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SOCIAL VULNERABILITY IN BUCHAREST: AN EXPLORATORY SPATIAL DATA ANALYSIS APPROACH

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ABSTRACT. – Social Vulnerability in Bucharest: An Exploratory Spatial Data Analysis Approach. This study examines the social vulnerability of Bucharest through a spatial exploratory analysis. Changes from the past 20 years at urban development in Romania, and particular in Bucharest, are reflected into an increasing social vulnerability. The profile is constructed by numerous social processes to which population has been faced it to. The aging of population, increasing urban density, lower wages, and school graduated, living conditions are just a few of the indicators showing social vulnerability in Bucharest. Data provided by the National Institute of Statistics, CPUMB are used to explore the existence of spatial clusters significant as social vulnerability areas. Methodology framework is constructed on the basis of spatial analysis by analyzing the results of SoV index. The added value to the scientific literature resides in a different approach of calculation – score Hull, instead of the additive model proposed by Cutter *et al.* (2003). The result is a step forward to the mapping of vulnerability in the city of Bucharest, which should provide solutions and possible decisions.

Keywords: *social vulnerability, ESDA methodology, SoV index, Bucharest.*

1. INTRODUCTION

The interest in assessing population vulnerability increased steadily for the past two decades. It was a direct consequence of population expansion in number and its concentration in areas likely to be affected by destructive events where the risk of exposure to hazards is high. The result is that more and more human systems, ranging from states to the local communities, confronted with human and material losses have decided to tackle these issues. The goal is to diminish the losses to a minimum and, to develop programs for helping the local population to cope with possible harsh conditions. To do this the academic research addressed various indices for measuring vulnerability. The different approach and various methodologies were incongruous, without a good correlation between their programs and the scientific results (Fekete, 2009).

Different studies in the field of natural hazards assessment were rapidly developed because of the rising interest of the researchers in answering the new challenge. The differences among these studies are great. The discrepancies in literature starts with the conceptual framework (Cutter *et al.,* 2003), continues with the academic tradition

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and affiliation while trying to balance the target of the studies with the analysis scale, passing through numerous methodological practice, examining differently the factors involved as the data allowed (Dwyer *et al.* 2004; Gall, 2007) and finishes with a large area of results obtained in similar conditions (Boholm, 1998). Moreover, the integration of studies conducted at different scale of analysis is a continuous effort, showing good results in regional approaches (Kumpulainen, 2006) and global analysis (Nakamura *et al.,* 2001). At institutional level, different summits and events for a better management of hazards are also on a positive trend (Rio Conference 1992, IDNDR, 1990-1999, World Conferences on Disaster Reduction in Yokohama 2004, The International Strategy for Disaster Reduction (ISDR) 2001).

Romania is a country with a high seismic activity (550 earthquakes/year as noted by Armaş, 2006), and an increasing number of hydro-graphical hazards even in cities centers with rivers. The national studies focused on hazards are in a direct relation with occurrence of such events and especially with their magnitude. After the 1977 earthquake, the academic activity for seismic activities was greatly supported. This meant good results in the form of mapping the seismic risk at national level for the first time (Bălan *et al.,* 1982). In this period, Bucharest was also in the center of attention (Cornea and Radu, 1979). Studies determined by the next important earthquakes (1986, 1990) were the next to follow with the interest focused on national level (Lungu *et al.,* 1995; Tanislav *et al.,* 2009). But the regional and urban analyses are few and between large intervals of years.

The catastrophes are well represented in Bucharest, a city where the destruction caused by the earthquake in 1977 is often brought to attention by almost every small seismic activity and intense media promotion. The increased attention after such events is nevertheless exaggerated, but their small perception by the people determines the only coherent projects for evaluation the sensitivity of population against events with high natural risk. The most important measure of the authorities was a survey of all the buildings with high earthquake risk in Bucharest which were signaled with a red dot (Lungu *et al.,* 2000). With the exception of this program, the interest in helping the population to cope with various natural risks is reduced. The reasons are many, but the most important one is represented by the difficulty in detecting the areas with problems due to the absence of data or their opacity. Because of this, the data cannot be used frequently for improving urban management and nurture better policies. Moreover, there is a lack of reaction from the authorities and the society as a whole for requesting analysis. In this context, the study of vulnerability and connected topics within Bucharest has manifested itself only in sporadic individual initiatives.

