

**GIS APPLICATIONS IN THE ANALYSIS OF  
TERRITORIAL EVOLUTION OF LOCALITIES**  
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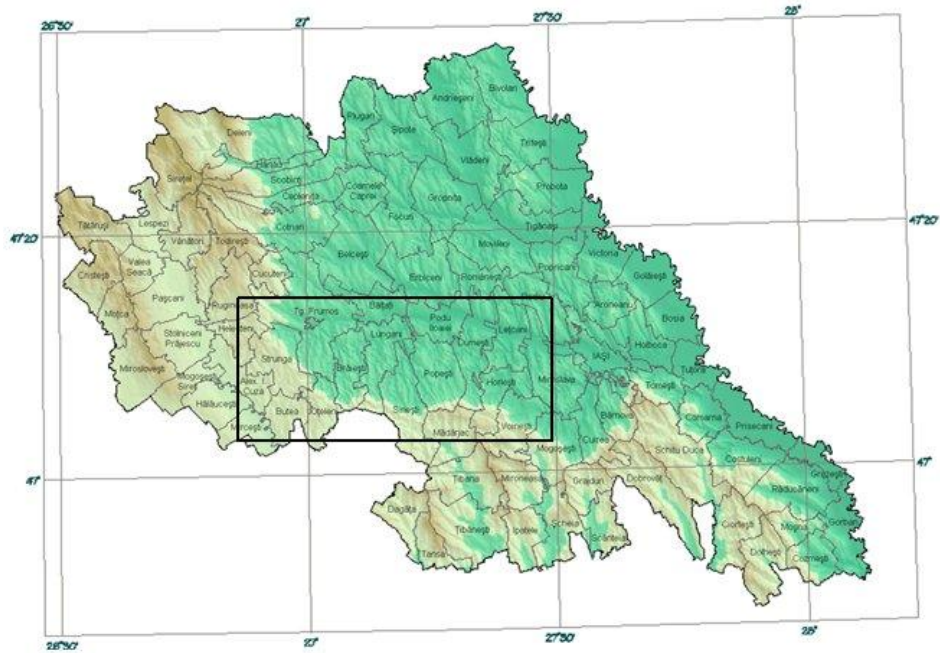
**Abstract** The present paper approaches the problem of township territorial evolution, analyzing it with the help of GIS techniques. In the analysis was taken a number of 42 villages situated in the south-western part of the Jijia's Hilly Plain, a region characterized by a relatively low favorability degree in what regards human settling. Analyzing four cartographic materials at very large scales, and benefiting from the georeferenced environment offered by the TNTMips 6.9 software, the general territorial evolution of the townships and its local particularities have been reconstructed.

**Keywords:** territorial evolution, GIS, Jijia's Hilly Plain

### **1. Introduction**

Besides the socio-demographic component, territorial evolution represents a fundamental aspect of localities' dynamics. The modern methods of managing spatial data based on the use of Geographical Information Systems allow the introduction and integrated analysis of numerous information characterized by a high exactness degree. The georeferencing of maps realized in different time periods and cartographic projections gives the possibility of analyzing data in different formats (mainly vector and raster), and at the same time ensures the basis of high precision diachronic analyses.

