SPATIAL PATTERNS OF UNDERDEVELOPMENT IN MARAMUREŞ - CHIOAR REGION, ROMANIA

SORIN FILIP[1], ŞTEFAN BILAŞCO[2]

ABSTRACT - This article approaches aspects of spatial patterns associated with underdevelopment situations in Maramureş – Chioar Region, Romania. Based on the concept according to which territorial balance results from a harmonization between structure and function, the analysis performed considers three territorial aspects: the road network, the economic characteristics and the spatial positioning of the human settlements. The correlated analysis of these aspects allowed capturing certain recurrent spatial situations of association between settlements without business organizations, with a poor road network development. Such situations, translated in terms of space as patterns of underdevelopment, are, due to the big number of cases, a symptom of uneven regional development. We have identified three classes of spatial patterns associated with economic underdevelopment situations: the sidewise pattern, the cul-de-sac pattern, and the proximity pattern. The analysis of network indicators (α, β, γ, μ) and of a compound indicator (κ) reveals in many cases that the identified spatial patterns coincide with low values of road network connectivity. From a systemic point of view, the significance of these indicators derives from the fact that they signal dysfunctions manifested at structural and functional level. The optimization of the patterns of underdevelopment requires both a harmonious relationship between road network meshes and nodes and an efficient network flow transmission, i.e. an optimization between time, space and consumed energy factors. Under these conditions, the emergence of new structural elements and network segments that will close the non-functional network meshes can be a possible solution that might eliminate underdevelopment situations by increasing the positional value of these settlements.

Keywords: spatial patterns, road network, underdevelopment, Maramureş – Chioar Region, Romania

INTRODUCTION

Many specialists (geographers, economists, mathematicians, planners, etc.) have approached aspects of regional development in terms of transportation networks, with significant results both in theory and practice (Nystuen and Dacey, 1961; Kansky, 1963; O'Sullivan, 1968, Hay, 1973; Johansson, 1993; Johansson and Karlsson, 1994; Vickerman et al., 1999; Rodrigue et al., 2009; Nagurney, 2000; Andersson and Karlsson 2004; Almeida et al., 2010). Unlike studies with an analytical approach aiming at identifying certain dependency connections between economic development and transportation networks characteristics (e.g. Kansky, 1963, p. 52: "Results of the exploratory analyses are very encouraging, indicating that economic characteristics are the major factor influencing the structure of transportation networks."), this case's working hypothesis is that, for the analyzed region, the level of economic development and the regional disparities are influenced by the characteristics of the transportation network.

Studies on transportation network accomplished since the mid-twentieth century have approached various aspects and scales, ranging from measuring accessibility (Kansky, 1963; Ingram, 1971; Baxter and Lenzi, 1975; Kirby, 1976; Li and Shum, 2001; Xie and Levinson, 2011), connectivity (Hagget and Chorley, 1969), network development (Taafe et al., 1963), and the networks'

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structure (Xie and Levinson, 2007; Ducruet and Lugo, 2011), to the spatial patterns (Marshall, 2005) and aspects of human behaviour interdependence (Zipf, 1949) .

According to the conceptual premise considered when developing this study, the condition of territorial balance results from a harmonized functioning, which involves, among other things, the absence of structural disparities and the absence of dysfunctions. Achieving the balance at regional level may occur more like a trend than a fact, under the intense dynamics of the components, on an internal synergistic background perturbed by external influences. This is, in fact, typical for any complex system that evolves over time (Arthur, 1999; Reggiani and Nijkamp, 2009), the region as a territorial system being such an example (Allen et al., 1998; Macleod and Jones, 2007).

The region studied is located in Northern Romania, covering about 7200 km^2, and with a population exceeding at least 600,000 inhabitants. The polarizing centre of the region is the city of Baia Mare (about 140,000 inhabitants), together with a second polarizing centre, Sighetu Marmarţiei (about 42,000 inhabitants), and a series of small-sized cities with regional importance (less than 30,000 inhabitants). The region has a diverse character (Cocean and Filip, 2008), deriving from both landscape features (mountains, depressions and hills) and natural resources (agricultural fields, forests, non-ferrous ores, mineral water springs).

