What influences forest clearing decisions in shifting cultivation systems? Evidence from Western Amazonia

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Introduction

Shifting cultivation is common throughout the tropics and subtropics. It is a system in which small patches of forest are selected, cleared, and burned by farmers to provide nutrients for crop production. After cultivating for a few years, farmers leave their plot in fallow due to decreasing soil fertility and weeding problems. So other types of vegetation take over and eventually secondary forest arises before the cycle is repeated.

This system creates disturbances in tropical landscapes by converting forests into agricultural land for a temporary period. These disturbances may induce adverse impacts on not only the ecosystem but also human livelihoods by decreasing biodiversity and aggravating climate change. Since preserving biodiverse old-growth forests has a higher conservation value than secondary forests, we are interested in identifying factors that drive farmers to clear old-growth forests.

Objective and Research Questions

- ***To*** investigate what factors drive ***old-growth forest*** clearing over ***secondary forest fallow*** in shifting cultivation systems by drawing evidence from Western Amazonia
  - Q1. What factors have been analyzed in deforestation models from previous studies?
  - Q2. What factors are considered by farmers during the plot selection process in shifting cultivation systems?
  - Q3. What factors have the potential of driving farmers to clear old-growth forests over secondary forests in shifting cultivation systems?
  - Q4. What recommendations can be made to design better policies for forest conservation in the tropics?

Conceptual Framework

Causes of Deforestation

Underlying Causes
- Macro-economic variables
- Policy Instruments

Immediate Causes
- Institution
- Market
- Infrastructure
- Technology

Agents
- Household
- Community

Determinants of Plot Selection

Biophysical Factors
- Topography
- Proximity
- Soil fertility
- Vegetation cover
- Land availability
- Ease of access
- Ease of enclosing

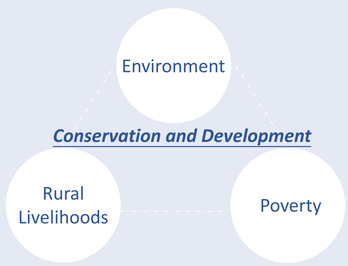
Socio-economic Factors
- Land tenure
- Household needs
- Labour availability

Factors driving old-growth forest clearing over secondary forest in shifting cultivation systems

Methodology

Study Area

- Peru (Loreto and Ucayali)
- "Riverscape"
  - Amazon river
  - Napo river
  - Pastaza river
  - Ucayali river
- Transportation: riverboat
- Amazon-Napo basin
  - 317 communities
- "Forest peasants"
  - Indigenous people
  - *ribereños*
- Diverse activities
  - **Shifting cultivation**
  - Floodplain agriculture
  - Fishing, hunting, and other forest-related activities



PARLAP

- Community census
  - 2013-2014
  - 919 communities
  - 117680 km²
  - 4 basins
- Household Survey
  - 2014-2016
  - Stratified sample
  - 235 communities
  - ~ 4000 households
- GIS Analysis
  - Natural resources

Empirical Analyses

- Exploratory Analyses
  - Descriptive Analysis
  - Endogenous Variables Analysis
    - Forest land availability
    - Forest protection
    - Land holding
    - Labour availability
- **Multivariate Regression**
  - OLS models
  - Upland Analysis
    - Upland vs. Lowland
  - Forest Analysis
    - Old-growth forests vs. Secondary forests
- Model Selection
  - AIC
  - F-test: global vs. nested

Community- and household-level analyses

- Historical background and current characteristics
- Livelihood strategies and community economic orientation
- Natural resources and land endowments

Potential Factors

Factors influencing people's land clearing decisions

Community Level

Characteristics
- Size (#households)
- Age (decades)

History
- Relocation (1/0)
- Ethnicity (nativity)

Accessibility
- To main river channel (1/0)
- Distance to city (ln_km)

Initial conditions
- Terrestrial endowment (z-score)
- Aquatic endowment (z-score)
- Distance to the nearest community (ln_km)

Household Level

Characteristics
- Size (#adults)
- Age (years)

History
- Number of generations lived in the community (Jefe and Spouse)

Initial conditions
- Land holding (ha)
- Assets (z-score)

Biophysical

Holocene soil (% in a 5km buffer)

Intact forest on upland (ha)

Experience of the major flood event (1/0)

Upland or Lowland?

Regression model. Adjusted R^2: 0.23 No.Obs: 942

- ***Holocene soils (-)***: -0.5712** (0.2630)
  - This factor reflects the relative location of communities within the river network (i.e., proximity to lowlands).
- ***Community ethnicity (+)***: 0.1846* (0.0962)
  - Native communities are more likely to work on the upland due to their history and cultural preferences.
- ***Distance to city (-)***: -0.1682** (0.0704)
  - Communities closer to cities are better developed and more populated, so their expansion on the upland is greater than communities that are further away from the city.
- ***Initial aquatic endowment (-)***: -0.1097*** (0.0398)
  - This factor also reflects the proximity of communities to rivers: communities with greater aquatic endowments are closer to rivers, so rely more on rich aquatic resources than upland agriculture.

Upland Old-growth or Secondary Forest Fallows?

Regression model. Adjusted R^2: 0.54 No.Obs: 455

- ***Holocene soils (+)***: 0.4270*** (0.1274)
  - Households in communities with more Holocene soils have more landholdings in the lowland, and they work less frequently on the upland.
- ***Initial aquatic endowment (-)***: -0.0529*** (0.0175)
  - This factor could have shaped early livelihood choices among households. In communities with greater aquatic endowments, households may devote more time into fishing than into agricultural production, so there is no need for them to expand deep into the intact forests for clearing new fields.
- ***Distance to the nearest community (-)***: -0.0393*** (0.0118)
  - With greater distance to other settlements, communities are able to claim greater areas of forest land and accumulate more fallows for the current generation, thus decreasing the need to clear old-growth forests.
- **Several factors became more influential after excluding the fallow holding control**
  - ***Community size (-)***: More densely populated communities have restricted access to old-growth forests as they are reaching full enclosure, so they are more likely to clear fallows due to the lack of available intact forests.
  - ***Community relocation (+)***: Communities moved before are more likely to clear old-growth forests.
  - ***Household age (-)***: Younger households are more likely to clear old-growth forests due to the lack of fallows.
  - ***Experience of major flood event (+)***: For households that lost their lands or crops due to the flood, they need to establish new fields by clearing old-growth forests. Households in the lowland may prefer establishing new plots on the upland for security in the event of future major flood.
- **Endogenous variables**
  - Community land availability, regulations on forest protection, household landholdings, and labour availability are correlated with the probability of clearing old-growth forests.

Conclusion

Community-level factors (i.e., community age, initial aquatic endowments, and land availability) and biophysical factors (i.e., percentage of Holocene soils, old-growth forests availability) were found to predict the probability of clearing old-growth forests better than household-level factors.

Implications for policy design

- Government and NGOs could promote the creation of community forests reserves as this would reduce pressure on old-growth forests and increase the importance of secondary forest fallows.
- Government can encourage farmers to plant leguminous trees and/or use biochar in order to enhance soil fertility recovery in secondary forest fallows.
- Communities could agree to assign one secondary forest fallow to each young household.
- Government could provide support for lowland communities and households in upland communities with extensive lowland holdings when a major flood strikes.

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