The studies directed on analyzing the social vulnerability of the largest city from Romania – Bucharest – are few and started in the last decade (Mândrescu *et al.,* 2004; Armaş and Neacşu, 2003; Armaş, 2006; S. Rufat, 2009). The most recent initiative with a large goal belongs to I. Armaş which developed the HERA program (2007-2011). This study is concerned with the integrated assessment of city vulnerability in order to inform the population and authorities quickly and well. The success of the program is determined by the continuous monitoring with the help of an IT system for multicriterial and multidimensional evaluation of the state of the urban system in vulnerability and risk studies (hera.ase.ro/obiective).

The study of phenomena and processes at regional or local level has been even more intense, determined by the GIS development and the integration of statistical methods in them (Getis and Ord, 1992; Wise *et al.,* 2001; Anselin *et al.,* 2002 and 2006; Takatsuka and Gahegan, 2002; Rey and Janikas, 2004; Levine, 2006; Rey and Anselin, 2009). Many advantages were created and continue to emerge from this integration. A first advantage is that of a direct observation of the space in which analysis is conducted by its visualization at scale. An emphasis was on the fact that there is a much improved handling in data use and a complex integration for observing different processes and relations (Bailey, 1994). Spatial processes can be easily identified as clustering, or hot spots noticed as useful for understanding the spatial characteristics of functional structure and regional development. Last but not least, this combination allows analysis in various fields that supports the economic decisions (understood as administration, planning and management of elements from territory). Adding to the properties of phenomena reflected by data, though exploratory spatial data analysis – ESDA, it is possible to highlight eventual errors, to state work hypothesis from the spatial point of view of our data. Within this large framework pointed out by hazards impact and spatial analysis, Bucharest is the case study for analyzing the social vulnerability.

The current study on statistical exploration of spatial data connected to the social vulnerability from Bucharest proposes for analysis some methodological refinements where the index developed by Cutter et al. over time (1996, 2000, 2003, and 2007) is obtained slightly different: the additive score is replaced by a variant in which a different formula is adopted – the Hull score. The latter has been adopted for a better understanding of the way in which the index maps the reality in Bucharest, but also because of its successful use in the identification of regional disparities as used in Romanian literature (Ianoş, 1997; Sîrodoev, 2008). The comparison of statistical image of SoVI can be further considered as useful in perspective because the results can be reused for more validation with other studies concerning the social vulnerability in Bucharest; this is the case for the study conducted by Armaş (2007-2011) and Rufat (2009). The decision for measuring the vulnerability with the help of SoVI methodology emerges from its application in the EU (Kumpulainen, 2006), from its proposal as solution for regional management in Portugal (de Oliveira Mendes, 2009) and its adoption for mapping of regional vulnerabilities from Norway (Holand *et al.*, 2009). The scale of such analysis is the regional one and while Bucharest is at an inferior level, the study tackles this situation by the importance given to Bucharest through its function as a capital, but also by the high degree of population density in a small area highly affected by hazards.

In this theoretical account the goal of the study is to understand the concentration of population vulnerability and to assess the resulted image. Thus, the emphasis of the study is on spatial depicting of the clusters. For achieving this goal, as well as the other two, the exploratory spatial data analysis (ESDA) is used. The spatial method allows the exploration both statistical as well visual of social vulnerability focused on Romania's Capital. The advantage of the spatial methods application relies on the highlighting of the first law of the geography "Everything is related to everything else, but near things are more related than distant things" (Tobler, 1970, p. 236). In the current case is possible to stress the spatial dependence of the vulnerability areas situated next to each other even if they may be further apart among Bucharest.

The study contains the following structure: the first part aims at indicating the issues which are at the basis of the utilization of social vulnerability concept. The second part has as a goal the presentation of the study area and the data used in the analysis. The methodology is covering the third part, where the techniques used for factors and cluster identification are commented. The last part is reserved to the discussion of the results obtained by the application of the methods.

2. CONCEPTUAL ISSUES IN THE LITERATURE

In the field of vulnerability analysis there are many studies emerged in different contexts. The resulted profile of the vulnerability research shows a heterogeneous image at almost every level (results, methods, approach, theory etc.) (Boholm, 1998; Gall, 2007; Fekete, 2009). Under the stimulus of international organizations, states, changes of paradigm regarding the global evolution and even of the increasing natural hazards, the studies of vulnerability can be structured in three major groups (Rufat 2009):

- the approach centered on financial assessing of foreseeable losses;
- the emphasis of vulnerability factors though algorithmic or matrix methods for developing a representative index;
- the systemic approach, where the highlighting of vulnerability origin and the evaluation of policies involved in risk management are tracked.

These can be included in another 3 direction of analysis:

- the identification of the condition determining the vulnerability of the people or the places importance for it in the case of some extreme natural events occurrence;
- the supposition of vulnerability as social condition in which the society demonstrates resilience against the hazards;
- the integration of the potential exposure focused on microscale or regional level.

