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Designing and implementing a Role-Playing Game: A tool to explain factors, decision making and landscape transformation

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ABSTRACT

In this paper we describe a research process on contextual driving factors and decision-making processes used by local actors for land use change in a zone of the Colombian Amazonian frontier. We integrated landscape multi-temporal analysis, Role-Playing Games (RPG), interviews based on flow diagrams and an historical study of landscape dynamics for the construction of our methodological approach. Findings of the study include individual detailed decision-making insights at the farm level that shed light on the mechanisms that boost the advance of the agricultural frontier into the Amazonian forest. We illustrate how individual decisions are related with the general landscape dynamics. A formalization of results was carried out in UML (Unified Modeling Language) for the future construction of a Multi Agent System (MAS) model, the implementation of which will be useful for land use planning, discussions among local and regional actors and scenario building. The RPG constitutes a device that could "talk" by itself, in the name of local actors. Facts that hardly would be communicated in an interview emerge implicitly and explicitly through the exercise. The RPG is a device that we call a "dense methodological tool", in the sense that it is a designed object that synthesizes a complex system. This is central to territorial planning because RPG and derived MAS models talk to actors and researchers in the same language that human memory and projection mental capabilities function. These objects condense time and space and help make problems clear, and they assist in the finding of solutions and exploration of possible scenarios.

1. Introduction

Throughout Colombian environmental history, human activities have affected the components, structure and functioning of natural ecosystems. Economic and social forces have been the drivers of these transformations, which interact in a highly complex manner (Palacios, 2001). In Amazonian colonization zones, transformations have produced the establishment of pastures for cattle raising, replacing and affecting the tropical forest.

Landscape dynamics studies, especially multi-temporal studies, have been utilized to observe and to quantify land cover changes and the tendencies of a specific research problem. However, in Colombian contexts, the transformation factors of ecosystems, the behavior of social actors regarding natural resource management and the possible scenarios derived from specific decision-making processes have not been studied in depth. There is a need to develop and implement alternative methodologies that allow the study of the relationships among transformation dynamics, factors, and decisions, as well as the underlying processes that lead to change.

The objective of this study, carried out in 2004–2005, was to identify: 1) the factors that determine the decisions of a group of *colonos*[1] in a colonized area of the Department of Guaviare (Colombian Amazon) during the establishment of pastures.[2] These factors refer to the identification of the contextual conditioning elements that contribute to the process of land cover transformation. These are the variables that affect the land use intensity, resource access, and environmental, economic and cultural changes that induce local actors' decisions; and 2) the decisions that generate a change in land cover from tropical forest to pasture. Decisions refer to the actors' decision-making processes and includes decision rules and land use activities which in turn generate land cover change.

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[1] In this study the term *colono* refers to peasants from other parts of Colombia that migrate to Amazonian border zones.
[2] We use the terms 'pasture' to specific land cover where grass vegetation is the dominant form of plant life and 'grassland' to the specific land use where herbage is suitable for grazing by livestock.

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The study of land cover change was carried out through a multi-temporal analysis focused on forest and pasture change, based on the guidelines of landscape ecology and the use of GIS and satellite imagery interpretation from the years 1988, 1994 and 2001. With the aim of understanding the links between spatial dynamics and social interactions, we carried out interviews based on flow diagrams and a role-playing game (RPG). Information generated by these tools fed the conceptualization of a UML (Unified Modeling Language) model used to begin a construction of a multi-agent system to explore the land cover change problem in the zone. In this way we contributed to building a tool that could be used by government agencies, such as SINCHI[3], to formalize information that they have acquired, and to better understand the expansion dynamics of the agricultural frontier. The tools utilized allowed an understanding of territorial occupation, land uses types, actors' decisions and their interrelationships, as well as the production of information for territorial planning and natural resource management.

2. Case study

During the last 30 years, a colonization zone has formed with cattle raising as one of the dominant productive systems in the north Colombian Amazonian region (Murcia, 2003). One of the more visible consequences of colonization in tropical forests is the logging activity used to clear areas for the introduction of cattle raising systems. The research problems addressed in the study zone include: 1) the loss of natural forest in order to add value to the land with pastures for cattle raising and agricultural production (SINCHI, 1998); and 2) the tendency to increase the area of pasture which is an inadequate productive system according to the eco-biological conditions of the Amazonian environment. The last point has been the perspective of SINCHI on the situation. SINCHI notes that cattle raising production is a non-viable productive system in environmental, social and economic dimensions. This lack of feasibility is partially due to the limitations in market access, the deficiencies in communication and transport, and the poor soil condition (Fajardo, 2002).

The Guaviare colonization area is located in the northern tip of the Colombian Amazonian region covering approximately one million hectares (SINCHI, 1999). The study zone extends over 48.719 ha. Guaviare region is a transition zone between the savannas from the Orinoco to the Amazonian tropical rain forest ecosystems. The region is characterized by a transition landscape of savannas, forests, grasslands, coca crops and subsistence agriculture (see Fig. 1) (Ordóñez et al., 1989).

