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SPATIAL MANAGEMENT OF AGRICULTURAL PARCELS IN THE CONTEXT OF DIRECT PAYMENTS*

Summary

Dynamics of changes in the Polish agriculture was undoubtedly affected the most by Poland's accession to the European Union. During the first years of the membership the EU agricultural policy based mainly on supporting economic development of agricultural farms in the new member states. After the introduction of Rural Development Policy (RDP) for the years 2007-2013, greater emphasis was put on the natural environment protection, rural development but also on the measures for farm support. The amount of money allocated to this objective increased but simultaneously the regulations concerning the requirements a farmer must fulfil to get the payment were tightened.

Yearly changeability of cropping structure and acreage causes numerous troubles for farmers who apply for direct payments but also to farms implementing modernization projects because they have to makes yearly reporting concerning cropping structure for ARMA.

At present, in order to obtain regional, national or EU subventions agricultural holding should submit annual reports of its agricultural activity.

The paper suggests the use of GIS techniques to conduct spatial registration of agricultural parcels included in the crop rotation of the farm production. The created database will facilitate an analysis of agricultural farm production providing the information necessary for reporting required for direct payments. The farm where the investigations were conducted is situated in the Łódzkie voivodeship. Apart from agri-food industry, agriculture is the main specialization of this region.

Key words: direct payments, GPS, vectorization, orthophotomap, spatial database, expanse of agricultural parcels, farm

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INTRODUCTION

Poland accessed the European Union on 1 May 2004. At that time unwillingness and apprehension concerning the membership in this organization prevailed among farmers. Now this social group belongs to its greatest enthusiasts. It is due to the benefits they received after the accession. The most important comprise: increasing financial transfers to support agriculture, causing an increase in farmers' incomes [Starzyński 2009], achieving a positive balance of agri-food products turnover owing to our membership in the Common Market [Czyżewski et al, 2010], increase in purchase prices of most agricultural products, increased money transfer targeting infrastructural investments and modernizing rural development, increased exports of agricultural products, improved quality of final products and stabilization of agricultural policy [Kania, 2008].

Such favourable attitude of farmers is undoubtedly affected by the fact that the European Union so strongly supports development and modernization of agriculture. This sector absorbs a considerable portion of EU budget which currently reaches 34% of the total sum. The Common Agricultural Policy (CAP) was formulated in 1957. At that time its main objective was counteracting food deficiencies and sustaining farmers' incomes [Zaręba et al, 2007].

At present the main objectives of CAP comprise: increasing agricultural production, financial support for farmers' incomes, stabilization of agricultural markets, co-financing of projects aimed at the development and modernizing of rural areas, ensuring regular food supplies and creating rational price level [Czyżewski et al, 2010].

In result of the introduced reforms, the number of farmers eligible for grants increased, but on the other hand the risk of frauds connected with it also grew. Therefore the EU introduced Integrated Administration and Control System (IACS). It is used as a tool for the realization of common Agricultural Policy. It is a complex administrative and information system allowing for efficient distribution and control of assistance for farmers [www.arimr.gov.pl].

IACS application ensures a reliable and compliant with the regulations allocation of funding from the European Agricultural Guidance and Guarantee Fund (EAGGF). The Integrated System of Material and Financial Inspection bases mainly on two elements, i.e., on the system of identification of agricultural parcels and animal identification system. Both these pillars must be properly defined whereas the other elements should be well developed and efficiently implemented [http://h4113.www4.hp.com].

In Poland the Integrated System of Material and Financial Inspection is supervised by the Agency for Restructuring and Modernization of Agriculture. Each year the system examines over 6 million applications for assistance funds,

processes them and conducts administrative check. The applications are verified all the time. A minimum of 5% of all applications concerning land and 10% concerning animals are checked. The control allows to diminish expenditure on the realization of applications [http://h4113.www4.hp.com].

The crucial role of the Common Agricultural Policy involves taking care to maintain farmer incomes on the appropriate level. One of the main tools serving this purpose are direct payments.

To obtain a direct payment, farmers should submit proper applications. In 2011, for the first time since Poland's accession into the EU, the farmer will have the possibility to submit applications for direct payments both on paper and on-line. The application form for direct payment consists of graphic materials and a form describing activities conducted on agricultural parcels [www.agror.pl].

