chiesa

Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa

Increasing Knowledge, Building Capacity and Developing Adaptation Strategies

POLICY BRIEF 8
September, 2014

Restoring the fertility of degraded lands through soil organic carbon sequestration

Emerging trends and patterns in Taita hills in Kenya

icipe

FORMIN.FINLAND.FI
MINISTRY FOR FOREIGN AFFAIRS OF FINLAND


Chamber placement for CO2 gas measurement in avocado-agro-forestry systems (left), and chamber based CO2 gas measurements in Taita hills natural forests. Photos by: Crispus Mugambi/ CHIESA

Introduction

Loss of soil fertility has continued to exacerbate land degradation in agricultural and natural ecosystems in sub-Sahara Africa. Conversion of indigenous forests into agricultural crop lands has destroyed natural soil nutrient cycling systems, leading to their loss through profile leaching, soil erosion, gaseous emissions and nutrient export (harvested grain and biomass plant products).

As human population in Sub-Saharan Africa continues to grow, substantial soil nutrient losses resulting from agricultural intensification and destruction of natural lands for agricultural expansion are expected. By observing trends in soil fertility indicators (organic matter, soil macro- and micro-nutrients) and how they influence land use change/ management and species abundance/diversity, deliberate actions for ecosystem restoration can be achieved.

Furthermore, in consideration of the changing climate and weather patterns, such actions should include a framework for assessment of these indicators in short and medium term, as well as projections for the future. In this approach, organic matter and particularly soil organic matter (SOM) plays a central role as a key quality indicator.

What action is being taken?

CHIESA project has undertaken a soil carbon assessment in Taita Hills, along the altitudinal transect (stretching from Mwatate town to the top of Vuria mountain) with a broad objective to determine the effect of conversion of natural forested landscapes to agricultural land-use systems on soil organic carbon storage and sequestration.

The carbon assessment aims to provide an in-depth understanding of how land use types, soil characteristics, climate cycles, and species occurrence in an ecosystem determine trends and fluctuations in soil organic carbon (Figure 1 below). Resulting scenarios from the assessment will help determine potential land use changes that, while sequestering carbon, enhance the ecosystem services and benefits.

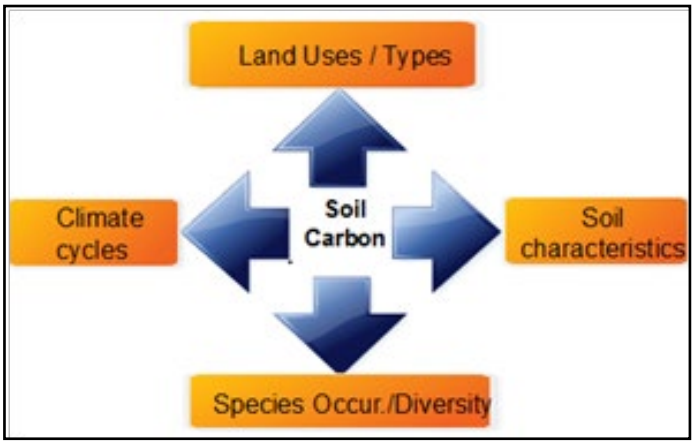

Figure 1: Summary of carbon assessment to determine the effect of conversion of natural forested landscapes to agricultural land-use systems on soil organic carbon storage and sequestration.
Illustration by: Crispus Mugambi/ CHIESA

What have we done so far?

Forty five (45) fields were selected along the Taita Hills research site to represent different land use types and elevation ranges. Three fields were selected in each elevation range; 790 – 900, 950 – 1100, 1150 – 1300, 1350 – 1500 and 1500 – 2200 metres above sea level (m.a.s.l), to represent land use types such as maize cropping, mango/avocado agro-forestry and natural shrub land.

Monthly sampling of Soil Organic Carbon (SOC), Total Nitrogen (TN), Acidity (pH), Moisture (MC), Bulk Density (BD) and Carbon dioxide (CO_2) gas flux emissions were measured from August 2012 to December 2013.

Additional weather (daily rainfall and temperature), soil condition (humidity, temperatures) and other field parameters (erosion, disturbance, cropping status) were also recorded at the time of sampling.

What we have found out so far?

- An increasing trend of CO_2 flux emissions was observed with increase in altitude across all land use types upto the higher elevation (1550-2200 m.a.s.l)

- Declining CO_2 flux levels at higher altitude gradient (1550-2200 m.a.s.l) represents forest lands converted over 50 years ago hence soils limiting in physico-chemical properties

- Natural and agro-forestry land-use systems having closed nutrient cycling systems resulted in higher fluxes compared to cereal and shrub-land systems.

