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

Increasing Knowledge, Building Capacity and Developing Adaptation Strategies

POLICY BRIEF 9
November, 2014

Mapping Land Cover and the Probability of Understory Coffee in Jimma, Ethiopia

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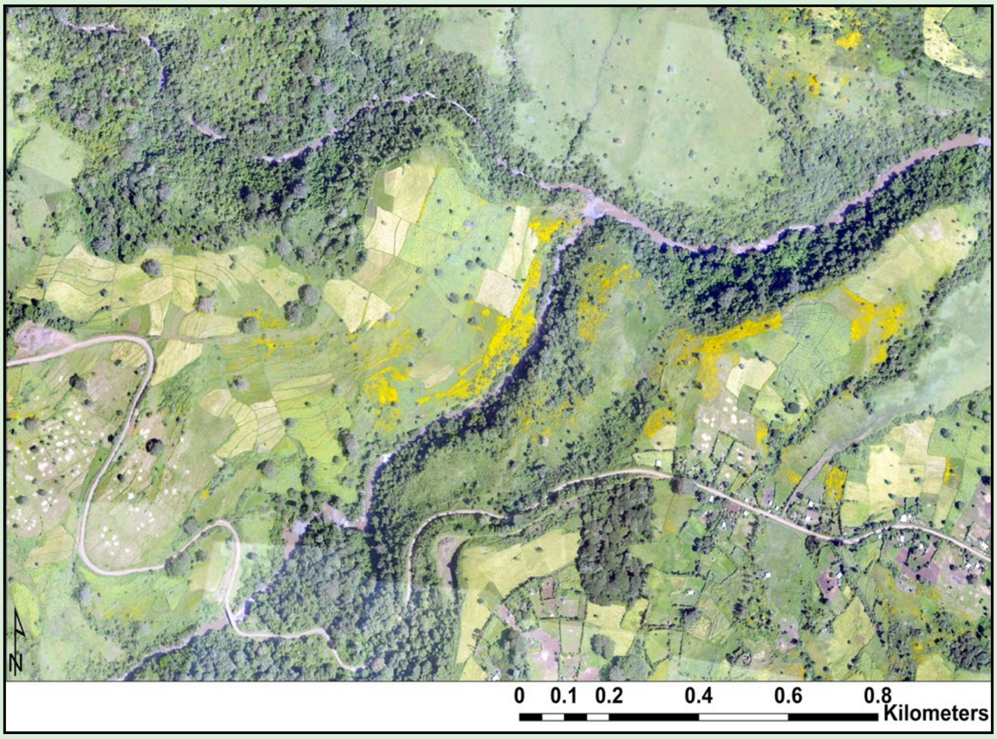


Left: The current land cover in Jimma mapped using aerial photographs. CHIESA Researchers were especially interested to map the extent of indigenous forests.

Photo by: Binyam Hailu/ CHIESA

Introduction

Indigenous forest management and conservation has a major importance for ecosystem services in Eastern Africa. In the southwestern highlands of Ethiopia, indigenous forests are particularly relevant for coffee producers, given that Coffea arabica grows as understory shrub in these forests (cover picture). Identifying and mapping understory coffee was until recently considered a challenging task because exotic tree plantations are largely overspread among indigenous forests.