Following a subsequent CAP reform of 26 June, 2003, Luxembourg, a system of payments independent of the output volume was introduced because the main objective of direct payments is supporting farmer income and not encouraging him for increasing production. It forced farmers to adjust their production to the situation on the market (depending on the demand and consumer preferences), and to dominate the competition rather than be stimulated by the rate of payments. Therefore, realization of direct payments was unconnected with obligation of conducting specified activity, whereas their amount was established on the basis of historical data of the referential period. In fact it means that the EU farmers receive a determined financial assistance per farm or hectare of arable land [www.minrol.gov.pl]

Currently in order to receive the payment a farmer must observe the cross-compliance rule. This measure was introduced to counteract negative outcomes of agricultural production liberalization for the environment. In case of non-observance, the payments are either decreased or annulled [Piekut, 2007].

On the basis of accession treaty, Polish farmers were included in a simplified system of direct payments. Simultaneously, Polish Government decided to introduce complementary area payments to the determined crop areas, financed from the national budget. First payments for farmers were realized between 18 October 2004 and 30 September 2005.

All agricultural crops cultivated on arable land maintained in good agricultural condition as of 30 June, 2003, comprising arable lands, permanent grassland, permanent crops and kitchen gardens, but also: tree and shrub nurseries, plants cultivated in greenhouses and in plastic tunnels, fallow land, osier, short rotation coppices (uniform tree species of birch, poplar or willow genii, on the area of at least 0.1 ha, harvested in the cycle no longer than: 8 years for birch and 6 years for the other trees) are also eligible for area payments [www.arimr.pl].

Because of payments for farmers realized from the European Union assistance funds, the Land Parcel Identification System (LPIS) was set up in Poland. It is the main element of IACS. The following source materials were used for its creation: cadastral maps, digital orthophotomap, descriptive part of the land register [Gotlib et al, 2007].

LPIS makes use of GIS technologies and data. It comprises the register of producers, farms, applications for payments and integrated control system [www.arimr.gov.pl/ gis leaflet]. Its main objectives are: identification of the situation of agricultural parcels declared by farmers - uniform for the whole Poland, check of the correctness of declared areas, check of the number of applications submitted per each agricultural parcel or its part, determining whether the agricultural parcel is situated in the areas eligible for payments [Zaręba et al., 2007].

AIM AND SCOPE OF WORK

The aim of the paper is to realize a spatial database for the expanse agricultural parcels of a selected farm. The base was produced using the Spatial Information System techniques in the ArcView environment that contains thematic layers connected with the shape and size of agricultural parcels and road network of the studied area.

Information accumulated in the spatial database allow for automatic generation of a graphic attachment which is an obligatory element of application for direct payments. Attribute data describe the activity carried on the agricultural plots and allow to obtain easily information about the production space on the farm. Owing to this fact it is possible to maintain so called history of fields required from the beneficiaries of the agri-environmental programme who are obliged to collect this type of information for 5-year periods. A spatial database realized in GIS systems enables improvement of agricultural production space management system. The spatial database describing agricultural production on agricultural parcels was prepared in the way to minimize the necessity of analogous reporting. A user introduces the information about the production to an Excel worksheet in the proper lines.

The work comprises:

– delimitation of parcel boundaries;

– delimitation of agricultural parcels by means of orthophotomap vectorization on the screen;

– code conversion from American Standard Code for information Interchange to the *.dwx files;

– creating spatial database of parcel extent;

– entering attribute data about agricultural production carried on the agricultural parcel for the last five years.

SPATIAL DATABASE

Spatial databases are definitely different from other bases. Their fundamental part has the direct reference to the determined spatial distribution, moreover, the data are saved in the structures that make possible to obtain the coordinates of the objects in a factual coordinate system. The data referring to the space which is the area of geographical investigations form the geographical database.

Spatial database must ensure at least the geometrical service of data type – in the first place a proper record of the object coordinates and management of coordinate system, spatial index ensuring efficient access to the data, proper visualization of spatial data.

In spatial databases, spatial relations are based on the analysis of object coordinates or on the record of complex topological relations among the objects. While creating them, one needs a formal description which depends of the accepted spatial model. The most often defined groups of spatial relations comprise: topological relations which define the neighbourhood, containment and overlapping of objects, moreover, they are characterized by permanence in situations such as rotation or autosizing, metric relations which base on computations made on the object coordinates with ascribed definite kind of relation: in a radius of, between, beyond, within, relations which determine mutual spatial orientation of objects, e.g., to the north or to the south, etc. and other which are more difficult to define, determining mutual location of objects, usually less precisely, e.g. below, in front, close to, etc.

Correctly defined spatial relations make possible forcing proper spatial integration nodes and also allow making queries using spatial operators. For instance, it is possible to make queries (by means of the extended SQL language) of the type: search all river sections in mountain area, find all post offices in the radius of 3 km from the given address, find all road sections with water supply system underground [Gotlib et al, 2007].

