

THE LAND USE ANALYSIS IN NICOLINA CATCHMENT'S AREA USING G.I.S TECHNIQUES

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ABSTRACT

Land use, as a part of the geo-economic system has important structural variations over a short period of time. The Nicolina hydrographic basin is intensely modified by the urban pressure of nearby city of Iași. This pressure has become more and more intense in the last decade as a result of growing constructed area towards the “green” margins of the city, due to a real exodus of the population in an environment less polluted. The analysis of the land use changes is made using the G.I.S techniques. The methodology consists in vectorising the land use structures from cartographic maps DTM (1:25000) and also by remote sensing on satellite images from year 2000 (LANDSAT ETM). We compared online the ANCPI aerial-photos by accessing the site www.ancpi.ro from our area of interest. In our classification we have been analyzing the polygon with a minimum of 100 m²; this limit was related to the resolution satellite images. Our final purpose is to evidence the major changes of land use after 1989 and to correlate this with geomorphological and anthropical factors. By that, we intend to show the real problems regarding land use in the Nicolina catchment's area caused principally by the growing of the urban area.

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1. INTRODUCTION

Land use as a consequence of the anthropic factor is essential to demographic and spatial growth of human society. The meeting point of natural and human structures is a joint result of general and individual interests. The variety of land use is a common expression of relief, climate, soil and human factors. Land use analysis became more popular once the satellites were launched to observe the surface of the Earth (first satellite launched on October 4th 1957). The first satellite built for the purpose of imaging Earth's surface (Explorer 6) was launched on 14th of August 1959 by the United States. At the base of spatial analysis on Earth lie the LANDSAT images. The European programme Corine Land Cover (CLC) started in 1990 and finalized with the European land use map. The project also included Romania. Further on, new editions of the maps appeared in 2000 and 2006. The project relies on a high level of generalization (minimum distinct surface/polygon of 25 ha). A study for Corine Land Cover nomenclature in Romania was realized by Ursu et. colab., 2006.

For the catchment area of the Nicolina River we used as a starting point the CLC map from 2000. Using the online images on ANCPI server a more detailed analysis was performed on minimum surfaces of 100 m².

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2. DATA

The Nicolina catchment area lies in the North-East of Romania and is included in the geographic unit of Moldavian Plateau. More precisely this area lies at the contact of the south part of the region known in the literature as the Moldavian Plain, *Băcăuanu V.* (1968), with the Central Moldavian Plateau. (fig.1)

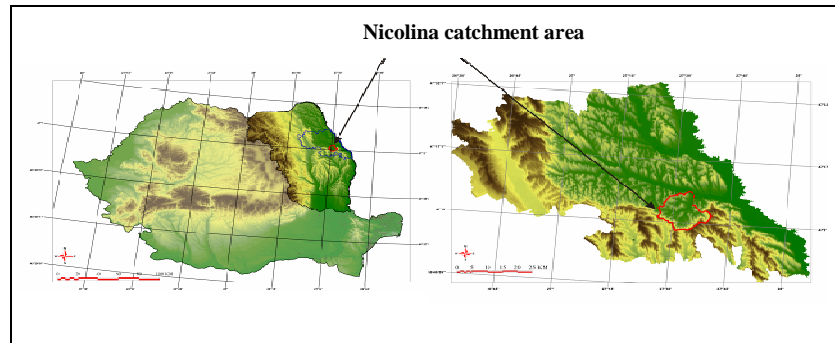


Fig. 1 The placement of the Nicolina catchment area

Our G.I.S project uses as support LANDSAT TM satellite images from the year 2000, some aerial photos taken from the spring of 2004 and also data acquired during our terrain expedition.

The data from the land use spatial analysis in the Nicolina catchment area were processed into the TNT Mips, which is G.I.S soft. The steps we have been following during our analysis were the editing of the elevation lines from topographic maps (1:25.000 DTM, 1986) into a vector layer. After data interpolation a (Digital Terrain Model) DTM of the region. Based on DTM several primary maps were obtained (slope, aspect, elevation), that were processed and classified.

