

BALANCING ECOSYSTEM SERVICES:

an agent-based approach to analysing tradeoffs between food production, carbon storage, and fuel production in tropical forests

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INTRODUCTION

With increasing demand for biofuels in the US and Europe, many tropical countries see the growing of biofuel crops such as maize and sugarcane as opportunities to kick-start their economies. However, there are growing concerns that this may not only divert crop production away from use as food, but also increase pressure to convert tropical forests to agriculture. As it is, an estimated 13 million hectares of tropical forest are already destroyed each year, resulting in the emission of 5.8 Gt of CO₂, about 20% of total anthropogenic emissions of GHGs. Currently this 20% is outside the Clean Development Mechanism of the Kyoto Protocol.



There are now discussions within the UN Framework Convention on Climate Change to try and develop mechanisms to reduce emissions from deforestation and degradation (REDD). A suggested mechanism is to reward countries that demonstrate a decrease in deforestation rate below a baseline based on average historical deforestation rates. However, it is unclear whether this approach would be sufficient to overcome the many pressures at the local level leading to deforestation, including the need to produce food, and the economic opportunities afforded by growing biofuel crops.

MODELLING FOREST MARGIN DYNAMICS: THE PEOPLE AND LANDSCAPES MODEL

PALM is an agent-based model operating at the level of a district, and contains a number of decision-making entities (e.g. farm households) located on a landscape made up of a number of heterogeneous land units. Agents make decisions based on rules given to them.

MODEL COMPONENTS

- Household agents
 - decision-making
 - inter-household interactions
- Patches on a landscape
 - CENTURY soil organic matter model
 - Currently including peat soils
 - Ritchie water balance model
 - DSSAT crop models
 - Trees model
- Livestock model

Reference: Matthews, R.B., 2006. Ecol. Modelling 194(4):329-343.

PRELIMINARY MODELLING WORK

In a preliminary analysis, the PALM model was used to simulate the adoption of biofuel cultivation by subsistence farmers at a forest margin. The model was set up with 200 household agents, with three possible land uses – undisturbed forest, subsistence farming, and biofuel crop cultivation. Agents could communicate successful land use strategies to each other through their social networks, and could expand their farm size to increase income.

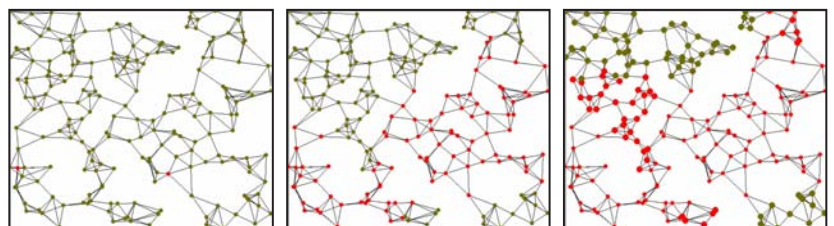


Figure 1: Spread of biofuel crop cultivation (red dots) through farmer networks at expense of subsistence agriculture (green dots).

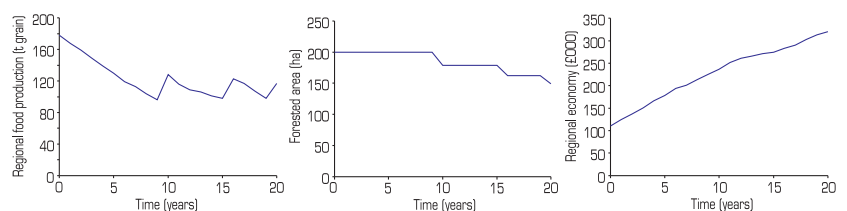


Figure 2: Impact of adoption of biofuel cultivation on food production, forested area, and local economy at the landscape level.

FUTURE WORK

The model will be used to consider biofuels and carbon price scenarios, migration in and out of the region, policy instruments to discourage deforestation, resistance to change, and different social network structures.