In the framework established by these directions, the explanation of social vulnerability remains a difficult topic. The lack of unity especially regarding the concepts used, where definition are overlaying, diverging or imply another linguistic register and then at the level of data available, determines that the main reason of the current studies – mitigation planning – to be still unresolved. Furthermore, the inconvenience of good quantitative representation represents another major issue (Cutter *et al.,* 2003).

In this case, the study presented here follows the geographical framework, where social vulnerability is a dimension of the 'hazards of place' model (Cutter, 1996; Cutter *et al.,* 2000; Cutter *et al.,* 2003). The model is successfully applied both in the US and more recently, in Europe. This general understanding addressed in this model is that social vulnerability can be referred as a "measure of both the sensitivity of a population to natural hazards and its ability to respond to and recover from the impacts of hazards" (Cutter and Finch, 2007, p. 1).

3. STUDY AREA AND DATA

Bucharest, the capital of Romania, represents the space for analysis. It has around 1.9 million inhabitants (INS 2002, 2011) or almost 10% of the country population, gathered in a compact territory (228 km2) in which the probability of hazards occurrence is high. Two elements determine here a high risk: the fact that the city is relatively closed

(cca. 150 km) to the Vrancea seismic area and the geological structure of the aluvial plane on which is situated. Studies concerned with seismic risk showed that the constructions are very susceptible to damage (INCERC, Lungu *et al.,* 2000). In addition to that, the urban development of the city emphasized strong inequities, many areas being still undeveloped and with few urban elements of intervention. In these areas, the improvised interventions in the buildings structure and the deficient infrastructure (age, abandonment, selective renewal etc.) enhance negatively the risk. Another issues is that the chaotically development after the 1990 determines the improper circulation in the city when the big rains occur. This situation produces some floods of many aged buildings from different parts of the city. The image of natural hazards from the city of Bucharest is enhanced by the risk of breaking the dam at Morii Lake if some conditions will be met.

The natural hazards aren't the only elements triggering a high risk. In the history of the city it may be found that the fires have played an important role, even if it is at a small scale for the past century. For example in the past 5 years there have been many small fires all over the city, especially in poor areas, but also some important ones in the so called commercial complex of Europe (situated in the eastern part of the city). Moreover, this situation is completed by the economic and social evolution of Romania, in which Bucharest has been its hallmark. The shocks supported by the population in the case of rapid transition to new social, political and economic structures have allowed a great sensitivity of the vulnerability.

The study comprises the residential areas, extracted from the census areas from the year 2002. The solution in the study was to rely on a better scale, but also because the determination of census areas has been an arbitrary one and could produce analysis or representation errors. The statistical social-demographic data have been provided by the National Institute for Statistics (INS), while those concerning the spatial limits of the residential areas come from the Urban and Metropolitan Planning Center of Bucharest (CPUMB). Table 1 shows the statistical dimension of the population living in 154 statistical units, distributed among the 6 administrative sectors of Bucharest.

Statistical Descriptives of Population in Bucharest

Table 1

Mean	Median	Standard Deviation	Minimum	Maximum	Sum	Count
12508.7	12373	3758.84	5550	24451	1926334	154

4. METHODOLOGY

Many and important statistical application on spatial level marked the past 20 years (Fisher and Getis, 2010). The spatial statistic analysis started with the development of EDA (Tukey, 1977), which evolved into exploratory spatial data analysis (ESDA) once the computing power and technology allowed that, at the beginning of the '90s. The method comprises of set of techniques which allow the easy depiction of statistical data by their visual representation, in order to facilitate the estimation and testing of the models. Complex phenomena as that of social vulnerability can be represented

with the help of ESDA for highlighting patterns and different characteristics of spatial structure. Moreover, it is possible to propose the hypothesis and models which will be tested in another set of techniques known as confirmatory spatial data analysis, but which isn't the goal of the study.

The analysis focused on studying the spatial differences of social vulnerability in Bucharest uses the SoV index (Cutter *et al.*, 2003). What differs from the initial algorithm is the use of different way of calculation of the index in the last step. It was preferred the testing of the Hull score in this case, relying on studies conducted in Romania with its help and which allowed some good identification of spatial inequities at regional level. Another argument is that SoVI can be verified for the current space, if data is available. The stages of the study are defined by following: factor identification, SoVI calculation, analysis of the results from ESDA.

1. The following steps determined the factor identification:

– as social vulnerability is strongly influenced by a high number of characteristics (Cutter *et al.,* 2003 tab. 1, p. 246), and in the case of census data in Bucharest, aren't essential variables available, we are aware that the results may suffer. Following the methodology described by Cutter *et al.* (2003), the study verified the variables for not overlaying, and then they were standardized.

