‘The REDD Game’: From Theory to Empirics, to Policy Simulation

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Introduction

NERC, ESRC and the DfID combined for a multi-disciplinary £40·5m research programme on Ecosystem Services for Poverty Alleviation (ESPA):

- Programme Framework award of £240K for **"The REDD Game: A didactic tool for designing effective, efficient and equitable policies to deliver REDD in Bolivia"** over two years (2010-12)
- Collaborators based in UK and Bolivia; main Bolivian partner is Conservation International

Outline

- Background to REDD+ and the project in Bolivia
- The ‘REDD Game’ concept
- From theory to empirics, to policy simulation
  - Micro-economic ‘engine’
  - Agent-based modelling (ABM) heuristics
- Policy options
- Illustrating outcomes
- Game risks
- Next steps

Background to REDD+

REDD+: Policies & activities to prevent or slow deforestation & degradation, and increase forest carbon stocks.

- Up to 20% global CO_2 emissions; cost-effective emissions reductions (Stern, 2006)?

Policy debates on different levels:

- International processes, e.g. design of global climate policy and launch of pilot projects with new public (and some private) funding
- At national level, range of policy options available – payments for environmental services very popular, including in Bolivia.

Background to the project

Using Bolivia as a test case, the project aims to develop a visually attractive, user-friendly, and accessible computer-based analytical tool, the 'REDD Game' (→ for wider dissemination).

The overall aim of the Game is to enable users to explore social, economic and environmental outcomes, and possible trade-offs among alternative REDD policy interventions:

- Develop a means of informing stakeholders, e.g. local policy makers and community leaders
- Enable more meaningful participation in any consultative process leading up to the implementation of REDD

Game concept

The Game simulates the functioning of a typical community on the edge of the agricultural-forest frontier, specifically the Rurrenabaque-Ixiamas frontier in Bolivia (high deforestation rates):

- But different initial circumstances can be created by varying a set of initial parameters, e.g. population density and land endowments.

The player is the community leader who makes public investments and establishes rules and incentives so as to maximize community welfare, subject to environmental, social and budgetary constraints over a 20 year period.

From Theory to Empirics, to Policy Simulation

Game as a micro-economic household optimization ‘engine’ embedded in an ABM vehicle:

- The engine provides a basic theoretical foundation for household behaviour, while…
- …the ABM vehicle provides dynamism, heterogeneity, interactions and realism.

Innovation in form of extension of Angelsen (1999) models and adaptation to REDD; ABM developed for REDD but based solely on heuristic decision-making (e.g. Purnomo et al., 2011).

1. Micro-economic ‘engine’

Reflecting the mix of household types observed in the study region, the following three types of farm households are modelled:

- Subsistence farmers with no access to markets (‘satisficers’ or ‘full belly’ agents)
- Settlers (*Colonos*) with limited access to markets, including off-farm labour either because of external or internal constraints
- Modern farmers (*Mestizos*, profit maximizers) with full access to both labour and goods markets

Market access proxied by distance to the ‘town’

2. Agent-based model features

Each period, households make their individual land-use decisions based on their initial endowments (land, labour, capital) and optimization behaviour.

Between periods a number of features are modelled in the ABM framework, which the households cannot take into account when optimizing:

a. Heterogeneity
b. Dynamics
c. Interactions
d. External shocks
e. Extended utility functions

2a. Heterogeneity

Introducing heterogeneity among agents not only adds realism but enables the analysis of the distributional effects of alternative policies:

- Important since both Bolivia's proposed REDD mechanism and the ESPA programme have the stated objective of poverty reduction.

Within certain classes of farmer, vary, for example:

- Household size
- Property size
- Initial wealth endowment
- Distance of each plot to the road

2a. Heterogeneity

Also heterogeneity in property rights. Three main types of land holdings identified in the region:

- **Communal land** (large communal territories jointly owned by the inhabitants; secure but no land sales);
- **Private land with title** (individually owned; secure if occupied; can be bought and sold);
- **Squatter land** (no title but can be made secure if occupied; cannot be sold; might gain official title after number of years).

Analysis of household surveys allows characterization of types of heterogeneity

2c. Interactions

Four types of interaction observed among households:

1. Deforestation in a given plot more likely if the neighbouring plot is already deforested;
2. Households may change type depending on the distance to markets, and also on their networks;
3. The rate of adoption of new ideas, such as REDD may be dependent on network using them;
4. Sharing shocks across linked households so that households with more links (‘greater cohesion’) would experience less volatility in utility.

Policy options

In order to increase community welfare, a set of policy options are available including the standard policies that frontier communities already use, e.g.:

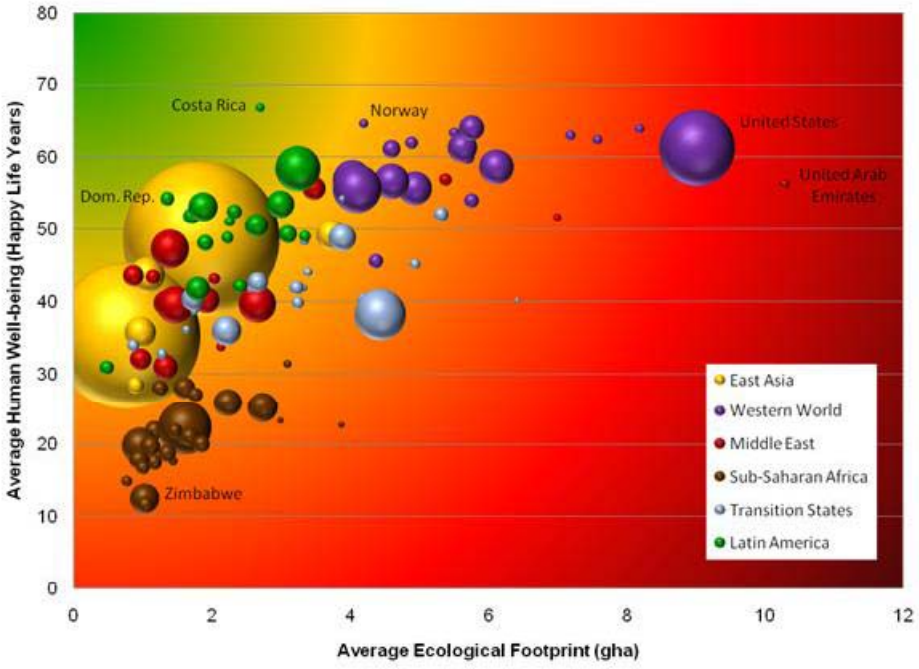
- Road building
- Health and education investments
- Off-farm job creation through development projects

In addition, REDD provides new policy options, e.g.:

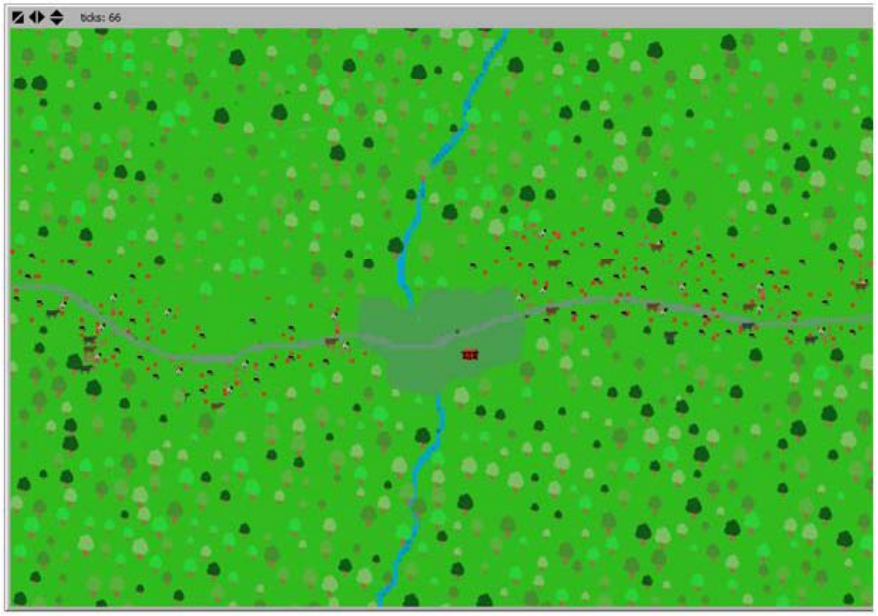
- Payments for reduced deforestation
- Controlling illegal deforestation
- Creation of protected areas

Illustrating outcomes

ABM framework allows for the presentation of outcomes to the player in several different ways.



Source: Anderson based on NEF (2009) and World Bank (2010)



NetLogo visualization of the modelled community.

Game risks

In order to inform the player about the different policy options available to improve outcomes for the community:

- The user needs to be able to track the outcomes, which should be comparable across games
- But if there are too many simultaneous external shocks and moving variables, then users are unlikely to understand how their inputs translate into outcomes.

→Trade-off between realism and learning – prioritize variables and shocks to be included

Next steps…

We just concluded a joint workshop in La Paz:

- Reached agreement on the structure and mechanics of the Game
- Discussed data needs and new field work and surveys
- Decided who will use the Game and how
- Developed a work plan for the rest of the year

Many thanks for your attention

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Next steps

NetLogo is the most adequate tool to use for programming the Game, as it has a reasonably attractive interface (although not by computer game standards) while still allowing advanced users full access to the programming code.

Once we have created the best “game” possible in NetLogo and are satisfied with the way the community simulation works and we feel that all parameters are well calibrated, we will hand over the model to a professional game designer to see if it is possible to improve the interface for non-advanced users, while still maintaining the motor behind the simulation

- Rationale behind use of ABM and how we get there
- Empirical work, secondary, ongoing and future

Game concept

The simulation runs for 20 years, but stops if the community leader runs out of money or becomes too unpopular.

The goal is to survive as community leader for all 20 years, achieve as high a community well-being score as possible. Achieving other policy goals for bonus points, e.g.:

- Average per capita deforestation of less than 0.2 ha/year
- Zero extreme poverty
- Gini coefficient below 0.5

Dynamics

At level of the Game (aggregate of all households, village/landscape level)

- Soil fertility (need to leave land fallow)
- Population growth (in- and out-migration; natural growth)
- Capital accumulation

External shocks & extended utility functions

Variations in agricultural production due to climatic variations and agricultural prices have implications for the implementation of REDD because they affect the level of deforestation.

Extended utility function could include an ecosystem services component which depends on the total size of the community's forest, which could potentially provide two different kinds of benefits based upon:

- Consumption/use values (e.g. food from hunting and gathering) and non-use values (e.g. the spiritual value of forests).