The land use map is the result of identification of the structures with similar spectral reply followed by interpretation on the aerial photos.

The method we have been using consists in the on-screen vectorisation. The land use classified vector contains 14 classes. The criteria we followed were:

- for the urban constructed areas the minimum surface of 100 m². This class includes buildings, outbuildings and houses. For Iași city the level of generalization was increased because of a higher density of constructed structures than our scale of analysis.

- the communication network from the city boundaries and from the outside the city boundaries was totally extracted as polygons resulting area occupied by this class. We didn't classify the communication network after its quality and purpose.

- the agricultural complex class is specific for those agriculture areas too small to be self identified and includes small cultivated areas with vineyards, fruit trees but also gardens and pastures.

The data were also obtained using an extraction method which consisted in intersecting each class with the primary maps (slope, aspect, elevation) and updating raster histogram of the information. The data were later exported for processing and statistical analysis and we present them Table 1, 2, 3.

*The frequency of land use classes related to elevation***Table 1**

Land use (%)	Elevation classes (meters)											
	<50	50-75	75-100	100-125	125-150	150-175	175-200	200-225	225-250	250-300	300-350	>350
agriculture	0.0	3.4	25.6	35.7	25.1	9.6	0.5	0.0	0.2	0.0	0.0	0.0
agricultural complex	0.0	4.5	16.1	27.9	24.0	12.8	5.7	3.3	3.1	2.5	0.1	0.2
deforestations	0.0	16.4	17.9	32.6	18.1	5.2	3.6	3.7	1.5	0.2	0.0	1.0
constructions	14.3	29.8	21.2	13.2	12.7	6.0	1.5	0.5	0.4	0.4	0.0	0.0
roads	0.3	10.7	27.2	27.6	17.4	7.5	3.1	2.2	1.7	2.2	0.2	0.0
lakes	0.0	93.8	5.8	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
fruit trees	0.0	0.7	9.2	43.2	39.9	6.9	0.1	0.0	0.0	0.0	0.0	0.0
pastures	0.0	15.5	28.8	18.9	11.5	7.1	4.9	4.4	3.8	4.0	1.1	0.0
forests	0.1	2.3	8.1	10.9	12.8	8.0	8.8	8.9	8.8	15.0	10.4	5.8
vineyards	0.0	0.0	1.4	7.8	41.1	42.9	6.7	0.0	0.0	0.0	0.0	0.0

*The frequency of land use classes related to slope***Table 2**

Land use (%)	Elevation (degrees)							
	<2	2-5	5-10	10-15	15-20	20-30	>30	
agriculture	41.90	32.88	25.10	0.12	0.00	0.00	0.00	
agricultural complex	18.58	30.66	43.85	6.55	0.34	0.02	0.00	
deforestations	13.80	17.73	45.34	21.86	1.18	0.08	0.00	
constructions	47.43	29.24	20.07	3.08	0.17	0.01	0.00	
roads	31.22	27.54	33.57	7.05	0.56	0.05	0.00	
mineral extraction sites	26.32	8.33	28.33	15.00	8.51	13.51	0.00	
fruit trees	35.04	36.74	25.31	2.78	0.13	0.00	0.00	
pastures	25.79	16.60	41.44	14.47	1.54	0.15	0.00	
forests	10.30	15.36	45.62	23.35	4.44	0.91	0.03	
vineyards	16.20	31.23	48.37	4.15	0.06	0.00	0.00	