METHODS

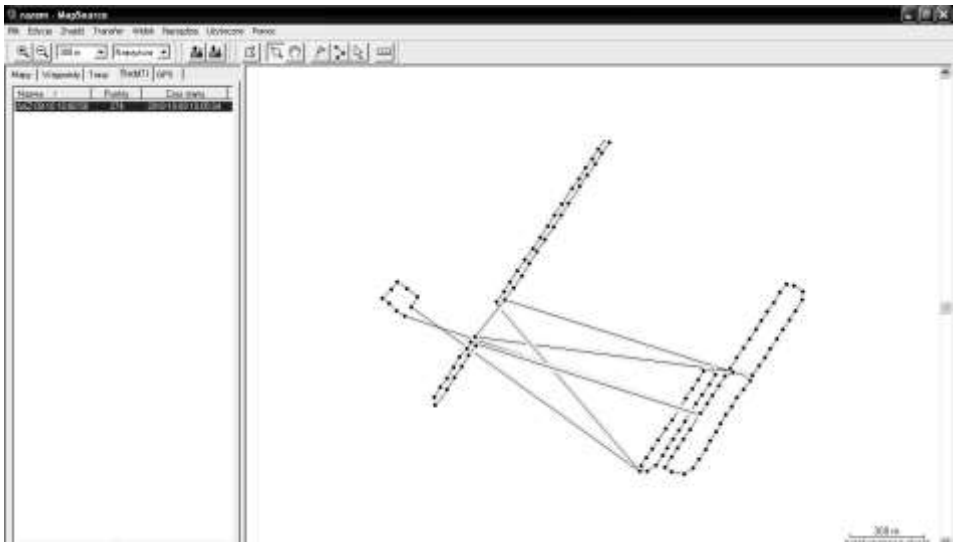
Investigations were conducted at four stages. The first involved guided interviews with farm owners, the second comprised activities connected with agricultural plots measurement by means of hand GPS receiver. Delimitation of agricultural parcels boundaries was done also by means of vectorization which led to graphic projection of the area.

At the subsequent stage the works focused on data conversion from American Standard Code for Information Interchange to the *.dwx files. Owing to the results obtained at the previous stages a spatial database of parcel extent was created.

The information gathered from farmers during the interview constitute the attributes of spatial database. It concerns crop rotation, yield, doses of organic and mineral fertilizers.

One of the requirements necessary to get direct payment to arable land is stating precise dimensions of individual cropping areas.

While enjoying the right to direct payments one should remember that the permissible measurement error of the cropping area cannot exceed 3%. The fact is stated in the Regulation of Commission of the European Communities No.1259/1999. In case of hand GPS receivers, the area measuring error is due to many reasons, e.g., signal interference, shape of the parcel, the area or technical parameters of the hand receiver. The investigations demonstrated that while measuring the plots of more than 3 ha the error usually does not exceed 3%.



Source: own study 2011

Figure 1. Fragmentary view of agricultural parcel boundaries in MapSource made by hand GPS receiver

The fundament of all spatial analyses are spatial databases. In the opinion of many users the base is the crucial part of GIS software due to the costs involved in acquisition and updating of spatial information.

The database developed for the presented paper is composed of three file types with extensions of shp, shx and dbf. Files with the*.shp extension define the image, files with *.shx ascribe identifier and associate adjacency, files with *.dbf contain attributes as a list of variables. Creating a base of this type is necessary for the analysis conducted in the areas in space.

A precise and efficient method of determining the area of agricultural parcels leads to better reporting and encourages farmers to apply for EU subventions for agricultural production. Polish farmers share the opinion that the best and fastest measurement of the area is carried out using hand GPS receiver. These devices are hardly available and difficult to operate, therefore farmers are unable to conduct the measurements themselves and commission this task to external institutions. An alternative may be the application of information and communication technologies used on farms for determining the dimension and range of subsidized crops [Sikora, 2010].

The farm where the research was conducted is situated in the Łódzkie voivodeship. Beside the agri-food industry agriculture is the main specialization in that region. The area is characterized by worse than average in Poland natural conditions for its development. Moreover, small and very small farms of low productivity are dominant in this area. Most (almost 85%) of the registered plots of the farm is situated in the Nowy Kawęczyn commune, whereas the rest 5.44 ha in the Głuchów commune. The Nowy Kawęczyn commune is the typical agricultural commune where the majority of farmers represent the traditional approach to agriculture. The largest portion of the area are arable lands.