Despite a considerable internal consistency and manifestation of centripetal flows, which assure the functionality of this region, there are significant differences in the level of development (Heller and Ianoş, 2004). Achieving an economic analysis comes to support this assertion, given that a number of places have a low level of development, lacking business organizations, and with an economy based on non-performing agricultural practices.

METHODOLOGY

The methodological approach aims at identifying economically underdeveloped settlements and spatial patterns associated with economic underdevelopment situations. The working method used in this case was the quantitative analysis of some economic indicators, the analysis of the road network and of the spatial patterns, the study's expected usefulness being related to the optimization of the development plans and maximization of the positional advantages.

The economic diagnosis was accomplished by analyzing three indicators of economic environment: the number of economic organizations, the number of employees and the turnover. They have been approached in every human settlement within the region, including 14 towns and 286 villages. Spatial distribution analysis and specific values classification into size groups were both achieved for each indicator in order to allow the identification of underdevelopment cases.

The road network and the settlement network have both been approached as an organized whole having a structure that implies the existence of certain relationships between its components. The approach of this whole has been made both in terms of network characteristics and spatial patterns.

Road network analysis was based on certain road network basic indicators (road density and rank) and some parameters characterizing the network in terms of graph theory. In order to estimate the degree of connectivity, the road network was reduced to a planar graph, characterized by the presence of 585 nodes (vertices) and 453 lines (edges). Therefore, a number of network parameters have been estimated, considering that, in terms of graph theory, settlements and road intersections are vertices, and roads are edges. In this respect, a series of well-known formulas used for this kind of analysis have been applied to the existing road network in the region (Berge, 1962; Garrison and Marble, 1961; Kansky, 1963; Haggett and Chorley, 1969):

- *cyclomatic number*: $\mu = E - V + G$
- *β index*: $\beta = \frac{E}{V}$
- *α index*: $\alpha = \frac{E - V + G}{2V - 5} X100$

- *γ index*: $\gamma = \frac{E}{3(V-2)} X100$,

where E = number of network edges, V = number of network vertices, and G = number of subgraphs.

Regarding the identification of spatial patterns associated with economic underdevelopment situations, the association of recurrent elements has been considered, together with their spatial repetition implying the existence of certain deterministic relations, excluding the possibility of certain random coincidences. Important milestones in identifying such patterns have been accomplished by works such as those of Taafe et al. (1963), Medvedkov (1967), Haggett and Chorley (1969), March and Steadman (1971), Rickaby (1987) and Marshall (2005).

RESULTS

The analysis of the three economic indicators (number of business organizations, number of employees and turnover) allows highlighting certain significant disparities, imbalances, under the concentration of economic activities in several privileged centres, especially in Baia Mare. In addition, the comparative analysis on types of settlements, urban - rural, reveals an even greater imbalance, economically positioning all rural settlements in disadvantage and having a negative effect on the quality of life and attractiveness of rural areas. A negative premise is thus emerging from urban-rural relations, with both short term and long term consequences on the territorial balance. The imbalance is also emphasized by the fact that, at regional level, there is a significant number of human settlements (59) lacking business organizations, all those belonging to the class of rural settlements. In such a context, an analysis of the economic development status has been accomplished, considering this indicator as the central element.

