



# A companion modelling approach applied to forest management planning

C. Simon, M. Etienne\*

INRA, Ecodéveloppement Unit, Site Agroparc, 84914 Avignon Cedex 9, France

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## ABSTRACT

To assist the Société Civile des Terres du Larzac (SCTL) in its effort to develop alternative forest management plans, a group of researchers and extension officers proposed applying a companion modelling approach. The objective was to support forest owners and livestock farmers while they worked out a solution to their forest management problems. The approach was based on the co-construction and use of an agent-based model providing a shared representation of the current management of farms and providing multiple view points on alternative forest management scenarios. The validation of the model allowed the development of a shared representation of the territory. The use of the model as an exploratory tool empowered local stakeholders to elaborate alternative management strategies for their renewable resources (forage, timber, firewood). It also expanded the discussion on forest management to a multi-scale level where managers assumed progressively a role of land administrators. When playing this role, they compared their forest policy orientations and forest harvesting decisions with farmers' individual situations and interests. Participants became aware of how spatial and temporal scales of management overlap and they progressively worked out a compromise between livestock breeding concerns of farmers and forest dynamics concerns of SCTL managers.

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## 1. Introduction

This case study is part of the growing research field of ecosystem management applications (Bousquet and Le Page, 2004) focussing on participatory approaches that take into account interactions between natural and social dynamics. It provides a sort of integrated modelling approach (Barthel et al., 2008; Liu et al., 2008) deep-rooted in the involvement of local stakeholders into the modelling process, in order to avoid some pitfalls of multi-objective optimization techniques (Raizada et al., 2008) or multiple criteria analysis tools (Marinoni et al., 2009).

The companion modelling process (collectif ComMod, 2006) based on a participatory, computer-based approach and landscape dynamics simulations supports local stakeholders in a collective reflection on spatial land pattern management. It was initiated in direct response to a request made by the Société Civile des Terres du Larzac (SCTL) to devise new ways to manage forests. An interdisciplinary team of researchers working on silvopastoral management, forestry, livestock farming systems and farm labour organisation was established to accompany local stakeholders in their search for a solution to the following question: "How can we make use of

forestry resources characterised by low wood production while consolidating farmers' livestock breeding activities?" Their curiosity having been roused by the application of a similar process in a neighbouring territory (Etienne et al., 2003), SCTL managers and farmers agreed to become involved in the conception and validation of an Agent-based Model (ABM), and to participate in the design and analysis of a set of optional management scenarios.

The model conception process was inspired by modelling methodologies developed by the Companion Modelling group (ComMod). These methodologies focus on using ABMs as a means to facilitate and enhance shared learning on social and ecological dynamics' interactions rather than as a tool to pilot a socio-ecological system (Bousquet and Le Page, 2004; ComMod, 2005). This model-based approach has proven to be particularly useful when dealing with complex systems to help local stakeholders embedded in these systems to collectively compare, evaluate, and implement concrete alternative management strategies (e.g. Becu et al., 2006; Purnomo et al., 2005). As SCTL managers explicitly requested that farmers be integrated into the process, we shifted the problematic to a question of scale: "How may the breeding management plans devised by individual farmers at the farm scale be reconciled with the emergence of a forest management plan developed by SCTL managers at a territorial scale?"

This paper describes the companion modelling steps that were followed by the stakeholders and researchers who worked together

\* Corresponding author. Fax: +33 432 722 562.

E-mail address: [etienne@avignon.inra.fr](mailto:etienne@avignon.inra.fr) (M. Etienne).

for 15 months over a 2-year period. We describe the main results of the participatory modelling process and discuss the outcomes from three different perspectives. As our approach is part of a research field that is evolving rapidly (Bousquet and Le Page, 2004; Hare and Deadman, 2004; Parker et al., 2003), we hope to provide insights and landmarks that will be useful to new users of agent-based modelling embedded in participatory ecosystem management.

## 2. Case study

Located in the south-eastern part of the Massif Central, the mountain range of Central France, the Causse du Larzac is an elevated (700–1100 m) limestone plateau cut off from surrounding plateaus by deep canyons. A long land use history of grazing and cereal cropping, and the particular rainfall and temperature conditions of a transitional climate bridging mountains and the Mediterranean, have led to a steppic, open landscape. Due to the karstic system, there are no permanent water sources.

Over the past few decades, deep socio-economic changes (rural migration, mechanization, and increased use of inputs) have led to a shift from a predominantly range system to agropastoral systems that depend more on forage and barley production and which are concentrated on the most fertile soils (Osty et al., 1994; O'Rourke, 1999). Simultaneously, a progressively increasing use of fuel and gas in place of firewood by farmers and other inhabitants has led to a dramatic decrease in firewood exploitation (Lepart et al., 2000). Both processes accelerated a shift from silvopastoral lands to dense forests that have no grass undergrowth. This trend was reinforced by the decline or abandonment of certain traditional practices which once helped to control shrub encroachment on pastures such as the harvest of forest by-products and the use of box (*Buxus sempervirens*) wood and leaves for handicrafts and litter production (Balsan and Bousquet, 1973).

