

# USING GIS IN ASSESSING THE TRENDS IN THE NUMBER OF PEOPLE IN MIDDLE AND UPPER BASIN OF THE RIVER BEGA

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**Abstract:** *The number of inhabitants and their distribution in a given area varies within very large limits of tolerance, both in time and space, regardless of geographic region considered. The natural and anthropogenic frame of the area studied in this paper, namely the upper and middle basin of the river Bega, was described on the basis of existing scientific literature, supplemented by produce maps to work with, such as digital elevation model generated with using Global Mapper software, model used to delimitate the analyzed area; the map of communal territories included in the investigated area was prepared by extracting them from the administrative-territorial map of Timis county, overall population density map and the map of population density developments, compiled from data of population censuses in each communal area, obtained by processing using GIS software. The purpose of this study is to highlight trends in the evolution of the population and to identify areas at risk of depopulation, which means, on the one hand knowledge of the number of inhabitants and for variations in this indicator, on the other hand density analysis population synthetic indicator used to highlight differences in the land surfaces occupied by humans. The upper and middle basin of the river Bega is characterized by a variety of natural and socio-economic conditions, resulting in major differences in the evolution of the number of inhabitants and their spatial distribution. In the period considered (1880 - 2011), the most populous census occurred in 1910, since then a definitely downward trend in this indicator can be observed, until the current period, in some cases "losses " were very large (village Bara, Balinț, Ohaba Lungă, etc). The downward trend in the number of inhabitants has direct implications on the overall density of the population, over time, this indicator registered a continued reduction in most cases and time periods considered. Estimates on future population numbers are difficult to achieve because some variables can not be predicted or quantified, such as political decisions, migrations and general demographic balance values.*

**Key-words:** assessment, population density, depopulation

## 1. Introduction

The number of inhabitants and their distribution in a given area varies within very large limits of tolerance, both in time and space, regardless of geographic region considered. The evolution of the number of inhabitants and therefore the so obvious disparities that occur in the territorial distribution of the population is the result of the action and interaction of several groups of factors whose influence may have directly or indirectly a favorable or restrictive character (Vert, 2000). Among these factors are: physical-geographical factors, such as geology (lithology, structure, underground resources), topography (elevation, massive, slope), climatic

conditions (temperature, precipitation, winds, radiation pressure), the characteristics and potential hydrographic system (quantity and quality of water resources, their availability); socio-economic factors (historical, migration, development opportunities, ensuring comfort level desired, etc.), economic factors (urban amenities, transport networks, employment, etc), demographic factors (the way in which the demographic indicators behave, etc.) or political (decision on that territory, political stability / instability, etc.). Thus, the manifestation and intensity of each of the above factors dictate trends in the evolution of the number of inhabitants and how people adapt to the

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conditions imposed by geographic area. Also, due to the different ways of action and interaction of these factors, it is difficult issuing patterns with a high precision on population dynamics in space and time. Number of inhabitants varies in space and time, being influenced by many factors, natural, socio - economical or political.

## 2. Materials and methods:

For this study we used the following materials:

- Administrative-territorial map of Timis County
- Statistical data collected from the Timis's Statistics Office/Timis County Office of Databases Management
- Statistics taken from Timis County Council
- population censuses in the period 1880 – 2011

The natural and anthropogenic frame of the area studied in this paper, namely the upper and middle basin of the river Bega, was described on the basis of existing scientific literature, supplemented by produce maps to work with, such as digital elevation model generated with using Global Mapper software, model used to delimitate the analyzed area; the map of communal territories included in the investigated area was prepared by extracting them from the administrative-territorial map of Timis county, overall population density map and the map of population density developments, compiled from data of population censuses in each communal area, obtained by processing using GIS software. Based on demographic data processed in ArcGIS 10.0 we present the graphical evolution of the number of people on the communal territory and subsequently on the region analyzed. We also compared the number of people at the beginning of the interval taken into account against the one of 2011, being presented graphical "differences" of the population.