What more can we do?

- Efforts are currently directed towards assessing trends in weather cycles, land use changes and species diversity, and how these influence present and future soil fertility indicators

- Observed trends will be used as guidelines for formulating action plans for soil fertility restoration at smallholder farm level

- Establish mechanisms for continuous monitoring of nutrient systems in natural lands and agricultural lands at field and ecosystem scales

- Further collaboration with ministries of Agriculture, Lands, Forestry and Natural resources to provide guidelines and strategies for "best bet" land use and management practices for restoration of deforested lands through community sensitization campaigns and re-forestation.

Recommendations for designing Soil Organic Carbon restoration strategies

- Research and local communities' collaboration in assessing SOC status at farm and ecosystem scales, quantifying SOC losses, design and implementation of restoration action plans with state and country actors, guided by emerging trends/ patterns/relationships from field measurement data

- Research and local communities' collaboration in the design and implementation of a continuous SOC monitoring plan.

Clockwise from left: A LICOR 7000 CO_2/H_2O analyzer, used for field measurements of carbon dioxide gas emissions from the soil; a mini laptop data logger that connects to and receives data from the LICOR analyzer; a minimum/maximum thermometer for measuring surface temperatures during gas sampling; and one of several calibration gas (401 ppm pure grade CO_2) cylinders used to calibrate the LICOR analyzer during sampling. Photos by: Kelah Kathure/ CHIESA

What is CHIESA?

The Climate Change Impacts on Ecosystem Services and Food Security in Eastern Africa (CHIESA) is a four-year research and development project aimed at increasing knowledge on the impacts of climate change on ecosystem services in the Eastern Afromontane Biodiversity Hotspot (EABH).

CHIESA is funded by the Ministry for Foreign Affairs of Finland, and coordinated by the International Centre of Insect Physiology and Ecology (icipe) in Nairobi, Kenya.

Through research and training, CHIESA will build the capacity of research communities, extension officers and decision makers in environmental research, as well as disseminate adaptation strategies in regard to climate change. The general areas for environmental research are in agriculture, hydrology, ecology and geoinformatics.

CHIESA activities focus on three mountain ecosystems in Eastern Africa, namely Mt. Kilimanjaro in Tanzania, the Taita Hills in Kenya and Jimma Highlands in Ethiopia. The project consortium monitors weather, detects land use/land cover change, and studies biophysical and socio-economical factors affecting crop yields and food security.

The project also builds the climate change adaptation capacity of East African research institutions, stakeholder organizations and decision-makers through research collaboration and training.

Together with local communities, the project will develop, test and disseminate climate change adaptation tools, options and strategies at the farm level.

Further, CHIESA provides researcher training for staff members of the stakeholder organizations, enhances monitoring and prediction facilities by installing Automatic Weather Stations, and disseminates scientific outputs to various actors from farmers to policy-makers.

WP5 - Assessment of Ecosystem Pest Management and Pollination

CHIESA involves farming communities at grass-root level as key collaborators. This collaboration is aimed at increasing their knowledge on various functional agro-biodiversity and their effects on productivity and production of selected crops, in the context of climate change. Functional agro-biodiversity in this case refers to the relationship between or status of insect pests and their natural enemies, pathogens, pollinators, soil engineers, decomposers etc.

CHIESA has also selected target crops to feature in the research, namely maize, coffee, avocado and crucifers, all of which are grown at altitudes between 0-2500 meters above sea level, making them ideal for bio-climatic studies.

The purpose of this WP is to increase the knowledge base among the local communities and partner institutions in the three target countries to address climate change issues. Furthermore, research programmes and technologies to assess the risks and impacts of climate and land use change on agro-ecosystems will be initiated and investigated.

chiesa

For more information about the CHIESA Project, contact:

The Project Coordinator - CHIESA
icipe – African Insect Science for Food and Health
P.O. Box 30772–00100 Nairobi, Kenya
Email: chiesa@icipe.org
Telephone: +254 (20) 863 2000
Website: http://chiesa.icipe.org

CHIESA Lead Partners:
University of Helsinki (Finland), University of York (United Kingdom),
University of Dar-es-Salaam (Tanzania), Sokoine University of Agriculture (Tanzania).

icipe

FORMIN.FINLAND.FI
MINISTRY FOR FOREIGN AFFAIRS OF FINLAND