BABEŞ-BOLYAI UNIVERSITY OF CLUJ-NAPOCA
FACULTY OF GEOGRAPHY

Doctoral THESIS

STUDY ON THE IMPLEMETATION OF A GEOGRAPHIC INFORMATION SYSTEM IN THE HEALTH MANAGEMENT OF THE BIHOR COUNTY

- Summary -

Ph.D. SUPERVISOR
Ph.D. Professor IONEL HAIDU

Ph.D. STUDENT
FLORIN-IOACHIM MUREȘAN

2010

CONTENTS

Keywords: *health management, GIS, spatial autocorrelation, spatial changes, the Bihor County*

1. INTRODUCTION

The health system in Romania is currently facing very serious problems mostly due to mismanagement. The organizational and functional healthcare activities in hospitals are regulated and under the control of the Ministry of Health, the central authority for public health care, which unfortunately seems not to guide itself by an adequate management plan in place.

This paper seeks to study the possibility of implementing a geographic information system for the health management of the Bihor County. Therefore, through the use of the Geographic Information Systems (GIS), an analysis of the health system of the Bihor County will be made, for a time span surpassing a period of ten years (1990-2005).

The building and management of a GIS database comprising the health units at the county level and the elements within these units are the starting point for shaping the spatial representation of the health management.

Furthermore, the GIS technology could be of use in the assessment of the patients' accessibility to specialised medical care and that of the medical staff to the patients in urgent need of medical care.

The main objectives of the current research theme are:

- the description of the most important aspects (conceptual, legislative, administrative, financial, investment etc.) regarding the management of the health system in Bihor County;

- the building of a GIS database for some of the needed parameters in the health management of Bihor County;

- the presenting a GIS methodology for spatial analysis based on a vector support by the means of autocorrelation for the health domain;

- running applications of the GIS algorithms based on spatial autocorrelation so as to study the parameters of the health system in the Bihor County;

- detecting, through the use of GIS, some spatial changes in health system of the Bihor County after 1990.

2. GENERAL ELEMENTS OF HOSPITAL MANAGEMENT

This chapter is dedicated to presenting the general bases of hospital management. The conceptual, legislative, administrative, financial aspect and so on, will be focused upon in the present section. This chapter comprises as well a case study regarding the capital goods in the public health system of the Bihor County.

The functioning of each hospital implies two informational fluxes: an internal and an external one. The description of the composing elements will refer only to health services data and financial and accounting data. **Figure 2.1.** is a schematic representation of the informational fluxes of hospitals, the internal and the external one.

The internal informational flux **comprises:**

- The sections and care divisions and laboratories;
- The Statistical Service of the Hospital;
- The Administrative Service;
- The Financial and Accounting Service

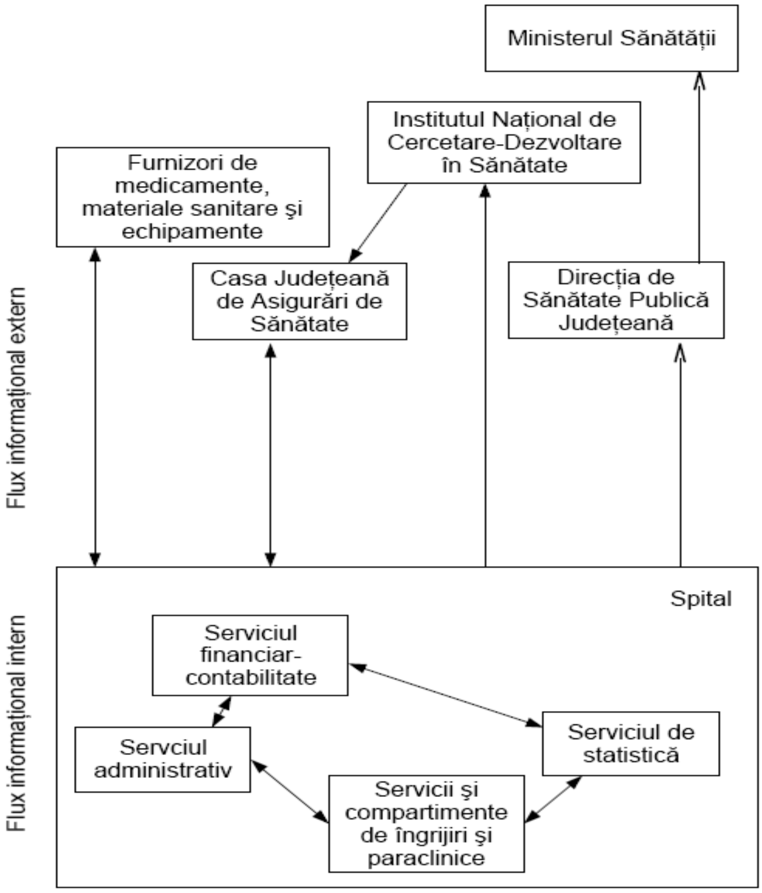


Fig. 2. 1. Informational fluxes of hospitals

The following components form the ***external informational flux*** of hospitals:

- The County Health Insurance House;
- The County Department for Public Health;
- The National Institute for Health Research and Development (**N.I.H.R.D.**)
- The medicine, medical supplies and equipment providers.

The financial manager of the health system must be able to control the financial flows in the organization. Good credit management and discount procedures for healthcare services could increase the revenues. With proper planning of the purchase of inventory, control can be exerted over the quality of services. The manager is the one who must decide what capital goods and equipment to purchase, a process requiring cash outflows, be it under the form of a total sum or leasing. The manager, dependant on the future plans, decides whether to make certain acquisitions or not. In addition, the manager is responsible for deciding whether to resort to credit when faced with a lack of money. Knowledge of these aspects is necessary for good financial management in the health sector.

The main sources of *investment financing* for hospitals in the public healthcare system are: equity (The Development Fund), the State budget and the capital borrowed. For the financial coverage of investments, hospitals should mobilize their own funds stemming from self-financing and only afterwards should turn to external resources.

In terms of *capital goods management*, effective management of the present assets is essential in order to improve delivery and the increase in accessibility to health services. The choice of capital goods meeting the needs of a medical unit involves a number of factors determining its functioning at optimal standards, factors such as: the building location, the communication network, utilities, climate and topography, etc.

The capital goods of a hospital medical unit described in this chapter are: *land and buildings, equipment and IT equipment, furniture (beds), high-performance medical devices.*

The first requirement for any medical service is to be both available and accessible to those who need it. It is obvious that when, in a community, the needed medical services are inexistent or unavailable or they exist and are available but not easily accessible, the quality care of the patients is low. The detailed study of five hospitals in Bihor shows their mono or multi pavilion character.

Accessibility refers to the user's possibility to obtain care/service in the right place at the right time, depending on the needs he/she has. It implies the absence of geographical, economic, financial, social, cultural, organizational restrictions or linguistic barriers.

Due to the complexity of the management of the assets in a building, our study comprises the analysis of five hospitals, the selection having been made according to their location and the medical services offered as general hospitals. The five hospitals are: The Oradea County Clinic Hospital; The Municipal Hospital „Ep. N. Popovici" Beiuş; The Municipal Hospital „Dr. Pop Mircea" Marghita; The Municipal Hospital Salonta; The City Hospital Aleşd;

3. THE CURRENT STATUS OF RESEARCH IN HEALTH MANAGEMENT

Among the many areas of application for the GIS technology and methodology, few can be as important as the health domain. GIS can help in various spatial applications when it comes to the health system, such as detecting the trends in the spreading of various diseases, the identification of areas with higher risks factors to certain diseases or to making associations between the occurrence a type of illness and other social or environmental factors.

The representation and analysis of the maps regarding disease incidence is important for the study of regional variability *(Lin G. et al., 2002; Danlin Yu, Yehua Dennis Wei, 2008)* and the public health. One of the first examples of mapping diseases through history is that belonging to the work of John Snow, in 1854. He registered the cholera victims' addresses and he identified the spatial relationship between them and the existing water sources. The map showed the victims' vicinity to certain water pumps, helping the medical community to find out that the disease was actually caused by water.

As time passed by, the interest for the use of geographic data in illness cases study analysis increased and various methods belonging to the area of Geography and Spatial Statistics emerged. The study of the geographical distribution of diseases can be divided in three main categories (*Craglia M., Maheswaran R., 2004*): the mapping of disease cases; the analysis of disease cases concentrating in certain areas; the ecologic analysis of factors that may cause the occurrence of disease cases. The first studies using GIS so as to determine the spatial distribution of certain diseases referred to very dangerous diseases which, however, didn't spread over a large territory.

One of the first studies of this type to be made was conducted by Openshaw and his collaborators (*Openshaw et al., 1987)* regarding the occurrence of childhood leukaemia.

A major health field where GIS is used as a research tool is Epidemiology *(Moore A.D., Carpenter E.T, 1999)* related to the environmental factors. In this field the studies focus on the connections between the illness and the physical environment along with the control and impact of the lifestyle factors such as smoking, diet and physical exercises.

Dunn and collaborators *(Dunn et al., 1995)* conducted another study on the use of GIS in exploring the connections between air pollution and health. In addition, Kingham (*Kingham, 1993*) attempted to establish a link between air pollution models and GIS, using the output data of these models in order to define exposure areas and afterwards to determine the link between these areas and the incidence of the disease.

The WHO Regional Office convened a meeting of the health and GIS professionals, at the National Institute of Public Health and Environmental Protection in Bilthoven, in 1990. The outcome was the idea of setting up a GIS for Health and

Environment (HEGIS), a matter discussed by Lepper and colleagues (*Lepper et al, 1995*).

