolulope. (2014). Factors influencing farmers' choices of adaptation to climate change In Ekiti State, Nigeria. *Journal of Agriculture and Environment for International Development*. 108: 3-16. 10.
- Oriana, O.-R., Peter, L., Christian, B., Michael, O., & Gotz, S. (2015). *Projected Shifts in Coffea arabica Suitability among Major Global Producing Regions Due to Climate Change*.
- Ovalle-Rivera O, L. P. (2015). *Projected shifts in Coffea arabica suitability among major global producing regions due to climate change*.
- Oxfam. (2013). *The impact of climate change on coffee in Uganda. Case study of Rwenzori Mountains*.
- R., M. (2008). *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies*. Intergovernmental Panel on Climate Change, Geneva, 132 pp.
- Sarr, A., Camara, M., & Diba, I. (2015). *Spatial Distribution of Cordex Regional Climate Models Biases over West Africa*. *International Journal of Geosciences*, 6, 1018-1031. <http://dx.doi.org/10.4236/ijg.2015.69081>.
- Schroth, G., Laderach, P., Dempewolf, J., Philpott, S., Haggard, J., Eakin, H., . . . Eitzinger, A. (2009). *Towards a climate change adaptation strategy for coffee communities and ecosystems in the Sierra Madre de Chiapa*.
- Smonett, O. (1989). *Potential Impacts of global warming, GRID-Geneva, Case studies on climate change, Geneva*.
- Stern, N. (2010, 12 8). *The Economics of Climate Change: The Stern Review*. Retrieved from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_elimate_change/sternreview_report.cfm; <http://www.hm-treasury.gov.uk>
- Sys, C., Van Ranst, E., Debaveye, J., & Beernaert, F. (1993). *Land Evaluation Part 3: Crop Requirements*.
- Tashakkori, A., Teddlie, C., & Teddlie, C. B. (2003). *Handbook of Mixed Methods in Social & Behavioral Research*. London: SAGE Publications.
- Temesgen, T., Rashid, M., Claudia, R., Tekie, A., & Mahmud, Y. (2009). *Determinants of farmers choice of adaptation methods to climate change in Nile Basin of Ethiopia*.

- Trochim, D. A. (2015). *Research Methods: The Essential Knowledge Base*.
- Trochim, W. M., Donnelly, J. P., & Arora, K. (2015). *Research Methods: The Essential Knowledge Base*. Austria: Cengage Learning.
- UBOS. (2014). *Uganda Bureau of Statistics*. Kampala, Uganda.
- UCDA. (2006). *Uganda Coffee Development Authority (UCDA) Annual report*. Kampala, Uganda.
- UCDA. (2015). *Uganda National Coffee Strategy 2040 Plan for 2015/16 - 2019/20*. Kampala, Uganda.
- UCDA. (2019). *Uganda Coffee Development Authority Fact Sheet*. Kampala, Uganda.
- UNFCCC. (1992). *United Nations Framework Convention on Climate Change*.
- UNFCCC. (2007). *Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries*.
- USAID. (2015). *Climate Change Information Fact Sheet UGANDA*.
- WiseM, C. T. (2009). *The Implications of Limiting CO2 Concentrations for Agriculture, Land-use Change Emissions, and Bioenergy*. Technical Report. [PNNL-17943].
- WorldBank. (2016). Climate change knowledge portal. p.
<https://climateknowledgeportal.worldbank.org/country/uganda>.
- WorldBank. (2018). *Climate change knowledge portal*. Retrieved from
<https://climateknowledgeportal.worldbank.org/country/uganda>