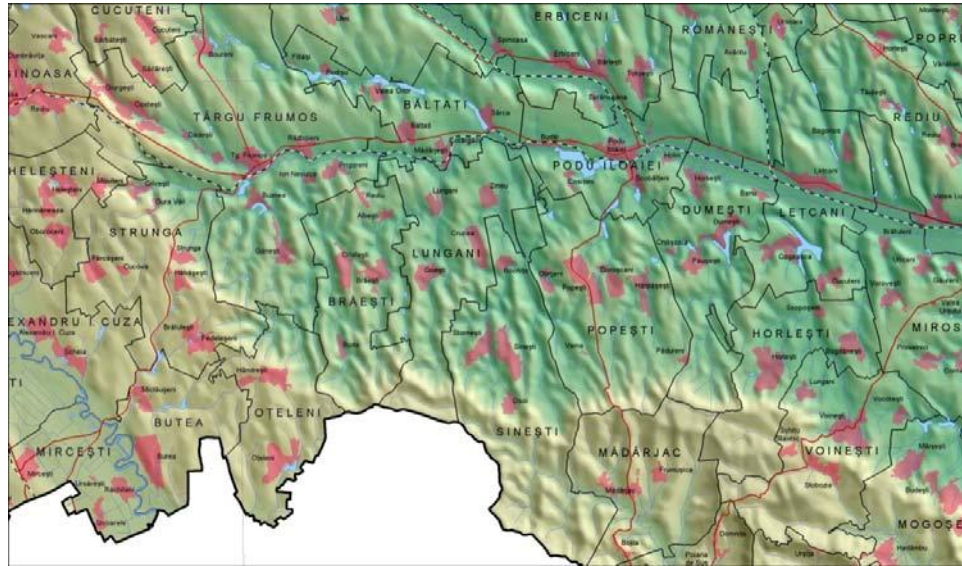
In the recent years' literature, the spatial evolution of localities has been largely viewed and analyzed mainly as plan (horizontal) dynamics. The integration in vector format of the localities' limits together with the products derived from the Digital Elevation Model in raster format (altitude, slope, exposition) also allow the three-dimensional analysis of localities. More, the geomorphometric data



**Figure 1. Iași County. Position of the study area ●**

characteristic to polygons offer important information related to land use categories on which have extended or receded the territories of localities. A series of analyses of this type have recently been published (Mărgărint et. al, 2010).

The applications have been continued for 42 villages situated in the south-western part of Jijia's Hilly Plain (Iași county), a region characterized by an interesting dynamics in the last centuries both as number and surface of the rural localities (fig. 1, 2). This dynamics is the result of the historical, demographic, socio-economical and political factors, which have led to the formation of a relatively uniform network of localities. Yet, from a geomorphological viewpoint, these localities haven't benefited from the best development conditions, because of the presence in high proportions of deluvial slopes, relief fragmentation and slope processes such as landslides.



**Figure 2. The network of localities from the south-western part of the Jijia's Hilly Plain.**

For this study region have been recognized several stages in the foundation and evolution of the localities, as follows:

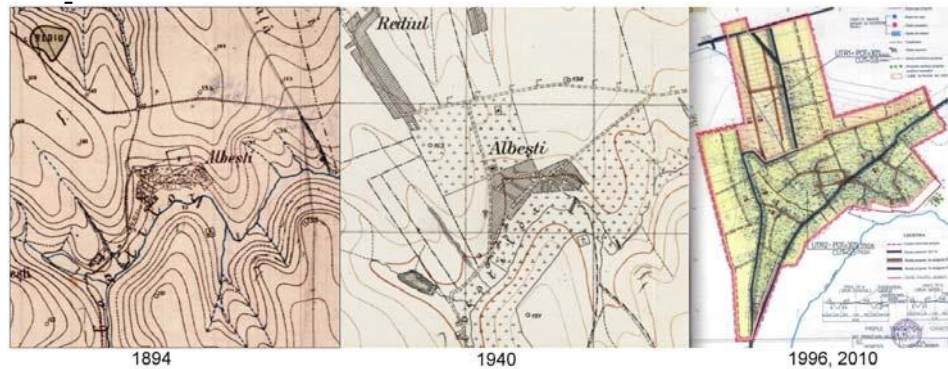
- a. *The pre-feudal stage*, when localities are identified archeologically. These were placed in sheltered places, with good micro-climatic and hydro-geological conditions, favored by the intense relief fragmentation;
- b. *The feudal stage*, in which the geomorphological factor is also well used. Numerous villages from this stage have disappeared during time. Thus, 61% of Iași County's localities (in the limits from 1948) existing between 1400 and 1457 and 58% of those mentioned between 1457 and 1504 have disappeared (Laetiția Lăzărescu, 1948).
- c. *The appropriation stage* (the second part of the 19<sup>th</sup> century and the first half of the 20<sup>th</sup>), in which have been issued several normative acts (1862, 1864, 1879, 1921 and 1945). As a

consequence, the localities' network has reached its present shape, registering a permanent and constant growth of the township surface.