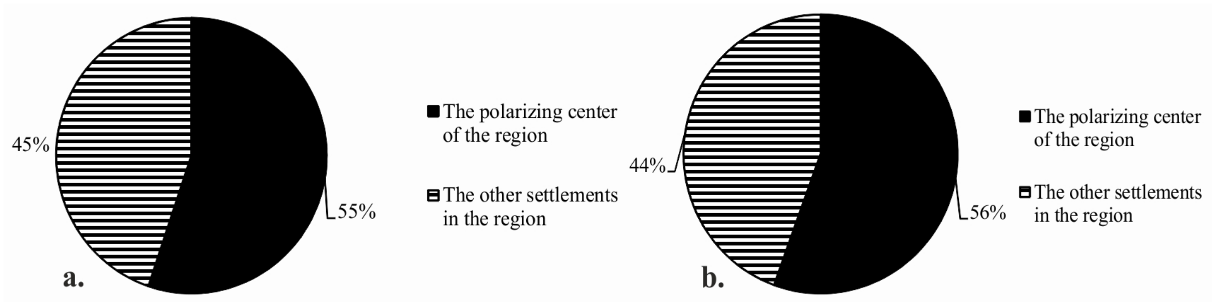

Figure 1. *a) Distribution of the number of employees in Maramureş-Chioar Region; b) Distribution of turnover in Maramureş-Chioar Region*
Source: National Institute of Statistics

In order to identify the spatial patterns associated with economic underdevelopment situations, these settlements have been spatially related to the road network, given that they are vital structural elements of a regional economic system. Therefore, the spatial interpolation of the "number of companies" indicator has been performed, resulting in a number of areas with a significant extension, having zero value. They overlap the mountain area without settlements, plus the areas around the settlements having no business organizations. However, there is a good correlation between the location of the areas with settlements without business organizations and the areas with low road density (Figure 3).

A particular attention has been paid to the cases of economic underdevelopment and to the characteristics of the road network, accomplishing a comparative analysis between the presence of non-economic settlements and the road rank (Figure 4 and Figure 5). A first finding is that there are very few cases where such settlements are located on order 1 roads (European or national roads). A second finding is related to the prevalent location of non-economic settlements within order 1 (European roads, national roads) and order 2 (county roads) network meshes, meaning their positioning on order 3 roads (local roads).

The road network analysis has been accomplished using the Network Analyst extension (ArcGIS 9.2), identifying vertices and edges. Both the approach of this network for each territorial-administrative unit from the perspective of a planar graph, and relating the network features to the presence of settlements without business organizations, reveal a series of correlative aspects.

