ANALELE ŞTIINTIFICE ALE UNIVERSITĂŢII „ALEXANDRU IOAN CUZA” din IAŞI
Tom LVIII, s. II – c, Geografie 2012
ISSN 1223-5334 (printed version)

SCIENTIFIC ANNALS OF “ALEXANDRU IOAN CUZA” UNIVERSITY of IAŞI
Vol. LVIII, s. II – c, Geography series 2012
(online version) 2284-6379 e-ISSN

DYNAMICS OF SPATIAL COMPLEXITY IN DISADVANTAGED SOCIO-ECONOMIC AREAS OF TODAY ROMANIA

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Abstract: This paper examines the relevance of spatial complexity concept, especially looking to the dynamics, applied to the disadvantaged socio-economic areas. Relations between different territorial sub-systems have a strong spatial component. Socio-economic sub-systems are connected and interrelated causally but this trend accumulates differentiated increases that are transmitted to spatial complexity. Spatial complexity is not synonymous with economic development unless specialization is achieved only in the primary sector. On the other hand, forced diversification of economic activities achieved by a centralized political system is not a way out of the vicious circle of underdevelopment. Using some relevant variables to measure the socio-economic territorial discrepancies, were delineated the disadvantaged areas. The deep analysis it was made on three selected socio-economic areas, located in different geographical contexts. Dynamics of spatial complexity of rural areas is a relative one, contradictory, with reducing trends of. These tendencies are defined by a subsistence dominant agriculture, accompanied by an incipient services sector.

Keywords: *spatial complexity, disadvantaged areas*

I. INTRODUCTION

Discontinuity is a concept originating in Camille Vallaux’s work (cited by Ianos and Heller, 2006), who felt that, in addition to expansion, space is characterized by diversity and contrast. Discontinuity was seen as a gap, without nuanced transition between two features of an entity individualized in a given space. According to the same author, when discussing the diversity between two features of the same entity, transitions are imperceptibly made step by step.

Until the 1960s, geographers had been attracted by the continuity of space omitted its discontinuous nature, that generated permanent territorial flows and determined even more complex spatial structures (Brunet, 1968).

Complex territorial researches have been conducted in order to discover ways by which deeply disadvantaged areas can register sustainable development by using, as main tool, controlled production of discontinuities (Ianos and Humeau, 2011). The production of discontinuities is intended to facilitate the transfer of center-periphery disparities at regional, intra-regional or even inter-local level. The dominant idea is to facilitate an equitable development of all human communities, of assuring the development of a defined state or regional territory (Ianos, 2010). Highlighting the main features of deeply disadvantaged areas was made by taking into account the overall regional conditions, the insertion environment being found in those areas studied in se. Regional insertion environments are extremely varied, featuring characteristics of the natural, social, economic and cultural environment. The diversity of these types of environmental differentiation largely explain, underdevelopment in the number and intensity of intra-regional spaces, as the authors put it.

The authors consider that the dynamics of spatial complexity could be measured using the active population changes reflected by information energy index (IEI) computed by Onicescu (1966). The differences between 1992 and 2002 reflect a reducing tendency of spatial complexity, taking into account the increasing of specialization.

II. MATERIALS AND METHODS

For elaboration of this study the statistical data were provided by National Institute for Statistics and for some local statistics institutions. To achieve the main goal of the paper, from methodological point of view we divided the scientific approach in two main steps.

a) The **first step** was to individualize disadvantaged areas in order to use three of them as case-studies in determining complexity dynamics.