## 2. Methodology

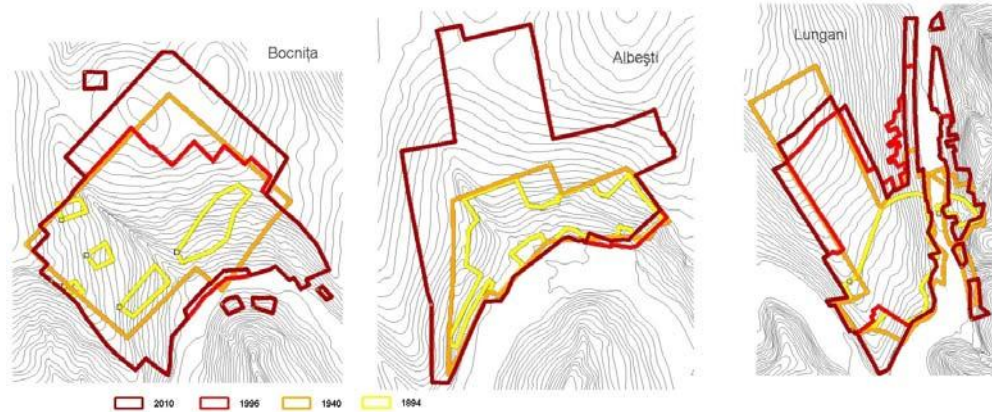
For the last of the mentioned periods, the characteristics of the evolution of the localities' surfaces have been analyzed on the basis of cartographic materials from distinct periods, at very large scales (fig. 3):

- the 1:50,000 scaled topographic map, projection Lambert, from 1894;
- the initial survey directory plans, scaled 1:20,000, projection Lambert, year 1940;
- topographic plans scaled 1:5000, Romanian stereographic projection 1970, with the limits of the localities existing during the last decade of the 20<sup>th</sup> century (1996, the year that most of the General Urban Plans of the administrative units from Iași county have been realized) and the proposals for the extensions of these limits, in fact the nowadays situation (year 2010).



**Figure 3. The cartographic materials used in drawing the limits of the localities. The village of Albești represented on the maps from 1894, 1940 and on the General Urban Plan of Brăiești township (1996).**

These materials have been scanned, imported, georeferenced and analyzed with the help of the TNTMips 6.9 software. The georeferencing of the maps from 1894 and 1940 was conducted using correspondence points from the 1:5000 scaled



**Figure 4. The limits of Bocnița, Albești and Lungani villages drawn from topographic maps editions 1894, 1940 and from the General Urban Plan, edition 1996.**

topographic plans (1984), the values of residual errors entering acceptable limits (lower than 20 meters). In each map's and locality's case has been drawn a polygonal file representing the perimeters of the localities (fig. 4). Later the statistical database was realized, including the files extracted from the DEM by digitizing the contour curves, equidistance 2.5 meters from the 1:5000 scaled topographic plans.