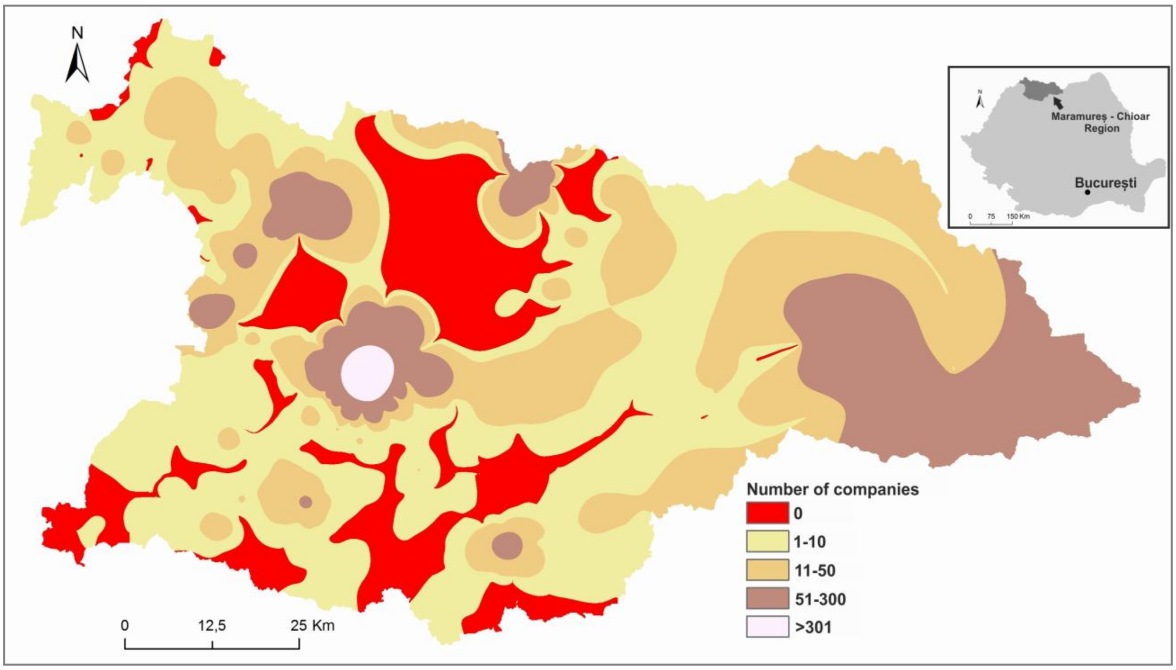

Figure 2. *Distribution of "number of companies" indicator as a result of spatial interpolation*

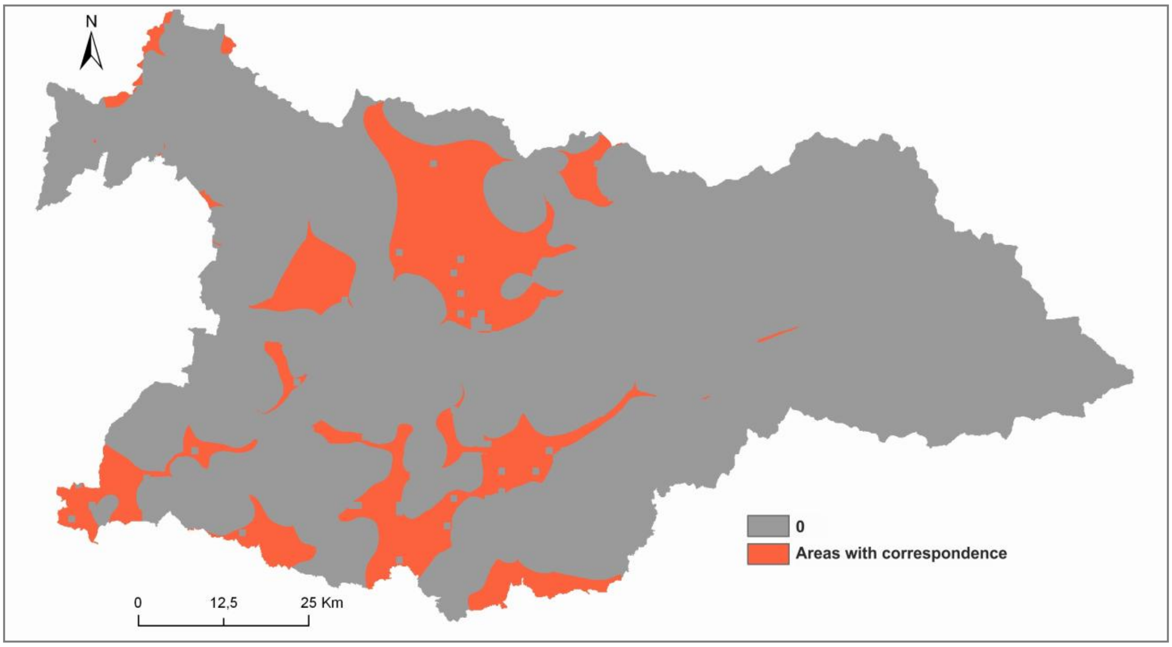

Figure 3. *Areas with correspondence between the lack of business organizations and low road density*

In what concerns the alpha index, the values recorded for the territorial-administrative units range between 0 and 58.8; out of all the 59 human settlements without business organizations, 46 are located within the territorial-administrative units where the alpha index has 0 value, the other 13 being located within the territorial-administrative units where alpha index has values between 0.1 and 15.

As regards the gamma index, the values range between 0 and 74.1. The values have been grouped into three size classes, using Jenks classification method (The Jenks Natural Breaks Classification). As shown in Figure 6, the existence of settlements lacking business organizations corresponds to lower values (0-40) of this index, except eight of them located within certain territorial-administrative units where the gamma index value ranges between 40.1 and 50.

