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Research Application Summary

Effect of land-use and climate change and variability on pollution loading in rivers of eastern Uganda and albertine rift

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Abstract

Climate change and variability is one of the major environmental challenges that are likely to affect the livelihood of mankind for a very long time. At local scale, global climate change and variability trends can be amplified by Land use/cover dramatic changes; with severe subsequent negative consequences on people's livelihood. Most climate change scenarios show that the eastern and western regions of Uganda are likely to be highly affected by climate change and variability. This study aimed at assessing the effect of Land Use and Climate Change and variability on livelihoods and Sediment and Carbon loading in the rivers of eastern Uganda and in the Albertine rift, to identify strategies to reduce vulnerability to climate change and variability, and to determine the best micro-organisms rate and combinations for quick tree growth in Eastern Uganda.

Key words: Climate change adaptation, climate change mitigation, Mycorrhiza inoculants

Résumé

Le changement climatique et la variabilité est l'un des grands défis environnementaux qui sont susceptibles d'affecter les moyens de subsistance de l'humanité pendant très long. A l'échelle locale, le changement climatique global et des tendances de la variabilité peuvent être amplifiés par l'utilisation des terres / couverture des changements spectaculaires, avec de graves conséquences négatives sur la suite des moyens de subsistance des populations. La plupart des scénarios de changement climatique montrent que les régions Est et Ouest de l'Ouganda sont susceptibles d'être fortement touchés par le changement climatique et la variabilité. Cette étude visait à évaluer l'effet de l'utilisation des terres et les changements climatiques et la variabilité sur les moyens de subsistance, des sédiments et de chargement de carbone dans les rivières de l'Est de l'Ouganda et dans le Rift Albertin, d'identifier des stratégies pour réduire la vulnérabilité au changement climatique

et la variabilité, et de déterminer les meilleurs taux de micro-organismes et combinaisons pour la croissance rapide des arbres dans l'Est de l'Ouganda.

Mots clés: Adaptation au changement climatique, l'atténuation du changement climatique, les inoculants mycorhizes

Background

The increasing carbon fluxes into the atmosphere have drastically modified water and energy flows on the earth and people's livelihood (IPCC, 2001; Houghton, 2005). Both the Albertine and eastern Uganda regions are among the most fragile and highly sensitive ecosystems in the region. Both regions possess a unique type of flora and fauna and drains into two important rivers, the Nile and the Congo rivers draining the continent, and all the major great Lakes of East and Central Africa. The region has experienced large-scale land clearing for cultivation, energy and construction demand, timber harvesting to satisfy the demand of Burundi, D.R. Congo, Kenya, Rwanda, Sudan and Uganda. It is believed that up to recently a large proportion of forest has been cleared and converted into agricultural land. This has led to enormous soil erosion and pollution related loadings into the fresh surface waters. The region has also suffered from political instability, refugee migration and civil war or ethnical clashes. In the Albertine rift the situation is complicated by the recent discovery and imminent exploitation of oil. Several studies report that in these Lakes essentially man-induced threats compounded by climate change all result into a wide range of effects, which have knock on consequences for food production, and therefore on human livelihoods (Jorgensen *et al.*, 2004).

Literature Summary

The Great Lakes region hosts one of the largest inland fisheries in Africa and is a significant source of food and livelihood to millions dwelling inside and outside their basins. The lakes and their environments support a wide array of subsistence and commercial activity as well as a remarkable assemblage of tropical flora and fauna, including highly diverse populations of endemic fish (Mölsä, 1999), and contains among the richest biotic assemblages of all lakes (Coulter, 1994). The lakes support highly productive pelagic fishery that provides significant quantities of animal protein to populations of the riparian countries (Alin *et al.*, 2002). The increase in sediment and C loading pose therefore a severe threat to biodiversity (Donohue *et al.*, 2003). A further complexity to assessing the impacts of these changes on the lakes arises because climate warming may be making the lakes temporarily more oligotrophic at the same time as catchment

changes increasing nutrient and sediment flows into them. So responses to enrichment may be delayed but eventually even more significant than the current oligotrophication trend.

Study Description

This study is being conducted in Soroti, Kapchorwa, Luwero for eastern Uganda and Kabale in western Uganda and Uvira in eastern D.R. Congo for Albertine Rift. The effect of land use change and climate variability and change on livelihoods, Sediment and Carbon loading in the rivers is being determined in two rivers Atari in Kapchorwa in eastern Uganda and Mulongwe, Kalamabenge and Kavinvira for eastern D.R. Congo. The main tasks consists of characterizing and quantifying land use changes trajectories; characterize soils and vegetation in terms of carbon stocks; estimate spatio-temporal fluxes of sediment, P, N and C owing to land use and potential climate changes using Soil and Water Assessing Tool (SWAT) and characterizing the livelihood change over the last decades.