For validating the results of polygon-drawing the limits of the localities, have been conducted correlations with the number of inhabitants of each village, registered in the population censuses from 1890, 1941, 1992 and 2002<sup>2</sup> (table 1, fig. 5). These correlations indicate strong relations between population number and the surface of the localities, the smallest value of  $r^2$  being registered in the case of the initial survey plans edition 1940

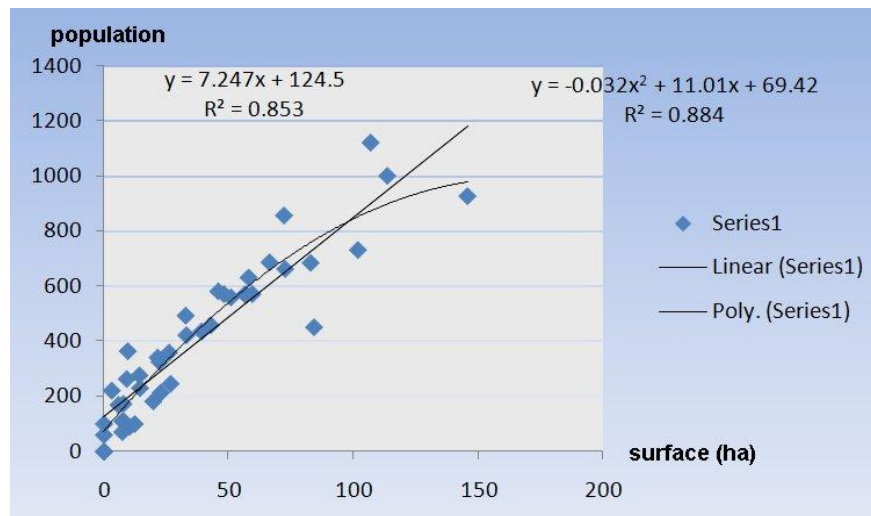
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<sup>2</sup> Population data at the village level available through the amiability of prof. I. Muntele

(0.770 for the 1<sup>st</sup> order polynomial regression and 0.779 for the second degree one).

**Table 1.  $r^2$  correlation indices (I and II degree polynomial regressions) between locality surface and number of inhabitants for the analyzed periods.**

	$r^2$			
	1894	1940	1996	2010
1 <sup>st</sup> order	<b>0.853</b>	<b>0.770</b>	<b>0.838</b>	<b>0.864</b>
2 <sup>nd</sup> order	<b>0.884</b>	<b>0.779</b>	<b>0.843</b>	<b>0.865</b>



**Figure 5. Polynomial regressions of the 1<sup>st</sup> and 2<sup>nd</sup> order for the values of the population and locality surface in 1894.**

### 3. Results

In what regards the evolution of the localities' surfaces from 1894 up to the present date, one can notice a constant territorial extension, in direct connection to the increase in the number of inhabitants (table 2), as well as a relatively uniform increase in the case of the cumulated localities' surface, yet with higher values.

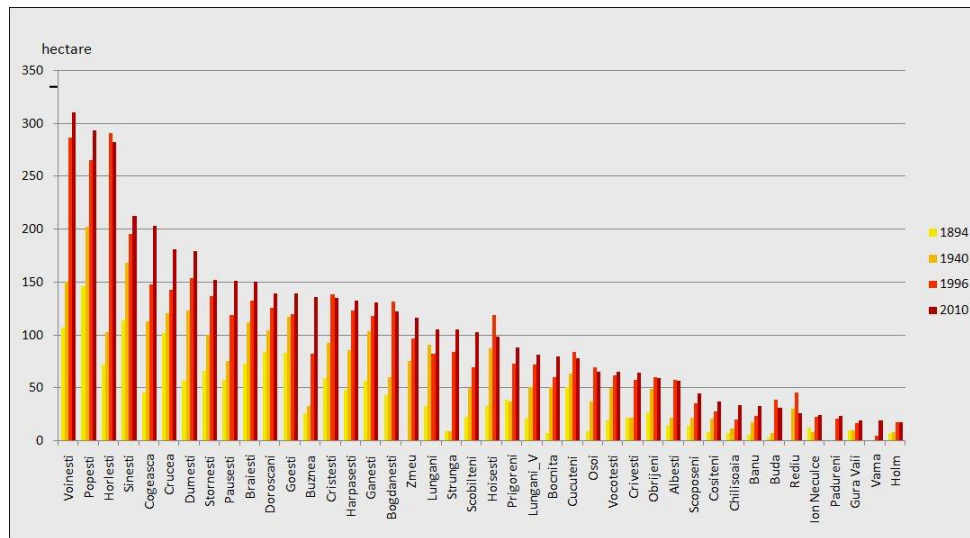
**Table 2. Absolute and relative cumulative values (in relation to the last analyzed period) of the localities' surfaces (from the maps' editions 1894, 1940, 1996 and 2010) and of the population number (according to the population censuses from 1890, 1941, 1992 and 2002).**

