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An agricultural statistical classification as a decision support tool for the definition of territorial local policies

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ABSTRACT

This work aims at exploiting a set of data collected from a prospective agricultural diagnosis conducted on the local authority named "Communauté de Communes de Desvres-Samer" (CCDS in Pas-de-Calais (France). Agriculture and agricultural sectors are a pillar of this land: that's why elected officials needed a precise analysis in order to adapt local policy to local needs. Based on data collected during this diagnosis, this classification intends to establish a territorial agriculture typology. Statistical and analytical processing-based, this typology has enabled to characterize more finely the landscape entities constituting the study area, with coherent farm units and similar issues. This work therefore provides a useful tool to deepen the understanding of the field reality and to guide future community's choices and territorialized action plan.

Keywords: Territorial statistical classification, diagnosis, data analysis, decision support tool

PAPER

1. Introduction

Territory development issues evolved from a local level to transversal approaches, which transformed process from a simple plots to multifactorial classification methodologies. Local urban masterplans ("Plan Local d'Urbanisme Intercommunal" - PLUI in French) are development tools built through a co-constructed and shared territory project. Besides the cadastral management, it is important for the concerned community to act on all components of its territory, whether in the environment fields, living environment, or economy (any activity sector including agriculture). Indeed, local urban masterplans require communities to achieve common agricultural diagnostics, to characterize local agriculture and to identify weakness sources (urbanization, for example), Melot (2009), Martin (2006).

Working on regional agriculture knowledge, GRECAT[1] laboratory has built from its multidisciplinary skills, its own analysis and regional foresight tool: the OPCRA®[2], several times amended since its inception, in order to fit to local authorities expectations.

In the context of CCDS agricultural diagnosis, GRECAT realized statistical data analysis to better exploit collected territorial information. In next section, a brief contextualization of this area is needed.

With 31 communes, the CCDS, territory of "Caps et Marais d'Opale" regional natural park remains mainly rural (fewer than 100 inhabitants/km2 and 250 farms in 2013). However, CCDS is close to the coast and various urban centers, which makes it an attractive region and causes suburbanization at the cost of agricultural lands. A strong agribusiness presence (Novandie Andros group) explains the major economic position of agriculture, with 20% of local jobs and over 30% of local businesses related to agriculture. Moreover, dairy farming is predominant in this territory, with almost 71% farms concerned in 2013 with a milk total production of 60 million liters (5% of regional production). This explains the bocage landscape: nearly 31% of total CCDS area were grassland in 2009 and almost 1 151 km of hedgerows were identified in 2012. Beyond loss of land, this landscape is threatened by serious difficulties in the dairy sector (e.g. milk price volatility, particularly given that production costs are high in this type of territory). Thus, nearly 38% of dairy farms have doubts about their medium-term life, which would imply a weakening of territorial dairy industry and impacts on environment and landscapes territory.

It is therefore essential for this territory to find appropriate responses to maintain its rural and agricultural character. Even if milk farming is dominant, other agricultural systems are observed too, which demonstrates the link between agriculture systems, environment and territory. Then, it was necessary to take into account these local disparities by crossing spatial and statistical approaches in order to provide appropriate and relevant recommendations.

[1] Research and concerted studies group on agriculture and territories in Nord-Pas-de-Calais (HEI-ISA-ISEN group).
[2] Permanent Observatory of rural and agricultural change.

The issue is to demonstrate coherent agricultural entities, which defined using a data segmentation tool based on collected information during surveys of farmers.

2. Materials and methods

The aim of this work is to develop a communal farm typology of the CCDS. Indeed, the study produced a large amount of data. This database is a valuable source to divide the whole territory by the most representative agricultural indicators.

2.1 Survey and collecting data

In the literature, the agricultural typologies are often based on two types of methods: Those based on surveys, Perrot (1990), and those resulting from an analytical and statistical processing of existing data, Ilari & al (2003), Trouve & al (2004), Alvarez-Lopez & al (2008).

For this study, data was collected through surveys conducted face-to-face with farmers. This choice resulted from the absence of complete and updated data characterizing the territory, and from the need of local authorities to understand local agricultural issues (land data, for example).