RESULTS AND DISCUSSION

Investigations focused on a farm in central Poland, in the district of Skierniewice. It is a private farm run by a framer and his wife (Fig. 2). Mainly plant production is conducted on the farm, but the farmer keeps also some dairy cattle (8 heads) and breeds pigs in three cycles per 100 heads. According to the land and buildings register data the total area of the farmer's registered parcels is 33.51 ha of which 29.13 ha are arable lands. Moreover, the owners of the studied farm rent 14 ha, but this area was not considered in the studies because the farmer does not receive direct payments to it.

Each year the farm owner submits to the Agency for Restructuring and Modernization of Agriculture an application for complementary payment to feed crops area cultivated on permanent grasslands and for financial assistance for farming in mountain areas and other less favoured areas (LFA). The area of feeds crops changes every year, whereas the area eligible for LFA payments is stabile, i.e. 18.64 ha. The farmer grows mainly cereals which are largely sold to the local mill immediately after the harvest. The remaining part is processed

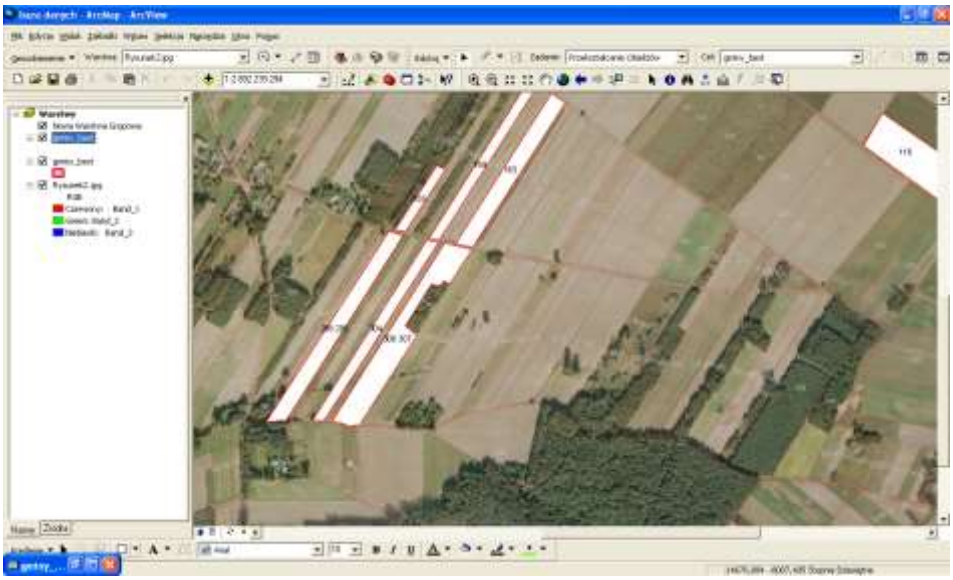
and used as the animal feed. The guided interview with the farmer supplied necessary information about the activity conducted on the registered parcels, which served as the attributes in the spatial database.

The areas of agricultural parcels on which the farmer runs production were delineated using vectorization of the orthophotomap and a hand GPS receiver.

The results will be used by the farmer in the preparation of the next-year application for direct payments in which the cropping area must be stated. The differences between the measurement obtained during vectorization and the measurement by hand GPS receiver for all parcels are within 2 ares and do not exceed the permissible error of the area measurement.