	1894 (1890)		1940 (1941)		1996 (1992)		2010 (2002)	
	total	% from 2010 (2002)	total	% from 2010 (2002)	total	% from 2010 (2002)	total	% from 2010 (2002)
Surface (ha)	1621.11	34.48 (39 sate)	2700.34	57.64 (41 sate)	4035.89	89.52	4530.93	100.00
Population (inh.)	16,978	46.18	29,357	79.86	34,309	93.33	36,762	100.00

The mean value of the surfaces has increased from 42.66 ha (1894) up to 67.51 ha (1940), then to 96.09 ha (1996), reaching in present 107.86 ha. With few exceptions, for each locality the tendency has been one of increase (fig. 6).

From this general law of locality's surface increase can be locally noticed some decreases in the surfaces of some villages, for each of the surveyed periods:

- 1996-1940: villages Ion Neculce and Prigoreni, decreases that can be explained by surveying errors of constructed surfaces, mainly in the case of the 1940 maps;
- 1940-1996: Lungani village, consequence of the extension of the arable terrains in the disadvantage of the areas initially destined for living (phenomenon specific to the communist period);
- 1996-present day: Albești, Reditu, Buda, Osoi, Obrijeni, Hoișești, Horlești, Bogdănești and Cucuteni villages, mainly as a consequence of the elimination from the localities' surfaces of the areas with vineyards and orchards, and partly of those susceptible to landslides and floods.



**Figure 6. Dynamics of the localities' surfaces.**

The specific of the evolution of the localities' surfaces can also be evidenced for each locality from the analysis of the percentages of surfaces from different periods in relation to the present situation (table 3). Thus it can be seen that the villages that registered the most accentuated surface increases – Strunga, Buznea, Buda, Osoi, Bocnița, Banu, each with percentages of under 20% a century ago in comparison to the present situation (including villages that have occurred during the analyzed period – Reditu, Vama and Pădureni), are most of them of small dimensions, recent, or that have benefited of good local development conditions in the 20<sup>th</sup> century (Strunga). On the other side, the villages with moderate increases in the analyzed period are old, generally of large dimensions: Sinești, Goești, Doroșcani, Popești, Brăiești, but also of medium dimensions (Gura Văii, Cucuteni, Ion Neculce). In this last category enters an isolated case, that of the village Crucea, which has been from the beginning (1879) “projected” as a large locality.