Miu index used for road network characterization has a lower variability in the region, the values ranging between 0 and 10; the values have been grouped into four size classes, using Jenks classification method. This case has also revealed a good correlation between the existence of settlements without business organizations and low miu index values. Thus, most settlements lacking business organizations are located in territorial-administrative units where miu index is zero. Exceptions are represented by 11 such settlements positioned within certain territorial-administrative units part of 0.1 - 2 size class (according to Jenks classification) and a settlement located in a territorial-administrative unit where miu index value is 3 (size class 3 according to Jenks classification).

Beta index calculation for each territorial-administrative unit revealed a 0.5-1.8 value gap. The three size class classification according to Jenks algorithm reveals an apparently paradoxical situation, where most of the settlements without business organizations belong to the second value class (0.8 - 1.2), while only 12 of them are located within the territorial-administrative units belonging to the lower size class (0.5 - 0.8). This indicates the great importance of network characterization indices that specifically regard network connectivity (α, γ, μ).

We used a compound index (κ) to better highlight the characteristics of the road network. It combines the values of α, γ and μ indices: $k = (\alpha + \gamma) \times \mu$.

Table 1. *Distribution of settlements without business organizations versus κ index value*

Compound index value class (κ)	**0**	**0.1 - 10**	**10.1 - 20**	**20.1 - 44**
Number of settlements without business organizations	44	14	1	0

Combining index values within a single indicator shows that, in most cases, the presence of settlements without business organizations is associated with low values of network indices (Table 1), i.e. with reduced road network connectivity.

The detailed scale analysis of all spatial situations associated with the presence of settlements without business organizations allowed the identification of common, recurring elements, which combine spatial position, road network configuration and underdevelopment, outlining certain spatial patterns associated with cases of peripheralization-underdevelopment:

a. sidewise location (P1) from the main roads (county, national or European roads). This situation has been identified for a number of 12 human settlements located laterally to the main roads, on the local roads.

b. "cul-de-sac" location (P2), which can be seen as a special case of the remote pattern. This case also reveals a sidewise location of the settlements, except that, unlike the others, they are placed at one road end, with a total number of 22 such cases.

c. proximity effect location, with spatial developed-undeveloped couples, as a result of domination-effacement mechanisms, when located on order 1 and 2 road networks, and of domination of transit flows. A number of 25 such settlements has been identified throughout the region; the mechanisms generating a deficiency of business organizations are here related to the inability of these habitational structures to "metabolize" transit flows and to generate strong economic activities, thus creating the premises for dependency relations from the proximal settlements.

The analysis of the three spatial patterns associated with economic underdevelopment cases shows that the most detrimental spatial context is associated with the second pattern, namely, the cul-de-sac pattern. It is precisely in such situations that the network's malfunction is maximum. In these circumstances, the quantitative aspect of the correspondence between low road density and settlements without business organizations also receives qualitative connotations derived from the attributes of road network connectivity.

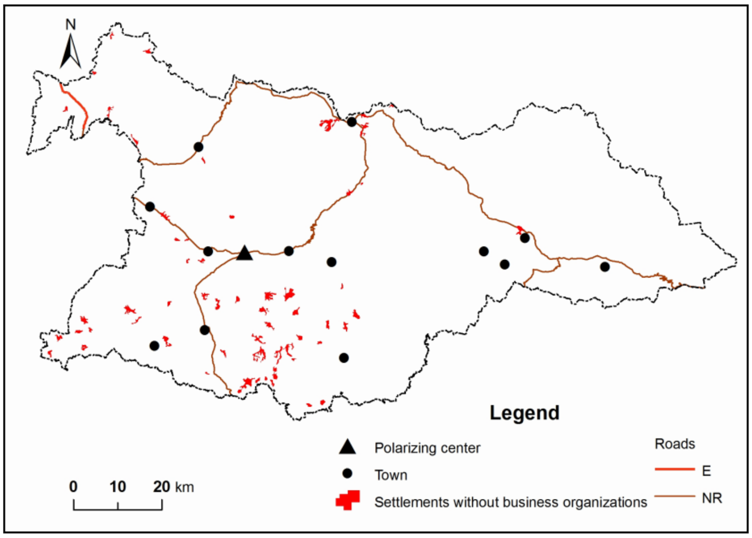

Figure 4. *Distribution of human settlements without business organizations in relation to order 1 road network (European and national roads)*