– utilization of principal component analysis (PCA) for selecting the variables which explain the most the social vulnerability. The results show that the three selected factors explain 78.698% of the variance (tab. 2).

Factors of social vulnerability in Bucharest

Table 2

Factor	Name	Explaining %	Dominant variable	Influence
1	Social-economic structure	33.730	Persons in need of assistance	+
2	Social structure	28.440	Widows	+
3	Housing	16.529	Private property	+

The first factor involving social vulnerability has 8 components (tab. 3). They are the population under 5 years, dependent persons, mean number of population from a household and people involved in tertiary activities, all with positive loading. The remaining ones comprise the negative loading and they are determined by the active women and people with faculty degree. These variables are explained by the fact the people with a good intellectual background may react better and the women that were promoted by the communist regime (as being equals with men) have found good opportunities for business. The surprising part is that people involved in services record positive loading. The economic conditions from the beginning of the 21st century in Bucharest may be a proof; many people trying to open small business, but mostly for survival at those times (so called boutiques – buticuri).

Rotated component matrix of social indicators in Bucharest

Table 3

Persons in need of assistance	0.897		
Children under 5y	0.839		
Unemployment	0.816		
Population with tertiary activities	0.798		
Women in total active population	-0.71	0.374	0.417
No. of people/house	0.699	-0.539	
People which graduated a faculty	-0.698	0.602	
Health conditions	-0.575		-0.513
Widows		0.943	
Population above 65y		0.917	
Women in total population	-0.329	0.818	
Housing area	-0.45	0.694	
Private property			0.844
Active population from the total			0.805
Personal heating conditions		0.556	-0.656

The general opinion on the most affected people by risky situation is that women and elderly people are first, though this may vary, especially in the Nordic countries (Holand *et al.,* 2009). In the city of Bucharest the general approach applies, just that they are overlapped by even a strong influence of widow people. This new variable is the result of the Romanian society where the family values from the past maintained. Thus people in communism would receive an apartment if they had a family and the large families were better supported by the regime. After the '90 the social dissolution may allowed other explanation, not clear at this moment though.

Housing conditions are determined by the, the living area per person, own heating (stoves) and air conditioning presence. As the apartments are in general small and the improvised infrastructure (air conditioning and heating) were many, the explanation is logical. The difference is that it may look awkward when one looks on them in the literature. Numerous fires though, have started as a consequence of such self made equipment or interventions in the house structure with no legal permits (wall demolishing, balcony building with no authorization).

The third factor shows that overall active population used to work mainly in industry has a large influence on social vulnerability. People still involved in industry in 2002 where the ones who couldn't adapt to the new economic conditions. Moreover the wages were diminishing fast so their chances to recover are directly proportional. This factor is alongside private property and private heating conditions, forming a mix which was labeled as housing due to ratio of elements involved.

2. SoVI calculation in which Hull score is used. Regarding the Hull score this is determined as it follows:

$$SoVI_{Hull} = 50 + 14\frac{\sum x - \sum y}{n}$$

(after Ianoş, 1997, p. 107)

x - positive variables
y - negative variables
n- total number of variables

3. The results analysis by using ESDA with the help of Geoda software (Anselin and Syabri, 2002).

The next step is the building of cartographic representation for analyzing the spatial distribution of data and for identification of outliers (extreme values) or atypical locations. This was done by the help of choropletic map in the first case (Fig. 1), while on the latter the box-map underpinned the others.