The study was conducted from November 2012 to December 2013. Preliminary work began with a literature review and interviews with resource persons whose activities cover CCDS. All these territorial actors have also been regularly consulted through technical committees (e.g. agricultural commission) in order to monitor the study (in co-construction scheme). Other actors (economic actors, consumers, agricultural industries ...) have been also associated to improve the competitiveness of territorial agriculture and its various sectors.

After those preliminary steps, all farmers have been interviewed about their farms and territorial issues: 348 famers involved in 250 farms located in 31 municipalities.

The final questionnaire fit to various CCDS' expectations: make an inventory of territorial agriculture (past, current and future dynamics), identify strengths and weaknesses of the local agricultural sectors, highlight causes of farmland fragilities in some sectors and finally suggest territory evolution scenarios which better consider agriculture. The questionnaire was based on both quantitative and qualitative data collection, but also on parcel data. A significant variables number was collected, however, only 40 were used in the quantitative analysis (Table 1). All Open questions were excluded, as well as closed questions with too few responses.

Table 1: Summary of variables used for statistical analysis

Quantitative variables	Qualitative variables
- Farmer Age	- Farmer gender, marital status
- UAA (utilized agricultural area)	- Commune name
- Agricultural work unit (AWU)	- Farming type
- Milk Quota	- Landscape category
% fruit, market gardening	- Status : individual, societary
% industrial crops	- Direct selling: presence, types, forms…
% animal farm turnover	- Acces to property
% vegetal farm turnover	- Financial health
% cereals, oilseeds and protein crops	- Succession in 10 years
% grassland area	- Permanent and temporary grassland
% woodland area	
	- Diversification: activities, interest …
	- Membership structures (cooperatives, syndicates…)

2.2 Data analysis methodology

Before analysis, a preliminary step of validation was performed in order to check data coherence and ensure information quality (outliers, missing data ...).

Statistical analysis was structured around the factorial multivariate statistical methods, Izenman (2008). The interest of such methods is their powerful ability to synthesize a large mass of data and identify significant relationships between discriminating variables. These approaches have also proved effective in various agricultural issues, Choisis & al (2012), Debeljak & al (2007).

In this work, three main methods were used.

A. Principal Component Analysis (PCA). This technique allows a simple description of a complex reality. In other words, it can extract the maximum information from a large number of quantitative variables and draw conclusions on these variables and associated individuals. Another - essential - objective is to

identify the most relevant variables that characterize individuals from the whole variables set in order to optimize statistical analysis results. The last aim is to eliminate redundant variables and data without significant effect on the overall problem variability.

B. Multiple Correspondence Analysis (MCA). As for PCA, MCA aims to graphically represent a large set of data (qualitative in this case) by reducing problem dimensions. This method is also useful because it highlights the relationship between the terms of used variables. PCA and MCA techniques will serve as "pre-classification" stages as they bring out the most characteristic variables of the desired typology. These variables will be used as input data for the classification stage.

C. Hierarchical Ascendant Classification (HAC). An iterative classification technique that may -according to the quality of the input data - get a partial or complete typology of analyzed individuals, based on their most relevant indicators. This method involves building a partition of the population into homogeneous clusters (low within-variability) which are different the ones from the others (high between-variability).

The expected objectives with this analysis scheme are summarized as follows:

- Highlight communes with farmers groups showing similar characteristics, and determine homogeneous agricultural entities;

- Compare these agricultural entities with landscape categories previously established by CCDS;

- Highlight the main agricultural characteristics of each entity.

- Identify agricultural issues and actions related to other dimensions such as environment and landscape. There is obviously a strong link between agriculture, economy, environment and landscapes on the CCDS;

- Identify priority areas in terms of difficulties to optimize needed actions.

In summary, this both additional analytical and decision making tool is the subject of this work, which is also dedicated to help CCDS to develop a rational and efficient agricultural policy.

3. Results

The methodology described in the previous section achieved a territorial farmers classification (and therefore the associated farms). Moreover, six classes have been obtained, all 348 farmers and 250 farms have been categorized. The size and the name of each class are detailed in Table 2 below. Moreover, a synthesis of the characteristics associated with each class is provided in Table 3.

