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Dan-Adrian Chelaru and Adrian Ursu and Florin-Constantin
Mihai

”Alexandru Ioan Cuza” University, Department of Geography

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THE ANALYSIS OF AGRICULTURAL LANDSCAPE CHANGE USING GIS TECHNIQUES. CASE STUDY: PODOLENI, ROMANIA

Dan-Adrian CHELARU¹, Adrian URSU¹, Florin Constantin MIHAI¹

E-mail: chelarudanadrian@yahoo.com

Abstract

The increasingly tensions rising between society's need for resources and space on the one hand, and the capacity of the land to support these needs on the other hand lead to unprecedented changes in landscape configuration, and hence, to the environment.

This paper analyzes changes in the agricultural landscape of Podoleni, Neamt County, Romania, in spatio - temporal terms, as a result of the modernization of the ground processing techniques, types of crops, and the degree of fragmentation of land parcels. The study was conducted using Geographical Information Systems techniques, the main materials used in the analysis are topographic maps from different representative periods, and the 2006 orthophotomaps. Application of GIS techniques at a detailed scale (1:5000) allows an efficient management of land use for local authorities.

The results highlight the optimal management of agricultural land so as to maintain a balance between their basic function (food needs) and preservation of nature (landscape, environment).

Key words: land use change, agricultural landscape, GIS, spatio-temporal analysis, Podoleni

The post-socialist countries underwent dramatic changes in agricultural land ownership and production system (Vidican G, 2009). In agriculture, the most dramatic form of restructuring is the break-up of state and collective farms into individual farms (Rizov M., et al, 2001). After 1989, the agrarian reform based on the principle of restitution that had an immediate effect on the land's fragmentation and on/as the decreasing the agriculture productivity.

Property rights to the land are constituted to each landowner who was forced to join a collective farm. Most of these people have died and their rights were transferred to a large number of heirs, who have to apportion the land between them (Rusu M. et al, 2000). This excessive fragmentation lead to major changes in the agriculture landscape. The economic difficulties caused by the transition period and also the faulty management of the agriculture infrastructure after 1989 determined the practice of the subsistence agriculture by the majority of the rural population. Land use patterns influence the long-term productivity of agro-ecosystems (Fraser E, Stringer L., 2009). Once Romania entered the EU, the farmers are encouraged to associate to have access to the financing resources.

MATERIAL AND METHOD

In order to describe the overall agricultural landscape structure changes over time GIS techniques were used through the professional software TNT Mips Microimages 7.2.

For a better analysis of the phenomenon have been used a number of statistical data obtained from the National Statistics Institute and the following cartographic materials: 1:10000 cadastral plan, 1986 edition, 1:5000 topographic plans, 1976 edition, 2006 ortophotomaps, and satellite images from Google Earth for guidance.

Because we took into account spatial and temporal dynamics of the agricultural landscape of Podoleni was necessary to analyze cartographic materials from different periods of time representative of the phenomenon studied. Thus, the cadastral plan was used for the land use map, to identify the types of crops cultivated in the past, and also the degree of parcel fragmentation resulted from the 18/1991 law enforcement. 1:5000 scale topographic maps allow a detailed analysis of the surface topography, by performing the digital elevation model(DEM). By combining the DEM with different vector layers made on the mentioned cartographic materials resulted a number of maps necessary for our analysis. Finally, the recent aerial images were used for representing the actual state of land use and the administrative agricultural structures, with direct implications on the landscape.

¹ University Alexandru Ioan Cuza of Iasi, Faculty of Geography and Geology

Statistical data were processed using Excel 2007. Also, for the final version of graphs and maps was used Corel Draw X4 graphics program.

Regarding the methods used is highlighted the cartographic method, but the results can be obtained only by combining it with the direct observation in the field, synthesis, and off course, comparison methods.

RESULTS AND DISCUSSIONS

Podoleni village is located in the southern extremity of Cracău - Bistrita depression on the left bank of the river Bistrita, on several terrace levels. Geographical conditions favor the practice of agriculture that can be competitive in terms of appropriate mechanization.

Field crop and livestock is the main occupation of the local population. Thus, agricultural land within the village is used in 90%.