*The frequency of land use classes related to aspect***Table 3**

Land use (%)	Aspect								
	N	NE	E	SE	S	SV	V	NV	
agriculture	11.6	16.5	16.9	9.9	7.6	10.5	15.8	11.1	
agricultural complex	10.6	19.1	17.1	9.7	5.9	12.9	15.9	8.9	
deforestations	20.6	24.8	10.7	3.6	2.1	2.7	18.2	17.2	
constructions	5.8	19.4	24.2	15.8	10.6	10.5	8.1	5.5	
roads	11.5	16.2	18.9	11.6	7.9	9.4	14.7	9.9	
fruit trees	3.8	13.6	29.3	21.9	11.5	7.2	10.9	1.7	
pastures	14.5	18.1	16.0	7.3	5.3	9.0	17.3	12.5	
forests	15.5	15.5	9.4	3.6	2.5	9.2	26.0	18.3	
vineyards	12.1	11.8	16.7	20.6	4.8	14.1	12.0	7.8	

3. RESULTS

By analysing the informations we obtained during the statistical processing and photo interpretation of the satellite images and aerial photos we observed a spatial dynamic of the agricultural, construction and

Data statistical analysis and interpretation of the satellite images and aerial photos showed the growth of constructed areas on behalf of agricultural and natural-like (mostly pastures) areas. The dynamics of land use categories follow a pattern related to several parameters: altitude, slope gradient and exposition. Altitude related pattern (fig. 2) shows a decrease of agricultural land use with the increase of elevation. Agriculture land in the studied area is widely spread between the altitudes of 50 to 150 m because of its placement at the contact of 2 geographical subunits, the Moldavian Plain (elevation up to 250 m) and the Central Moldavian Plateau (elevation higher then 250 m). The altitudes lower then 50 m are included in the urban area of the city of Iași and its proximity and correspond with the junction between Nicolina and Bahlui Rivers. Between the altitudes of 50-175 m most of cuesta's scarps are affected by actual geomorphologic processes and function as pastures. The forests between 50-250 m are plantations for slope protection and those higher then 250 m belong to the natural vegetation of the Central Moldavian Plateau (*Carpinus* spp. and *Fagus* spp.)

In the city's proximity between the altitudes of 50-100 m the presence of man made reservoirs is due to economic (pisciculture) and protection reasons (to prevent flooding). Lately these reservoirs have been also largely used for leisure activities. The vineyards and orchards are specifically placed on highly degraded terrains making thus possible their use as agricultural lands. Most of them are situated in the contact area between the plain and plateau units.

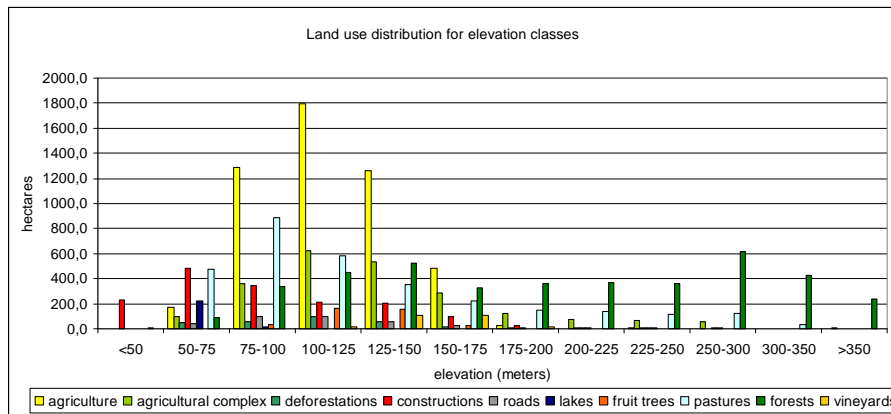


Fig. 2 Land use distribution for elevation classes

Fig. 3 shows the land use distribution for slope classes. The maximum slope gradient for agricultural land use and constructed areas is 10 degrees. Pastures and forests lie on slopes with higher gradients (over 15 degrees) that can not be proper for other uses.