In Romania applications using GIS for the mapping and the study of public health have been developed as well. As an example there is the application developed by the Department of Public Health of the Bihor County (*Tîrţ, 2009*) seeking the representation of certain public health data and indicators for the Bihor County and the presentation of the experience gained, in order to encourage the use of geographical information systems in the public health management of Romania.

4. THE DATABASE FOR THE GIS APPLICATION

4.1. SPATIAL DIMENSIONS. GEOGRAPHICAL ASPECTS

This chapter considers the presentation of the database needed in health management. Spatial dimensions are referred to the study area, the location of health entities as well as technical characteristics of GIS databases (database, graphics, database attribute).

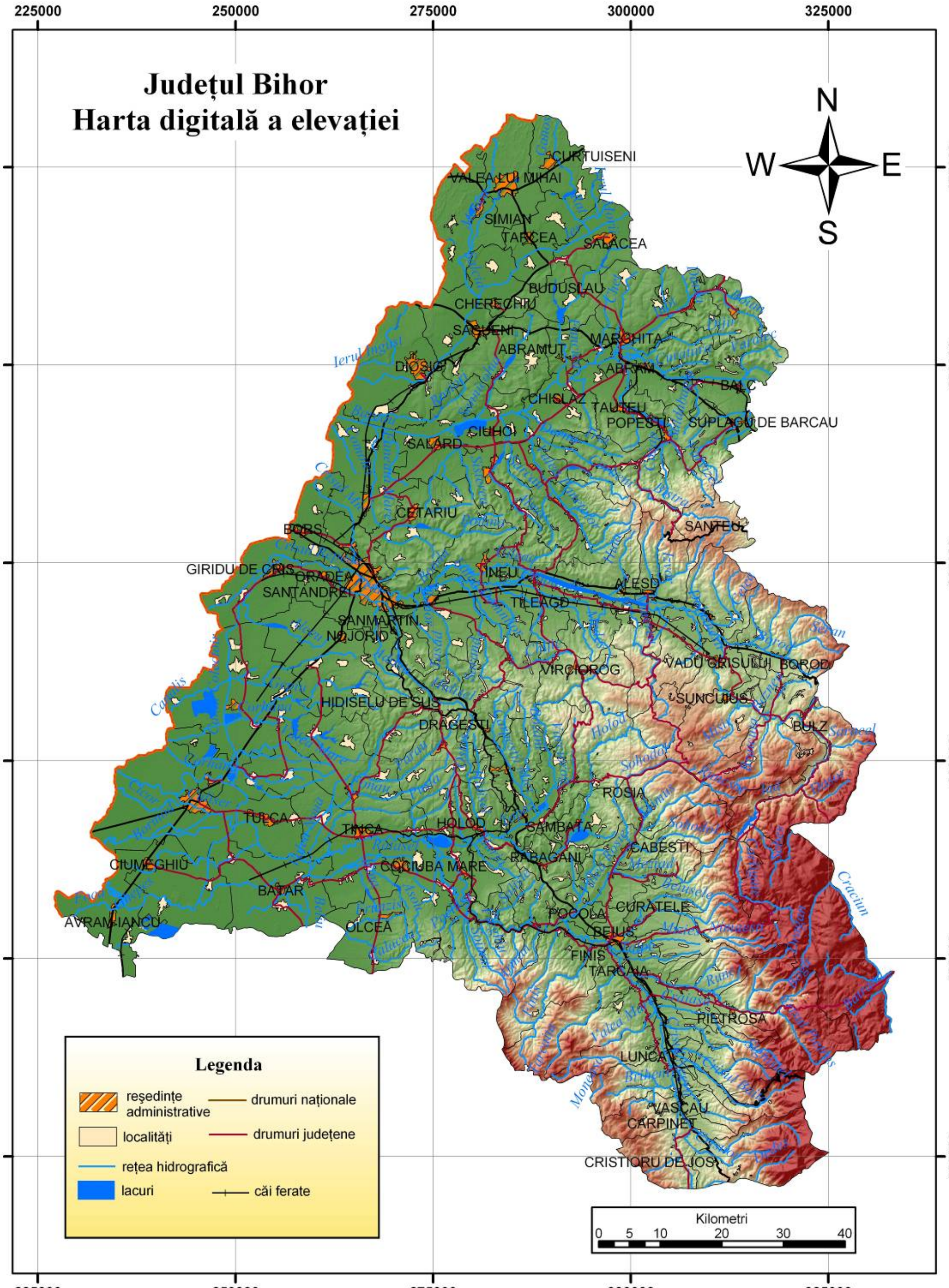


Fig. 4. 1. Physical map of Bihor County

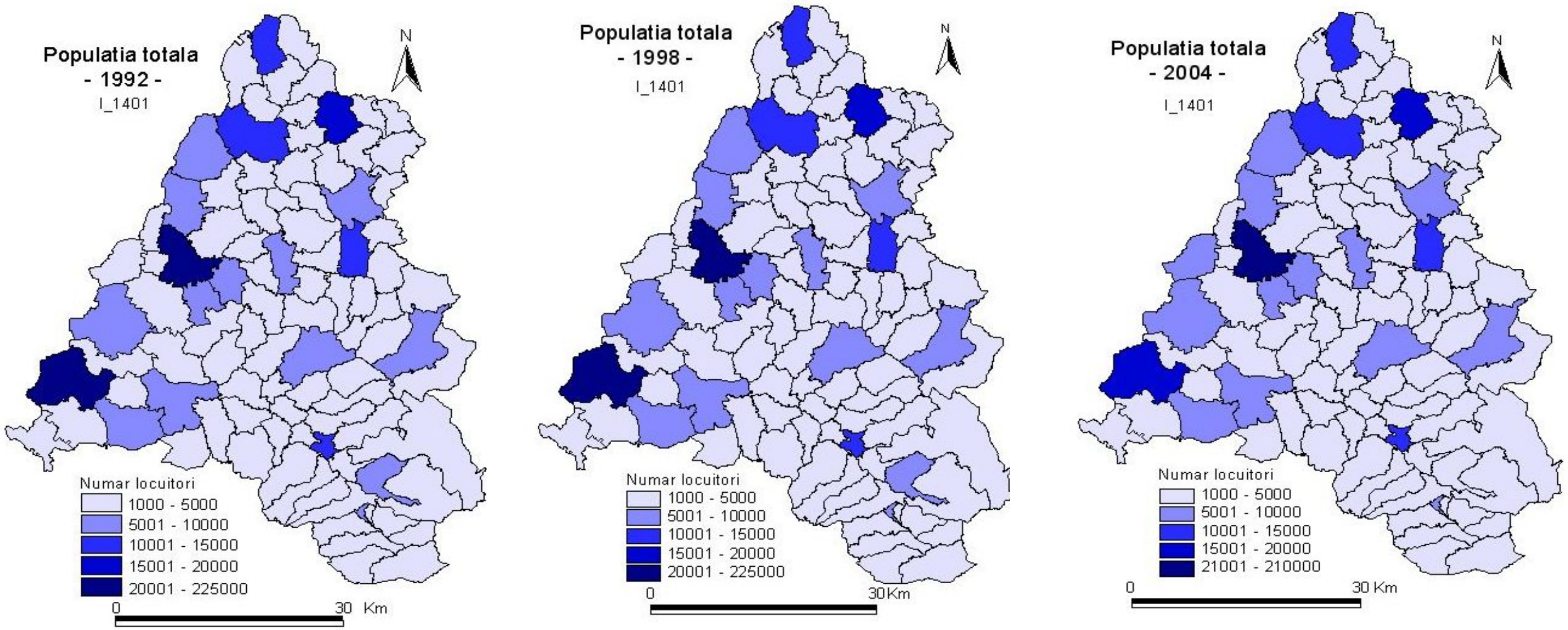


Fig. 4. 2. Population in Bihor county in the years 1992, 1998, 2004

Database needed for a study on integrated management in health care primarily includes internal elements of the health system (eg number of rooms, number of hospital beds, number of physicians, number of patients, etc..).

To these are added, of course, a number of geographic features (Fig. 4.1) of human, physical and social foreign nature, but often put their imprint on the work of the health system (eg, relief units, climate factors facilitate or constrain, as appropriate interventions in medical emergencies). The proposed GIS model is for Bihor county hospital management to take into account the territorial aspects of the study area. To ensure a comprehensive analysis there wes created a GIS database on the following geographic features for Bihor county: relief, hydrography, climate elements, locations, number of inhabitants in municipalities.

Human-geographical knowledge about the territory under the administration of county health care units are also an important step towards a more efficient management practices. Number of locations, population, distance in relation to settlements closest hospital, etc.. parameters to show their influence on the number of qualified medical staff, number of pharmacies, intervention time during a medical emergency, etc.. In Bihor county there are 455 district towns, 10 important towns and cities (six towns and four cities), 90 communes that have in administration beside the center of the villages, another 355 villages. Oradea is the county capital and other cities, in order of size, are: Beiuş, Margita and Salonta.