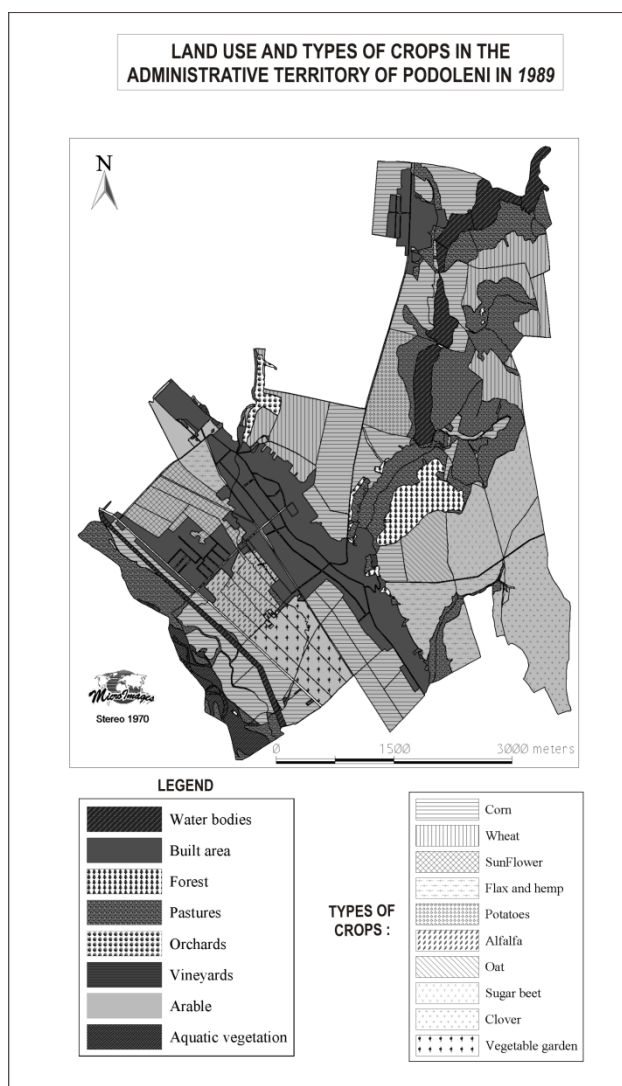


Figure 1 Land use map of Podoleni, 1989

Multi-temporal agricultural landscape change of Podoleni

The analysis was structured in 3 main stages, depending on the evolution of political and socio-economic factors. To capture the socio-economic driving factors of agricultural landscape change, many aspects need to be considered. (Zhang et al., 2004).

A. *In the communist period, before 1989*, the only form of agriculture organization was the agriculture cooperatives, where the peasants couldn't have any property right. On the other hand, there were some positive aspects regarding these agricultural cooperatives: agricultural land use was organised on large areas, the infrastructure and the technological level at that time provided efficient agricultural production.

B. The political, social and economic changes *after the events in December '89*, reflects also into the landscape. The main change that occurred in the next transition period was the land stock change, by passing from the cooperative-collectivist and state property to the private property. Regarding the soil's quality and implicitly the landscape's, the agrarian reform had only negative consequences. Thereby, the agriculture cooperatives were abolished and the peasant regained their land by their documents.

Due to the peasant's rudimentary land processing techniques and to the exaggerated demarcation that caused the prevailing of the small agriculture exploitation, the production level suffered serious repercussions. The parcel's fragmentation level was even bigger than the interwar period. Therefore, the peasants practiced a subsistence agriculture. The ex-SMA/ACS (agriculture car station) were privatized and abolished after that, because of some dues/debts to the state and because of the expensive fuel.

Also, the changes in the use of agriculture surfaces had visible effect on the landscape. There was a period when the crop surfaces diminished because of the land abandoning. The main causes were the maintenance's high prices, poor infrastructure, the lack of the production way, the relatively small production, the aged population and the uninterested new owners. Same thing happened to the vineyards and the orchard, that reduced their productivity because of the precarious maintenance. Therefore, these surfaces had been grubbed and arable lands, pastures and meadows took place.

C. In the administrative territory of Podoleni, since 1995 there is a tendency of farmers association, who wanted to practice intensive agriculture, possible only on large lands. Because of an old agricultural infrastructure and the lack of financial resources, few farmers were able to follow this model.