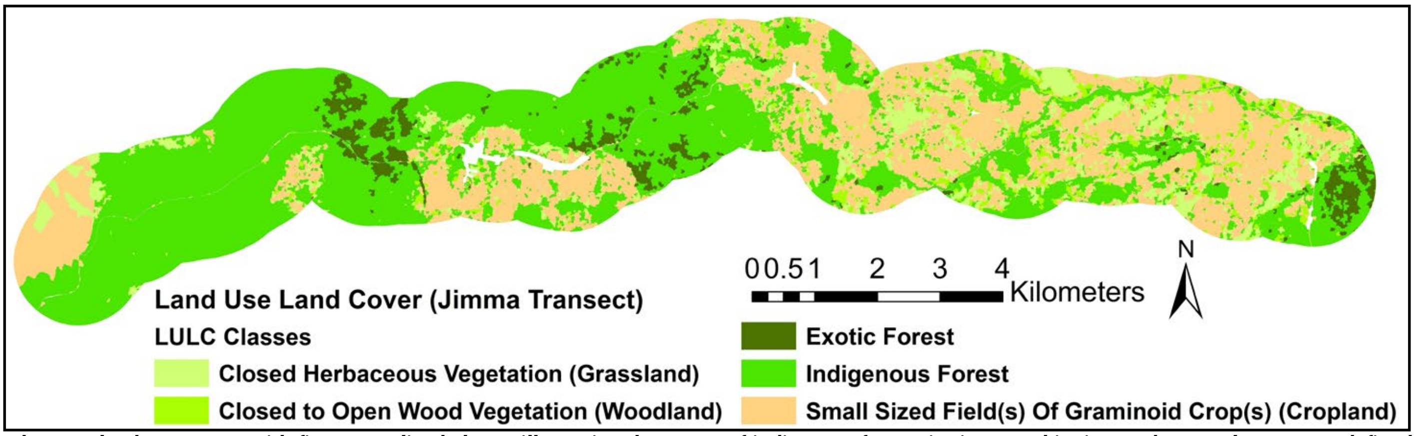
Objectives Achieved

Our first objective was to map the current land cover in Jimma using satellite images and aerial photographs. We were especially interested to map the extent of indigenous forests. Land cover classes were defined based on field work and FAO's LCCS classification protocol. Multi-scale segmentation/object relationship modelling methodology was applied in the mapping. The final land cover map with five generalized classes is shown below.

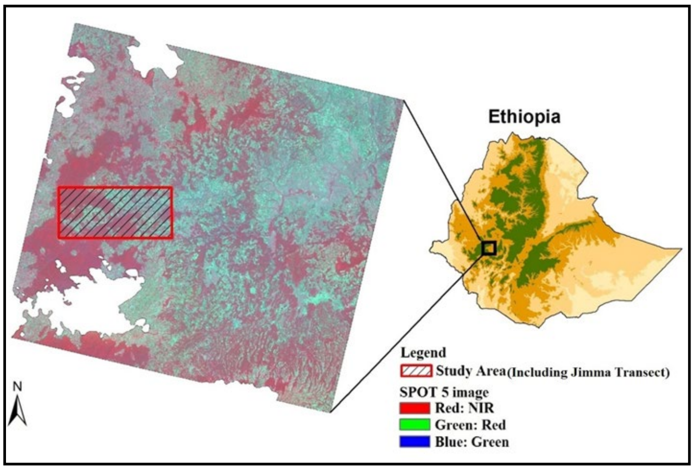
Our second objective was to map potential understory coffee sites using probabilistic predictive modelling. In the previous land cover mapping exercise, we mapped the extent of indigenous forests in Jimma transect. After accuracy assessment of the land cover map, it was shown that we could separate indigenous from exotic forests with an overall accuracy of 84.3 %, while users and producer's accuracies of indigenous forest were 84.7 and 94.4 %, respectively. These levels of accuracy were considered to be high enough for modelling the probabilistic occurrence of coffee.

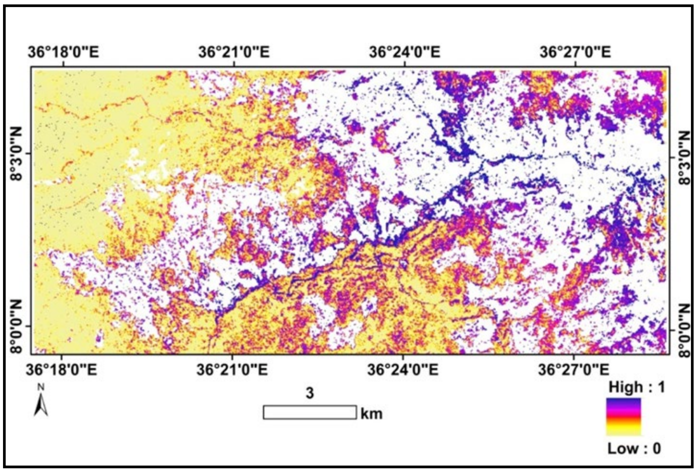
The probability of occurrence of understory coffee plantations was modelled with statistical methods combining GIS and remote sensing data. Five explanatory variables were employed in the modelling: two present-day climatic variables from WorldClim data (precipitation and minimum temperature) and three radiometric vegetation indices (Normalized Difference Vegetation Index, Simple Ratio and shadow fraction). As a result of the predictive model, the probabilistic occurrence of understory coffee map is shown in figure 5, with coffee probability values ranging from 0 to 1 for the known understory coffee forest areas.