4.2. OBJECTS AND LOCATION OF HOSPITAL SERVICE AREA

The hospital type objects located in the Bihor county are:

I. Hospitals:

- *County Hospital Oradea (x= 269141,715; y= 622793,546);*
- *Children Hospital Oradea (x=266161,047; y= 623957,142);*
- *Obstetrics Gynecology Hospital Oradea (x= 268712,240; y= 621110,155);*
- *Infectious Diseases Hospital Oradea (x= 267441,211; y= 622164,913);*
- *Neurology and Psychiatry Hospital Oradea (x= 267818,522; y= 623087,979);*
- *TB Hospital Oradea (x= 268384,489; y= 624462,470);*
- *Rehabilitation Hospital Băile Felix (x= 270459,532; y= 614379,758).*

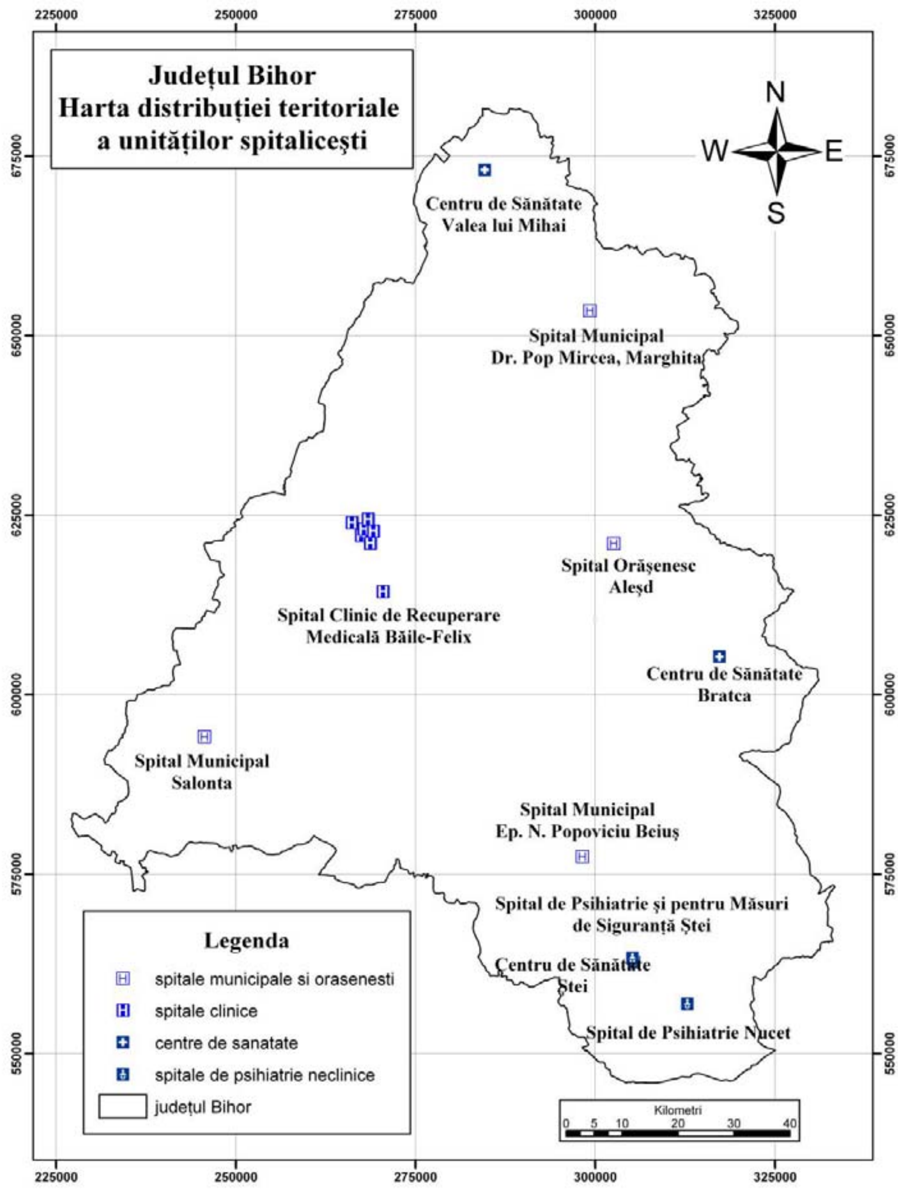


Fig. 4. 3. Bihor county hospitals

II. Municipal and town hospitals:

- *Municipal Hospital „Ep. N. Popovici" Beiuş (x= 298210,120; y= 577468,219);*
- *Municipal Hospital „Dr. Pop Mircea" Marghita (x= 299258,046; y= 653458,275);*
- *Municipal Hospital Salonta (x= 245646,892; y= 594151,126);*
- *Town Hospital Aleşd (x= 302577,181; y= 621054,792).*

III. Specialized Hospitals:

- *Psychiatric and Safety Measures Hospital Ştei (x = 305176,279; y= 563340,319);*
- *Psychiatric Hospital Nucet (x= 312831,158; y= 556942,817).*

IV. Health Centers:

- *Health Center Ştei (x= 305384,544; y= 562756,771);*
- *Health Center Bratca (x= 317275,463; y= 605282,461);*
- *Health Center Valea lui Mihai (x= 284620,432; y= 673102,640).*

In **Fig. 4.3**, the map presents the distribution of the four categories of hospitals with beds made on the basis of their topographical details. It can be seen balanced location of hospitals in the territory, which ensures adequate accessibility to public hospital services.

4.3. STATISTICAL/ATTRIBUTES DATABASE

The attribute table , the actual storage of data, can store the following types of information: number, text (character), date, logical, memo, image. File a DBMS standard requires each field (column) in the table have specified one of these types, and a width (number of characters reserved for those data).

For the study area was established a .dbf attribute database format that has the following structure:

a). *for polygon vector layers* – there was generated for each commune an attribute database for the years 1992, 1998, 2004, containing fields reffering to healthcare and demographic factors such as:

- Commune name
- Total population,
- Female population,
- People with permanent residence,
- Birth,
- Mortality
- Infant mortality
- Average number of employees in health and social work,
- Number of children enrolled in kindergartens
- Number of public sector hospitals,
- Number of clinics in the private sector
- Number of beds in hospitals - public sector,
- Number of beds in homes of birth - public sector,
- Number of beds in the nursery - the public sector,
- Number of doctors in the public sector

- Number of dentists in the public sector
- Number of dentists in private sector
- Number of dental practices - private sector,
- Number of technical dental laboratories - private sector
- Number of medical practices - private sector,
- Number of laboratories - private sector,
- Number of nurseries - public sector,
- Number of pharmacies - public sector,
- Number of pharmacies - the private sector.

Attributes of baza_date_1998

DENUMIRE	POP__TOT_	POP__FEM_	NASCUTIVII	DECEDATI	DECED__1AN	I_1524	COPII_GRAD	PAT__SPIT_
Girisu de Cris	4835	2480	53	86	3	56	166	0
Cefa	5848	2984	89	98	1	36	143	0
Nojorid	4310	2164	46	54	3	26	131	0
Bors	3161	1636	24	56	0	17	143	0
Santandrei	3767	1965	41	48	2	10	136	0
Sanmartin	7468	3821	97	86	4	637	282	335
Osorhei	5274	2685	56	73	0	26	176	0
Copacel	2367	1171	28	50	1	8	94	0
Sacadat	1854	993	19	42	0	32	52	0
Tileagd	6905	3474	89	111	1	54	248	0
Varciorog	2459	1215	25	38	0	7	85	0
Brusturi	4363	2182	70	72	2	35	137	0
Tetchea	2999	1520	42	53	1	10	65	0
Lugasu de Jos	3168	1555	47	55	3	8	89	0
Astileu	3991	1932	43	58	3	18	129	0
Magesti	2919	1454	30	41	0	11	140	0
Vadu Crisului	4515	2271	73	67	4	37	151	0
Auseu	2992	1499	42	49	2	37	85	55
Sinteu	1427	672	10	22	0	5	63	0
Oradea	222239	115879	1969	2237	36	5900	5914	3160
Biharia	5292	2717	45	94	0	37	187	0

Record: 0 Show: All Selected Records (0 out of 95 Selected) Options

Fig. 4. 4. Attribute database structure for polygon vector layers

In Fig. 4.5 it is shown, as a sample, a portion of an attribute table of the municipalities made for Bihor county in 1998.

b). *for point vector layers* - it was obtained an attribute database for the towns of Bihor county, and aswell for the hospitals in Oradea.

4.4. GRAPHICS DATABASE

Geographic Information Systems have the following roles:

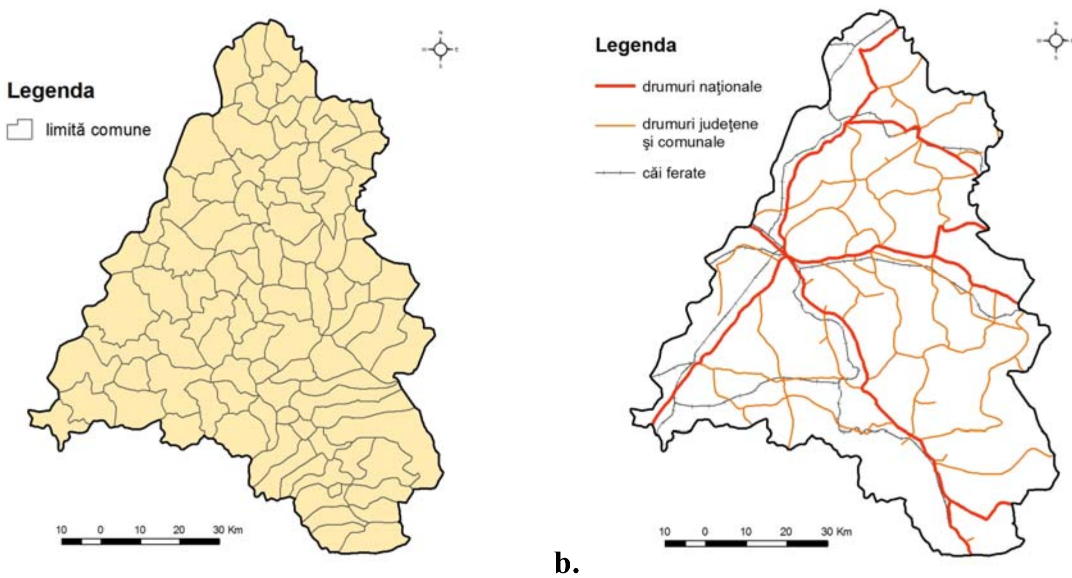
- Link any information on the place of origin (spatial location);
- Displays information as layers (layers) or thematic maps;
- Use the analytical capacity to answer questions, make correlations, predictions and improve the deficit in the traditional way of organizing data;
- Represents all geographic features in terms of geometry - point (for sampling the cases of the disease, a town center), lines or arcs (rivers, inland road and railways), polygons or surfaces (lakes, administrative-territorial units).

