chiesa

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

Increasing Knowledge, Building Capacity and Developing Adaptation Strategies

POLICY BRIEF 6
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Ecosystem services pest management

Coffee Production System Response to Climate Change

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Introduction

Global earth climate change is now certain. While various models predict various scenarios, each indicates global warming as a trend to be wary of. Despite these predictions being valid at 'planet-scale', climate models are still not definitive on how these same predictions translate at small-scale.

Locally, at regional level for instance, the diversity of environments, including altitude, wind, water and vegetation will generate diverse and variable local answers to global changes. This either strengthens or mitigates the effects of warming. It goes without saying that these changes will significantly impact agriculture, which is largely dependent on specific climatic conditions to thrive. Crop distribution and yield are affected. Consequently, nations' economies may suffer.

A major yield-reducing factor is the damage caused to crops by pests and diseases. Temperature and humidity are primary factors of biological cycles, thus global warming may impact crop pests and their damage. However, the magnitude and direction of such impact is still unknown and difficult to predict.

CHIESA's study objectives

One of CHIESA's key objectives is to address crop response to climate change. Research activities are aimed at characterizing crop and environment's resilience to climate events, as well as assessment of crop potential for mitigation and adaptation to climate change.

CHIESA Work Package 5 (WP5) focuses on characterization of the climate events that regulate the interaction between crops and the populations of affiliated pests and diseases. One of these crops is Arabica coffee, an important source of cash and revenues for hundreds of thousands of smallholder farmers in Eastern Africa.

CHIESA research on pests and diseases of Arabica coffee in East Africa

Coffee Leaf Rust and Coffee Berry Disease, caused by fungi *Hemileia vastatrix* and *Coletotrichum kahawae* respectively, threaten Arabica coffee production in the region.

Monitoring coffee white stem borer and parasitoids in the lab

Pair of coffee white stem borer on coffee wood

Antestia eggs on a coffee berry

While Coffee Leaf Rust causes severe defoliation that weakens the crop, Coffee Berry Disease as its name suggests, specifically destroys the berries.

Coffee pests, much like the diseases, cause massive damage and losses estimated in the millions of dollars. *Hypothenemus hampei*, or simply coffee berry borer, is the most notorious and widely distributed insect pest of coffee worldwide. The coffee berry borer causes berry loss of Arabica coffee at low altitudes.

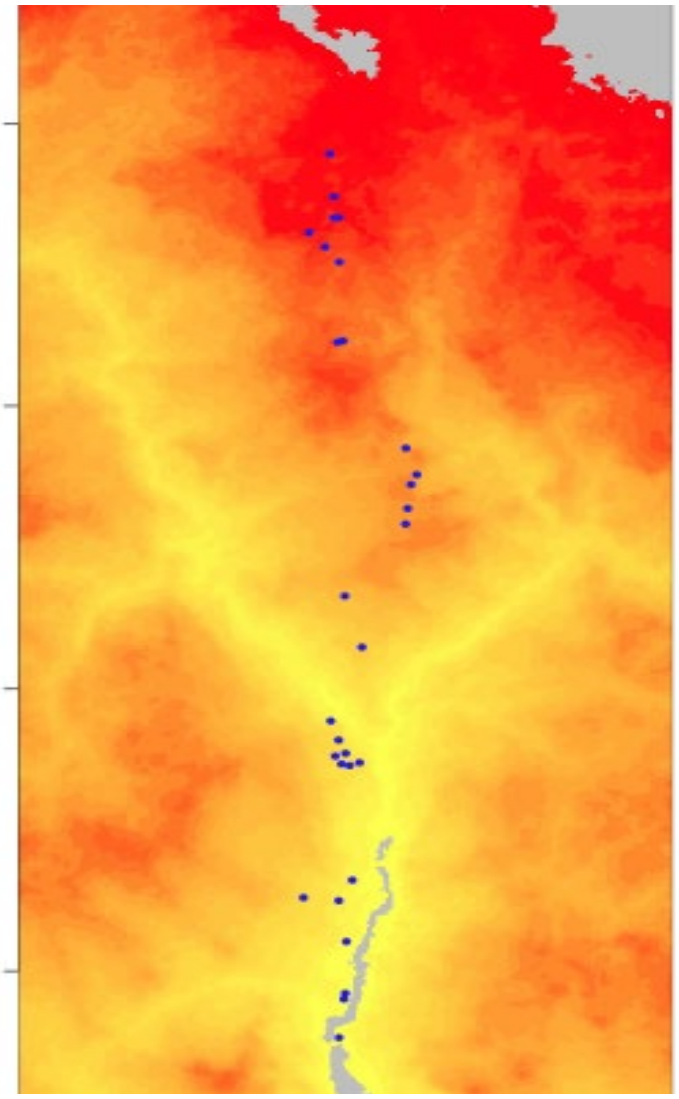
On the flipside, Antestia bugs (*Antestiopsis* spp.) cause losses in berry numbers and quality at higher altitudes. Finally, the coffee white stem borer, *Monochamus leuconotus*, attacks the coffee trees resulting in production drop, and sometimes the death of coffee bushes in the most damaged coffee farms.

