Computers and Electronics in Agriculture 127 (2016) 541–552

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Original papers

RPG Explorer: A new tool to ease the analysis of agricultural landscape dynamics with the Land Parcel Identification System

F. Levavasseur [a,b,*], P. Martin [c], C. Bouty [c], A. Barbottin [a], V. Bretagnolle [d,e], O. Thérond [f,g], O. Scheurer [h], N. Piskiewicz [i]

[a] UMR SADAPT, INRA, AgroParisTech, Université Paris-Saclay, 78850 Thiverval-Grignon, France
[b] UMR ECOSYS, INRA, AgroParisTech, Université Paris-Saclay, 78850 Thiverval-Grignon, France
[c] UMR SADAPT, AgroParisTech, INRA, Université Paris-Saclay, 78850 Thiverval-Grignon, France
[d] UMR 7372 CNRS, Université de la Rochelle, CEBC, Beauvoir-sur-Niort 79360, France
[e] LTER "Zone Atelier Plaine & Val de Sèvre", Centre d'Études Biologiques de Chizé, CNRS, Villiers-en-Bois F-79360, France
[f] UMR AGIR, INRA, INPT, 31326 Castanet Tolosan, France
[g] UMR LAE, INRA, Université de Lorraine, 68000 Colmar, France
[h] Institut Polytechnique Lasalle Beauvais, 60000 Beauvais, France
[i] Société Nicolas Piskiewicz, 14000 Caen, France

ARTICLE INFO

Article history:
Received 5 April 2016
Received in revised form 1 July 2016
Accepted 16 July 2016
Available online 25 July 2016

Keywords:
Land Parcel Identification System
Agricultural landscape
GIS
Rotation
Farm cropping area
Crop proportions

ABSTRACT

In the early 2000s a Land Parcel Identification System (LPIS) was set up by each member state of the European Union, to manage agricultural subsidies. These databases describe field geometry and land-cover, and provide information on farm characteristics. LPIS data could therefore be used to describe agricultural landscape dynamics, but are seldom put to this purpose by scientists and local stakeholders because it requires the use of GIS software and programming skills. The objective of this paper is thus to present RPG Explorer, a new tool that we developed to analyze agricultural landscape dynamics with LPIS data. RPG Explorer doesn't require any specific skills in GIS and programming allowing non specialist to deal with complex data.

RPG Explorer includes a first module which computes the changes in crop proportions and farm characteristics (numbers of farm, farm area, farm type). A second module computes crop sequences on each farmer block of LPIS data. We also included a crop rotation model in a third module.

We illustrated the use of RPG Explorer for two example neighboring catchments located in western France, the Vivier catchment (16,000 ha) and the Courance catchment (15,000 ha). For example, RPG Explorer easily revealed the evolution of crop proportions, such as the increase of temporary grasslands in the Courance catchment (from 7.2% of the Utilized Agricultural Area (UAA) in 2007 to 11.7% in 2013). The number of farms was also shown to vary a lot: from 230 in 2007 to 207 in 2013 for the Vivier catchment, with a subsequent increase of their mean UAA (from 101 ha to 119 ha). RPG Explorer also showed that more than half of the Vivier catchment UAA (59%) was occupied by only 50 farms in 2013. Concerning crop sequences, the sunflower → winter wheat sequence was the most frequent 2-year sequence in both catchments, but some differences appeared with for example, a higher proportion of winter wheat → winter wheat sequence in the Courance catchment (7.2% against 3.6%). Crop rotation modeling indicated that the rapeseed → winter wheat → sunflower → winter wheat, sunflower → winter wheat and maize monoculture were the three main crop rotations.

Finally, these examples illustrate well the ability for scientist and local stakeholders to easily describe some major agricultural landscape dynamics with RPG Explorer.

1. Introduction

Apart from food production, new issues are constantly arising in agricultural landscapes, such as the ecological impacts of agriculture (Stoate et al., 2009) and the loss of agricultural land (Thompson and Prokopy, 2009). Local stakeholders thus need to

* Corresponding author at: UMR ECOSYS, INRA, AgroParisTech, Université Paris-Saclay, 78850 Thiverval-Grignon, France.
E-mail addresses: florent.levavasseur@grignon.inra.fr (F. Levavasseur), pmartin@agroparistech.fr (P. Martin), clemencebouty.agroparistech@gmail.com (C. Bouty), aude.barbottin@grignon.inra.fr (A. Barbottin), vincent.bretagnolle@cebc.cnrs.fr (V. Bretagnolle), olivier.therond@toulouse.inra.fr (O. Thérond), olivier.scheurer@lasalle-beauvais.fr (O. Scheurer), npiskiewicz@gmail.com (N. Piskiewicz).

http://dx.doi.org/10.1016/j.compag.2016.07.015
0168-1699/

describe these agricultural landscapes and their dynamics. For example, when a water resource manager develops an agri-environmental scheme, he can be interested in the location of crops and crop rotations which may have the most impact on water quality (nitrate and pesticide leaching, etc.), as well as to quantify their evolution in time. The knowledge of what farmers should be involved to reach the largest area around the water catchment is also important for the implementation of an agri-environmental scheme. Although these kind of issues are common to most agricultural landscapes, the variability and dynamics of these landscapes can be very local, and the study of this local context is often largely ignored in the literature (Benoît et al., 2012).

