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Research Application Summary

Climate change impacts to agriculture in Uganda's semi arid areas, farmers' means of adaptation: An application of cross-section data

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Abstract

The most climate change prone communities in Uganda are those living in semi arid areas of Karamoja and parts of Teso where droughts have been most frequent and most prolonged. In Karamoja alone, during the last decade more than 10 severe droughts have occurred indicating a > 50% rise. There are no known studies that have quantified the economic impacts of climate change particularly to agriculture in these areas of Uganda and the country at large. This study will use cross-sectional data to quantify the climate change impacts to farming in Uganda's semi arid areas of Karamoja and parts of Teso, as well as to determine farmers' choice of climate adaptation mechanisms. Results will enhance policy formulation and decision-making in terms of climate adaptation and mitigation strategies in Uganda and eastern Africa region.

Key words: Adaptation, climate change, economic impact, mitigation, Uganda

Résumé

La plupart de communautés prédisposées au changement climatique en Ouganda sont celles-là vivant dans les régions semi-arides de Karamoja et les parties de Teso où les sécheresses ont été les plus fréquentes et les plus prolongées. Seule la zone de Karamoja a connu, pendant la dernière décennie, plus de 10 sécheresses graves indiquant une élévation de plus de 50%. Il n'y a aucune étude connue qui a mesuré les impacts économiques du changement de climat sur l'agriculture de ces régions de l'Ouganda en particulier et celle du pays en général. Cette étude emploiera des données en coupe transversale pour mesurer les impacts de changement de climat sur l'agriculture dans les régions semi-arides de Karamoja et les parties de Teso en Ouganda, aussi bien pour déterminer le choix des fermiers sur les mécanismes d'adaptation au climat. Les résultats susciteront la formulation de politique et la prise de décision en terme de stratégies d'adaptation et d'atténuation de climat en Ouganda et dans la région orientale de l'Afrique.

Mots clés: Adaptation, changement climatique, impact économique, atténuation, Ouganda

Background

Climate change is caused by accelerated increase in greenhouse gas (GHG) concentrations in the atmosphere. There is now a strong consensus that climate change presents a fundamental challenge to the well-being of all countries, with the arid and semi-arid parts of countries suffering water scarcity. The African continent climate "hot spots" mapping exercise (Thornton *et al*., 2006), identified mixed arid-semi-arid systems in the Sahel, arid-semi-arid rangeland systems in parts of eastern Africa (semi arid parts of Uganda inclusive) to be vulnerable to climate change and variability. In Uganda, the Teso and Karamoja regions have experienced increased incidences of drought and floods, causing widespread suffering (DFID, 2008).

Climate in Uganda is the most important determinant of the productivity of natural resources. The rise in temperature, redistribution of rainfall, and more frequent flooding and droughts due to global climate changes cause considerable damage to crop production and the agricultural sector in general. Some conclusions regarding the impacts of climate change on agricultural production in Uganda have been drawn from few studies with a lot of uncertainties (Kirsten *et al.,* 2008). Examples include; decrease in maize crop and coffee output, and decrease in potential for livestock grazing lands in the cattle corridor. However, there are no known studies that have quantified climate change effects on agricultural production in semi-arid areas of Uganda. This study will seek to quantify economic impact of climate change on agricultural production, determine farmer's choice of adaptation strategies, and make predictions on climate effects to agricultural production in Teso and semi-arid (Karamoja) areas of Uganda. The study objectives include: i) to assess the impact of climate, soil and household variables on net farm production and revenue in the study areas; ii) to determine factors that influence choice of adaptation strategies among farm households and communities in the study areas; and iii) to predict the impact of future climate scenarios on farm production in the study areas.

Literature Summary

Agriculture sector remains the mainstay of Uganda's economy. The sector contribution to the total GDP in 2008 was 21.5 percent and employment 73% (UBOS, 2009). Agriculture in Uganda is almost exclusively rain-fed, which means that it is extremely vulnerable to rainfall variability and weather extremes. Climate variability and climate change in spheres of long-term droughts and heavy rains have so far characterized reduced agriculture production in the country (Twinomugisha, 2005). Kirsten *et al.*

(2008) summarized recent weather-related adverse effects in Uganda as: food insecurity as a consequence of droughts and floods; outbreak of diseases (malaria, water-borne diseases) associated with floods; respiratory diseases associated with droughts; and heavy rainfalls which tend to accelerate land degradation and damage to infrastructure by floods.

There are alternative methodologies in the economics literature that have been used to measure the agricultural impacts of climate change. One approach used panel data to examine and explore the intertemporal changes in net revenues with weather (Deschenes and Greenstone, 2007). Some studies have used the Ricardian approaches to analyse impacts of climate change. The Ricardian model that analyses a cross section of farms under different climatic conditions and examines the relationship between the value of land or net revenue and agro-climatic factors has been applied in a number of studies (Mendelsohn *et al.*, 1994). Deressa and Hassan (2006) used Ricardian approach capturing farmers' adaptation to varying environmental factors to analyse impact of climate change in Ethiopian agriculture.

Study Description

The study will cover four districts, two from Teso and two from Karamoja (semi arid) sub regions in the north eastern part of Uganda. Multistage sampling techniques will be applied to determine a sample of 800 farmers. The study will use panel data to be collected for two seasons during 2011 on climate and farm production variables using pretested questionnaires.

To achieve objective (i) and (iii), the Ricardian approach developed by Mendelsohn *et al.* (1994) will be used. Theoretically by maximising net revenue subject to a set of environmental inputs, the Ricardian approach makes it possible to measure the marginal contribution of each input to farm income as capitalised in land value. Following Mendelsohn *et al.* (1994, 1996), the Ricardian approach involves specifying a net revenue function of the form:

$$R = \sum P_i Q_i(X, F, G, Z) - \sum P_x X \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where R is net revenue per hectare, Pi is the market price of crop i, Q_i is output of crop i, X is a vector of purchased inputs, F is a vector of climate variables, G is a set of economic variables such as livestock ownership, Z is a set of soil variables and P_X is a vector of input prices.

By using parameters from the fitted net revenue model, the impact of changing climatic variables on the net revenue per hectare is analysed as:

$$\delta Y = y^1 - y \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$NRh = \Sigma(\delta Y/n) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where y^1 is the predicted net revenue per hectare from the estimated net revenue model under the new (future) climate scenario, y is the predicted value of the net revenue per hectare from the estimation model under the current climate scenario, δY is the difference between the predicted value of the net revenue per hectare under the new climate scenarios and the current climate scenario, *NRh* is the average of the change in the net revenue per hectare and *n* is the number of observations.

The multinomial logit will be applied to realize objective (ii). The adaptation measures are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X_i. The multinomial logit model for adaptation choice specifies the following relationship between the probability of choosing option Y_i (0, 1, 2,.J) and the set of explanatory variables X_i (Green, 2003).

$$Prob(Yi = j) = \frac{e^{\beta_j X_i}}{\sum_{k=0}^{j} e^{\beta' k X_i}} \quad , j = 0,1,2, \ldots . J \quad \ldots\ldots\ldots\ldots \quad (4)$$

Where β_j is a vector of coefficients on each of the independent variables X_i; β_k is the vector of coefficients of the base alternative; j denotes the specific one of the $J+1$ possible unordered choices.

Research Application

The opportunities for enhancing climate adaptive capacity among local farmers will be identified and knowledge spread on climate impacts on farm households enhanced. The study will also document adaptation technologies and mechanisms in the study area. The information generated will be used to inform policy in Uganda and the Eastern African region at large.

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