Table 2: Distribution of farmers number per class

Farmers number per class	
Class 1 = Landscape 1 : « Coeur du territoire » in French (CT)	43
Class 2 = Landscape 2 : « Plateau Ouest et vallée de la Course » in French (POVC)	80
Class 3 = Landscape 3 : « Basse vallée de la Liane » in French (BVL)	25
Class 4 = Landscape 4 : « Clos du territoire et moyenne vallée de la Liane » in French (CTMVL)	63
Class 5 = Landscape 5 : « Fond de la boutonnière, la porte du bocage » in French (FBPB)	78
Class 6 = Landscape 6 : « Seuil Nord du territoire » in French (SNT)	59

The statistical analysis produced a very similar classification to six landscape entities characterizing CCDS (Figure 1). Differences are related to one or two farms located in "Le Wast" (attached to class 4) or "Desvres" (attached to Class 2). These small differences are explained by the fact that those two municipalities only have one farm, whose characteristics belong to other classes. Also, it should be noted that "Longueville" municipality is not attached to any class because no farm was based there.

Figure 1 – Comparison between the obtained typology and landscape categories

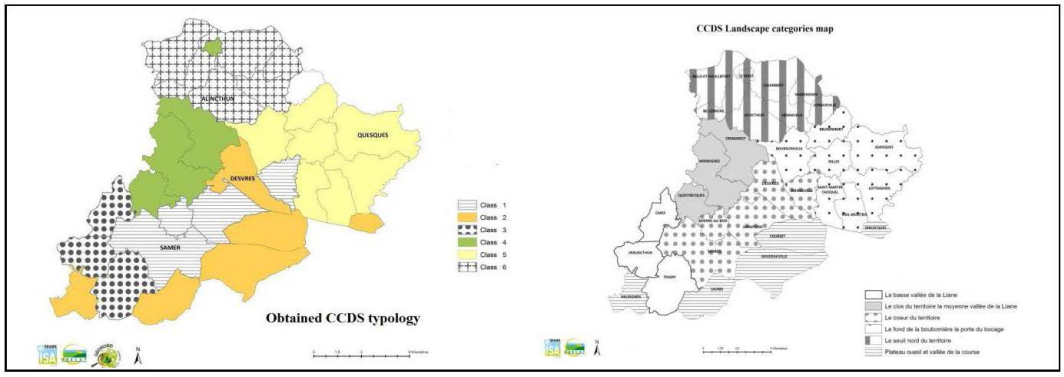
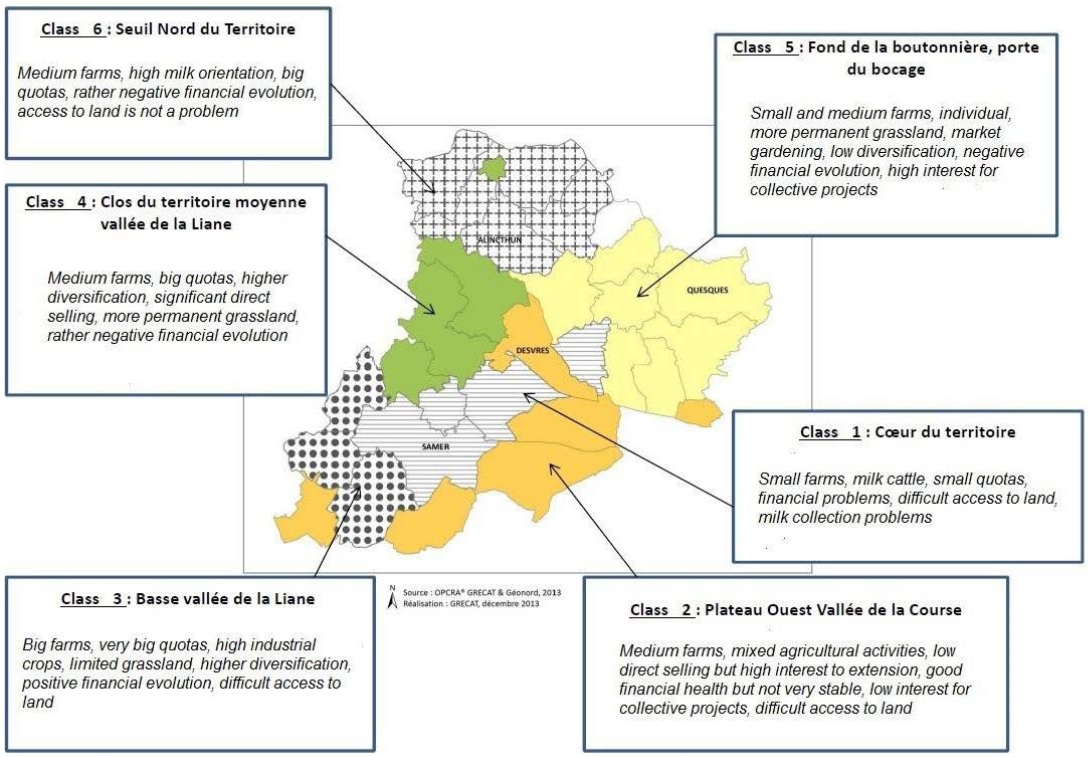