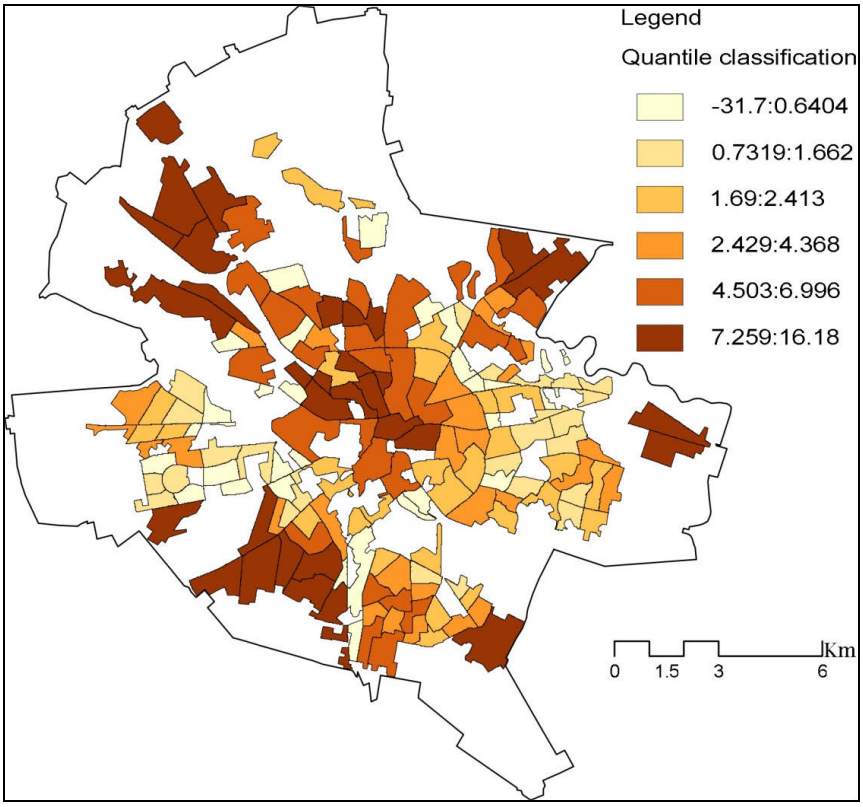

Fig. 1. Exploratory mapping of social vulnerability in Bucharest.

Applying Moran's I at global level for highlighting the existence of clustering in the case of areas with social vulnerability – clustering test (Anselin *et al.* 2006) and by this of identifying the spatial auto-correlation for the residential units in Bucharest. The representation given by Moran scatterplot (Fig. 2) doesn't take into account the location from the map. It allows the view of the statistical testing result of the significance for social vulnerability clusters against the possibility of existence of null hypothesis.

The conditions in which the null hypothesis is reject, allows proving that vulnerability clusters aren't the result of chance, but they are a consequence of some spatial process (Dogaru and Mocanu 2010). It can be noticed that the Moran's I showed a significant spatial correlation of data (ranging from 0.01 to 0.001) (Fig. 3). Moran's I scatterplot displays the linear association of the distribution of the SoVI standard deviation with the spatially weighted average (lag_i) of the data index corresponding to the neighboring values of the Bucharest units. The spatial lag was calculated as it follows:

$$lag_i = \frac{\sum_{j=1}^{n} W_{ij}\, x_j}{\sum_{j=1}^{n} W_{ij}}$$

(Fisher and Getis 2010, p. 290)

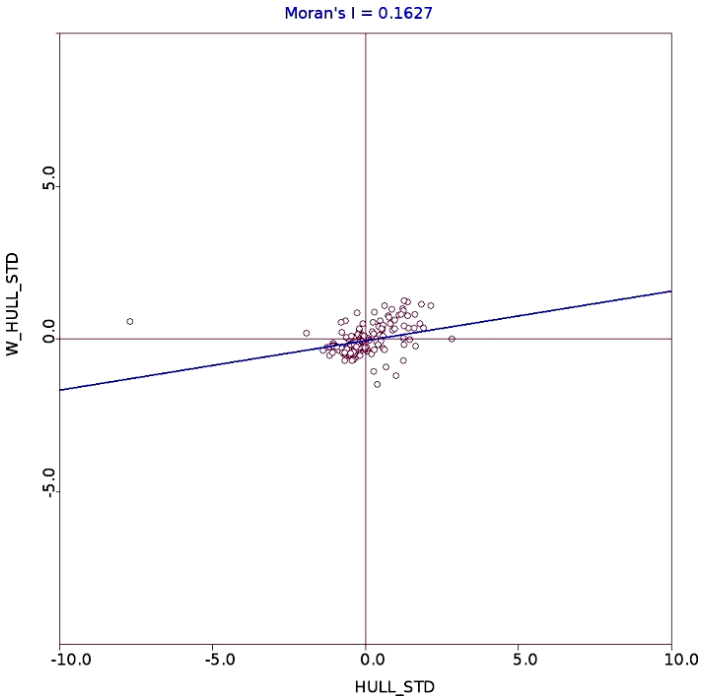

Fig. 2. Moran's I scatterplot.