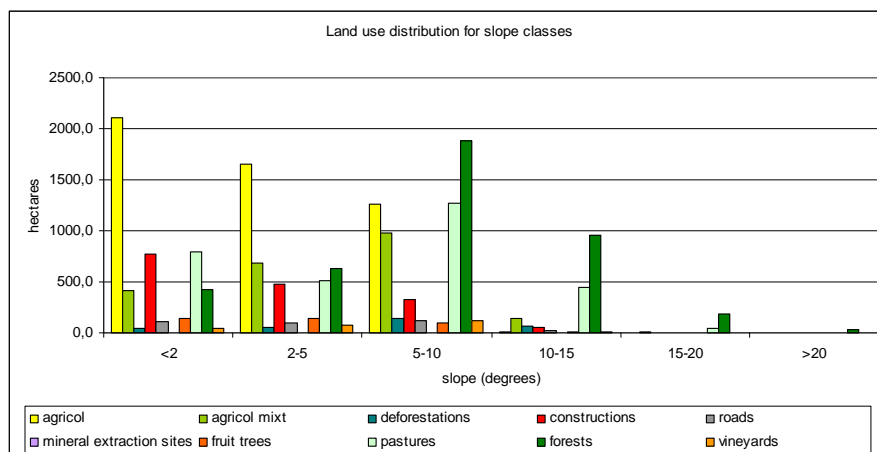


Fig. 3 Land use distribution for slope classes

Fig. 4 shows the correlation between land use and slope exposition. The distribution of most land use categories on the main slope expositions is similar to the general distribution of the same categories in the whole catchment's area. The situation is slightly different for forests which prefer V and NV expositions that are mostly cuesta's scarps formed by the regressive evolution of the Nicolina River.

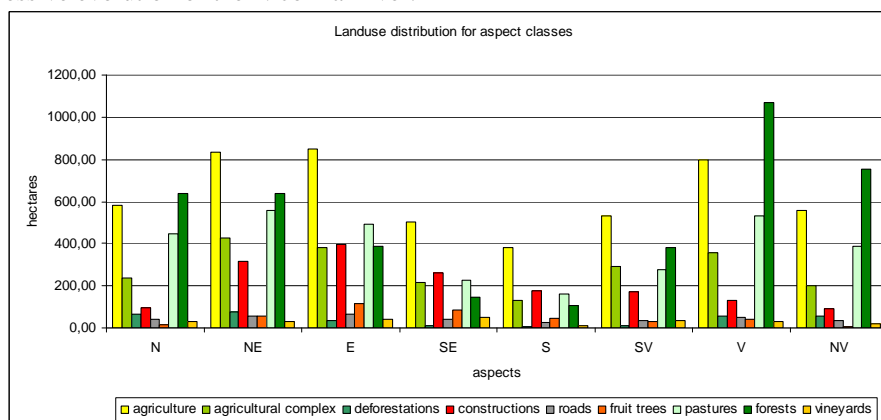


Fig. 4 Land use distribution for aspect classes

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Comparing the CLC methodology with the one used by us we can see the following aspects:

-the construction class that we used is included in the urban constructions, rural constructions and industrial constructions classes from CLC, because our analysis takes all the constructed areas into one class;

-in the CLC methodology includes two classes for the class we named agricultural complex. We separated the natural vegetation from agricultural complex with natural vegetation, and distributed those structures as pasture, forests and deforestations;

-because of a lower image resolution used in the CLC analyses the coniferous and mixed forests weren't separated into distinctive classes, as we did in our case by using terrain observations and aerial photography;