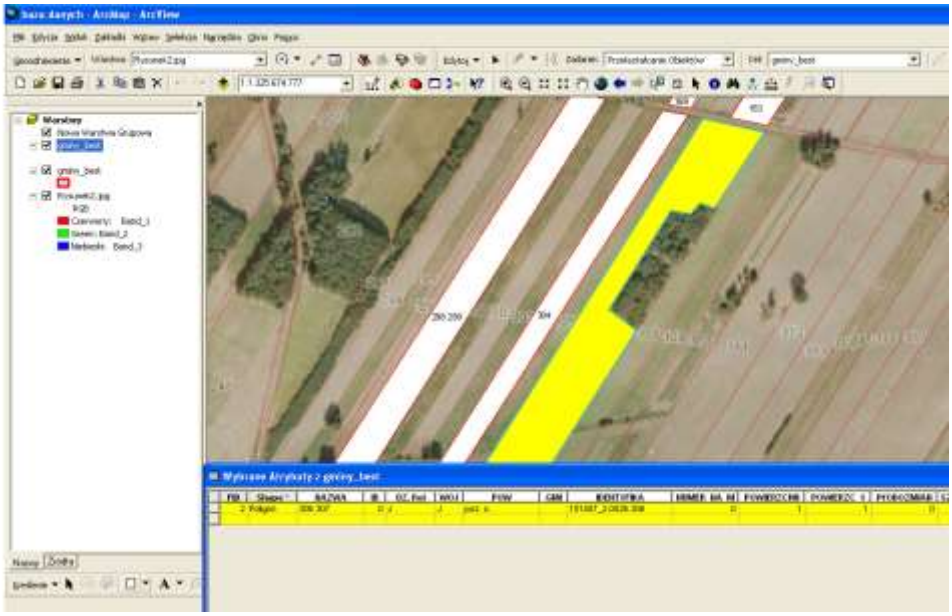
A fragment of the range of agricultural parcels spatial distribution is shown in Fig. 2 with highlighted attributes. The number of registered parcel was highlighted as the object label. In the realized spatial database this number is the identification code (name of object) on the basis of which other attributes describing a given spatial object (agricultural parcel) may be joined. In this case the image is impossible to edit and presents the area of the commune range in geographical arrangement. On the other hand, polygons as thematic layers of agricultural parcels are fully editable in the range of the added attributes, outline and shape.

At this stage of research information about the activity conducted on the basis of the identifier (the number of registered parcel) collected during the guided interviews was linked with the spatial data (spatial objects). The image resulting from the link is shown in Figs. 2 and 3. The combined data will serve the agri-producer for graphic preparation of the application.



Source: own studies 2011

Figure 2. Expanse of registered parcels of the studied farm introduced to the ArcView environment



Source: own studies 2011

Figure 3. Visualization of agricultural parcel parameters with marked polygon on background map

Raster background, which was prepared in the 1:4000 scale, covers the area of the studied farm objects' expanse and is in the scale of the graphic attachments which the farmer sends to ARMA. In the adopted scale the area covers 1544x558 mm, and using this format in an analogous form would be difficult. Using the scale-freedom feature of GIS systems analysis of this area is conducted on the screen of a computer. All parcels of the farm are located in this area. The image describing the area characteristics was introduced into the coordinate system compatible with the system of trace records by the hand GPS receiver. The system to which the raster background was adjusted is the commonly used WGS84 system. The orthophotomaps which the farmer receives from ARMA are in the 1992 system (it is the reference system most commonly used for the areas of Poland). In the ArcView environment the cross-over between these two systems is automatic. The prepared polygonal thematic layer showing the parcel arrangement has the options of adding and modification of attributes in the *.dbf files.

Source: Own study 2011

Figure 4. Graphic attachment to an application for direct payments made in ArcView on the basis of spatial database

Each of the polygons on the parcel layer was given defined attributes. In the basis of the ascribed attributes it is possible to identify agricultural parcels on the farm. For the ARMA needs, the attributes identifying agricultural parcels are the area and the crop rotation. Moreover, the Agency requires:

– the boundary of agricultural parcel marked in red,

– the parcel identifier, e.g. A, A_1.

The prepared spatial database makes possible the automatic exploration of geographic image of agricultural parcels required by ARMA as a graphic attachment to the application for direct payments. It was shown in Fig. 4. Since 2011 the agri-producer may apply for an internet account in ARMA. Those who have such account may submit the application on-line using the password generated by the governing body. The realized spatial database makes possible the automatic acquisition of the graphic attachment to the application for direct payment on the basis of attribute data in electronic form and in the proper scale.

CONCLUSIONS

The GIS system environment may be to certain degree applied to archiving and visualizing data referring to agricultural production conducted on farm agricultural parcels.

The prepared database allows for automatic generation of the graphic attachment to the application for direct payments. However, the attribute data describing the production conducted by the farmer in a given year must be first introduced to the database.

On the basis of the archived attribute data it is possible to conduct an analysis connected with fertilization, yields and plant protection on individual agricultural parcels. The resulting information may be automatically tabularized and, on this basis, reporting for other subventions, which require knowledge about crop rotation and fertilization, may be done.

The database realized in Spatial Information System may be one of the ways to store data about agricultural production, required by the assistance programs.

Archiving of attributes in the Spatial Information System enables to make changes in the spatial geometry of agricultural parcels and attributes, which causes that the database user will avoid laborious drawing while preparing the attachments for direct payment applications.

The agricultural production space may be easily and efficiently managed on the basis of information in the database connected with space. It is possible to conduct analyses of yielding, fertilization and plant protection. The archived

information may be supplemented depending on the agri-producer requirements, e.g., the dates of performed cultivation measures.

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