To select the disadvantaged social-economic areas, we proposed a development index (Id) consisting of the following indicators:

$$Id = Imin - Ip65 + Isl + Imp + Idp – Iocp – Irs – Imi + Iabtv$$

where:
- Imin - internal migration rate
- Ip65 - share of population aged 65 years and over
- Isl - living space/capita
- Imp - the number of doctors in the public system /1000 people
- Idp - population dynamics in the 1992-2002 period
- Iocp – the share of people employed in the primary sector
- Irs - the unemployment rate

- Imi- infant mortality (average 1998-2002)
- Iabtv – TV users/1000 people

These indicators were standardized by the formula:

Is = (Vr-Vmin)/(Vmax-Vmin),

where

Vr – the value recorded in a region (common) for a certain indicator

Vmin – the minimum value recorded for that indicator

Vmax – the maximum value recorded for that indicator

Using the resulted values, it was obtained an Id map, where three socio-economic disadvantaged areas were selected.

b) The **second step** it was to mark the dynamics of the spatial complexity inside of the selected areas applying the IEI. This index it was computed following the Onicescu formula, applied to the active population structure at each commune from the selected areas (for 1992, 2002):

$$IEI = \sum_{n}^{i=1} I_i^2$$

where

$I_{i,\ i=1,\ 2\ldots n}$ represent the proportion of active population occupied in each main activity sector.

To reflect the dynamics of spatial complexity it was produced an IEI differences map. The main idea is that the IEI value increases, this means a reducing of local complexity. The spatial clusters of communes show the main actual tendencies.

III. RESULTS AND DISCUSSIONS

Disadvantaged areas are the least developed ones in a territory, and several factors are responsible for that situation. At the same time, adding the region's development level may influence endeavours to establish disadvantaged areas. Small, deeply disadvantaged areas within a developed region are actually catastrophic areas, although similar ones do exist in an underdeveloped region as well. In the latter case the discrepancy between advantaged and disadvantaged areas is not so great, but is of greater local significance.

Holland (1998) makes only a brief mention of complex adaptive system models applications, underlining the opportunity to locate "leverage points" where small strategic changes can make useful changes for huge real-life complex systems.

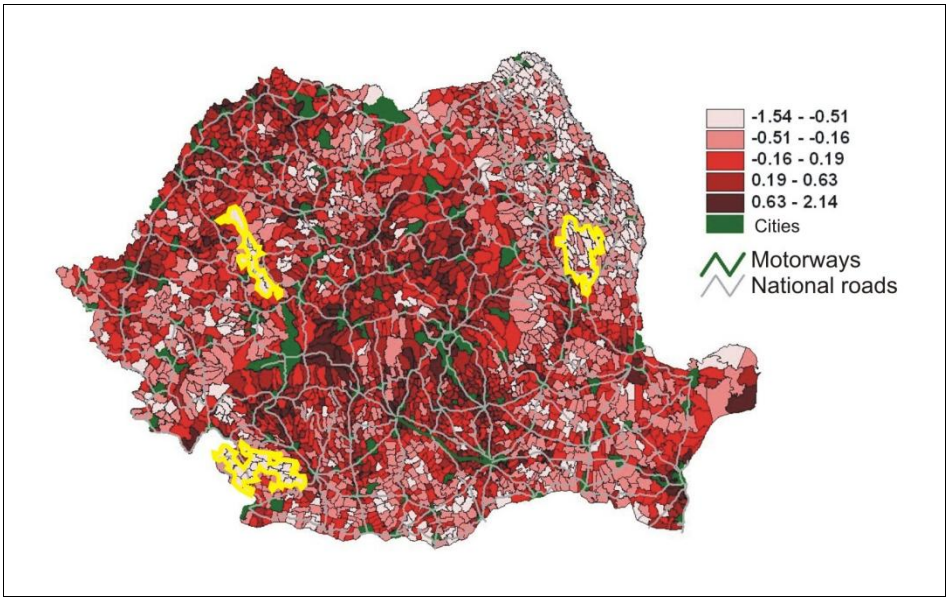

Fig. 1 Regional disparity of Id, 2002

To plot development of Id at communal level we used methods which divide the data series according to the thresholds (natural breaks) of discontinuity (Ianos et al., 2009). In this way we obtained areas of similar values out which we selected, conforming with the previously mentioned criteria, three areas with a minimum value index (Fig.1), as follows:

a) area A in Oltenia, comprising the communes, located in the Blahnita Plain, Danube Valley, and Balacita Plateau (Burila Mare, Devesel, Jiana, Pătulele, Gârla Mare, Salcia, Vânători, Punghina, Corlățel, Vlădaia, Livezile, Poiana Mare, Padina Mare, Bâcleş, Bălăcița, Carpen, Seaca de Pădure, Secu, Gogoşu, Şopot, Brobova, Vela, Terpezița, Vârvoru de Jos, Sălcuța, Vârtop, and Izvoarele);