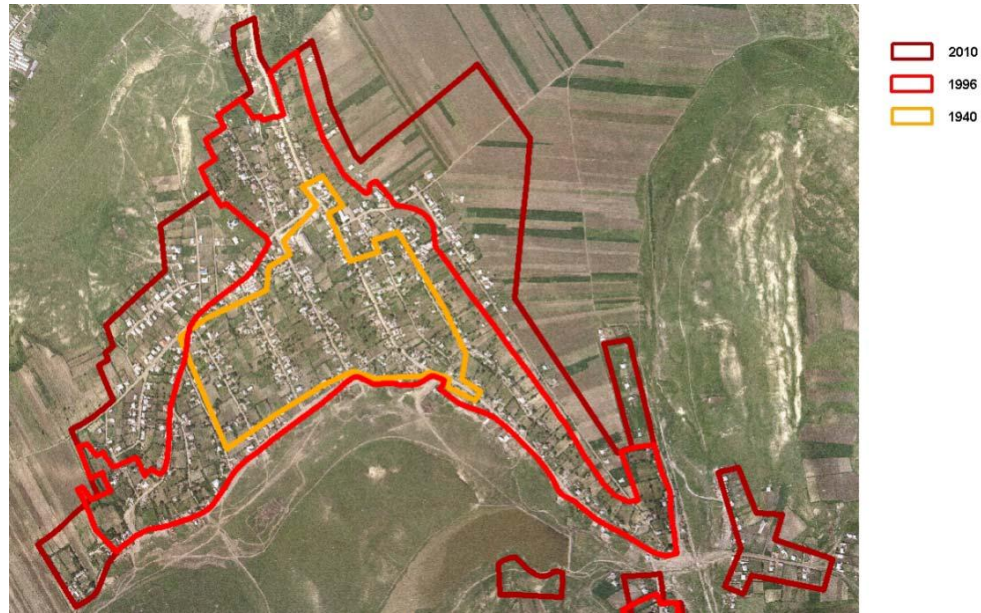


**Table 3. The percentages of the localities' surfaces in 1894, 1940 and 1996 in comparison to the present situation (100%).**

Nr	Village	1894	1940	1996	Nr	Village	1894	1940	1996
1.	Strunga	9.1	9.1	80.4	22.	Scobâlțeni	22.2	48.3	67.9
2.	Gura Văii	56.0	52.9	89.3	23.	Holm	42.7	47.3	99.6
3.	Crivești	34.7	34.7	89.9	24.	Popești	49.8	68.9	90.6
4.	Buznea	19.2	24.3	60.9	25.	Obrijeni	44.8	82.4	101.2
5.	Gănești	43.6	79.0	89.9	26.	Doroșceni	60.6	75.4	90.6
6.	Ion Neculce	50.2	33.6	93.4	27.	Hărpășești	36.2	64.4	92.5
7.	Prigoreni	44.2	42.4	82.4	28.	Vama	-	-	24.9
8.	Brăiești	48.4	74.5	88.1	29.	Pădureni	-	-	91.5
9.	Cristești	44.1	68.7	102.2	30.	Dumești	31.5	68.5	85.6
10.	Albești	24.9	38.4	101.7	31.	Păușești	38.5	50.1	78.6
11.	Rediu	-	115.5	171.4	32.	Chilișoiaia	22.0	35.7	59.7
12.	Buda	9.8	23.1	124.9	33.	Hoișești	33.2	88.1	120.5
13.	Lungani	31.4	86.2	78.4	34.	Banu	17.7	53.7	73.4
14.	Goești	59.7	84.5	86.1	35.	Horlești	25.6	36.5	103.1
15.	Crucea	56.4	67.0	78.8	36.	Bogdănești	35.0	48.8	106.9
16.	Zmeu	-	64.8	83.6	37.	Scopoșeni	32.1	49.7	78.7
17.	Sinești	53.7	79.3	92.1	38.	Cogeașca	22.6	55.5	72.6
18.	Stornești	43.7	66.0	89.9	39.	Cucuteni	65.5	81.9	107.6
19.	Osoi	13.2	54.2	101.0	40.	Voinești	34.6	48.4	92.6
20.	Bocnița	9.24	63.8	75.1	41.	Lungani V	26.4	62.1	88.3
21.	Cosițeni	21.9	57.7	75.9	42.	Vocotești	30.2	76,0	94.4