Colonos in the Guaviare colonization zone have settled in the Amazonian plains. This territory is characterized by three different degrees of human intervention, which are determined by the predominance of cultivated pastures (SINCHI, 1998): 1) high human intervention zone (above 70%), 2) moderate intervention zone (between 40 and 70%), and 3) low intervention zone (below 40%). The peasant household is a combination between productive and consumption units. It does not function as an enterprise, but as a family unit which depends on its relationships with the socio-cultural and natural environments (Forero et al., 2002). Although the *colonos* have peasant origins, when they arrive in the colonization zone they integrate new attributes into their culture. In new geographical spaces and environments, their rationality, in addition to maintaining the family unit, tends to maximize their utility for self benefit (SINCHI, 1998). Therefore, a society exists in this zone with peasants-*colonos* who have an atypical peasant rationality, one that is mixed (SINCHI, 1998).

We identified three types of actors, without taking into account indigenous groups:

1) The pioneer-*colono,* of peasant origin who generally comes from the Colombian Andean zone. These people settle in the unconsolidated zone, and they do not have land property titles even if they own the land by *de facto* occupation. Social and productive actions are based on family relations (Salazar, 2002). 2) The peasant-*colono* has a rationality of household maintenance where the basic unit is the family and the goal is the territorial consolidation for familial reproduction. In addition, this type of actor seeks to invest capital, buying land and increasing land rent through the establishment of pastures. The peasant-*colono* can be considered as a semi-entrepreneurial unit (Salazar, 2002). According to Salazar and Molano (in Salazar, 2002) the unique way to avoid the peasant degradation is through coca crops (although these are illegal) and cattle raising. 3) The *latifundista*[4], according Salazar (2002), has two possible origins. This actor could be either an enriched peasant or a person who, traditionally, accumulates large land extensions. The large state owner invests in establishing pastures for cattle raising. This actor has a high capacity to contract a labor force.

Colonization zones in Colombia are affected by the internal armed conflict and the Guaviare region is not an exception. The region has experienced periods of violence and territorial domination by different armed groups. This characteristic makes field work in the zone difficult and has consequences in the decision-making processes of local actors. Regarding land use, a critical issue is the practice of growing illegal products such as coca crops, which provide an important economic incentive for *colonos* and armed groups. This form of land use is an important component of landscape transformation, as will be demonstrated by the results of this study. Methodologically, this situation posed a challenge because it was not possible to visit the peasants-*colonos* on their properties, or to stay for a long period in the zone. Consequently, the RPG tool provided an alternative to represent the conditions of the region and the land cover changes at household level, in a safer environment such as in the administrative center of the region, San Jose del Guaviare village.

3. Methodological framework

3.1. The integral approach

In order to meet the objectives of the study a four phase methodology was designed. Fig. 2 portraits the methodological framework.

During phase I we carried out the identification of: 1) land covers, 2) actors, 3) decisions, 4) factors affecting the process of establishment of pastures and 5) information needed for a preliminary conceptual multi-agent system (MAS) model. The literature review allowed the building of an historical profile of land cover evolution in the colonization zone. This historical profile proved useful in identifying the factors that influenced landscape transformation, to define actors and their possible decisions regarding the establishment of grasslands. In order to identify the land covers we used Landsat satellite images[5] supplied by SINCHI. We produced a map of land cover units after cartographic processing. Finally, based on collected information and semi-structured interviews, we designed the tools that would used in the field. The principal objective of RPG was to identify decisions and factors that influence land cover transformation.

During phase II field work was carried out in order to: 1) verify the types of land covers identified in the satellite image, 2) to collect information for the RPG and, 3) to carry out semi-structured interviews to construct, with field informants, activity diagrams about the activities that describe the land use transformation process from forest to pasture. During phase III a land cover multi-temporal analysis was carried out with the purpose of quantifying changes in land covers in two periods. Fig. 3 shows the results of the multi-temporal analysis. The historical profile generated information about relevant factors that have conditioned actors' decisions identified in the literature review. RPG, interviews and direct observation were utilized to construct UML diagrams of most important activities. This information was the input for the UML formalization of decision rules of peasants-*colonos*, and the construction of a MAS model using CORMAS (Bousquet et al., 1998) platform. This information allowed us to generate a discussion with actors, researchers and technicians from local institutions, and to improve the understanding of land cover evolution in the study zone.

3.2. The Role-Playing Game (RPG)

RPG is an educative tool as well as a device that facilitates negotiation processes in ecosystem management and it contributes

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[4] The English translation of *latifundista* would be landlord, but the concept in the region does not have to do with the fact that a person lets land to a tenant. In the region, these people arrived as pioneer-colonos, then they become peasant-*colonos* and accumulated a considerable quantity of land compared with the average colonos in the zone. Locally, these people are called latifundista.

[5] Satellite images utilized in cover analysis: Path Row Date Sensor Id Uni Observations d/m/a 7 58 11-01-88 TM 032-334 Landsat 7 58 1994 TM 075-994 Landsat 7 58 03-03-01 ETM+ 042-736 Landsat.