b) area B in Moldavia, including the communes, located in the Tutova Hills (Colonești, Izvoru Bercheciului, Plopana, Filipeni, Parincea, Lichitişeni, Stănişeşti, Găiceana, Huruieşti, Tătărăşti, Sohor, Priponeşti, Şerbăneşti, Bogheşti, Iveşti, Glăvăneşti, Motoşeni, Coroieşti, Puieşti, Voineşti, Ghergheşti, Iana, Alexandru Vlahuță, and Bogdana);

c) area C in Transylvania, with the communes: Budureasa, Gârda de Sus, Scărişoara, Poiana Vadului, Vadu Moților, Vidra, Bulzeştii de Sus, Blăjeni, Buceş, Balşa, Almaşu Mare, and Ceru-Băcăinți, all located in the mountain area (Apuseni Mountains).

The delineation of these areas is very important for the efforts made by the country and the local community to reduce regional and territorial tensions generated by big discrepancies in the development degree at the intra-regional level. Very closely linked to the regional development policy, some disadvantaged areas will be included among priority areas in the implementation of the regional development policy.

The components of systems represent themselves self-organizing complex systems, which means that there is a degree of freedom in their dynamics which translates into various responses to environmental changes in terms of the differentiated internal structure of their components (Ianos, 2008). Self-organizing internal structure determines the response to component interaction with the environment and the fact that internal organization is robust to external changes (requiring some intensity of external stimuli to change the internal structure) makes response different to a linear determinism. So, in environment change there is an opportunity for transformation within sub-systems, yet without causing it (as homeostasis in biology does). A certain degree of clustering of spatial units based on the common features of the above-mentioned socio-economic indicators does exist. In order to prove it we performed an 11-classes hierarchical ascending classification.

The three study-areas included communes belonging to the following classes:

- Area A, class No 8 communes (large elderly population, the share of population employed in agriculture is above average, similarly television users; population dynamics is negative, unemployment rate slightly below average); class No 9 communes (the share of population employed in agriculture is above average, negative internal migration and unemployment slightly below average).

- Area B, class No 1 communes (positive population dynamics, the share of employment in agriculture is above average, below average TV users); class no 9 communes (the share of population employed in agriculture is above average, negative internal migration, television users are below average, unemployment rate slightly below the average).

- Area C, class No 1 communes (positive population dynamics, the share of employment in agriculture is above average, below average TV users); class No 3 communes (internal migration rate above average, the share of population employed in agriculture is below average, below average TV users, below average infant mortality rate); class No 9 communes (the share of population employed in agriculture is above average, negative internal migration, below average television users, unemployment rate slightly below the average).

As seen, this area includes communes with very different, sometimes opposite demographic and socio-economic characteristics.