The observation on Moran's I (equation 2) scatterplot shows also, that points with high values over the mean and which belong to the index, are surrounded by values which surpass the mean. This situation is encountered in the upper right section from the display. Similar is the case for the inferior left part (low-low), where the residential units have low values under the mean of vulnerability index, but closer to each other. In the current stage of analysis the other two sections of the scatterplot tell about the values found on sides against the mean value of vulnerability.

$$I=\left(\frac{n}{S_0}\right)\sum_i\sum_j w_{ij}z_{ij} / \sum_i z_i^2$$

(Anselin, 1995, pg. 99)

I – Moran's I
n – number of observations
S_0 – sum of all spatial weights inside the matrix $(S_0=\sum_i\sum_j w_{ij})$
w_{ij} – spatial weighted average matrix (connectivity) among the neighboring units
z_{ij} – standardized scores of attribute values for unit i and j

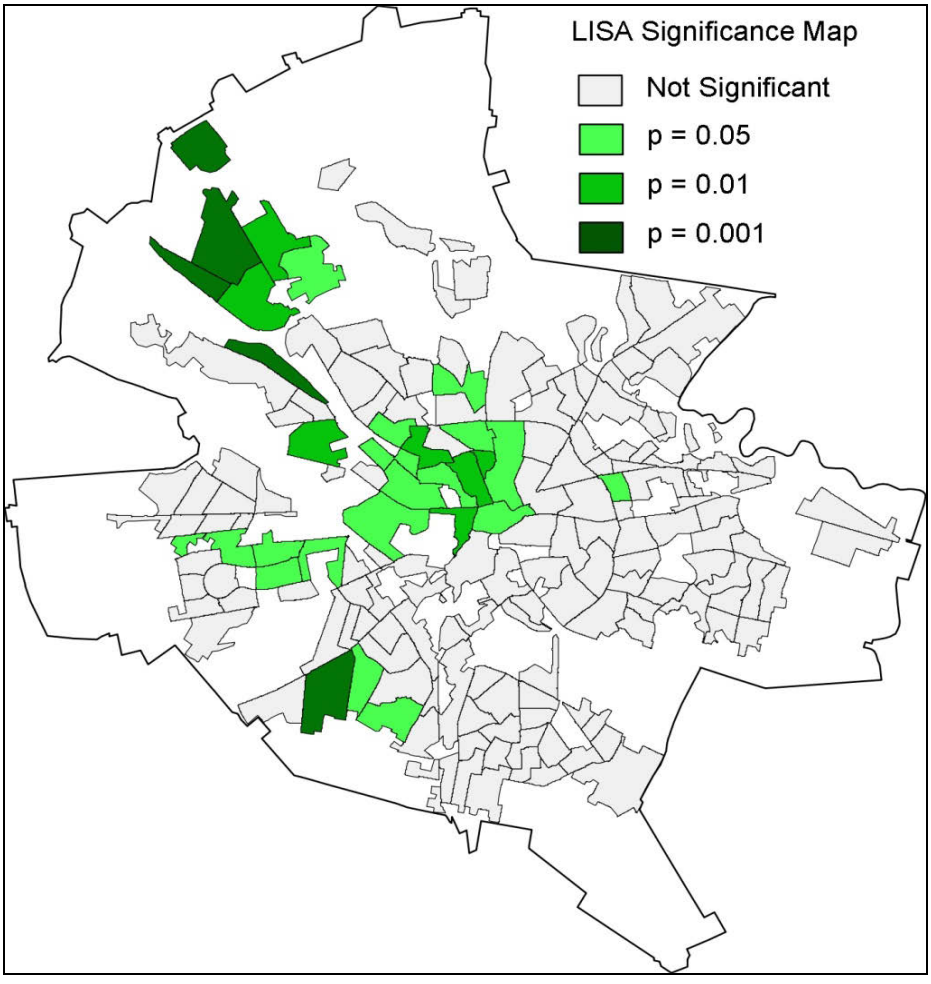

Fig. 3. LISA significance map of social vulnerability.

Though many techniques are components of ESDA (Sang-Il L., 2005, p. 276), the preference is towards the local indicators of spatial autocorrelation. The study uses LISA for identification the clusters distribution and the possibility of examining maybe patterns where areas with similar values of social vulnerability are nearby to each other. This is done by the visual information determined by maps where it can be seen those grouping areal as hot spots or cold spots (Fig. 4). In fact they are the residential units in which the social vulnerability is similar (positive or negative against the mean), being surrounded by other units with the same characteristic of data. This means the localization of those areas according high clustering of some process can be identified, despite of its position against the mean value. The subjective description perceived before the study is mostly proved: the central part of the Bucharest contains the most areas with high social vulnerability. Regarding the explanation of the Moran's I scatterplot applied on local level, the case differs no more from the presentation made above for global level.

