PhD project in spatial statistics and stochastic geometry

Spatio-temporal modeling and simulation of agricultural landslides, with an application to pest regulation

Supervisors:
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Motivation : agro-ecology

In agroecosystems, species interactions between pests and auxiliaries are often strongly influenced by the proportion and spatial organization of semi-natural elements of agricultural landscapes. By conducting sensitivity analyses for biological control strategies of pests with respect to the composition and configuration of agricultural landscape elements, it will be possible to assess the effect of such interactions and to improve existing strategies of biological control.

Research questions : stochastic geometry and sensitivity analysis

This PhD project proposes to utilize methods from the field of stochastic geometry to **model and simulate realistic agricultural landsapes** through the development of models based on a small number of interpretable parameters characterizing the landscape structure. Mathematically, we will represent a study region as a tessellation of space, whose edges and cells are the spatial support for other elements such as hedgerows (i.e., linear segments) and crop types. A first goal of the thesis will be to propose **realistic stochastic generator models for linear segments** (hedges, ditches, grassy field margins...), and for the **occupation of agricultural fields by various crops**, while taking into account crop rotation. Our approaches will be based on censored **Gaussian random fields** and on **marked Gibbs point processes**.
In the following step, in order to model the spatial distribution of species, we will couple partial differential equations (PDEs) in 2D for modeling the population dynamics within the fields with PDEs in 1D for the dynamics on linear elements. This approach allows studying the size and the spatial distribution of the species populations with respect to geometric characteristics of the landscape such as the density and the connectivity of the hedgerow network. By simulating a multitude of scenarios, the **sensitivity of population dynamics with respect to landscape structure** will be studied. The framework of stochastic simulation makes it possible to quantitatively assess the part of uncertainty related to landscape.
In the applied part of the thesis, the methodological results will be applied to the study region "Basse Vallée de la Durance" with the pest "codling moth" and its auxiliary species in apple orchards.

Candidate profile : Statistician with interest in spatial modeling and ecology.
Knowledge of fundamentals of spatial statistics and/or stochastic geometry and of the R programming language is appreciated.

Contact

The successful candidate will become part of the Biostatistics and Spatial Processes lab (BioSP) of INRA Avignon. The starting date is October 2018. This PhD project will be supervised by Julien Papaïx (julien.papaix@inra.fr), Thomas Opitz (thomas.opitz@inra.fr) and Edith Gabriel (edith.gabriel@univ-avignon.fr). To apply, please contact the supervisors by providing a detailed CV, a motivation letter and a recommendation letter from at least one former supervisor / professor.