

Chapter 14

Pyroxene: A Territorial Decision Support System Based on Spatial Simulators Integration for Forest Fire Risk Management

Eric Maillé

*Cemagref, Mediterranean Ecosystems and Risks Research Group (EMAX),
Territorial Management Department (GT), France*

Bernard Espinasse

*Aix-Marseilles University, Information Sciences and Systems Laboratory,
LSIS UMR CNRS 6168, France*

ABSTRACT

Medium term management of territorial risk increase requires decision support tools able to represent and simulate spatial dynamics. For forest fire risk, simulators of spatial dynamics of both fuel zones and vulnerable zones are produced by specialised disciplines, like ecology and geography. In order to integrate simulators of spatial dynamics of different themes at different scale levels, this paper proposes a spatial agent and GIS based software infrastructure called Pyroxene. This infrastructure is designed to implement “models for models integration”, specified by domain expert users. To do so, end users have to use a specification framework, specifically designed for spatio-dynamic models integration. The purpose of the implemented platform is to execute and synchronise integrated simulations. To operate the semantic and syntax requirements of such integration, the platform is structured in an HLA-like architecture, and implemented as a multi-agents system for models integration, compliant with the FIPA specification. It is also organised around a GIS. First steps of validation confirm the validity of the system at the functional level and precise the limits of using the approach on the operational level.

1. INTRODUCTION

Nowadays environmental changes, from global climate change up to local land cover change, often lead to natural risks severe increase, like flood risks or forest fire risk. Modelling the in-

teraction between natural systems (ecosystems) and human system dynamics is a key activity to produce decision support tools for environmental risks management. In the case of forest fire, the increase of the risk stems from the interaction between fuel ecosystem dynamic (forest) and

vulnerable human system dynamic (discontinuously urbanised zone) occurring on the same territory. Moreover, decision of risk management is a multi-scale approach, and refers to diagnostics and operational actions at different scale levels.

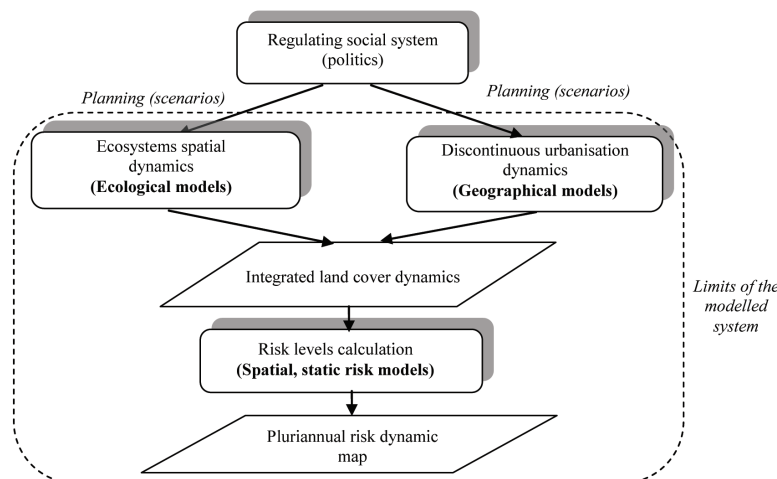
Many models and implemented simulators exist, designed to represent either spatial human systems dynamics (Veldkamp, 1996) or ecosystems dynamics (Coquillard & Hill, 1997). Models can be very heterogeneous, regarding notably their mode of representation of space and time (Ramat, 2004). Moreover, aggregated approaches contrast with individual based approaches (Grimm, 1999), like agents based modelling (Ferber, 1999). These models are usually not specialised in risk dynamic representation, but can be used to represent the interaction between spatial systems sharing the same territory.

Trying to design one unique model of the global « humanised-ecosystem » is highly difficult first because of the complexity of such a global system, and secondly because the required knowledge is distributed in very different disciplines. On the other hand, using existing models, already produced by the different scientific disciplines, requires an integration process.

We propose a conceptual and operational solution for a decision support tool to manage forest fire risk increase due to land cover changes. The tool is based on existing spatial dynamic simulators integration. The integration system is “multi-thematic”: it permits to integrate models referring to different ontological fields (Grüber, 1995), like forest ecosystems, urban dynamics and natural risk. It is also a “multi-scale” integration system, as it permits to integrate models describing the same territory at two different scale levels.

In section 2, a general presentation of forest fire risk change modelling based on thematic and scale integration of several disciplinary spatial models is proposed. In section 3, the conceptual framework of the integration system is described. In section 4, the implementation of this framework as an agent-based integration platform called PYROXENE is presented. Finally, in section 5, a description of operational use of the platform for land planning decision support is proposed.

Figure 1. Integration of land cover change models to simulate risk evolutions



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