## 3. Results and discussions

Since the subject of this paper is a hydrographic basin, it's delineation has been done on the watershed, with the exception of

western and south-western boundary, which follows an administrative limit, respectively the administrative limit of communes limit Ohaba Lungă, Bara and Balinț. We chose this method of delimitation in order to be able to use existing data for communal areas ( especially demographic data) thus to obtain an overview of the studied area, given the fact that the administrative-territorial limit coincides largely with the boundaries of the basin.

The region analyzed in this paper, namely the upper and middle BH of river Bega is defined by the following characteristics:

- the presence of several major relief units, mountains, hills and plains (Mountain Poiana-Ruscă, Western hills and valleys, high plains and Bega Meadows), framed in terms of altitude in a very wide range, between 76 - 1360 m
- physical and geographical characteristics with direct implications on the spatial distribution of population
- weather conditions with a high degree of diversity, altitude floors, which condition the human activity and therefore population distribution
- water resources varied but unevenly distributed which creates the "cluster" a tendency of the population, especially in the central part of the analyzed area, crossed by the river Bega
- great variety of soil (qualitative and quantitative) that generates differences in spatial distribution of population, areas with fertile soils are well populated, given the fact that the region has a pronounced rural character
- accessibility, which presents striking regional differences, thus existing an uneven development of components and sub-areas and also existing the risk of depopulation
- different socio-economic and cultural backgrounds, giving rise to regional differences

The purpose of this study is to highlight trends in the evolution of the population and to identify areas at risk of depopulation, which means, on the one hand knowledge of the

number of inhabitants and for variations in this indicator, on the other hand density analysis population synthetic indicator used to highlight differences in the land surfaces occupied by humans.

Therefore, to analyze the spatial distribution of the population in a given territory is essential to know the number of inhabitants

and its evolution over time. Based on data from population censuses, starting from the 14 communal areas included in the study (Table 1) we created an overview of the evolution of this indicator in the studied region.

Number of inhabitants varies in space and time (Table 1), being influenced by many factors, natural, socio-economical or political.

Table 1

*Number of inhabitants at censuses during 1880 - 2011*

(sursa: <http://www.kia.hu/konyvtar/erdely/erd2002/tmetn02.pdf> și Consiliul Județean Timiș)

Commune	Total population at census in year:												
	1880	1890	1900	1910	1920	1930	1941	1956	1966	1977	1992	2002	2011
Balinț	2208	2411	3868	4903	4164	4018	3732	3309	2987	2523	1849	1751	1589
Bara	2980	2857	3378	3381	3190	3105	2927	2633	1885	816	427	378	280
Barna	2310	2476	2862	2959	2644	2608	2521	2188	1882	1803	1691	1573	1543
Bethausen	3288	4112	4877	5448	5244	4954	4863	4430	4014	3474	2909	3033	2758
Curtea	2109	2158	2266	2399	2275	2215	2071	1927	1731	1656	1459	1323	1211
Dumbrava	1995	2183	4223	4413	4005	3870	3763	3400	3224	2993	2799	2797	2654
Făget	6516	6882	7642	8724	7920	8024	7769	7833	8276	7868	7722	7213	7270
Fârdea	3271	3281	3430	3470	3277	3217	3172	2846	3164	2899	2164	1919	1767
Mănăstur	1563	1677	1952	2287	2129	2220	2285	2464	2365	2094	1741	1781	1684
Margina	4045	4180	4157	4305	3964	4240	3941	3637	3494	2987	2469	2356	2300
OhabaLungă	2492	2714	2822	3167	2855	3048	3130	2744	2221	1681	1347	1225	1139
Pietroasa	1817	2032	2138	2208	1919	1942	1760	1578	1691	1412	1166	1174	1034
Tomești	2362	2233	2411	2455	2339	2671	2345	2517	3327	3201	2888	2261	2053
Traian Vuia	2963	3197	3576	4134	3506	3697	3870	3350	3188	3005	2404	2241	2021