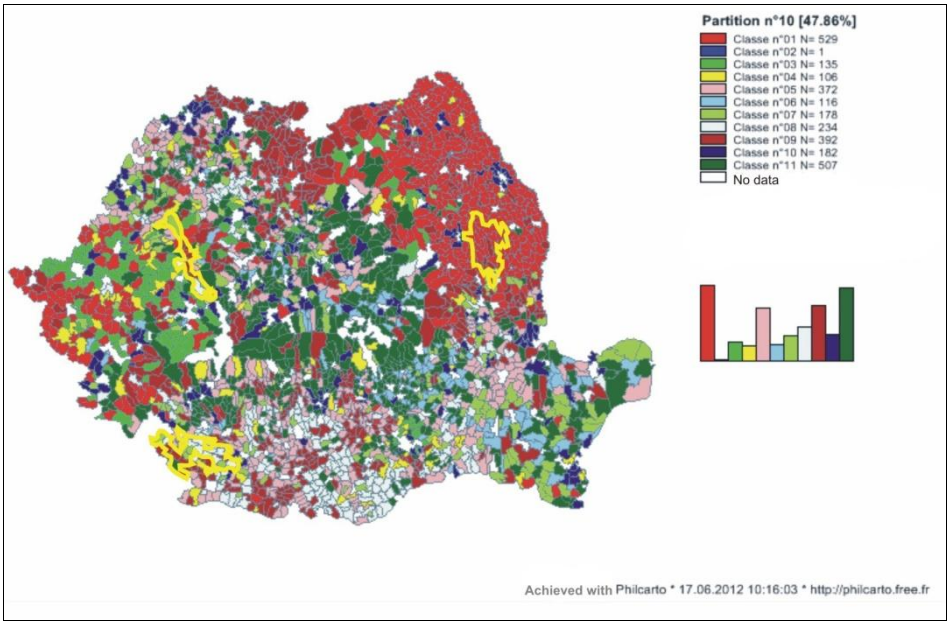

Fig. 2. Typology of communes, 2002

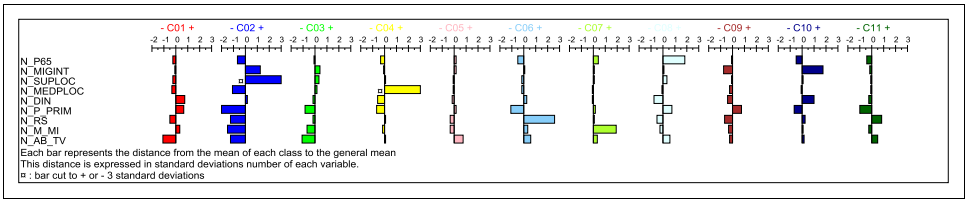

Fig. 3 Average profile of communes

Territorial synergism leads to the articulation of spatial structures resulting in a kind of spatial organization. Territorial synergism determines the orientation of territorial flows to and from certain centers of convergence. Through network connections, based on flow filtration, according to its quality and type, and flow production for a higher territorial level, permanent discontinuities are generated, a process that can be controlled and directed. The importance of discontinuities

consists in the individualization of spatial systems to be subjected to an appropriate treatment according to the particular problems facing each region.

The urbanization trend attracts the population and economic activities of remote rural areas to urban ones. Peripheral areas (mountainous and predominantly rural areas) register a loss of population because economic and social opportunities are missing. The depopulation of rural areas is a critical issue, which is not the case of rural areas located close to big cities, rural areas that are more attractive economically and offers more job opportunities. In turn, expanding urban settlements and infrastructure and the development of economic activities put pressure on the ecosystems and regional identity of the rural area which, through national integration, is expected to represent variety and diversity.

Spatial complexity at communal level

The-far-from equilibrium evolution of complex systems as stated in the second law of thermodynamics, discovered in mid-19th century, reads that heat flows move from higher-to-lower temperatures, being a kind of engine for streams. This proves that energy distribution is far from being in equilibrium and that the thermodynamic force, acting spontaneously, minimizes potential or maximizes entropy, time being considered irreversible. Entropy clarifies order and disorder emerging in the dynamics of complex systems due to "information uncertainty" (Shannon and Weaver, 1949).

Systems fluctuate, exchange energy, matter and information with their environment, but sometimes these fluctuations are so strong that they create "singularity" or "bifurcation", breaking the existing order (Prigogine, I. and Stangers, I. 1984). At this point the system "jumps" onto a higher level of order or organization, called by Prigogine "dissipative structures". Prigogine is convinced that order can exist spontaneously out of chaos through self-organization. The dissipative system is characterized by a balance of trade (energy input, entropy output) and spontaneous development of broken spatial symmetry (anisotropy) which can turn into a complex structure. Dissipation theory is used to designate feedback control laws in nonlinear systems.

Data on sectoral employment for two reference years (1992 and 2002) in areas previously designated as disadvantaged, were fed into Onicescu's mathematical formula of information energy index (IEI) by. The changes produced are relevant to the spatial complexity dynamics of these areas.