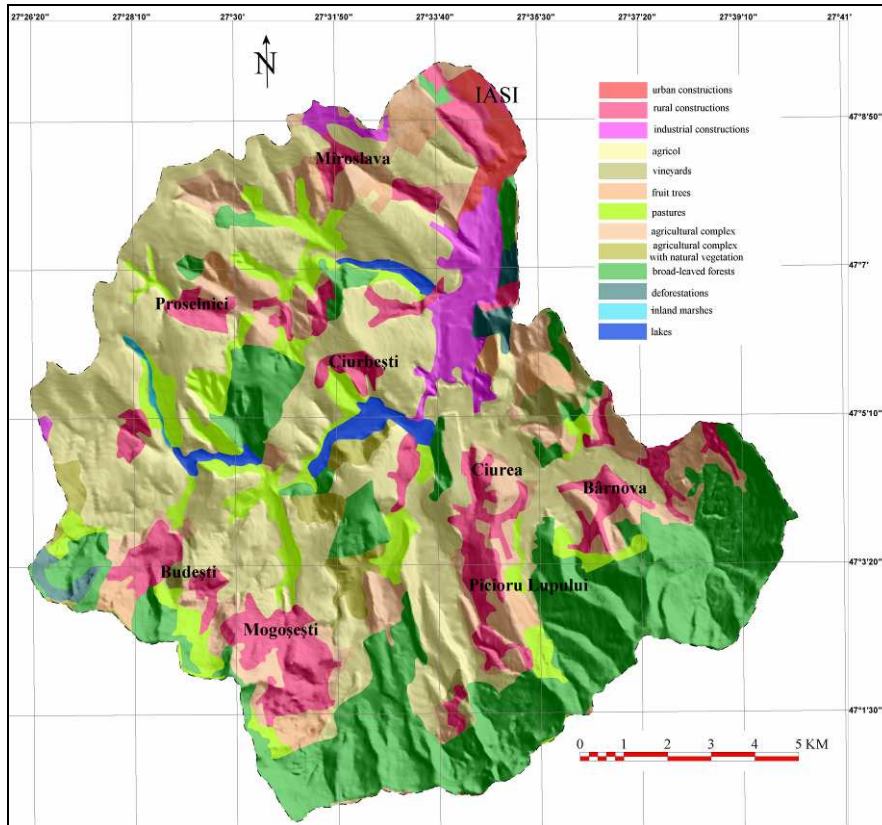


Fig. 5 Land use for Nicolina basin (CLC methodology, 1990)

We can observe from the map regarding the land use in 1990 (fig. 5) created using the CLC methodology that the structures were more compact, and more homogeny. The Nicolina catchment area was occupied in a large proportion by the agriculture areas (aprox.11130 ha which includes the agricultural complex, vineyards and fruit trees classes) and constructed areas witch includes urban constructions, rural constructions, and industrial constructions (aprox. 2837 ha), as a consequence to the communist doctrine. We also can notice a clear limit between the Iași urban boundaries and proximate rural areas.