To highlight the quantitative evolution of the number of inhabitants in a period of 130 years, we compared the number of people registered in 1880 and in 2011. This analysis gives an overview of quantitative changes during the specified time frame taken into account, but gives no data on changes within the period under review, indication of major importance. The comparative analysis revealed the following conclusions:

- only three of the municipalities analyzed have a larger population in 2011 compared to 1880 (fig 1) Faget (754 inhabitants), Dumbrava (659 inhabitants) and Mănăstur (119 people)
- from 1880 to 2011 in the village Tomești there is a shortage of 310 inhabitants, and in 10 of the 14 communities included in the study area have a deficit greater than 500 inhabitants (fig 1)
- the biggest "loss" of population are in the Bara village in 2011 having 2700 inhabitants less than in 1880, also Margina

village also has a deficit of 1,745 inhabitants and commune Ohaba Lungă has a deficit of 1,353 inhabitants (fig 1).

Based on the data presented can be drawn the conclusion that the municipalities located in the center of the analyzed area - with a higher degree of development - Făget, Dumbrava, Mănăstur, the number of people has increased slightly, but not significant given the large time frame taken for analysis. All villages located in hilly and mountain areas recorded "loss" of population, more pronounced in the case of municipalities Bara and Ohaba Lungă (Fig. 1).

Data presented are reported at an interval of time, approx. 130 years and shows no population dynamics within this range, so it is necessary to analyze population dynamics on small time intervals (10-15 years) to highlight changes over time, the evolution of the number of inhabitants also, in this way, it can be established the causes that led to the major changes as well as trends in the evolution of the number of inhabitants in the current period.

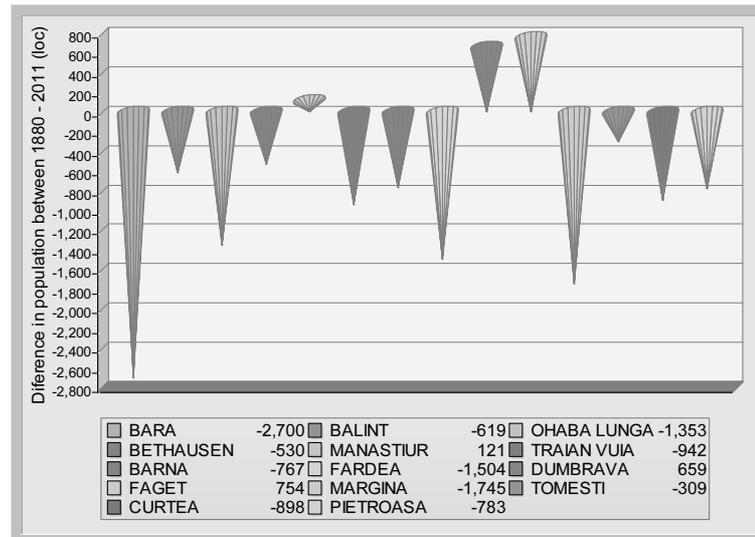


Fig 1 The difference between the number of inhabitants from 1880 to 2011

Between 1880-1890 there is an upward trend in the number of inhabitants due largely to colonization by Germans and Hungarians thus the largest population increases are recorded in the village Bethausen (a difference of approx. 900 inhabitants) due to German settlers established in this area in 1883, also merchant Hebrew families and German craftsmen set to increase the number of people Balint by approx. 200 people, 150 families of Hungarians are settled in Mănăştur, thus influencing positively the number of people, in villages Bara and Tomeşti, there was a slight descent in the evolution of the number of inhabitants, these communes "lose" about 100 inhabitants.

Between 1890-1900 the number of people registered an upward trend in the villages included in the studied area, except for Margina village which "loses" 23 people (Table 1), a situation which is reflected also at the level of the analyzed region, in 1890 the number of inhabitants is higher by approx. 200 to 1880 (Fig. 2), mainly due to colonization with Hungarians (in Bodo and Dumbrava) and of a positive natural population balance.