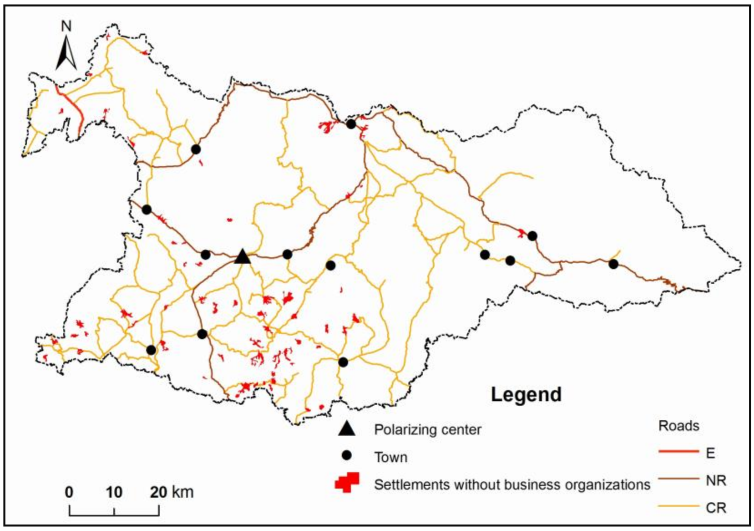

Figure 5. *Distribution of human settlements without business organizations in relation to order 1 road network (European – E and national roads NR) and order 2 road network (county roads - CR)*

Therefore, in order to remove the underdevelopment condition from underdeveloped/ peripheralized settlements it is necessary to optimize network characteristics, i.e. to optimize accessibility (as consumed energy and time factor) and to increase connectivity (as space factor). The importance of these two features is also augmented by their relation to two territorially important concepts. The first is the isolation concept, as an attribute of spatial objects' relational structure (Kwan et al., 2003), being inversely proportional to that of accessibility. The second concept is attractiveness, as an attribute deriving from the synergistic cooperation between all the features of a place (from spatial position to natural and human resources, up to what is called "genius loci"), setting up the premises of an increase in local attractiveness and territorial balance.

In what concerns the cul-de-sac pattern, eliminating the network's lack of functionality is possible in most settlements involved, with a few exceptions, those located in high geomorphological restrictiveness spatial context. Transforming inoperable patterns and increasing connectivity help ensure a natural link between form (network mesh) and function (relationship). In terms of spatial patterns, closing network meshes means replacing P1 and P2 patterns, the two patterns associated with territorial dysfunction situations, with a new and functional pattern (P_f).