Generally speaking, when IEI ranges within certain values, we have the following assumptions:

- between 0.25 and 0.5 the workforce is not concentrated in the first two sectors of activity since the share or the first sector is no more than 66% of the workforce;

- between 0.5 and 0.7 the workforce can be concentrated in two or three sectors of which the first may hold 80% of total;

- at over 0.82, the share of the first sector exceeds 90% of the workforce.

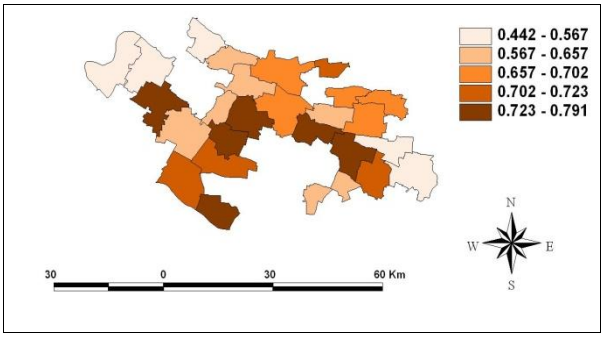

Fig. 4 Information Energy Index in Area A, 1992

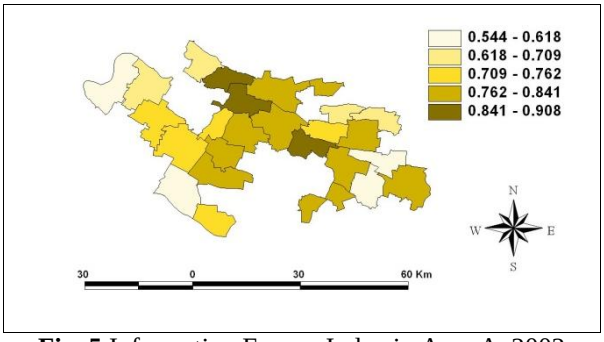

Fig. 5 Information Energy Index in Area A, 2002

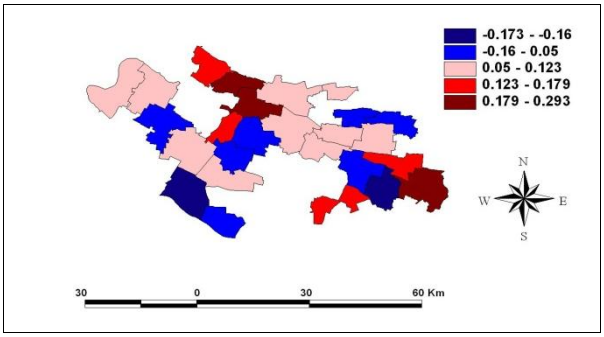

Fig. 6 Dynamics of the Information Energy Index in Area A, 1992-2002

In 1992, the highest Information Energy Index values were found in the communes of Punghina, Vlădaia, Jiana, Salcia, Carpen, and Vela, the lowest ones values in Burila Mare, Devesel, Livezile, Terpezița, and Vârvoru de Jos, the localities in which no activity sector includes more than 75% of the workforce. Within laps of only 10 years, the spatial complexity of the area changes, at the top of IEI being the communes of Poroia Mare, Padina Mare and Carpen, with Burila Mare, Gârla Mare, Terpezița, and Sălcuța covering the bottom of the table, as the share of the first activity sector does not exceed 80% of the workforce. This change in the hierarchy is due to the differentiated dynamics of spatial complexity in the 1992-2002 period, in that the communes experiencing significant IEI decreases were Gârla Mare, and Sălcuța which in 1992 had been among those with had the highest index values. Significant increases in IEI were recorded in the low-value communes of Poroina Mare, Padina Mare, and Vârvoru de Jos. These changes were due to modifications of the economic profile:

- decreases in the share of primary sector and significant increase in the share of tertiary sector where IEI was low;
- significant increases in the share of the primary sector and a significant decrease in the share of secondary and tertiary sectors where IEI rose, which was the most common situation.