In the period 1900-1910 is maintained an upward trend in the evolution of the number of people in all villages, situation which sets the guidelines outlining developments across the region, thus producing a quantum leap in the number of inhabitants, with a difference of approx. 500 people compared to 1900 (fig 2).

During this period the greatest changes occur in commune Faget, with a difference of approx. 2000 inhabitants due to colonization by Hungarians in 1900 and in commune Balint, which increases its population by approx. 1000 inhabitants, also due to the Hungarian colonization since 1904 (Table 1)

Around the year 1910 recorded the highest number of inhabitants throughout the period considered (Fig. 2). The increase of the number of people is explained by the action of several factors such as political, economic, social, such as Hungarian and German colonization of this period, the development of industrial activities (the establishment of the glass factory in Tomeşti in the 18 century century), exploitation of subsoil resources (iron exploitation begins in 1724 at Luncani and subsequently exploiting quartz sand in Faget), development of the city of Faget, etc. all these activities constitute elements of "attraction" for the population, jobs being created, optimal living conditions, development opportunities, etc.

Since the early 20 century to the present it can be noted the following: the greatest communes in terms of number of inhabitants are Făget, Bethausen, Margina, Dumbrava, overlapping an area of plains, depressions or low hills areas where environmental conditions allow farming, housing location and spatial extent of cities, and the smallest communes in terms of their population are located in areas of

high hills and mountains (Pietroasa, Tomești, Fârdea, Curtea, etc.) where natural conditions are not favorable to housing or to the development of network settlements. Although some industrial activities are located in

mountain and hill areas, they were not "nucleus" for human settlements development in most cases the population is dispersed in the surrounding areas, practicing commuting.

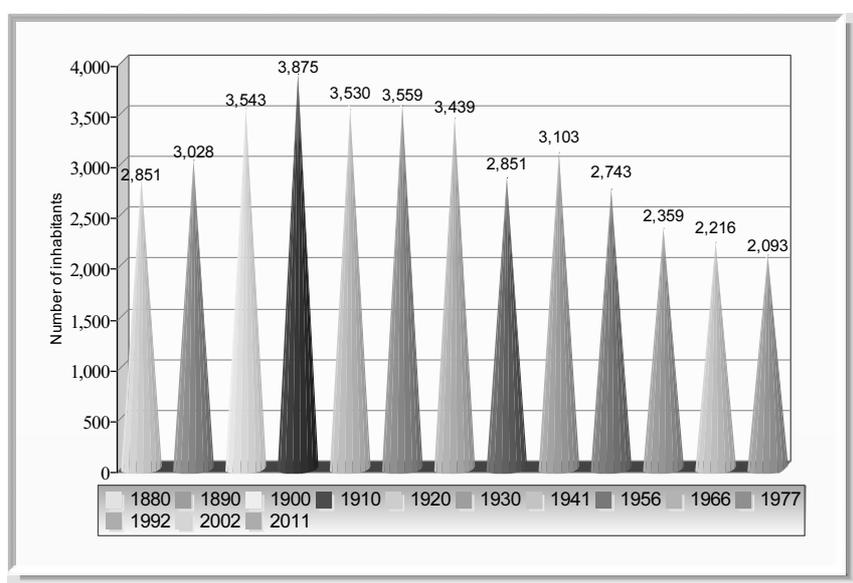


Fig 2. Evolution of the number of inhabitants in the upper and middle basin of the river Bega between 1880 - 2011

The Political instability caused by World War One is reflected in the evolution of the number of inhabitants, so that in the 1920s, its population is numerically reduced compared with demographic data recorded in 1910, it was found a difference of approx. 300 inhabitants (fig 2)

From the 1920s until the census of 1941 the number of inhabitants of the region analyzed has maintained relatively constant values with small oscillations +/- 100 people. (fig 2).