Graphic database made for the county of Bihor is mostly Shapefile vector format and has the following structure (Fig. 4.7 and 4.8):

- *Graphical base .shp polygon format* - on a set of health indicators in the communes in Bihor county.

- *Graphical base .shp point format*- the localities and hospitals.

- *Graphical base .shp polyline format* - for communication networks.



a. **b.**

Fig. 4. 5. Polygon (a) and polyline (b) graphical database

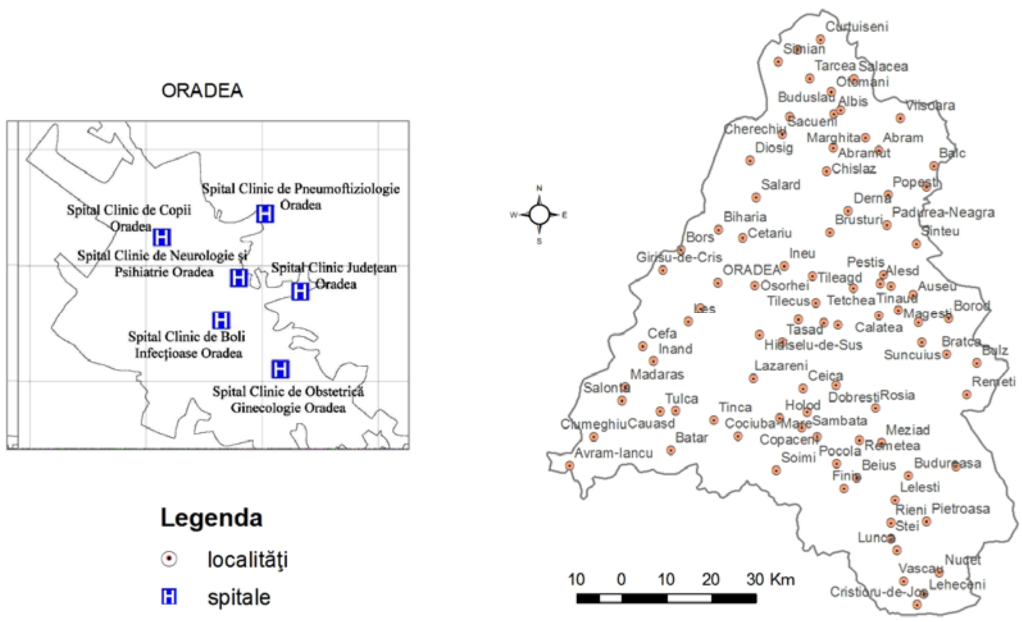


Fig. 4. 6. Point graphical database

5. SPATIAL ANALYSIS METHODOLOGY

This chapter highlights the role of GIS spatial analysis algorithm on a polygon vector support, based on geostatistical indicators of spatial autocorrelation *(Sokal R. R. et al., 1998; Lichstein J. W. et al., 2002; Diniz J. A. F. et al., 2003)*.

Spatial autocorrelation method has found application over time in various areas, including health. In Bihor county was built, therefore, a database of domain-specific parameters relating to health, for the years 1992, 1998 and 2004. There were statistically analyzed a series of parameters such as number of doctors, the number of nurses and auxiliaries, infant mortality and other domain-specific health indicators. The GIS software used is ArcView 3.2, which takes place through the commissioning of a script *(Space Autocorrelation)* developed by *Lee J. and Wong W. S. D. (2001)*.

5.2. METHODS USED FOR COMPUTATIONS

The geostatistical method for detecting spatial changes used for start is the *spatial autocorrelation (Haidu I. et al., 2009, Shaker R. et al. 2009)*. This study assumes that attribute values are possibly correlated and that correlation size can be attributed to specific geographical distribution of objects. To measure the spatial autocorrelation in a set of graphical objects should be discussed methods that can capture spatial relationships *(Roth N. E et al, 1996)* of the variables communes. Spatial autocorrelation can be a valuable tool for studying how health administration parameters are changing over time.

Thw GIS software used is ArcView 3.2, which takes place through running a script developed by *Lee J. and Wong W. S. D. (2001)* and it is named *Spatial Autocorrelation* **(Fig. 5.2)**.

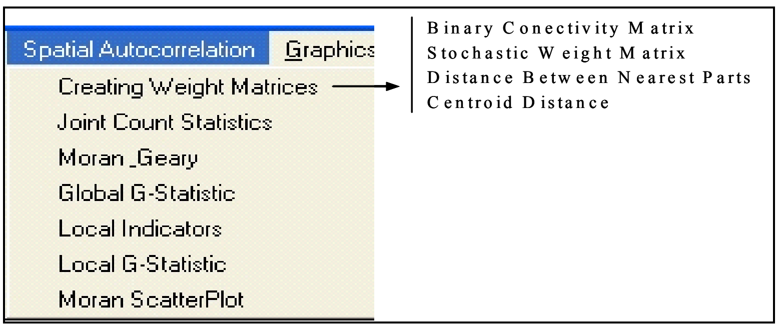


Fig. 5. 1. List of functions included into the *Spatial Autocorrelation* script

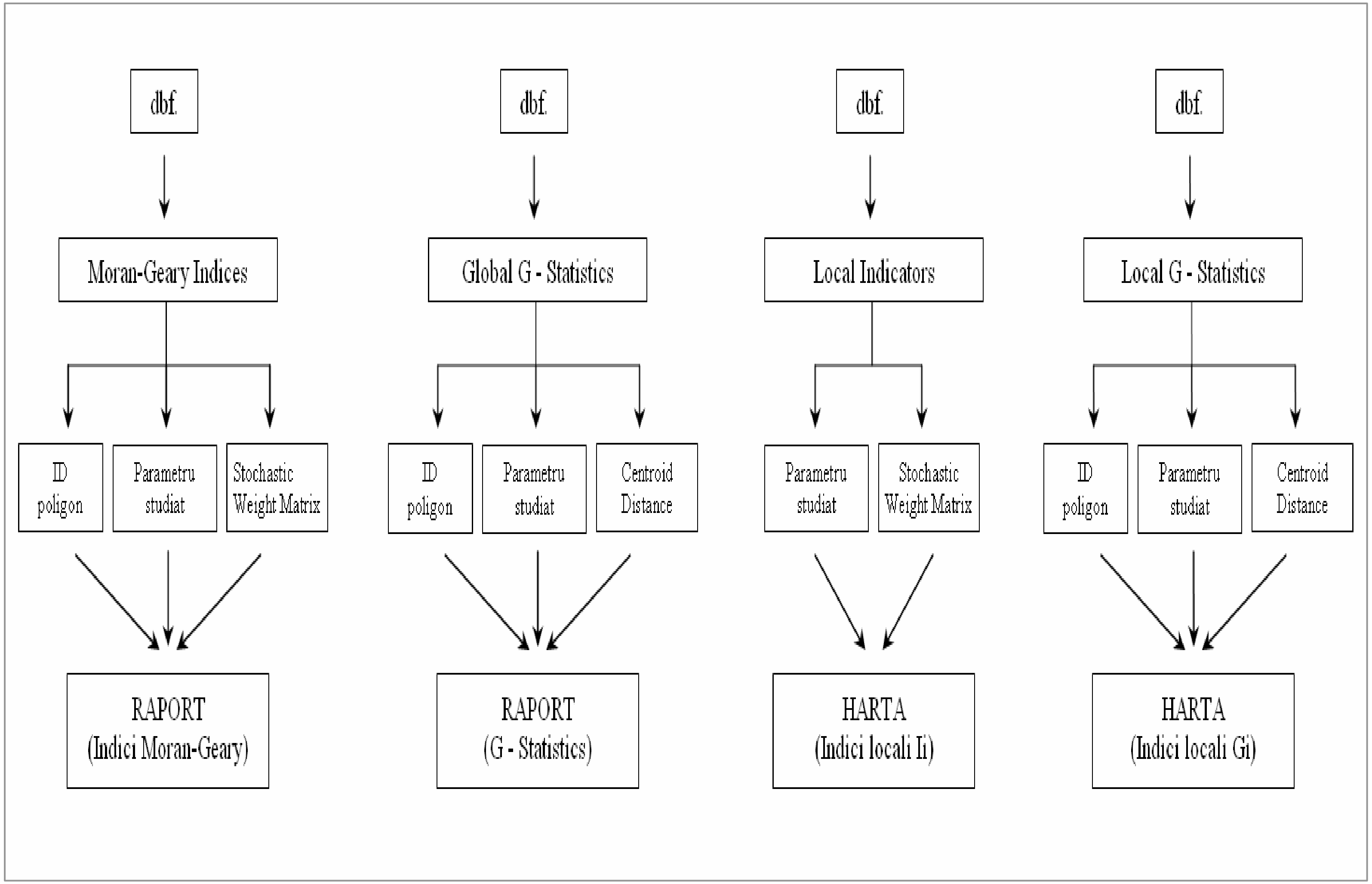


Fig. 5. 2. Algorithm schema for obtaining the spatial autocorrelation indices

A first step in applying the algorithm automated script as mentioned above cosists in generating the spatial matrices (*binary connectivity matrix, stochastic matrix weighted distance matrix fot the nearest neighbors, the matrix of distance between centroids of polygons*).