Table 3: Obtained classes characteristics

Criteria	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
size	43	80	25	63	78	59
Farming	Milk cattle	Milk cattle, mixed culture	Milk cattle, milk or meat + aboveground	Milk cattle, mixed culture	Milk cattle, mixed culture	Milk cattle, milk or meat + aboveground
Landscape type (in french)	CT	POVC	BVL	CTMVL	FBPB	SNT
Status	Individual	Societary - individual	Societary	Societary - individual	Individual	Individual
UAA	Small	Medium	Large	Medium	Medium	Medium
Direct selling (DS)	Medium	Low	Medium	High	Low	Medium
Diversification activities	Medium	Medium	More frequent	Less frequent	Less frequent	Medium
Land access problems	Yes	Yes	Yes	Medium	Medium	No
Agricultural work unit (AWU)	Medium	Medium	High	Medium	Medium	Medium
% Woodland area	High	Low	Medium	Medium	Medium	Medium
% cereals, oilseeds and protein crops	Medium	High	High	Medium	Medium	Medium
% Grassland area	Medium	Low	Low	Medium	Medium	Medium
% industrial crops	Low	Low	High	None	None	Low
% fruit, market gardening	Low	None	Low	Low	High	None
Dairy livestock	Low	Medium	High	High	Medium	High
Milk quota	Low	Medium	High	High	Medium	High
% Vegetal farm turnover	Low	Medium	High	Low	Low	Low
% Animal farm turnover	High	Medium	Low	High	High	High
Financial health	Medium	Good	Good	Medium	Medium	Medium
Financial evolution	Stable	Stable	Improved	Degraded	Degraded	Degraded
Collective projects interest	Maybe	No	No	Maybe	Yes	Maybe
Succession	Yes	Not concerned	Not concerned	Not concerned	Yes	Not concerned

Following this classification, it was possible to extract the most significant features of each class. The mapping of Figure 2 summarizes the most important indicators of the obtained typology.

Figure 2 – Significant characteristics of obtained typology classes



For example, class 5 has a weakened farms structure (compared to Class 3) with a large dependence on livestock farming. Thereby, grasslands are very important for agriculture and landscape identity. Moreover, these farms are rather "isolated" from the rest of CCDS (very rural area with few farmers' market).

Therefore, solutions that could be developed through an action plan supported by CCDS, could be the following (some measures could also be applied for other classes):

- Regulate afforestation (in progress in some communes);

- Assist farmers in the development of local agricultural production valuation, which could be part of existing procedures (collective points of sale or local farm networks);

- Discuss with farmers about workforce sharing strategies;

- Promote the use of "non-agricultural" products such as hedgerows to establish local wood energy industry.

4. Conclusion

Performed according to the specific requirements of the used statistical methods, this obtained statistical territorial typology provides an innovative vision for the studied territory. Indeed, it highlighted six agricultural geographic areas, which finely describe the similarities and differences within CCDS. Moreover, the similarity between the obtained typology and landscape categories consolidates the former CCDS' work, which were primarily based on empirical criteria. The statistical approach being more rigorous, it helped to enhance the contours of this territory by marking a link between landscape entity and agricultural type.

However, the undertaken work should go on as this typology will be only meaningful if it is facing the territory reality. Based on the obtained results and following a "decision support tool" methodology, an operational approach based on targeted actions will validate conclusions of this study. It will also open the way for further reflection on the possible extension of this work in other geographical areas, with as a possible outcome, obtaining a real statistical agro-territorial modeling tool.

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