Between 1941 - 1956 the number of inhabitants decreases, the World War two is the main reason that determined a decrease by approx. 600 inhabitants of the population of the upper and middle basin of the river Bega (fig 2).

World War two ending and restoring political balance (beginnings of communism), positive natural increase of the population at a national level and the economic factors, causes a rise in the number of inhabitants, in the studied region was observed an increase by approx. 300 inhabitants at the Census of 1966 (Figure 2), explained by population growth in villages Faget (Faget city is evolving economic

Tomești (existence of industry), Fârdea (the exploitation of rocks for construction).

Since 1977 the number of inhabitants in the region studied begins to decline, a trend maintained to date (fig 2), the reduction caused by many factors including:

- negative natural increase, both at national and local level and trend of population aging
- termination and/or reduction of industrial activities and exploitation of natural resources since 1990, which initially formed poles of attraction for population
- development of Lugoj in detriment of Făget, and the population of the analyzed area migrates, looking for a job or a higher standard of living

To highlight differences in employment of land area by the population and depopulation default risk, we calculated *overall population density* for each communal territory and can thus shaping an image of the distribution of the population as a whole in the studied region, thus

differences arising from geographical subdivision to another. Given that the sample area overlaps a geographical area with highly uneven environmental conditions, population density is characterized by high spatial variability and evolution of the number of people over times change the density values, so this indicator varies in large limits from one

period of time to another.

The time taken in the analysis (1880 - 2011), at the level of communal territory included in the study, population density values register significant variations (Table 2)

The highest population density values were recorded around the year 1910 for all municipalities analyzed (Table 2).

Table 2

*Evolution of population density in the range 1880 - 2011 in the communal territories (inhabitants/km<sup>2</sup>)*

Commune	1880	1910	1956	1966	1992	2011
Balinț	39	88	39	53	33	28
Bara	42	48	42	27	6	4
Bârna	29	37	29	24	21	20
Bethausen	37	61	37	45	32	31
Curtea	48	55	48	39	33	28
Dumbrava	35	77	35	57	49	47
Făget	43	58	43	55	51	48
Fârdea	25	26	25	24	17	13
Mănăștiur	37	54	37	56	41	40
Margina	30	32	30	26	19	17
Ohaba Lungă	24	30	24	21	13	11
Pietroasa	12	14	12	11	7	7
Tomești	17	17	17	24	20	15
Traian Vuia	42	59	42	46	34	29

During 1910-1956 density values decreased significantly, except Tomești village, for which these remain constant (Table 2). Following a further increase in population density in the years before 1966, especially for villages in the plains area, depression or hill with low altitudes Balinț, Bethausen, Mănăștiur, Dumbrava). In the period 1966-2011 density values are reduced for all municipalities included in the study, the largest differences are noted in Bara village, where the density decreases from 27 inhabitants/km<sup>2</sup> in 1966 to 4 inhab/km<sup>2</sup> in 2011, decreased determined by the drastic reduction in the number of inhabitants and the same situation is found in commune Balint: from 53 inhabitants/km<sup>2</sup> in 1966, the rate drops to 28 inhabitants/km<sup>2</sup> in 2011 (table 2).

Lowest population densities in both the past and the present period, are in villages in south-eastern parts of the analyzed area (Fig. 3) respectively Fârdea, Tomești and Pietroasa, where natural conditions (mountain and high

hill area) did not allow the location and development of human settlements.

Although in Luncani and Tomești industrial units were located and extraction of subsoil resources centers operated, the values of density are maintained low being practiced commuting to and from surrounding areas.

The communes Bârna, Margina and Ohaba Lungă with have slightly higher values, however in their case it's the landscape that conditions the spatial distribution of the population (Fig. 3). In accordance with the general principles of territorial distribution of the population in the case of the analyzed area, the highest density values were recorded in the lowlands, with terrain and climatic conditions that allow human activity, along rivers and major communication routes in villages Făget, Mănăștiur, Bethausen, Traian Vuia, Dumbrava and Balinț (Fig. 3).