Transition from a centralized to a decentralized economic system meant reaching a bifurcation point in the dynamics of spatial complexity. Depending on the economic factors that caused the turning point in economic development, spatial polarization relationships change in respect of the weakening or disruption of old relations and the emergence of new structures (Ianos et all, 2011). The relational structure of the new spatial system preserves "traces" of the previous one and for a shorter or longer period of time (depending on the policies adopted and their radicalism) entropy increases. System topology is the one that meets the

entropy level (organization) and the degree of independence of the subsystems, assuming the possibility of analyzing spatial relationships (networking and neighbor hooding).

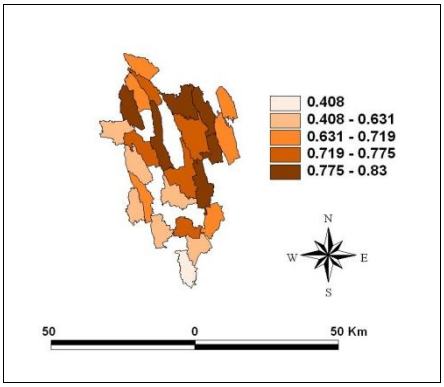

Fig. 7 Energy Information Index in Area B, 1992

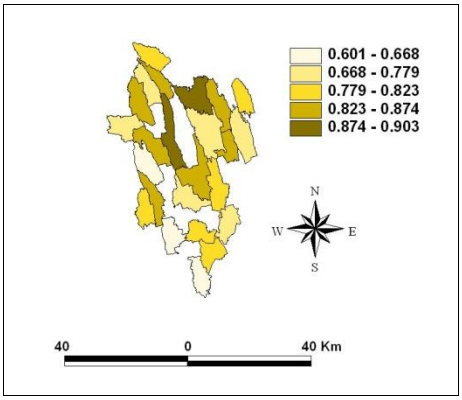

Fig. 8 Energy Information Index in Area B, 2002

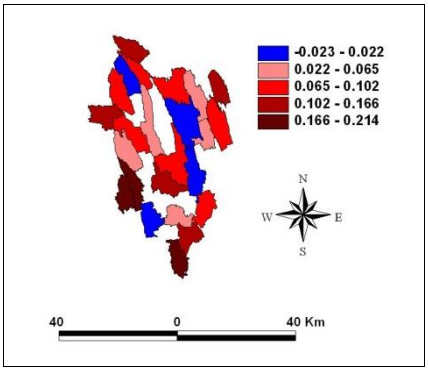

Fig. 9 Dynamic of Energy Information Index in Area B, 1992-2002

The general trend in Area B was of IEI increase that reflected in a slight modification of commune hierarchy in terms of index value. At the head of the table stood the communes of Voineşti, Ghergheşti, Iana, Stănişeşti, and Filipeni, but compared to the communes of Tătărăşti, Huruieşti, and Gohor growth was reduced both in 1992 and 2002. In 1992, Gohor had the lowest Energy Information Index value, the primary sector exceeding 50% in 1992 and reaching 75% in 2002 thanks to the positive dynamics of this sector.

Significant increase in IEI value was based on a rise in the share of the primary sector at the expense of the secondary and tertiary sectors. Even small index increases were based on the expansion of the primary sector and the shrinking of the other two sectors, but changes were small. Just one commune showed negative index dynamic which meant preservation of the share of the primary sector at 75% of the workforce.

During the turning point in the system's dynamics one cannot predict what relationships between the components are preserve and what relationship breaks down while new ones appear, due to increasing entropy in the system and the observer's inability to process a large quantity of information. Subsequently, related components are delimited creating, during evolution, some positive and negative feedback loops, and new directions for the system's development.

Area C has the narrowest gap dynamics compared with the other two areas, but the general index trend was increasing information energy.

Information energy index values indicate that the share of the dominant sector of activity was less than 75% for more than half the communes in 1992 and for half of those in 2002.

Changes in the hierarchy of communes according to IEI value were due to different increase rates and, very rarely, to different decrease rates. The IEI increasing meant augmentation of primary sector specialization of communes in the area, communes which in 1992 had a mixed economic profile (eg. Buceş, and Scărişoara) became deeply agricultural in 2002. Two communes (Almaşu Mare, and Budureasa), with a decreased IEI value, maintained a mixed economic profile.