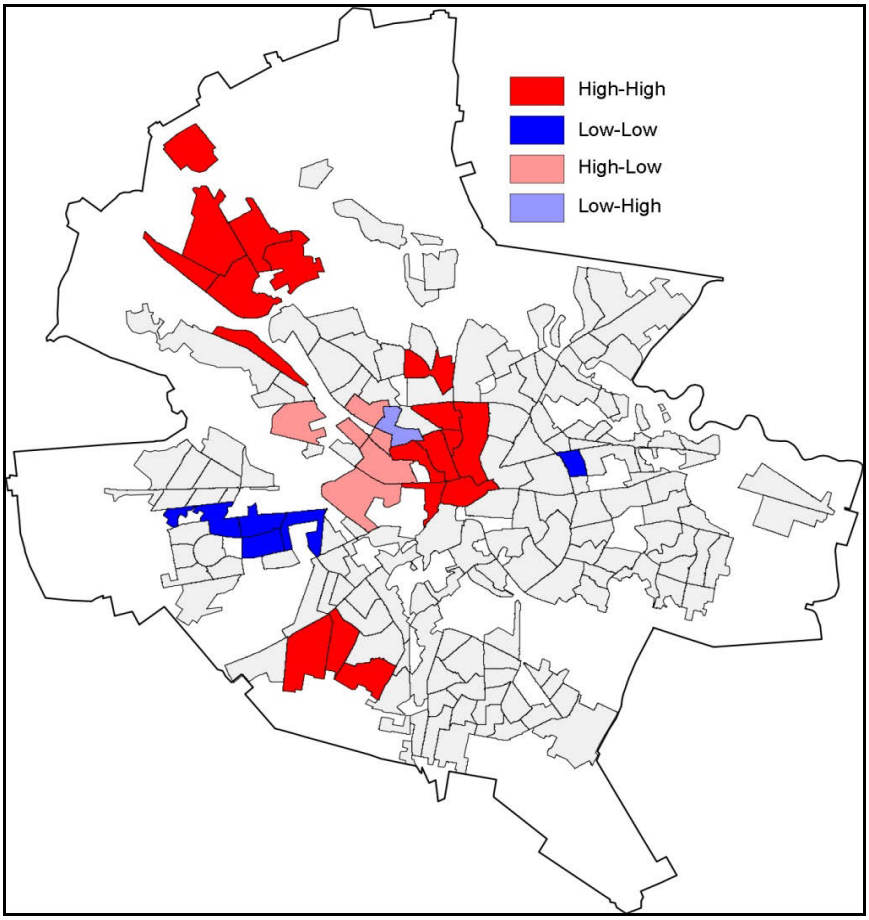

Fig. 4. Clusters of social vulnerability in Bucharest.

The permutation (999) of the results of Moran's I (equation 3) emphasizes of the degree of significance of spatial auto-correlation with the help of the corresponding map. The graphical results display a strong spatial association in the central part of the map of the values over the mean, while there are some smaller clusters where the vulnerability records a good image (cold spots). The acceptance of the alternative hypothesis which states that in Bucharest the association isn't the result of chance shows, by the obtained results, that it can be the consequence of the complex interaction of factors analyzed, but which can be further completed by a more data as they will be available.

$$I = \frac{z_i}{\sum_i z_i^2} \sum_j w_{ij} z_j$$

5. DISCUSSIONS

The main goal of the study was to emphasis the space in which population may be greatly affected in the case of some extreme events and to verify the spatial image resulted from applying the algorithm used by proposing an alternative in the last step. Thus, the study on social vulnerability in Bucharest city detected some noteworthy elements. The calculation of SoVI shows the high risk covering the central area of the city. By using the Hull score it is highlighted the fact that population from the south-western part, overlaying on areas with strong accents of segregation, may suffer highly in the case of natural or anthropic negative incidents. From the normative point of view it is important to say that the study presents a useful image, though the above clusters formations, for all the stakeholder involved in the city (with the mention that it has to be updated with newer data and filled with more variables, if available).

Amid the rapid change of the society it is noticed the major importance of the social factors. They play one of the most important roles in Bucharest. Here, they explain the most part of the social vulnerability (this may be too strong because of the unavailable economic factors). The relation among these factors shows strong tendencies of increasing the gap for the social vulnerability in Bucharest.

Another factor to be considered in the study is the building age. Though it is another dimension of vulnerability, buildings related elements can increase the vulnerability of the society as the time goes by. Many buildings are over the limits of construction in the central part, and those erected in the communist period are reaching fast also. The quality of materials and techniques used for the buildings may display more, but at the moment there hasn't been an update study for the last decade.