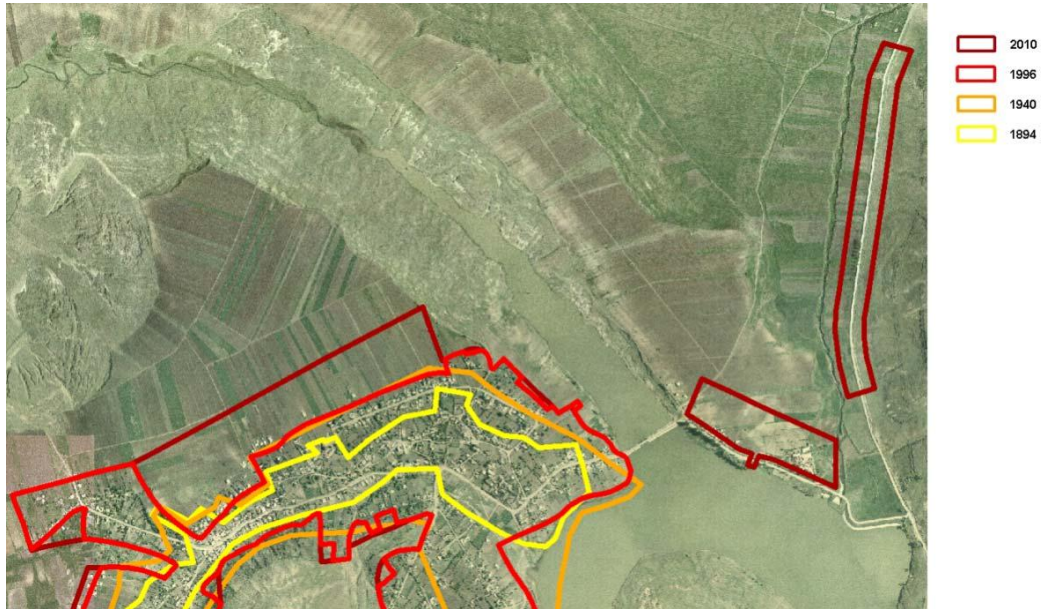
Quite interesting is also the dynamics of the localities' surfaces during the last period, respectively the "retouches" realized with the occasion of the

General Urban Plans' implementation in the last decade of the past century. The highest variations, both positive and negative, are characteristic only to villages of small dimensions. Still a few larger villages (of over 100 ha) catch our glimpse, registering surface increases of over 20%: Buznea, Lungani, Crucea, Bocnița, Scobâlțeni, Păușești and Cogeasca. These increases are weakly correlated with the increase in the number of inhabitants, taking place through the inclusion in the localities' surfaces of settlements outside the village. This is also the case of the localities close to the Bahlui valley, which present a higher development potential (fig. 7).



**Figure 7. The territorial evolution of Buznea village over-imposed on the 2006 orto-rectified aerial image.**

In some cases the Urban Plans have anticipated the extension of the localities' surfaces along the communication networks, situation visible in fig. 8.



**Figure 8. Territorial evolution of Cogeasca village (over-imposed on 2006 orto-rectified aerial images).**

In what regards altitude, for the analyzed period can be witnesses a “vertical” extension in the majority of cases of locality surfaces. A characteristic aspect is the fact that the mean altitudes have increased, demonstrating the tendency of localities to extend on surfaces at the upper parts of the slopes, as well as on interfluves. There are also numerous perimeters of new extensions on slopes with high declivities, situation which does not take into account the minimum building requirements.

#### **4. Conclusions**

The management of cartographic materials in georeferenced environments offered by Geographical Information Systems permit for quite precise retracing of the evolution of the geosystemic components, mainly of those that can be identified and mapped. The present study evidenced the fact that the surfaces of the 42 villages taken into analysis have registered an obvious dynamics during the last century, situation highly correlated with the increase in the number of inhabitants. Along the general ascending trend of

the localities' surfaces, have been witnessed negative deviations, related to a series of local demographic, political and administrative factors. It can also be seen that the geomorphological factor does not offer the best conditions for inhabiting, the study region having a high degree of landslide susceptibility. From this motive, the authors consider that in the future planning of this territory, the geomorphological parameters will represent limitative or favorability criteria.

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