The probability map was validated based on the known understory coffee forest areas. 72% of known understory coffee pixels have a probability between 0.50 and 1, while 55% of the pixels have a probability between 0.75 and 1. This implies that 72% of the known understory coffee pixels falls to the darkest areas of the probability map.



Above: A land cover map with five generalized classes illustrating the extent of indigenous forests in Jimma, Ethiopia. Land cover classes were defined based on field work and FAO's LCCS classification protocol. Multi-scale segmentation/object relationship modelling methodology was applied in the mapping. Map by: Pekka Hurskainen/ CHIESA





Above left: Location of the study area and the SPOT-5 satellite image used for land cover mapping. Map by: Binyam Hailu/ CHIESA

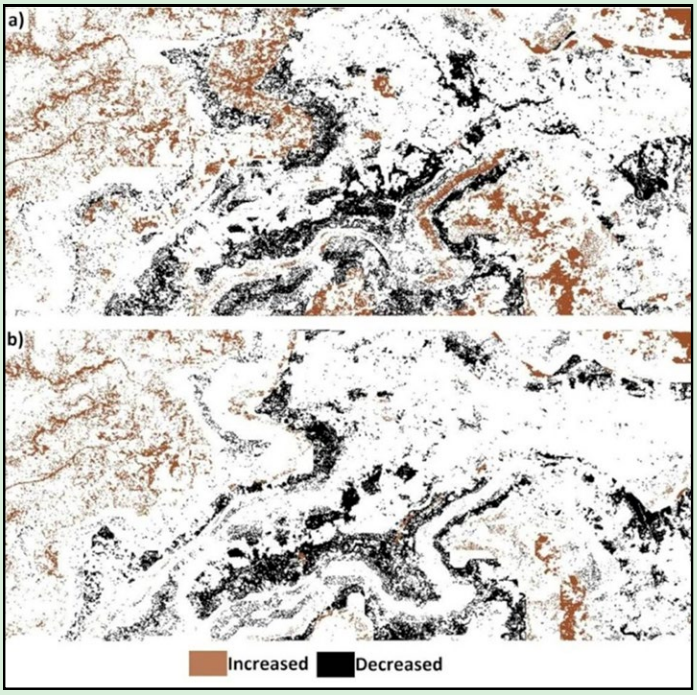
Above right: Map showing the current probabilistic presence of understory coffee in Jimma, Ethiopia. CHIESA Researchers aim to evaluate potential changes in coffee suitability under projections of climate change (changes in precipitation and temperature) by 2050. Map by: Binyam Hailu/ CHIESA

Our third and final objective was to evaluate potential changes in coffee suitability maps under projections of climate change (changes in precipitation and temperature) by 2050. We selected three climate models that were considered to have the best performance over the Ethiopian highlands, and used the average of these for analyzing the effect of climate change. After the selection of the climate models, two representative concentration pathways (RCP2.6 and RCP6) were used for the analysis.

According to the two RCP scenarios, precipitation and maximum temperature would be increased by ~4mm and ~1.4°C in 2050, respectively. This implies that the area would be warmer and have higher rainfall amount in 2050.
Due to these changes in precipitation and maximum temperature, the presence of understory coffee probability shows changes (map below). In both scenarios, generally, understory coffee probability increases towards higher altitudes. That is, this result shows there would be a shifting of optimal growing zones of coffee in the area. However, the extent of change varies between the two scenarios analysed. For example, changes in the magnitude and extent of understory coffee probability is higher for the RCP2.6 scenario.

Conclusion

This study contributes new information not only to coffee and environmental researchers but also benefits local communities by allowing the identification of indigenous and exotic forest areas, and leading to better informed natural resources management and conservation. Climate change scenarios indicate that precipitation and maximum temperature are likely to increase by 2050, having impact on the dynamics of landscape patterns. The result shows that there would be shifting of the optimal growing area of understory coffee to the higher altitude areas. This information is crucial for local coffee farmers and policy makers.



Above left: A woman picking fallen berries from coffee trees grown under shade. Photo by: Weyessa Garedew/ CHIESA

Above right: The impact of climate change on probability presence understory coffee a) probability presence understory coffee change for the year 2050 using RCP2.6 and b) probability presence understory coffee change for the year 2050 using RCP6. Map by: Binyam Hailu/ 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.

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