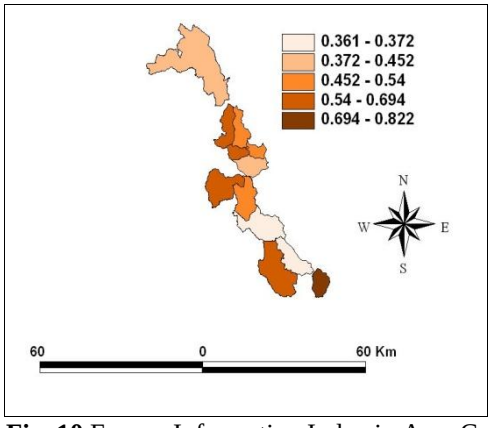

Fig. 10 Energy Information Index in Area C, 1992

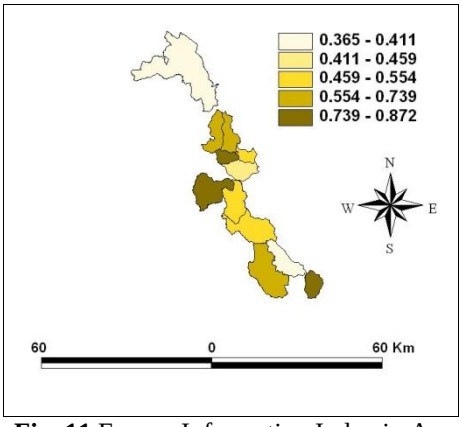

Fig. 11 Energy Information Index in Area C, 2002

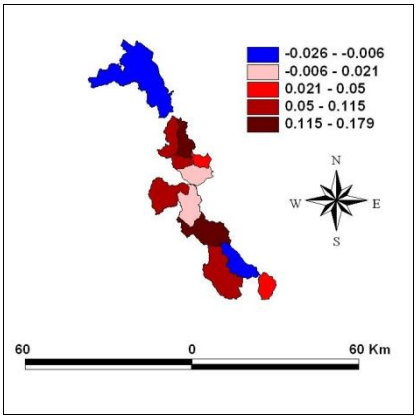

Fig. 12 Dynamic of Energy Information Index in Area C, 1992-2002

IV. CONCLUSIONS

To adapt to a changing environment, the system needs a variety of stable states large enough to react to any disturbances, but not so large as to make its evolution uncontrollable and chaotic. The appropriate states are selected according to their degree of fitness, either directly to the environment, or to the sub-systems that have adapted to the environment in an earlier stage. Formally, the basic mechanism underlying self-organization is variation (often driven by noise), which explores different regions of system state space until it enters into an attractor. This hampers future variations outside the attractor, thus restricting the freedom of the system's components to behave independently. This is equivalent to increasing consistency, or statistical entropy reduction that defines self-organization (Heylighen, 2002).

Negative population dynamics in Area A is associated with an aging population. On the other hand there are areas in which unemployment is depleted because young people, which probably had been made redundant in the tertiary or secondary sectors, in 2002 are migrated to seek a job elsewhere, while the aging population works in the primary sector.

In Area B, population dynamics is positive or negative, depending on the positive or negative balance of internal migration, basically a positive balance of natural movement. The low number of TV users/1,000 people indicates poverty. Reduced spatial complexity, based on the dominance of the primary sector is the cause of reduced Id value which also maintains a low complexity-forming vicious circle.

In Area C, people use to migrate when the share of the primary sector is reduced, which means that the secondary or tertiary sector lay-offs prefer to leave and seek employment elsewhere rather than remain and work in agriculture; when the primary sector has a high share, people use to migrate or not, a situation that influences population dynamics.

Aknowledgments

This work was supported by project: POSDRU/88/1.5/S/61150 "Doctoral Studies in the field of life and earth sciences", project co-financed through Sectoral Operational Program for the Development of Human Resources 2007-2013 from European Social Fund.

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Received: 06.09.2012
Revised: 02.11.2012
Accepted: 06.11.2012
Published: 20.12.2012