Presented in the collective perception as the sum of superlatives from the country (Nica and Gavriş, 2009), the city is the realm of manifestation of a stronger process of advanced dissolution on many levels (economics, social, politics etc.). Being at the top of territorial planning system, but with acute problems of management, forms continued from the over-centralization communist period, the city looks like being less flexible in adaption to the new changes. The lack of intervention and coordination, together with the habit of the people for waiting a signal from authorities first, determines the weakness of population resilience. This fact is best proved by the presence of vulnerability clusters in the central part of the city with extension on the northern part of the sector 1, where the elite population has maintained over time. So even if an

area is comprised of important population (economics, politics) it is in the same situation as the poorer areas from the sector 5 and 6. One can say that people from the high-class areas may lose all, while the others have nothing to lose. Irrespective of the social characteristics or the economic level of the population and the interest for development, the city remains under the high incidence of risks, population and authorities having no real answer to the catastrophic events.

The reference over the situation presented above is determined as it is a key point in framing the image used for understanding the distribution of social vulnerability. As in the communist period, the elites where living especially in the central part and the old constructions remained difficult to renew or demolished, even after the 1977 earthquake, the central part of the city encountered few interventions. Moreover, the law which allowed people to buy their living apartment (only 5-10 the wage from the beginning of the '90), has allowed that most of the investments to be at personal level and not in the urban space as a whole. On the other hand, the boom of the real estate price from the 2000s created some specific situation. People owning a dwelling (apartment or house) from the central part of the city were mostly aged people with little interest in selling them. The image is completed by the legal incidents over buildings which remained in no man lands for some years, entering into a decaying process. Thus this area is characterized by some particularities as the style of the aged population and the high proportion of private ownership constrained greatly the protection intervention and urban renewal plans for buildings, identified as being in the first class of seismic risk.

Regarding the social vulnerability clusters situated in the South-West and North-West, they are the results of industrial policies. The housing estates build rapidly in the '50s (Ferentari – SW) or those in which the risk of earthquake effects has been neglected at the end of '80s (poor materials in the Griviței, Bucureștii Noi or Dămăroaia neighborhoods – NW) have been some of the places in which rural population was attracted by the communist regime of that time to live and work in nearby industrial platforms. These people maintained mostly the way of life of their origins, this being a great issue nowadays. The massive restructuring of the industry started in the '90s led to more difficulties for population adaptation and thus, some clusters of high social vulnerability have been formed. Because of this, it can be considered, unlike other studies where the active population determines negative influence of social vulnerability, that in Bucharest it allowed an opposite influence, yielding population sensitivity.

Another area of clusters in Bucharest is the one located in the western and eastern parts of the city. It is a cluster where the values are highly similar and under the mean (cold spots). The explanation forms around the communist strategy of bringing here many high skilled people – Drumul Taberei was known as an intellectual neighborhood. Moreover, the commercial boom at micro-territorial level in this area shows a fast adaptation of the population previously employed mostly in industrial activities. The field study recorded signals of social vulnerability in these areas, which shouldn't miss nor being ignored. It is considered that data missing determined such situation.

These anomalies against the perception on Bucharest need further testing and the integration of more variants for calculation or data which should allow the calibration of future results. The monitoring of these areas is necessary for understanding those possible advantages which created a clustering of population able to become resilient to risks and thus, they may be copied and updated though improved policies in areas sensitive to hazards.

6. CONCLUSIONS

The study on social vulnerability in the city of Bucharest showed some interesting elements in terms of scientific novelty. At this stage of analysis, the research offered the chance of identifying some spatial patterns of social vulnerability. The spatial patterns were represented by the maps of clusters and they have been found as being statistical valid at different levels. The calculation of SoVI created a broad image of the vulnerability across Bucharest, little known from this point of view.

Though the study examines a much discussed and highly important phenomena, it is limited by some elements. At first, it can be easily noticed that obtaining data represents the highest barrier in processing a useful analysis for future actions. From these results emerges the low possibility for development of new strategies or improving the existing ones in order to allow the population to overcome the risks and to adapt to new situation of possible hazards occurrence as a prevention measure. Another issue is the opacity and the possible absence of reliable economic data, which in every study are presented for assessing the cost or the losses and policies interventions. Likewise, the study is only a snapshot, a moment in time for the year 2002, without being able to make a comparison with that of the 1992 regarding social vulnerability.

Although, many drawbacks exist, the study is a starting point that can be developed with the introducing of additional techniques and more testing instruments. Future plans rely in applying CSDA for testing the spatial regression and possible modeling. In this case it can be considered the framing of the models, the estimation and its diagnosis at statistical level for those predictions which may complete the social vulnerability in Bucharest. Some directions will be targeted toward the new census from 2011 and the possible inclusion of different methodology for comparison of the results and the updated social vulnerability image.

In this phase, the results are a good scientific asset and an opportunity for authorities to reconsider the impact of natural hazards and especially to develop and strengthen the measures for improving the population resilience.

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