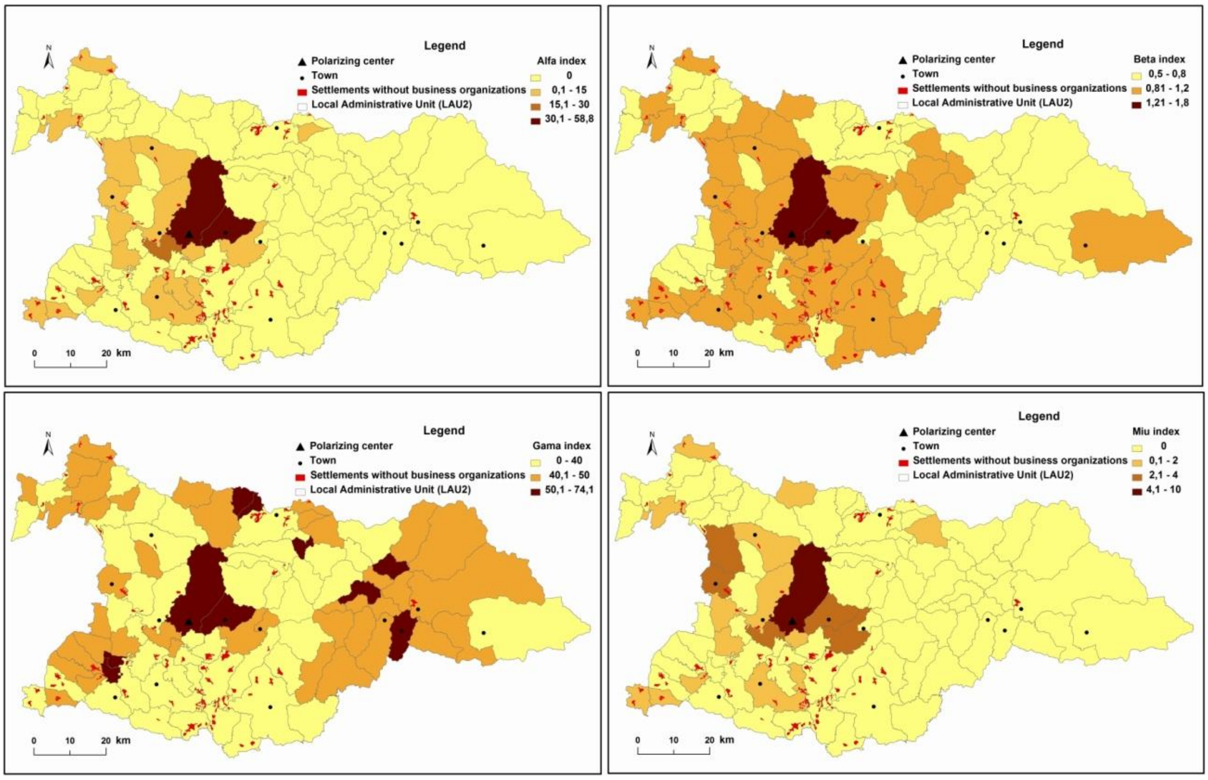

Figure 6. *Values of α, β, γ and μ indices for the road network of the territorial-administrative units and the location of the settlements without business organizations in Maramureş - Chioar Region*

