Temporospatial analysis of agricultural systems at regional watershed level : 30 years of data to characterize the Meuse and Moselle watersheds, France

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TEMPOROSPATIAL ANALYSIS OF AGRICULTURAL SYSTEMS AT REGIONAL WATERSHED LEVEL: 30 years of data to characterize the Meuse and Moselle watersheds, France

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Introduction

Agriculture is challenged by large scale issues, such as the impacts of wide land system changes on environmental resources, urging agronomy to evolve. Landscape agronomy emerged as a new perspective to address these issues through spatially-explicit modeling of the interactions between farming practices and natural resources at the landscape level (Benoit, Rizzo et al. 2012). In this study we aimed at characterizing agricultural systems focusing major crop sequences and the related fertilization practices to so as to map the potential pressure on water quality.

Materials and Methods

We analyzed the land cover organization at time and spatial scales that were relevant for regional watershed managers. In particular, crop and grassland dynamics were stressed as one of the major factors influencing the water quality. The Meuse and Moselle watersheds (24 000 km^2, NE France) were chosen as study area. The modeling spatial unit was the primary watershed as mapped by the Rhin-Meuse Water Agency (AERM) to facilitate the integration of the results into their management plans. Land covers were described using the TerUti database, whose data are collected annually by the French Ministry of Agriculture (cf. Slak and Lee, 2003 for details). Data covered the years: (i) 1981-1990 and 1992-2003 with 23 580 points classified in 81 land cover types, (ii) 2006-2010 with 11 588 points classified in 59 land cover types (adaptation to the EUROSTAT Lucas sampling protocol). Two methods were combined to characterize the agricultural system dynamics: (1) stochastic data-mining (Mari and Le Ber, 2006), (2) multivariate statistical analysis of main typologies of land cover trajectories (R software packages by Lê et al., 2008 and Gabadinho et al., 2011). The time-space dynamics of the agricultural systems for each watershed were assessed measuring the return time frequency of the 11 major land cover groups with a 5-year sliding window. The results were then processed with a hierarchical clustering on principal component, and the clusters used for a spatial estimation of the agricultural pressure on freshwater quality related to the organic and chemical nitrogen fertilization.

Results and Discussion

The main result is a baseline of grassland and cropping system dynamics at a watershed level over the thirty year period (Fig. 1.1) and a map describing the trajectories of the primary watershed clusters (Fig. 1.2). Six elementary watersheds out of the total 16, characterized by a high frequency of barley during the 80's, evolved either toward a mixed cropping systems (b) or a steady increasing in rapeseed frequency (a), the latter

becoming similar to the stable agricultural system close to the two biggest cities in the region. On the other hand, systems that started with 4-years crop sequences in the 80's evolved either toward mixed systems with more maize and grassland (c) or intensified the rapeseed and wheat frequency (d). The other watershed either remained stable with a predominance of semi-natural land covers (g) or converged to it (f).

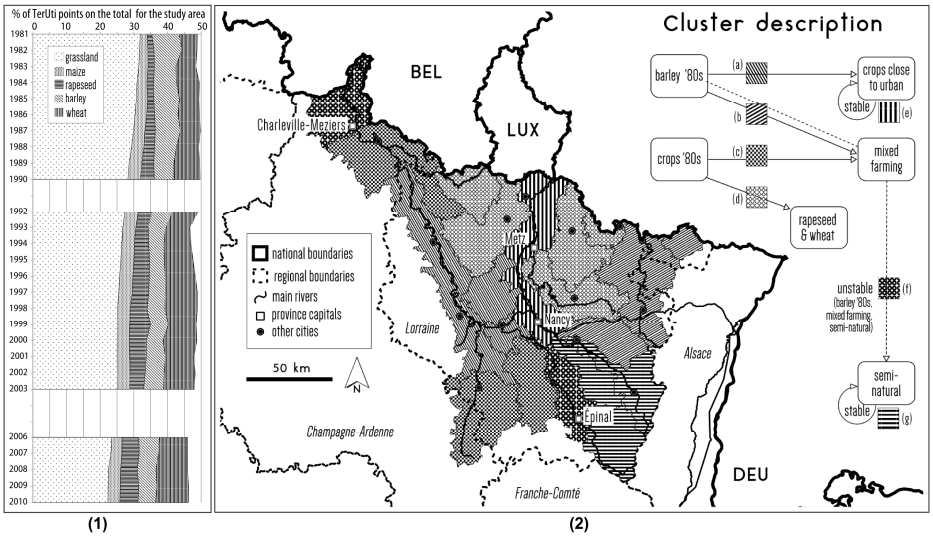

Figure 1. (1) Dynamics of the most relevant agricultural land covers in the study region. (2) Trajectories of the farming systems based on the agricultural land covers time-space clusters.

Conclusions

We proposed a specific methodological choice: modeling temporal dynamics first, then locating them instead of the classical spatio-temporo analysis. This allowed to elicit subtle agricultural system dynamics at the watershed level to support regional resource managers, thus providing advances in modeling methods of landscape agronomy.

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