Based on the matrix generated by using the values of global and local indices, the spatial autocorrelation study is being performed, as shown schematically in Fig. 5.3. calculation algorithm. Must be specified that the results global indicators of spatial autocorrelation obtained by running the Spatial Autocorrelation script consist in reports that can be saved as .txt documents. Using the determination functions of local indicators of spatial autocorrelation lead instead to the production of cartographic representations to the study area.

5.2.1 Global indices of spatial autocorrelation

a) *Global Moran index* - measuring spatial autocorrelation on a variable one based on weight matrices previously generated. It is characterized by values between -1 (negative spatial autocorrelation) and 1 (positive spatial autocorrelation).

b). *Global Geary index* - is based on measurement of spatial autocorrelation, and, as in the case of Moran indicator, on one of the pre-generated weight matrices. It is characterized by values between 0 (perfect positive spatial autocorrelation) and 2 (perfect negative spatial autocorrelation), and 1 is the expected value (Expected Geary).

```
Moran = -0.00554538
Expected Moran = -0.0106383
Variance Under Normality = 0.00442257
  z-value = 0.0765825
Variance Under Randomization= 0.000357958
  z-value = 0.269185

Geary = 1.18724
Expected Geary = 1
Variance Under Normality = 0.00475042
  z-value = 2.71662
Variance Under Randomization= 0.0236149
  z-value = 1.21843
```

Fig. 5. 3. Generated report on global Moran and Geary indices. Example for the number of doctors in Bihor County in 2004

Global G-Statistics index has the advantage of detecting a hot or cool spot on the entire area studied, they can be identified as spatial concentrations. Similar to

Moran's I index and Geary's ratio, Global G-Statistics is also based on cross products statistics.

This indicator is studying the spatial concentration by identifying groups of polygons with high levels of the analized variable (hot spots), respectively those with low values (cold spots).

The automated of G-Statistics global index is done by calling Global G-Statistics function, where the output is a report whose structure is illustrated in **Fig. 5.6.**

```
G-Statistics = 0.361494
The Expected G = 0.430235
The Variance of G = 0.21641
Z-Value of G = -0.147767
```

Fig. 5. 4. Report generated on a global G-Statistics index . Example for the number of doctors in Bihor County in 2004

5.2.2 Local indicators of spatial autocorrelation

To highlight the heterogeneity of spatial autocorrelation must be taken into account the other sets of indicators too through which to conduct studies at local scale autocorrelation. Local spatial autocorrelation indices integrated in GIS via Spatial Autocorrelation script are: **Local Moran, Local Geary and Local G-Statistics.**

a). *Local Moran (I) Index* : Local high value of Moran shows a cluster of similar values (can be high or low), while a low value indicates an agglomeration of different values. The advantage of this indicator is that it produces a value for each polygon, for each commune and it allows their representation in graphical form.

b). *Local Geary (Ci) index* is the local version of the global Geary index.Using the ArcView script, Spatial Autocorrelation, obtaining local set of values on Geary index is automatic, as for Moran index via Local Indicators function.

c). Another way is to study the spatial correlation is the *local G-Statistics indicator*, which is derived from each area to indicate how the value of the area examined is associated with the values surrounding areas are defined by a certain distance "d".

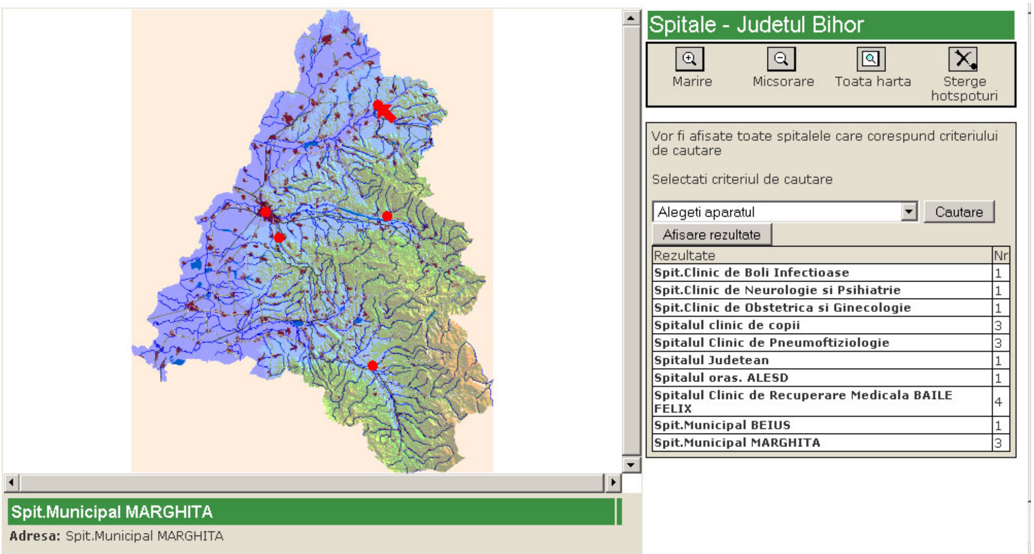
Global indicators of autocorrelation are centralized measurements for the entire region, while local indicators are describing the situation in each area. Some indices are suitable to identify spatial trends, while others have effectively distinguishing hot spots (hot spot) and the cold ones (cold spot). All these analysis methods are descriptive and exploratory for the database.

6. RESEARCH RESULTS

6.1. QUERY DATABASE ALGORITHM ON WEB-GIS SUPPORT

The application called "**interactive map**" is composed of a map, Apache Web server, MySQL database server, a Java applet to display the map and the pages written in PHP scripting language.

It can be used if desired as an end user to have access to the digital maps on the Internet and make search jobs, calculate distances, query the database with visualization of both the location and the point sought related information. Of course you can also perform zoom operations and also displayed an option, through which can be displaied the entire map (**Fig. 6.1**).



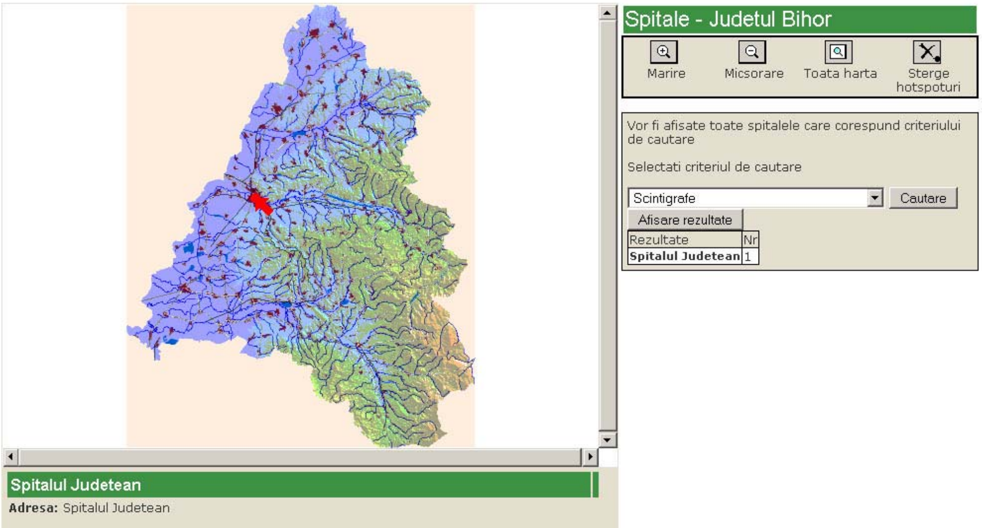


Fig. 6. 1. Hot spots for hospitals in Bihor County

6.2. RESULTS ON SPATIAL AUTOCORRELATION INDICES AND THE ANALYSIS OF SPATIAL CHANGES

Results which were obtained from the application of GIS spatial analysis functions using spatial autocorrelation indices are presented in the form of maps for 11 health area parameters in the range 1992-2004.

We summarize below the results obtained when studying the parameters "number of doctors" and "number of pharmacies.

Regarding the parameter 'number of doctors ", during 1992, the values of spatial autocorrelation (Local Moran and Local G-Statistics Indicators), interpretations of geographical and health management are:

a. Local Moran indicator - as shown in Fig. 6.3. resulting maps are dated on the three time periods studied, namely 1992, 1998 and 2004.