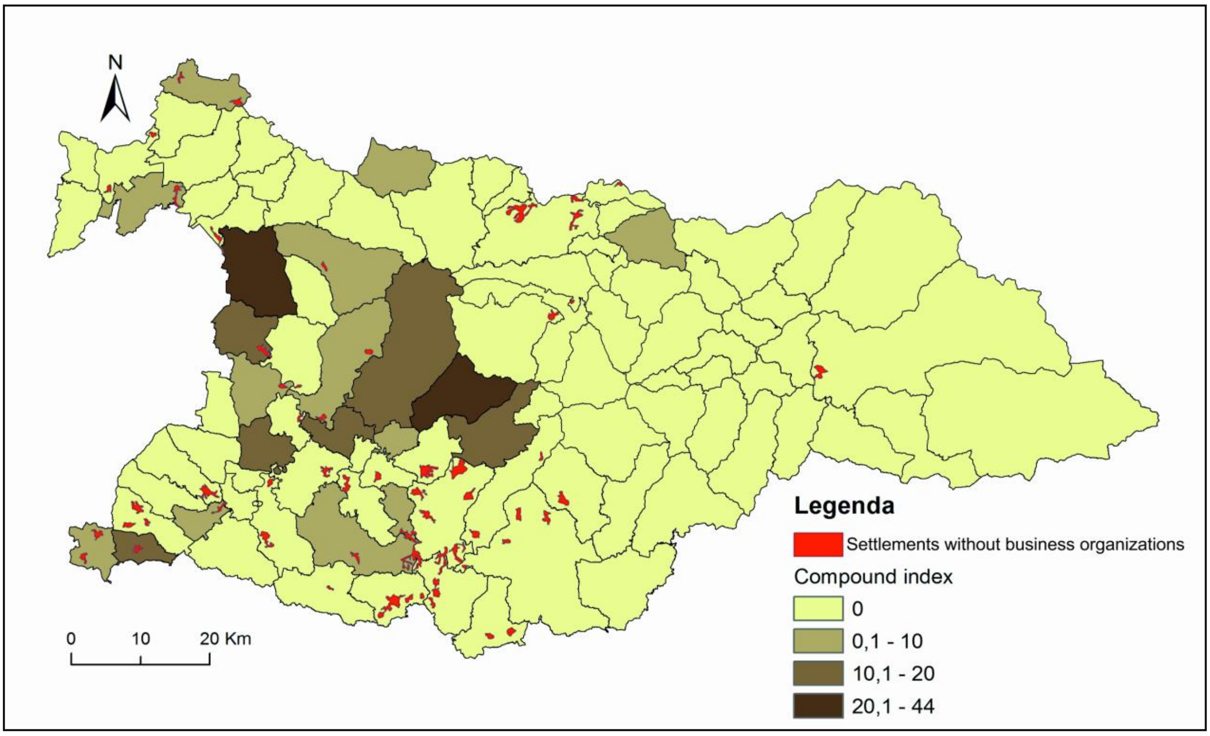

Figure 7. *Compound index value (κ) for the road network of the territorial-administrative units and the location of the settlements without business organizations in Maramureş – Chioar Region*

CONCLUSIONS

Territorial disparities are a current issue especially in developing countries, where frequently, the poles of attraction come to generate situations of territorial imbalance through the effect of domination and through the exacerbation of the benefits derived from the hierarchical position and functional attributes.

In terms of regional economic system, the roads are structural elements that allow the establishment and manifestation of matter, energy and information flows. The configuration and the characteristics of the road network are attributes directly reflected on the level of economic development.

The analysis performed here shows that, in most cases, the settlements without business organizations are positioned within territorial-administrative units where the local road network is poor in terms of connectivity. In such cases, network characterization indices have low values, being part of the low or average value class (some exceptions). These features are added to those related to the spatial pattern (remote and cul-de-sac), thus inhibiting the economic activity. Improving road network characteristics is likely to contribute to direct or indirect changes in local attractiveness, and transforming inoperative spatial patterns is likely to remove certain situations of spatial isolation. All local potentiating actions are finally able to generate positive effects on spatial relations and economic activities.

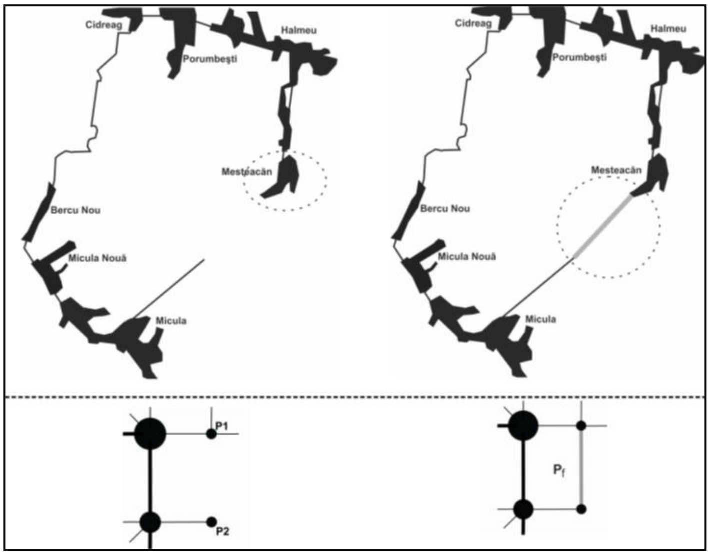

Figure 8. *Transforming spatial patterns (P1 and P2) by closing the network mesh and the new functional pattern (P_f)*

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