Describing agricultural landscape dynamics at a regional scale (i.e., thousands of hectares) is thus a challenge for local stakeholders who manage agricultural production or natural resources at landscape scale. Describing agricultural landscapes and cropping systems usually relies on farm or local expert surveys, remote sensing or the use of agricultural censuses (Leenhardt et al., 2010). All these methods suffer from one or more severe limits, such as the amount of work required, the nature of available variables, the accuracy of data, or the public availability of spatialized data.

Recently, a new type of data appeared in Europe. In the framework of the Common Agriculture Policy (CAP), European Commission asked for member states to set up a Geographic Information System (GIS) in order to manage and control subsidies given to farmers (European Commission, 2007). This GIS, called the Land Parcel Identification System (LPIS), has to specify field geometry and land cover, and to be updated yearly (European Commission, 2009). Although LPIS databases were not developed to study agricultural landscapes, their contents could *a priori* make them suitable for that use. LPIS data have thus been used for a wide range of purposes, including rural planning (Verhoeve et al., 2015), spread of weeds (Follak and Essl, 2013) or cattle diseases (Johnston et al., 2011), soil and water conservation (Murgue et al., 2015), biodiversity conservation (Persson and Smith, 2013) and development of new agricultural sectors (Vávrová et al., 2014). Most of the studies identified have only used raw landcover data in LPIS to assess the proportion of one particular crop or its location. Others studies have used several years of LPIS data to determine crop sequences or crop rotations (Leteinturier et al., 2006; Schönhart et al., 2011; Nitsch et al., 2012; Steinmann and Dobers, 2013; Murgue et al., 2015). The spatial delineation of farm cropping areas by means of LPIS data has also been used by some authors, e.g. for studying the effect of land fragmentation on farm performance (Latruffe and Piet, 2014) and on carbon dioxide emissions (Hiironen and Niukkanen, 2014), or for averaging the cost of erosion control measures per farm (Aurbacher and Dabbert, 2009; Martin et al., 2014).

LPIS data have thus been used in a variety of contexts, with different objectives and focuses (landcover, farm cropping area, etc.), to study agricultural landscapes dynamics. However, as their use often requires specific computer programming, it is not an option for most scholars and stakeholders who are not computer scientists. The main objective of this paper is therefore to present the RPG Explorer tool, which we developed to facilitate the use of LPIS data for analyzing agricultural landscape dynamics.

In this paper we first describe the characteristics of LPIS data and of the RPG Explorer tool. We then present the results of LPIS data analysis with RPG Explorer for an agricultural landscape located in western France. Finally, we discuss the potential and limits of LPIS data for describing agricultural landscapes and studying their dynamics. We underline the need for a specific tool such as RPG Explorer to carry out this study.

2. Materials and methods

2.1. Land Parcel Identification System

2.1.1. LPIS data in Europe

In Europe, each member state has to implement an Integrated Administration and Control System (IACS) to ensure that the European Agricultural Guarantee Fund is actually used correctly, and to prevent and deal with irregularities (European Commission, 2007). Since subsidies are area based, a Land Parcel Identification System (LPIS) covering all agricultural areas is part of IACS. LPIS is intented to ensure unique identification of each "reference parcel". Since LPIS is set up by each member state, a diversity of approaches exists concerning its implementation (Kay and Milenov, 2008). For example, reference parcels can be defined as cadastral parcels, agricultural parcels, farmers blocks (one or several agricultural parcels cultivated by a single farmer) or physical blocks (one or several agricultural parcels cultivated by one or several farmers). Land use nomenclature is roughly similar in the different states.

Each year, farmers applying for grants must specify the following for every reference parcel of their farm (parcels that can be granted or not): area, expressed in hectares to two decimal points, location and, where applicable, crop use (European Commission, 2009). This application is established with the use of computerized geographical information system techniques (e.g. aerial orthoimagery), with a minimum accuracy at least equivalent to cartography at a scale of 1:10 000.

Finally, the availability of LPIS to the public also varies in different states, from public access to restricted access.

2.1.2. French LPIS data

In France, LPIS was set up in 2002 and was called Registre Parcellaire Graphique (RPG) (Agence de Services et de Paiements, 2015). The reference unit is the farmer block (see Section 2.1.1). French LPIS contains over 6 million blocks, representing 27 million hectares, cultivated by 400,000 farmers. Every block of farms that had applied for European subsidies are in the LPIS data. According to Cantelaube and Carles (2014), French LPIS covered in 2009 almost all of the croplands (99%) and permanent grasslands (95%) (except moorlands and mountain pastures: 70%), but only 43% of perennial crops and market gardening areas which are not eligible crops for European subsidies. Landcover is described in a nomenclature of 28 groups of crops. A group of crops can correspond to a single crop, e.g., "wheat", or to several crops, e.g., "other oilseed crops" including oil linen, soybean, etc. An anonymous unique identifier for each farmer block and for each farmer is also provided. RPG is updated annually (landcover, farm identifier and block geometry). RPG is provided in yearly databases, with one database for each *département* (NUTS3 scale, the third subdivision of countries according to the European Union nomenclature). A database consists in a set of three files:

- a shapefile containing block geometry and associated unique identifiers,
- a csv file (comma-separated value, i.e., a file storing tabular data in plain text) containing areas of each group of crops per farmer block, and,
- a csv file containing a unique farm identifier and farm characteristics per block identifier (e.g., total utiized area, farm legal status), from 2007 only.

Public access is granted to RPG for every local stakeholder with a public service mission, free of charge or not according to the status of the applicant. In early 2015, only RPG from 2006 to 2013 was available.