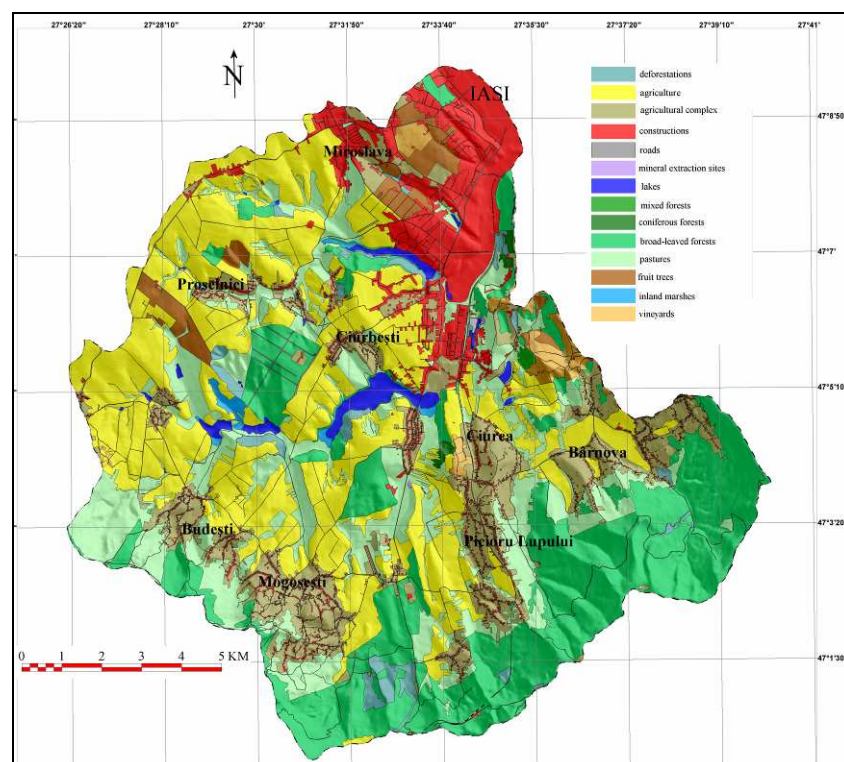


Fig. 6 Land use for Nicolina basin

The change from the planned communist regime to the one which began in 1990 brought some dramatic transformations on the land use. The agricultural areas due to the 18/1991, law suffered an intense fragmentation and change in the way of exploitation. The predominant classes in this case are the construction (1997 ha), agriculture (7910 ha), forest (4114 ha), and pastures (3077 ha).

In the analysis of the land use evolution between 1990 - 2008 we applied the merging of the classes high affected by human activity, like roads and mineral extraction sites and also the merging of the urban constructions, rural constructions and industrial constructions in one class.

In a period of 18 years the classes suffered several changes:

- the growing off the agricultural complex and pastures classes;
- the decrease of the agriculture forest, vineyard and fruit trees areas;

A particular case is the one represented by the construction class. As we can see the land use evolution chart (fig.7) indicates a decreasing trend which is different by the real situation. The improvements of the economic factor after 2000, rouse the immobile market causing a growth in the construction activity who led to the appearance of the metropolitan area of Iași. The anomaly of the chart is explainable to the fact that we applied a different methodology which takes into consideration a minimum surface of 100 m². The minimum surface area taken in consideration in CLC methodology is of 25 ha.

The coordinates of our area, which is situated at the contact of the nemoral with the forest steppe couldn't indicate a growing of the inland marshes class because off the low

quantities of precipitations. The reality is in stead different, due to a possible clogging of the lakes followed by the invasion of hygrophilous vegetation.

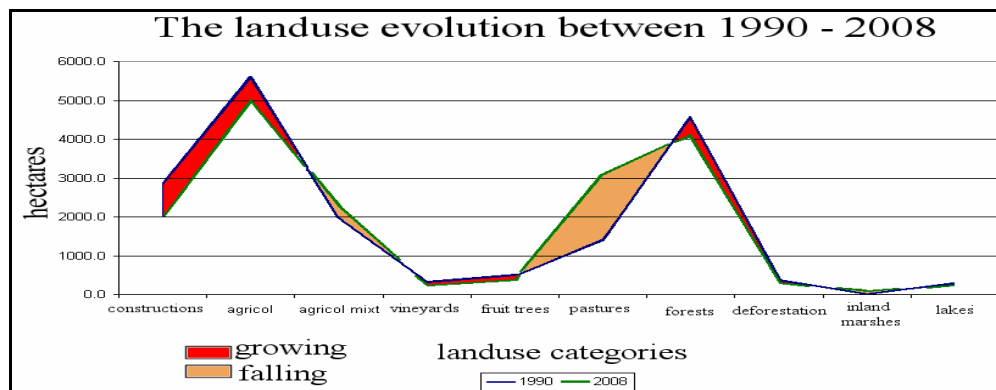


Fig. 7 The landuse evolution between 1990-2008

4. CONCLUSIONS

The use of G.I.S. methods for land use analysis brings more accurate and precise information. The CLC methodology has a more global character with a high level of generalization, not applicable for detailed analysis of relatively small areas like the Nicolina catchment area. The correlations identified in the present study are based on more detailed analysis as compared to CLC methodology. For small areas with diverse structures and complex functions there is a clear need of reducing the minimum surface considered to at least 100m², or even more.

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