-1992 - In Oradea and suburbs, Local Moran has the lowest level and is actually negative (see legend). Interpretation of management consists in identifying the largest gatherings of doctors in town and it's hiterland (communes Borş, Paleu, Biharia and Sânmartin). We speak here of eight large hospitals (County Hospital, Children's Hospital, Hospital for Neuro-Psychiatric. Infectious Hospital, TB Hospital, Maternity Hospital, Military and C.F.R. Hospital), eleven clinics (including two dental) and fifty-seven urban and communes clinics . In other major cities in the county, Beiuş, Marghita, Salonta and Aleşd, values are moderately high (similar low values are not next), which shows a group of doctors in addition to general hospitals, clinics and dispensaries;

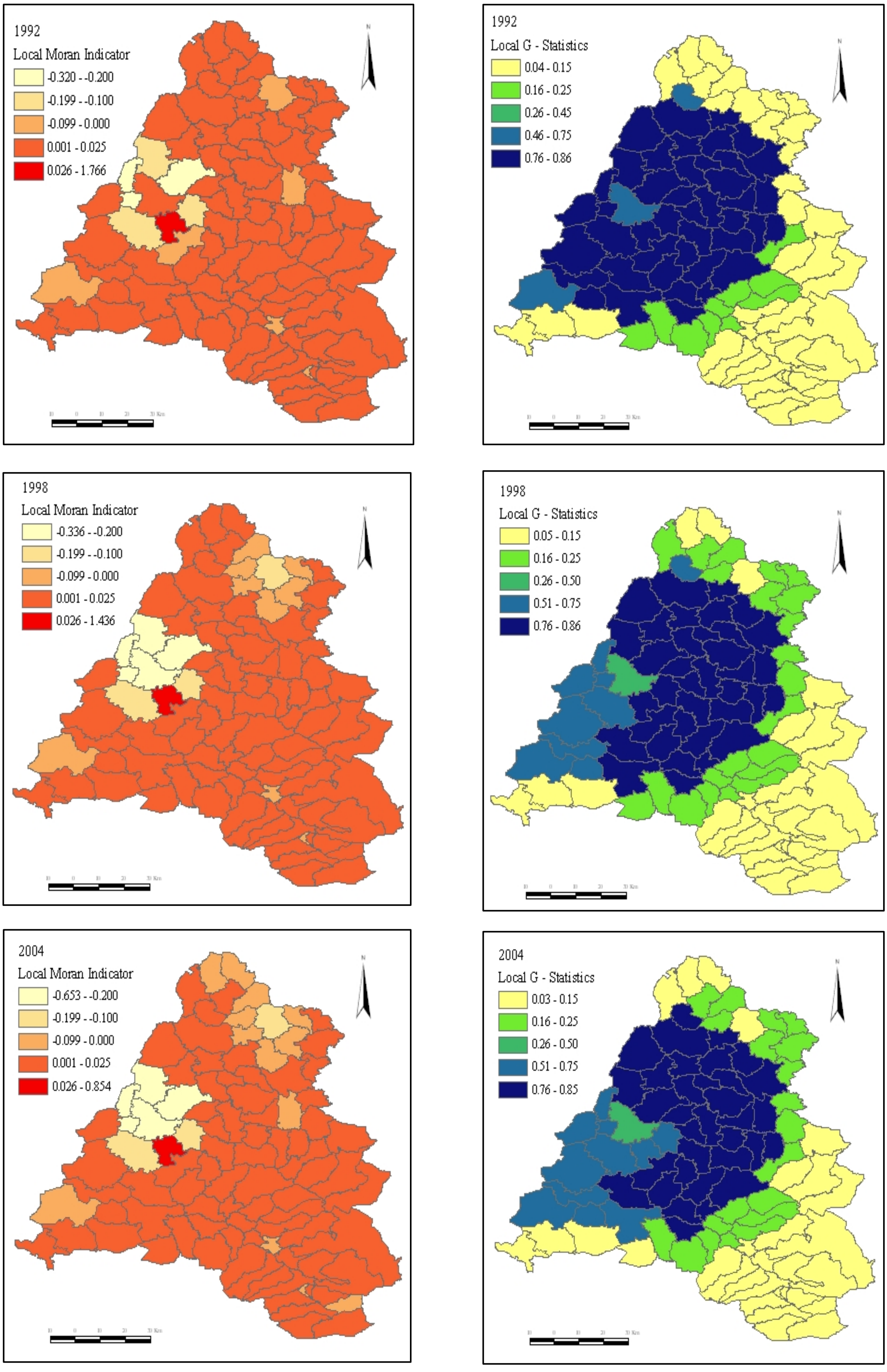


Fig. 6. 2. Values of local indices of spatial autocorrelation for *number of doctors* parameter

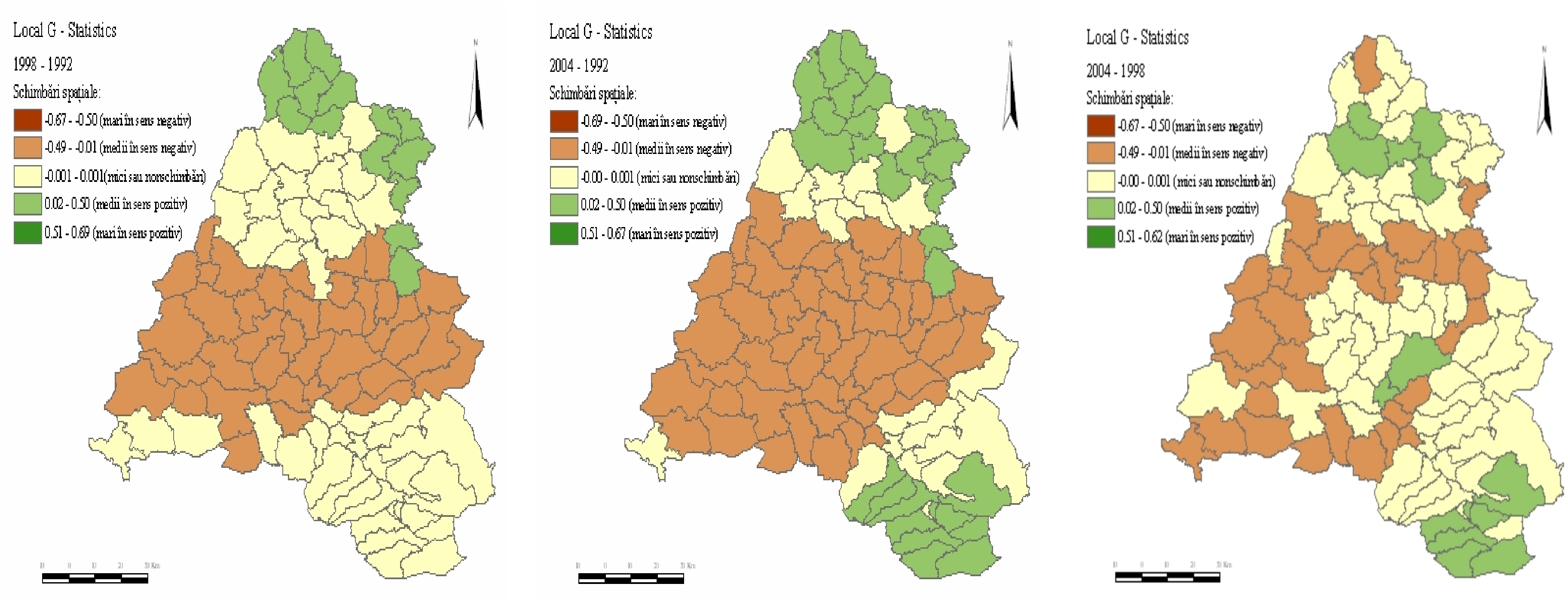


Fig. 6. 3. Differences between the values of the spatial autocorrelation indices, in bounded intervals, *number of doctors* parameter

-1998 - Note that decreasing the level of development of the local Moran value extends the Oradea, with an extension to Baile Felix, through the establishment of the clinical departments and the revitalization of Oradea County Hospital and Rehabilitation and Medical Balneology Hospital Felix; the phenomenon is repeated almost identically in the city Marghita with increasing number of medical specialties and therefore the sections of the hospital in town;

-2004 - Highlights the values of Local Moran slightly increasing in places: Salonta, Popești, Săcuieni, Valea lui Mihai and Nucet. The explanation lies in the founding of five new health and social units, one for each of the localities listed above, with over 700 beds in total.

b. Local G-Statistics - we represent the estimated values and statistical dispersion maps in Fig. 4.3, managerial interpretation was made in the context of standardized score:

-1992 - Accumulation space is made up of similar value, highly stressed in the area bounded by the following locations: Salonta, Oradea, Aleşd and Beiuş, resulting in a positive Z score, the density of doctors in this area being more pronounced since the socialist era with respect to the rest of the county;

-1998 – in Salonta area, there is a marked depopulation, an example being Sânicolau Român village, the lack of economic infrastructure and thus jobs, clinics doctors migrating to areas that benefited from the rapid development of manufacturing, such as Rieni and Sudrigiu communes(two modern factories producing soft drinks and fast-food) that attracted labor and including Beiuş and Stei cities. Geographical analysis indicates a spatial cluster of values, lower Z score tends to become negative.

-2004 - If we focus on Oradea metropolitan area and suburban communes (Biharia, Paleu, Borș, Sânmartin, Sântandrei) note that since 1992, shows a continuous decrease clutter space, Z score ranging around zero.

Regarding the parameter 'number of pharmacies' from the public-private sector of Bihor County, in the period 1992 - 2004 results are as follows.

a. Values of Local Moran, defined as the maps in Fig. 4.22. presents the following issues:

- The period 1992 - 1998 is characterized by exploratory legislative, privatization in this sector is only beginning;