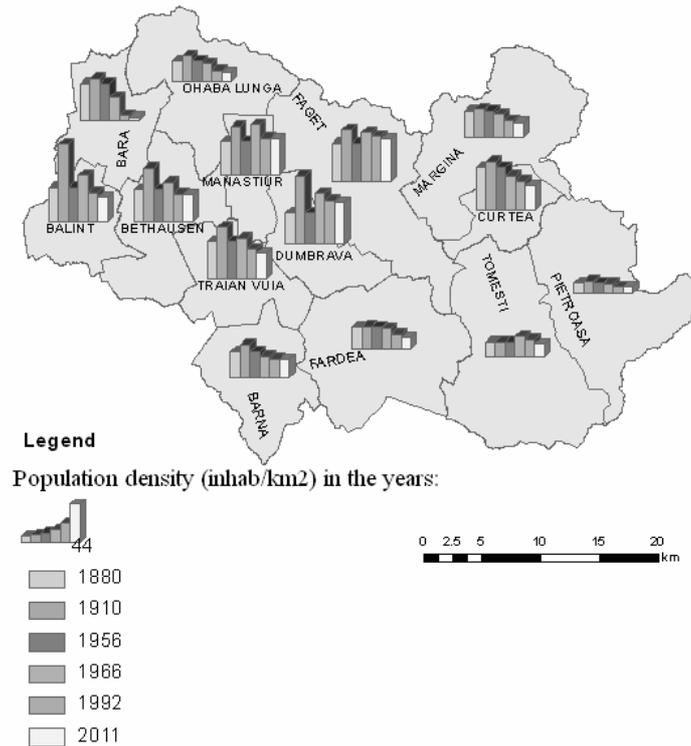


Fig 3 Evolution of population density in the range 1880 - 2011

The data presented in table 2 and the analysis of figure 3 it can be observed the tendency for decrease over time in the overall population density in the entire region analyzed. Among the causes which contributed to a low density include:

- rural exodus, respectively attractions of nearby cities (Lugoj Lipova Arad), the population migrating towards them looking for a job or a higher degree of comfort
- low level of development of the area in terms of technical municipal facilities (water supply, sewerage, telephone, etc.), the small number of schools (the only high school being in Faget), of cultural or sanitary facilities, etc.
- closure of industrial units (Tomești, Margina, Luncani, Faget) that attracted jobs crisis, people are forced to migrate to other areas
- increased external migration, especially after 1990
- high degree of population aging which entails negative natural population balance

- diminishing interest in exploiting the natural resources of the area, etc..

In 2011 the population spatial distribution in the upper and middle basin of the river Bega is also conditioned by socio-economic context, especially by natural features (fig 4).

In mountain and high hill areas recorded the lowest values of density (between 4-15 inhab/km<sup>2</sup>) natural conditions (relief, climate, hydrography, soils, etc.) do not allow the location and development of human settlements and restrict the socio - economic activities, leading to a significant reduction in occupancy of the territory (Fig. 4) and shows clearly depopulation. In the western part of Lugoj Hills, Bulzei Hills and in the Eastern side of Lipovei Hills density values are slightly higher than the ones in a higher altitude area, reaching 16-20 inhab/km<sup>2</sup> (Fig. 4). The population is concentrated mainly in easily accessible areas or along rivers.