Identification of climate change adaptation strategies is being done in Kabale and Luwero districts. Additionally, part of the study was conducted in two major agro-ecological zones of Eastern Uganda where 8 villages were selected according to the existence of sustainable Management projects and access to market.

Determination of the best micro-organisms rates and combination for quick tree growth was conducted in eastern Uganda. The major activities consisted of determining the population and diversity of AMF in selected semi-arid and sub-humid regions of Uganda, to identify the best mycorrhiza inoculants combination for quick crop/tree growth. Dominant AMF spores were identified, isolated and multiplied to produce inoculants. The performance of dominant AMF spores (*Gigaspora, Glomus, Scutellospora, Acaulospora,* and their mixture) at two rates of 30 and 50 spores per seed and a control (no inoculation) were tested on *Calliandra* in a pot experiment. The treatment with best *Calliandra* performance in term of height and biomass was used in the sorghum on-farm experiment.

Results

Preliminary results show that rivers under study were highly loaded by sediments and most especially during the rainy season. Small scale farming and grassland with scattered trees have increased exponentially to the expense of forest and woodlots for the last thirty years in Uganda and D.R. Congo; respectively

(Table 1). The single AMF isolate (*Glomus*) performed better in term of *Calliandra* height; while the mixture out-competed all the other treatment in term of biomass in potted experiment (Table 2). On-farm the AMF mixture stimulated maximum growth of sorghum. About 20% of interviewed farmers have tried to respond to extreme events (rains and drought) (Table 3). In semi-arid area of Nakasongola they only tried to adapt to prolonged drought events; while in highland areas of Kabale they have responded to both extreme rain and drought events. The major adaptation options included change in crop type, varieties and planting date.

Table 1. Land-use/cover change in Atari and Mulongwe.

USES	1974		1986		2010	
	Atari-Uganda	Mulongwe DRC	Atari-Uganda	Mulongwe DRC	Atari-Uganda	Mulongwe DRC
Built-up area		9.46		9.73		9.85
Forest	46.2	31.33	41.6	9.56	26.5	7.01
Grassland with scattered trees		50.10		60.49		72.96
Grassland	36.6	1.60	32.2	14.65	25.2	0.64
Lake		4.31		5.20		5.93
Swamp		1.00		0.00		0.00
Woodland	5.5	2.20	5.2	0.39	5.7	3.61
Cultivated land	11.7	0.00	20.9	15.68	42.6	0.00
Total	100	100	100	100	100	100

Table 2. Relative field mycorrhizal dependency for *Calliandra calothyrsus.*

Relative	Field mycorrhizal dependency	
Rate of application	30 spores	50 spores
Mixture	9.32	29.66
Glomus	27.15	13.39
Scutellospora	7.59	23.06
Gigaspora	26.38	14.99
Acaulospora	0.55	8.18
	14.20	17.86

Research Application

The output of these studies will be used to provide:

- A baseline for carbon stock trajectory and thus to develop carbon stock enhancing strategies for the selected region of Albertine Rift and Eastern Uganda

Table 3. Adaptation strategies in semi-arid and highland areas of Uganda.

Adaptation measure	% of respondents	
	Nakasongola	Kabale
(a) Drought adaptation strategies		
Change crop variety	25	16.7
Change crop type	18.2	22.9
Change planting dates	13.6	20.8
Reduce amount of land under production		6.3
Change fertilizers and application rates		8.3
(b) Extreme rain events adaptation strategies		
Change crop variety	0	20.8
Change crop type	0	18.75
Change planting dates	0	37.5
Build water harvesting schemes	0	2

- To guide the reconstitution of the land use/covers and design plans for enhancing stability of the selected ecosystems
- To assess the impact of land-use/cover and climate change on fisheries
- To develop context (cultural, market, gender etc.) specific adaptation strategies for different agro-ecological zones of Uganda
- Develop practical technologies for large scale production of AMF inoculants particularly and bio-fertilisers in general

Recommendation

There is need to:

- Integrate climate change projection in the estimation of future sediment and nutrients loading into the selected rivers.
- sensitize communities and other key stakeholders on climate change related issues
- test AMF inoculants on a range crop and tree species

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