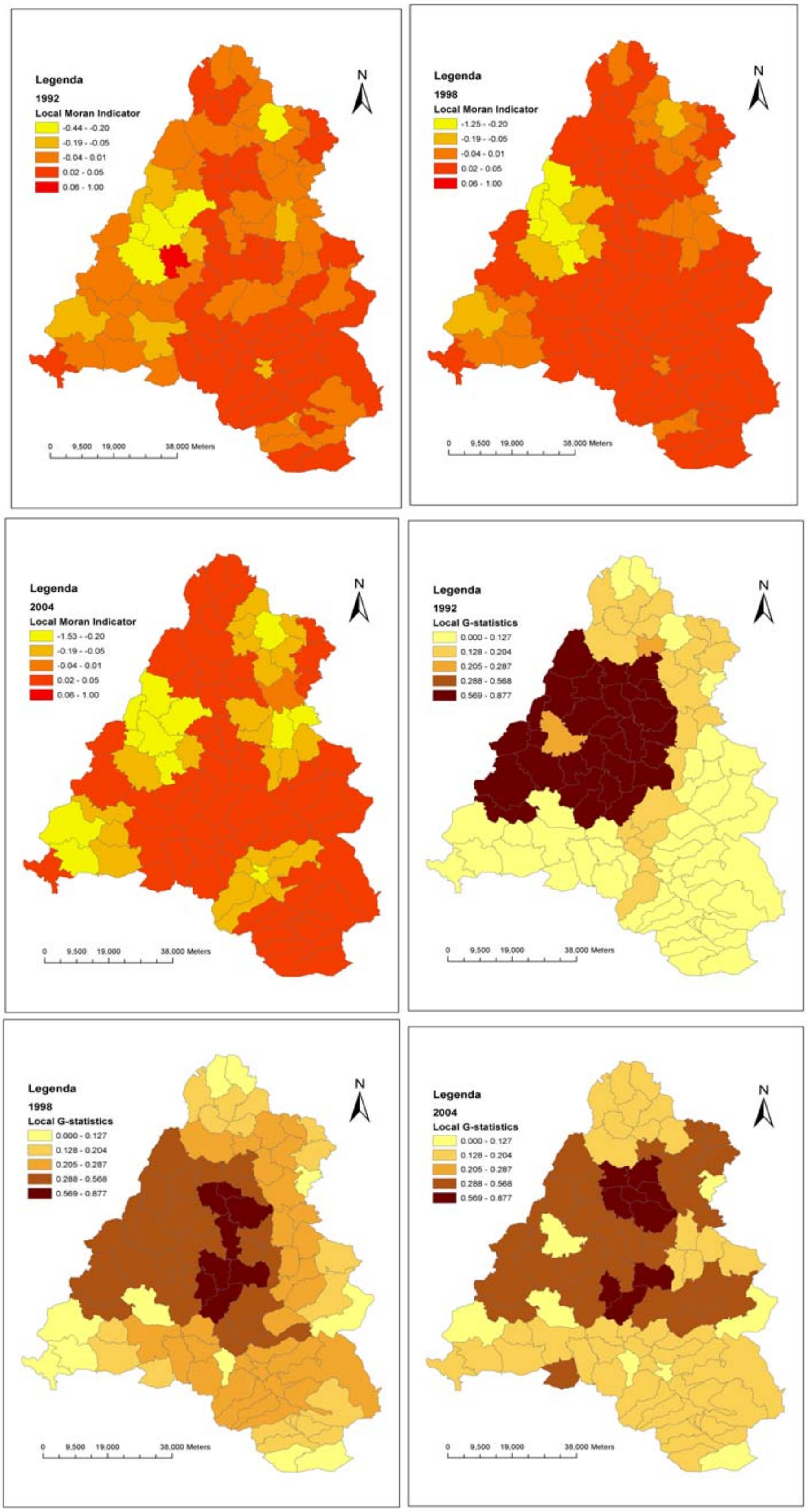


Fig. 6. 4. Values of local indices of spatial autocorrelation: *Pharmacies public-private sector* parameter

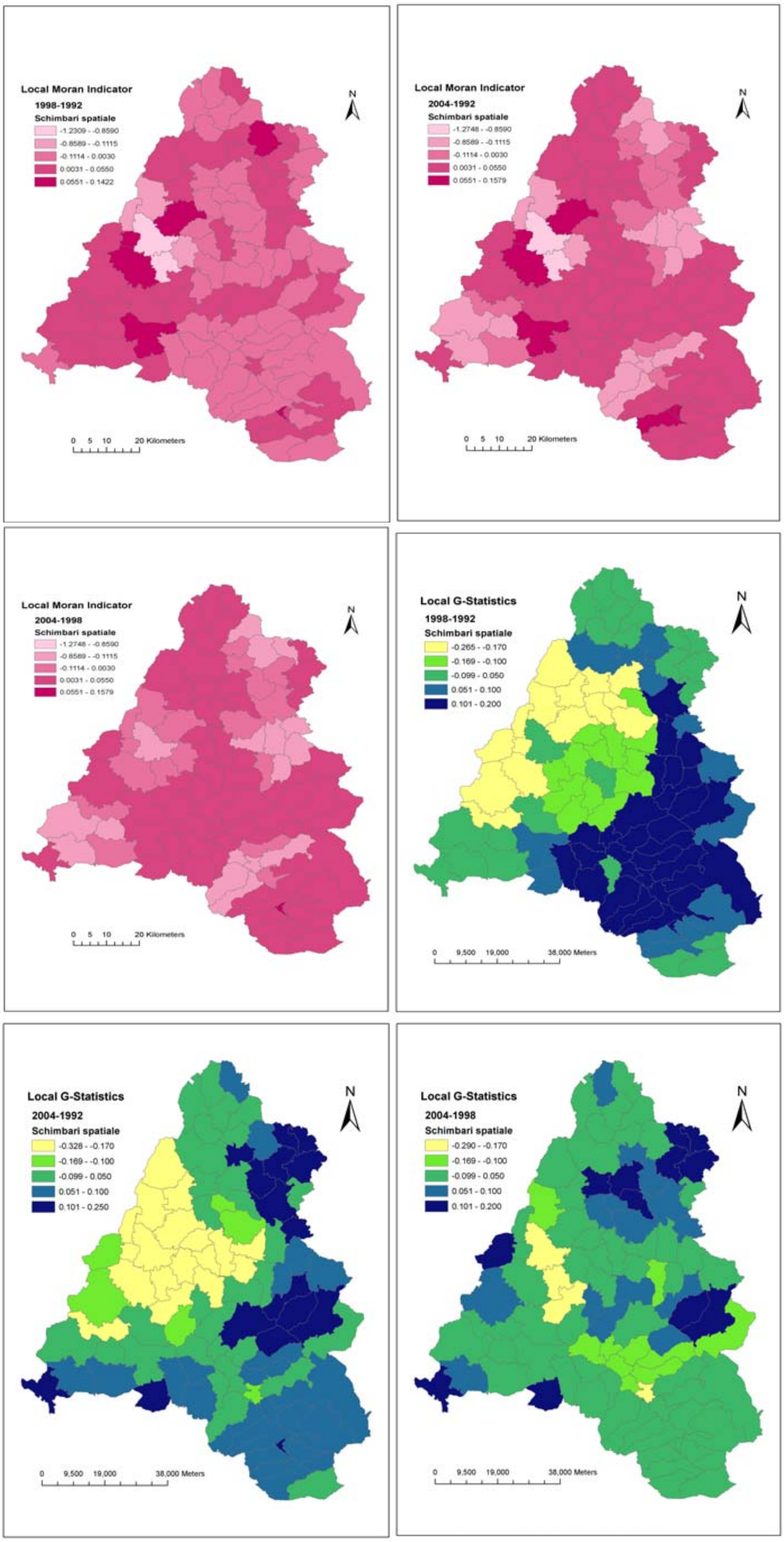


Fig. 6. 5. Differences between the values of the spatial autocorrelation indices, in bounded intervals, for *Pharmacies public-private sector* parameter

- During 1998 - 2004, we are witnessing an "explosion" on the establishment of private pharmacies, clustered mainly in urban areas, but they were covered by the end of the range studied, the countrysidearea too.

b. Changes detected by local G Statistics, configured in the maps' legend of **Fig. 4.23.** highlight the major spatial change management nineties compared to **2004**, namely, the domination of the private over public sector in the area, and pharmacies area too, almost to extinction of the previous.

Analysis by local *G-Statistic* indicator highlights, between 1998 and 1992, large spatial changes in a positive way especially in the eastern half of Bihor county (communes Popeşti, Auşeu, Vadu Crişului, Roşia, Pomezeu, Căbeşti, Remetea, Drăgăneşti, Tărcaia, Curăţele, Budureasa, Bunteşti, Finiş, Lazuri de Beiuş etc.) and large negative changes for a group of villages in the western part of the county (Diosig, Salard, Ghirişul de Criş, Cefa, Nojorid, Cetariu, Sârbi, Brusturi etc.). Between 2004 and 1998 are less space changes highlighted.

7. CONCLUSIONS

The legislative changes during the investigated period didn't influence in a significant manner the establishment or the abolition of hospitals, contrary nevertheless to the Health Centres.

Regarding the spatial change of the **number of doctors** parameter, two distinctive areas emerged by analysing the G-Statistics indicator for the 1992-1998 time span:

a). an area with high levels of positive changes, bordered by the Salonta, Oradea, Marghita Aleşd settlements;

b). an area with high values, but in a negative sense, bordered by Bratca, Beiuş Nucet and Ştei settlements.

The analysis performed on the same parameter for the 1998-2004 period shows the occurrence of two smaller areas, with high values, separated nevertheless by clusters of communes with lower values in terms of spatial changes (the perimeter Valea lui Mihai, Săcuieni, Diosig, Sălard, Biharia).

The local changes indicated by the Local G-Statistics for the **number of dentists** parameter reveal the major differences in management since the year 2000, as contrasted to the ’90s (the private sector dominance in dentistry over the public sector, leading to the disappearance of the latter). In this area as well, the reform was made in a typical aboriginal manner, leaving much of the population without financed dental care services.

Spatial changes in the **number of children enrolled in kindergartens** analysed through the use of the local indicator G-Statistics for the years 1992-1998 reveal the highest values, in a positive way, for the North-West of the County (the communes Simian, Valley Michael Tarcea, Curtuişeni, Cherechiu, Diosig, Salard) and the East of the County (the communes Bulz Bratca, Şuncuiuş, Dobreşti). The significant spatial changes in the negative sense were noted for the Tetchea settlement.

In between 2004 and 1998 large spatial positive changes were registered for the communes Auşeu, Şinteu, Aleşd, Popeşti, Dobreşti. The biggest negative change took place in the Western settlements of the County (the communes Diosig, Salard, Ciuhoi, Cetariu, Osorhei, Bors, Sântandrei).

The Geographic Information Systems, through their specific data and functions constitute essential tools in health management, both in terms of issuing documents of authority and especially as support for decision making.