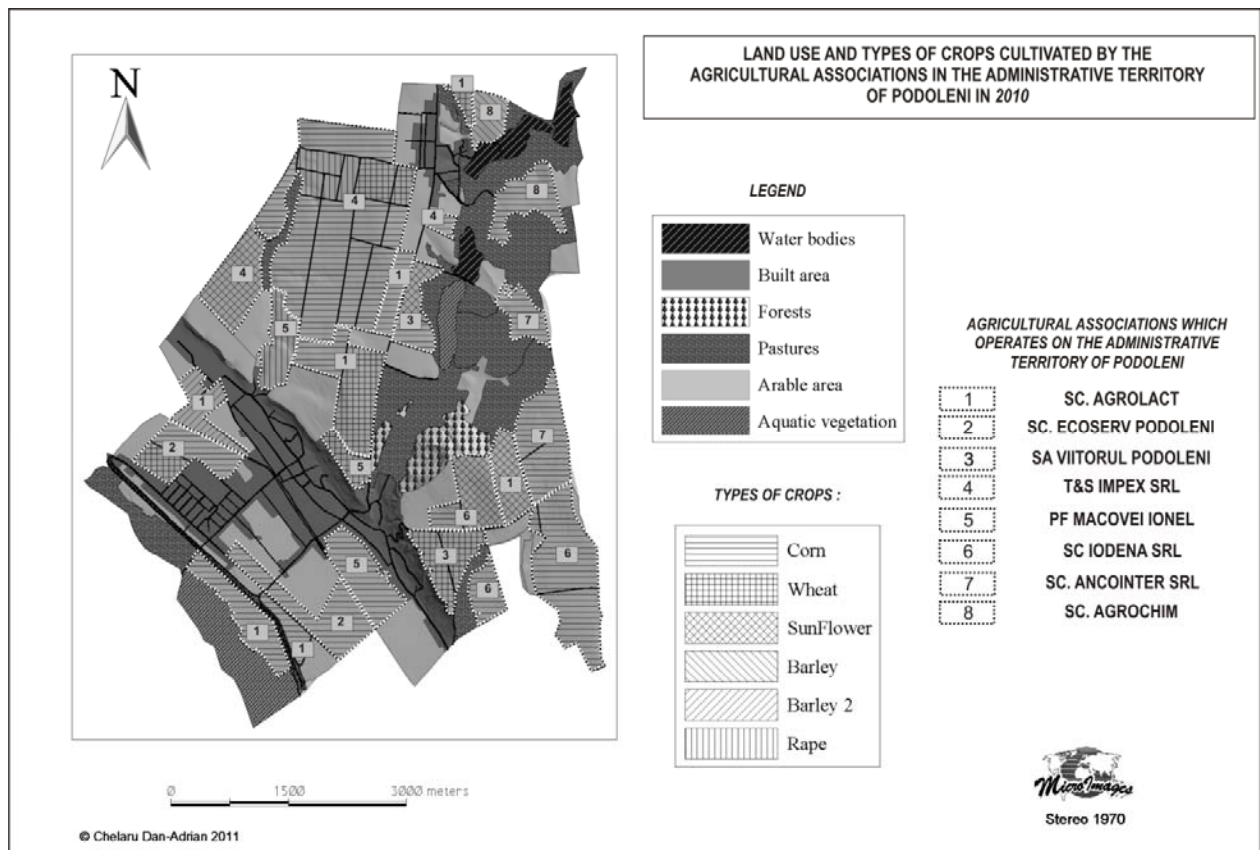


Figure 2 Land use map of Podoleni, 2010

Starting 2005, subsidies were been given (aproximately 60% of the acquisition cost) in order to get agriculture equipment, that helped to constitute an important agriculture infrastructure. The most advantageous agriculture organization form is the agriculture association with property rights. This model of agricultural organization complies with the requirements imposed by the European Union for the adhesion process in agriculture sector.

Regarding the types of crops in the Podoleni administrative territory, can be observed the transition of the agriculture to a cereal character; thus, the surfaced occupied by the textile plants, sugar beet or fodder had diminished.

Processing the data provided by the Hall of Podoleni, the main cultures practiced by agricultural associations are corn (518 ha), wheat (186) and sunflower (122 ha). In Podoleni, as in the rest of the country, the culture of rape increased over the traditional crops due to economic benefits. In the future this culture can be profitable for local associations, but requires an appropriate agricultural management especially on soil quality.