Research approach and methodology

Climate change is a slow process that takes even decades to become evident. This stretch of time makes it nearly impossible to set up field experiments for assessment of real crop answers to climate change.

So as to address the issue in an acceptable period of time (4 years in the case of the project), CHIESA operates along altitudinal gradients that mimic various scenarios of climate change. Where altitude generates various climate conditions, such as warmer at low altitude and cooler at higher elevation, impacts can then be measured on the crop.

The "coffee pests and diseases" component of WP5 within the CHIESA project implements this approach along two transects, one on the slopes of Mt. Kilimanjaro in Tanzania, and the other in Ethiopia, about 80 km north of Jimma town in the Didessa river basin.



Coffee Berry Disease distribution in Jimma transect (red: high incidence, yellow low incidence). The disease is mostly present in the higher part of the transect in the Didessa river basin. Monitored coffee farms are represented as blue dots in the picture.

With altitudes ranging from 1500 to 2100 metres above sea level, the Jimma site is dedicated to the coffee disease study while the Kilimanjaro site, which is slightly lower, warmer and more favourable to insects, concentrates on pest study. In both transects, 24 and 30 coffee farms are selected at different elevations and characterized for maintenance, microclimate and shade. Observations on pest and disease incidence are made on a regular basis. For insects, berries and wood are sampled to assess the occurrence and diversity of pest natural enemies.

Research on pests also includes laboratory activities, which take place at the *icipe* research centre in Nairobi, Kenya. Insect colonies are maintained in the lab in order to better know pest life history. Life table analyses are conducted to assess the impact of temperature on pest life cycles.

What do we know so far from our research on coffee?

First observations from Ethiopia indicate opposite distribution of Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR) along the gradient: CLR favours warmer and dryer climate conditions and is mainly observed in the lower part of the transect during the dry season; CBD, which is favoured by relatively cold and humid conditions, is mostly seen at higher elevation during the rainy season.

Expected outputs of the study

So far, we are able to explain the development of coffee pest and disease epidemics according to specific climate conditions along the transect. These conditions are strongly correlated with altitude.

Current research concentrates on biological cycles and environmental factors, like shade trees and canopy density above the coffee plot to evaluate their influence on the microclimate variables, and whether they expose or protect coffee against pests and diseases.

At the end of the project, we will be able to:

- Provide the scientific community with new information about life history of Arabica coffee pests and diseases, and their natural enemies in Eastern Africa
- Provide stakeholders of the studied areas with decision-making tools like maps and calendars for pest and disease risks
- Provide farmers with pest management recommendations, especially for shade, according to elevation
- Provide trends for pest and disease risks in case of temperature increase in the region.

Leaf Rust on coffee

Shade coffee captured with fish eye lense

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.

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