The use of GIS in *the management of capital goods* helps to improve the database through measurements and relevant up-to-date data. It constitutes a highly useful analysis, simulation and strategy development tool. The various scenarios and their consequences can be viewed quickly so that decisions are much easier to take and more efficient, as well as the planned actions that are more effective.

It is certain that the studying upon the Geographic Information Systems utility in health management can be further investigated by implementing other spatial analysis models and by the development of geospatial models, adapted to the needs of the health system.

SELECTIVE BIBLIOGRAPHY

1. Andronicescu A., (2008), *Managementul schimbărilor*, Editura All, Bucureşti;
2. Anselin L., Griffith D., (1988), *Do Spatial Effects Really Matter in Regression Analysis*, Regional Science Association, no. 65, pp. 11-34.
3. Anselin L., (1995), *Local indicators of spatial association—LISA*, Geographical Analysis, 27, pp. 93–115.
4. Berwick D., (2009), *10 Steps to Better Health Care*, New York Times Editorial.
5. Black M., Ebener S., Najera Aguilar Patricia, Vidaurre M., El Morjani Zine, (2004), *Using GIS to Measure Physical Accessibility to Health Care*, Paper presented during the 2004 International Health Users conference, Washington DC.
6. Boots B., (2002), *Local measures of spatial association*. Eco-science 9, pp. 168-176.
7. Brown P. J. B., Hirschfield A., Marsden J., (1995), *Analysing spatial patterns of disease: some issues in the mapping of incidence data for relatively rare conditions*, în de Lepper et al., *The Added Value of Geographical Information Systems in Public and Environmental Health,* Kluwer Academic Publishers, Dordrecht, pp. 145-163.
8. Carr-Hill R., Place M., Posnett J., (1997), *Access and the utilisation of healthcare services*, Concentration and Choice in Health Care, London: Financial Times Healthcare;
9. Craglia M., Maheswaran R., (2004), *GIS in Public Health Practice*, CRC Press; ISBN: 0415306558.
10. Cromley E. K., McLafferty S., (2002), *GIS and public health*, The Guildorf Pres, New York.
11. Croner M. C., (2003), *Public health, GIS, and the internet*, Annu. Rev. Public Health, 24, pp. 57–82.
12. Daina Lucia, Mureșan F. (2008), *Managementul calității–accesibilitatea populației la serviciile medicale în județul Bihor*. Studia Universitatis „Vasile Goldiş" Arad,
13. De Lepper M. J. C, Scholten H. J, Stern R. M., (1995), *The Added Value of Geographical Information Systems in Public and Environmental Health*. Kluwer Academic Publishers, Dordrecht.
14. ESF, (1995), *Environment and Health Research Needs in Europe. Chairman's*

Report of a meeting held in association with WHO/Europe, Leicester, 24–26 May.

15. Field R., (2010), *History of Health Care Reform,* Dept. of Health Management and Policy, Philadelphia.
16. Gatrell A.C., Löytönen M., (1998), *GIS and Health Research: An Introduction*, Taylor & Francis, ISBN 0-203-26998-5.
17. Getis A, Ord J. K., (1996), *Local spatial statistics: an overview. L*ongley PA and Batty M., editors; Spatial analysis: modeling in a GIS environment, *John Wiley & Sons, New York*, pp. 261-277.
18. Green C., Hoppa R. D, Young T. K, Blanchard J. F.. (2003), *Geographic analysis of diabetes prevalence in an urban area*. Social Science & Medicine **57**, pp. 551-560.
19. Haidu I., Crăciun A. I, Costea G, Mureşan F. (2009), *Using GIS for detecting spatial changes in the health system administration domain. Analele Ştiinţifice ale Universităţii „Al. I. Cuza" Iaşi*, ISSN: 1223-5334.
20. Haidu I., Mureșan F., Daina L., (2007), *Building management in public sector of health care, with and without GIS.* Geographia Technica, Nr.1- Cluj-Napoca Univesity Press, pp. 18-23.
21. Hanchana Nakhapakorn, Supet Jirakajohnkool (2006), *Temporal and Spatial Autocorrelation Statistics of Dengue Fever*. Dengue Bulletin vol. 30, New Delhi, India;
22. Lang Laura, (2000), *GIS for health organization*, ESRI 380, New York.
23. Le Sage J. P., (1999), *A family of geographically weighted regression models*. Regional Science Association International Meetings.
24. Lee J. and Wong D., (2001), *Statistical analysis with ArcView GIS*. New York: Wiley & Sons Inc.
25. Legendre P. (1993), *Spatial autocorrelation: trouble or new paradigm?*, Ecology, 74, pp. 1659-1673.
26. Lichstein J. W., Simons T. R, Shriner S. A, Franzreb K. E., (2002), *Spatial autocorrelation and autoregressive models in ecology*. Ecological Monographs 72 (3), pp. 445-463.
27. Lin G., Allan E. Diane, Penning J. Margaret, (2002), *Examining distance effects on hospitalizations using GIS: a study of three health regions in British Columbia, Canada*, Environment and Planning, A 34(11), pp. 2037 – 2053.
28. Lovett A., Sünnenberg Gisela, Haynes R.M., (2003), A*ccessibility to GP surgeries in South Norfolk: a GIS-based assessment of the changing situation 1997–2000, în*

Socio-economic Applications of Geographic Information Science; Innovations in GIS 9, Taylor & Francis Routledge, ISBN: 0203301072.

29. McGarigal K., Cushman S. A., Neel M. C, Ene E., (2002), *Fragstats: spatial pattern analysis program for categorical maps.* Computer software program produced by the authors at the University of Massachusetts, Amherst. Available at thefollowing web site: *http://www.umass.edu/landeco/research/fragstats/fragstats*.
30. Moore A. D., Carpenter E. T., (1999), *Spatial Analytical Methods and Geographic Information Systems: Use in Health Research and Epidemiology*, Epidemiologic Reviews, vol. 21, no.2, pp. 143-461.
31. Mureşan F., (2010), *Managementul imobiliar din sistemul sanitar public al judeţului Bihor cu metode clasice sau prin Sistemul Informatic Geografic*, Studia Universitatis „Vasile Goldiş" Arad, Seria Ştiinţe Economice, Partea a-II-a „Vasile Goldiş" University Press: pp.149-154.
32. Mureşan F., Daina Lucia, (2008), *The buildings management in the sanitary public system of district Bihor-detailed research*. Geographia Techninca ,Nr.1, University Press, Cluj-Napoca: pp.46-55.
33. Mureșan F, Țîrț D. P, Haidu I., (2006), *Specific features of GIS database for hospital management. An example for Bihor County*. Geographia Tachnica, Nr.1, Cluj-Napoca, University Press: pp.133-138;
34. O'Carroll P. W., Yasnoff W. A., Elizabeth Ward M., Ripp H. Laura, Martin E. L., Ross D.A., Hinman A.R., Saarlas K., Foege W. H., (2002), *Public Health Informatics and Information Systems*, Springer, ISBN: 0387954740, Press of America.
35. Ricketts T. C, Savitz L. A. (1994), *Access to health services, în Ricketts*. T.C. et al; Eds. Geographic Methods for Health Services Research. Langham, MD: University.
36. Shaker R., Crăciun A. I., Grădinaru Ionela, (2009), *Relating land cover and urban patterns to aquatic ecological integrity: a spatial analysis*. Geographia Technica, Cluj-Napoca, University Press, Nr. 1, pp.76 – 90.
37. Skinner R., (2010), *GIS in Hospital and Healthcare Emergency Management*. GISP, Sturbridge, Massachusetts, U.S.A..
38. Snow J., (1855), *On the Mode of Communication of Cholera*. 2nd Ed, John Churchill, New Burlington Street, London, England.
39. Sokal R. R., Oden N. L, Thomson B. A., (1998), *Local spatial autocorrelation in a biological model*. Geographical Analysis 30, pp. 331-354.

40. Taylor F. W., (1911), *The Principles of Scientific Management*. New York and London, Harper & brothers;
41. Țîrț D. P, Mureșan F. (2006), *Aspecte generale privind aplicarea Sistemelor de Informații Geografice în sănătate publică și management sanitary*, Acta Medica Transilvanica, Nr. 1, Sibiu, pp.16-18.
42. Ţîrț D. P. (2009), *Applications Of Geographic Information Systems In Public Health*, Acta Medica Transilvanica, Sibiu, v. II, no. 1, 2009, pp. 210-213.
43. Wagner H. H., Fortin M.J., (2005), *Spatial analysis of landscapes: concepts and statistics*. Ecology **86** (8), pp. 1975-1987.
44. Wong D., Lee J. (2005), *Spatial analysis of geographic information with ArcView GIS and ArcGIS*. New Jersey: Wiley & Sons Inc.
45. Xiaoyi Ma, Tao Pei, (2010), *Exploratory Spatial Data Analysis of Regional Economic Disparities in Beijing during 2001-2007*, Proceedings of the Joint International Conference on Theory, Data Handling and Modelling in GeoSpatial Information Science, Hong-Kong, ISSN 1682-175z, pp. 241-244.
46. *** OMS (Organizația Mondială a Sănătății), (2007), *Mapping public health resources and risks*.
47. *** Ordonanţa Guvernului României Nr. 70 din 29 august 2002 privind „Administrarea unităţilor sanitare publice de interes judeţean şi local".
48. *** National Agricultural Statistics Service, (2000), *Retrieved on* 6 January 2007 *from http://www.nass.usda.gov/Statistics_by_State/Wisconsin/index.asp.*
49. www.who.int/health_mapping/resources/MPHRR_may07.pdf
50. http://www.census.gov/census2000/states/wi.html.