The analysis of the chart (fig. 3) shows a significant increase in arable land (743 ha), pastures (492 ha) and grassland (125). This growth is due to expansion of the commune administrative territory in the northwest side, territory taken from

the neighboring village Zănești. As a result of local administrative reorganization, and Podoleni gave in turn two parcels of land in favor of neighboring villages (Români - NE and Costișa - SE). These changes of the agricultural landscape can be noticed by the comparative analyse of the two maps (fig. 1, fig. 2).

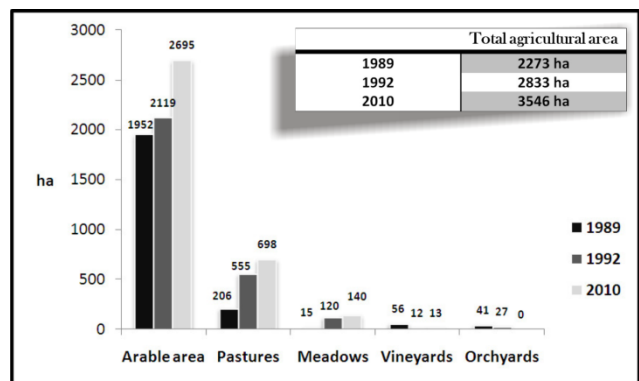


Figure 3 Agricultural land use (Data source: NSI)

Moreover, the inefficient management of the orchard led to their disappearance in the present, the 41 hectares in the communist period being converted into arable land. Also, forest areas have reduced their size as a result of uncontrolled deforestation.

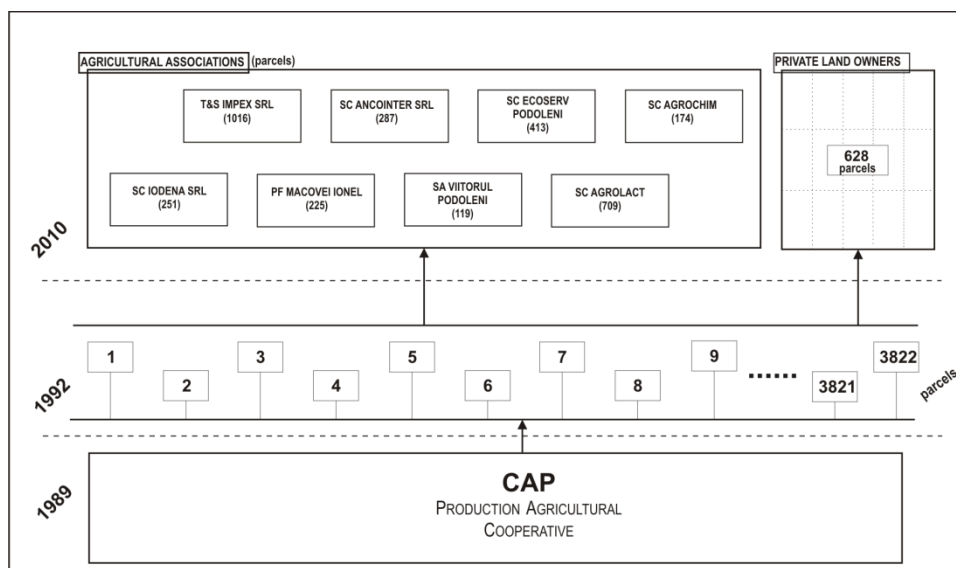


Figure 4 Historical management of agricultural land in Podoleni, Romania (Data source: Podoleni Hall)

As a member of the European Union Romania must implement the Common Agricultural Policy that focuses on the one hand on the economic aspect of agriculture and on the other hand on rural development. The purpose of this policy is to provide a sustainable agriculture at EU level. In Romania, agricultural productivity has decreased considerably due to excessive land fragmentation from 1989. The case study of Podoleni illustrates the same pattern at local level (fig. 4). SAPARD pre-adhesion period stimulated the local small farmers association to obtain the funds necessary for the renewal of the agricultural infrastructure. Road improvements and utilities in the last years lead to rural development and new investment opportunities.

CONCLUSIONS

Multi-temporal analysis using GIS techniques revealed major changes in agricultural landscape configuration of the Podoleni commune.

The excessive fragmentation of land has led to a subsistence agriculture. The increasing number of farmer association led to a parcel agglutination, providing the optimal management of agricultural landscape.

Practicing a sustainable agriculture may have a significant impact on the development of the local community.

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