Another important historical element is the French government's 1971 decision to enlarge the military camp of La Cavalerie, which was surrounded by the farms in this study. Between 1971 and 1981, 6300 ha of land were purchased or repossessed by the government. This social conflict ended in 1981 following the election of a new French President who decided to end the project and give the land back to farmers in the form of a 60-year lease. The farmers then created a civil society, the Société Civile des Terres du Larzac (SCTL) (De Crisenoy and Boscheron, 1986), to regulate the management of the 6300 ha of recovered land. Composed of pastures, forests, and fields, the land was divided into 40 farms that were rented in priority to the farmers who had exploited them prior to 1971. The forests located on these farms are owned by SCTL and the tenant farmers only are allowed to harvest firewood for their own domestic needs. SCTL is managed by a council whose members are elected by the farmers (Dambrin, 2001) and to whom we refer to in the remainder of the paper as the *SCTL managers*. The council currently is composed of 10 managers out of which nine are farmers and five manage farms in the study area.

Based on their perception of the past and present Larzac landscape (memories, stories, pictures...) and on their own experience as livestock farmers, SCTL managers jointly agreed to describe the changes that had taken place in their environment since the 1970s as, "a progressive closing of grazing areas to the benefit of pine stands and a densification of oak coppices leading to pasture shortage". A synchronic analysis of aerial photographs taken in 1948, 1964, 1978, 1990 and 1997 indicates a significant over-spreading of *Pinus sylvestris* (PS) and a clear densification of *Quercus pubescens* (QP) coppices between 1948 and 1997 and a clear acceleration of these dynamics between 1964 and 1990 (Simon, 2004). This phenomenon is partly explained by the interruption of

grazing and maintenance activities during the 10 years of *turmoil* between 1971 and 1981.

SCTL managers first thought that they faced a forestry problem and consequently asked a forestry expert for assistance. In accordance with French forest regulations, the expert established a simple forest management plan (period of validity: 1998–2012) that included yearly selective felling on *Quercus pubescens* (QP) stands and clear cuttings on the most productive *Pinus sylvestris* (PS) stands to reconvert these areas into pastures. The purpose of these cuttings was either to achieve a forestry or a grazing objective; both kinds of objectives were never sought on the same plot. The forest management plan scheduled three types of operations: wood exploitation and sale, improvement of QP wood stock quality, and the transformation of PS stands into pastures. These operations were assigned to only 280 ha of the 1930 ha of forest stands identified by the forestry expert. SCTL managers, however, were unconvinced that the expert's management plan would resolve their forest problem and consequently began searching for another solution.

The existence of this forest management plan was an advantage for this study because it gave us the opportunity to immediately compare the results worked out through the Larzac companion modelling exercise with the outputs of a conventional forestry expert approach.

## 3. Approach, methodology and schedule

In order to address both the managers' concerns and the research team's question, we pursued to improve the quality of the collective decision-making process and to promote local change. In this regard, a companion modelling approach was applied to promote bottom-up modelling for bottom-up decision-making. Our main goal was to support local stakeholders while they collectively designed and compared management options for their woodlands while simultaneously taking into account the impact of each option at the farm and forest massif levels.

### 3.1. Companion modelling approach

The companion modelling (ComMod) approach (<http://www.commod.org>) is a participatory approach used to support and accompany collective decision-making processes (Groot and Maarleveld, 2000; Ramirez, 2001; Borrini-Feyerabend et al., 2004). It relies on the co-construction and use with stakeholders of a model representing the functioning of their socio-ecological system (D'Aquino et al., 2002; Barreteau, 2003; Becu et al., 2006; Bousquet et al., 1996). The approach is based on the hypothesis that stakeholder participation in model development and implementation results in a model better fitted to stakeholders' needs and, consequently, is more useful (ComMod, 2005). The models developed play the role of boundary objects (Star and Griesemer, 1989) and allow stakeholders to share representations and evaluate scenarios (Etienne, 2006). Moreover, the development of a model typically follows an iterative methodological process in which each loop – also called iteration – corresponds to a succession of conceptualisation, implementation and validation phases.

When following the ComMod approach, a variety of methods are developed and tested as part of a methodological research effort (e.g. D'Aquino et al., 2002; Barreteau and Bousquet, 2000; Becu et al., 2006; Feuillette et al., 2003; Mathevet et al., 2003).

### 3.2. Methodology

The methodological posture was to use computer modelling and scenario simulations as part of a participatory approach that covered model design and development up to scenario building

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