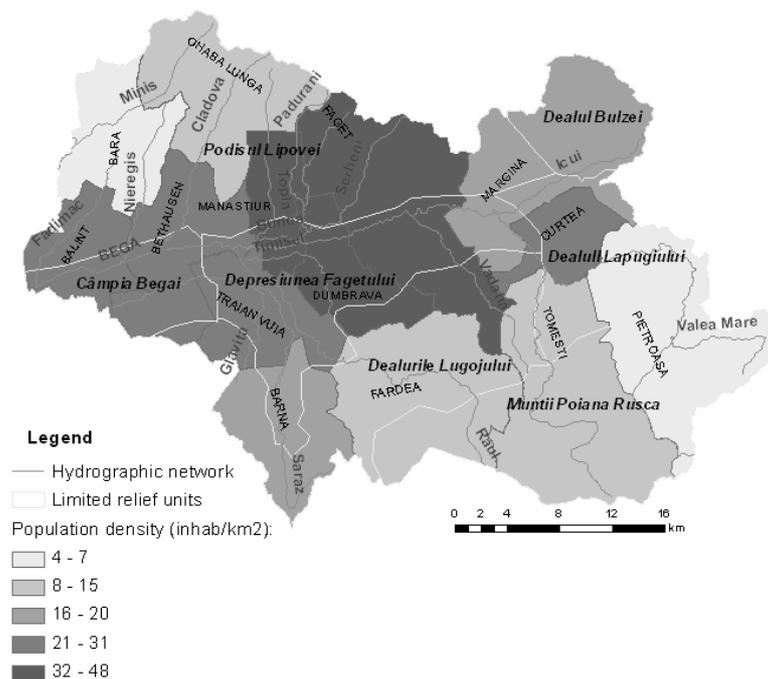


Fig 4 Population density in 2011

Parallel with the decrease of altitude the values of population density increase, such as in the Bega Plain, the western side of Făgetului Depression and in the southwestern Lipovei Hills it is recorded between 21 to 31 inhabitants/km<sup>2</sup> (Fig. 4), favorable natural conditions (smooth landscape, the existence of water resources, the climate and favorable soils for agriculture) maintained relatively high values of population density. The highest values of population density, between 32-48 inhab/km<sup>2</sup> is recorded in Făgetului Depression, in the central and southern part of Lipovei Hills, and in the southern part of Faget Hills, in which villages Făget, Dumbrava and Mănăştur are located (Fig. 4). Stronger concentration of the population in this area is due to on the one hand favorable natural conditions giving the possibility of human activities and on the other hand to the presence of the town of Faget, who polarizes part of the studied area.

It is therefore demonstrated that in this case the influence of natural conditions on the spatial distribution of the population: the increase of altitude entails the amendment of environmental factors that determine the scenery and impose limits to the spatial distribution of population and create large differences from one subunit to

another of population density. Besides natural factors in the territorial distribution of the population other factors may be involved such as social, economic, demographic, political, etc..

#### 4. Conclusions

The upper and middle basin of the river Bega is characterized by a variety of natural and socio-economic conditions, resulting in major differences in the evolution of the number of inhabitants and their spatial distribution. In the period considered (1880 - 2011), the most populous census occurred in 1910, since then a definitely downward trend in this indicator can be observed, until the current period, in some cases "losses" were very large (village Bara, Balinț, Ohaba Lungă, etc). Regional differences that occur in the area analyzed, can also be observed: in the mountains and high hills there is a downward trend in the evolution of the number of inhabitants, much higher compared to the central and south-west, where, although there is a population decrease, the differences are not so great. Among the causes for this phenomenon are included: cessation of industrial activities, generally negative demographic balance (natural and migratory), low level of socio-economic and cultural

development of the region analyzed, etc.

Estimates on future population numbers are difficult to achieve because some variables can not be predicted or quantified, such as political decisions, migrations and general demographic balance values. The downward trend in the number of inhabitants has direct implications on the overall density of the population, over time, this indicator registered a continued reduction in most cases and time periods considered.

Spatial distribution of population in the analyzed area follows the general principles of population distribution in the territory and highlights big territorial differences accented highlights: plains, valleys and hills with low altitudes (communes Dumbrava, Făget, Traian-Vuia) are "well" populated - but in these cases density decreased over time - in contrast to the high hill regions and mountains areas who are at

risk of depopulation, while drastically reducing the density values (communes Tomești, Pietroasa and Bara).

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