Urban Landscape Patterns of Iaşi City. Analysing City Relations Between Urban Land use, Topography and Inhabitants Pressure Upon Urban Morphology

Lucian ROŞU[1)*], Ana-Maria OIŞTE[2)*]

[1)] Faculty of Geography and Geology, University "Alexandru Ioan Cuza" Iaşi, Bulevardul Carol I 11, Iaşi, Romania; [2)] Faculty of Geography and Geology, University "Alexandru Ioan Cuza" Iaşi, Bulevardul Carol I 11, Iaşi, Romania
Corresponding author: anamaria.oiste@yahoo.com

Bulletin UASVM Agriculture 71(1) / 2014
Print ISSN 1843-5246; Electronic ISSN 1843-5386

Abstract

The quality of urban environment has increasingly been regarded as an important matter, being analysed from different points of view (quality of life, economic trends, accessibility to major facilities etc.). In this study case, we use Iaşi Municipality for analysing city-wide relationships betwen anthtropogenic factors (landuse, connectivity, population density, occurence of urban facilities) and natural ones (topographic features transformed into landslide susceptability). The indicators taken into consideration, appended into an factorial analyses are predictors for changing environment in a dynamic context. Connectivity is the most influent factor, having the capability to reshape the structure of density of population or occurence of facilities whence they modify the shape of the entire city. The landscape patterns of Iaşi city reveal a different image upon landuse of the city, creating an integral display upon the urban area analysed.

Keywords: *urban morphology, changing patterns, spatial distribution, land use, Iaşi municipality, factorial analyses*

INTRODUCTION

Continuous development of urban landscapes during the last decades related to political changes across Eastern Europe has reshaped the traditional city. However, even though cities have been traditionally seen as places of chaos and disorder requiring control, numerous studies in the last decades have shown that cities are surprisingly structured, with particular spatial patterns resulting from a multitude of decisions and processes in a context of intense competition for space (Batty, 2008). More than these factors, anthropogenic and natural disturbances, changes in land ownership, land cover and land use have redefined the landscape of the cities (Forman & Godron, 1986). Analyzing patterns of urban landscape is a major topic for researchers and the scientifically literature is consistent when it comes to emerged studies. Cities transformed into fractal analyses (Batty, Longley, & Fotheringham, 1989), changes from non-urban to urban categories, cellular automata studies (Iacob, Roşu, & Blageanu, 2012, White, Engelen, & Uljee, 1997) or agent-based models (Batty M. , 2007 Gewirtzman & Blumenfeld-Liberthad, 2012) have been applied in representing urban patterns.

The intensity and the diversity of changes in urban morphology create new functional urban areas across the urban areas. According to Athens Carter, the residence is the top priority for a city and a suitability evaluation index of urban landscape is an important measure for any land use planners. Across a given landscape, functionality of the city is affected by several factors (natural and artificial modeling agents) which should be analyzed together for a complete image of the functionality of a city. At the local scale, inhabitants and their actions power

fragmentation of the structure across the landscape (road fragmentations, industrial relocations, economical activities or population pressure) and by natural landscape (landslide vulnerability, green areas fill, slopes, geological deposits). Therefore, analyzing urban suitability for land use planning is an important issue for nowadays-fast changes in cities (Qiu & Zhang, 2011). Evaluation of an urban landscape is necessary in the agenda of all cities, most of all because improves the land use structures and optimize the overall functions of a city, having a more efficient living environment (Tao & Xinqi, 2000).

This paper is particularly concerned with identifying a functionality of the city taking into consideration anthropogenic factors, which occur and reshape the city structure among with natural factors that are determinant for defining urban landscape. Most of the studies that analyses land use patterns suggest that social, institutional and economic factors play an important role in determining land use and landscape pattern, while physical and ecological features of landscape constrain land use and landscape pattern over space and time (Hawbaker, Radeloff, Hammer, & Clayton, 2004). However, the variability and complexity within and between urban land use morphologies present a convoluted environment for analysis (Henderson & Xia, 1997).

Therefore, the main aim of this paper is to to reveal the patterns distinguishable in urban landscape of Iaşi Municipality by analysis different layers of urban morphology: land use, topography, inhabitant's pressure, road infrastructure, and other components of liveability (green space per capita, accessibility).

For achieving the aim of this paper, the study adopt a bottom-up approach, which considers cities as complex systems that emerges from individual behaviors. Thus, the objectives of this papers are to create a spatial database at a micro-scale level, to classify and to create a tipology of urban land use by overlapping several thematic layers and to analyse the result via hierarchical clustering.

MATERIALS AND METHODS

The main aim of the study: to reveal the patterns distinguishable in urban landscape by analysis different layers of urban morphology was accomplish using various materials and methods of analysis.

2.1 Study area

Iasi city is located in northeastern part of country, being the largest city from Iasi county and it build-up area was chosen as area of study. The location of Iasi city is shown in figure 1. This area was selected due to the significant anthropic pressure exercised by the urbanization process during over 600 years, causing various changes in landscape. These changes contributed at delimitation of patterns in urban landscape, which can be investigated using different methods and materials. The total urban surface was divided in XXX grids with the size 250x250 meters.

2.2 Materials

The main materials used were: satellite images (2008 edition) for collecting data concerning buildings characteristic, critical areas, land use and NDVI, topographic plans - 1:5000, 1964 edition for digitizing and realizing the Digital elevation model and for computing a model of landslide vulnerability, Geological map 1966 edition and Open Street Map thematic layer for obtaining connectivity and urban facilities occurrence map

Different database were used to obtain information concerning the population (results of population Census from 2011), green space area per capita (Annual report of environment state in Iaşi County in 2011).

Grids network was used to present the results due to numerous previous studies, (including Rosu, Oiste, 2013) that utilized grids to present with accuracy the results of landscape patterns.

2.3 Data analysis

Our methods are mainly focusing on GIS analyses using interpolation through IDW method to obtain population density map, connectivity and facilities occurrence map. Defining critical areas from Iasi city represent the aim of an anterior study realized by the same authors, with a methodology and results present using the same grids network.

HAC was generated with free software that performs several descriptive statistics tasks. Maps presented in the last section describing the final results were also realized with Philcarto.

2.4. Software

Due to large number of thematic layers used for achieve the scope of the study was necessary to use various GIS software: Auto CAD Map 3D 2010,

TNT Mips 6.4, ArcGIS 9.3, Philcarto 6.3 and Global Mapper 11.

RESULTS AND DISCUSSIONS

3.1. Land use map

Land use represent an useful tool in urban pattern delimitation giving supplementary information about the human activities, highlighting functional areas of the city as residential, transportation, administrative and commercial, industrial and natural vegetation areas, water bodies.

Natural landscape modification occurred mainly as a result of the vegetation cover change, and anthropic landscape is represented by: residential areas - dominating the urban space with 23.91% (with higher among of individual houses), followed by 44.47% (forest, green spaces, pastures and vineyards).

Including this indicator in general landscape zonation was useful in identification of the areas were a type of landscape dominate.

3.2. Landslide

Landslide hazard zonation represent a method that use four thematic layers (slope, geology, land-use and hill orientation each one divided in different classes and receiving an score according to the original methodology -) to reveal five

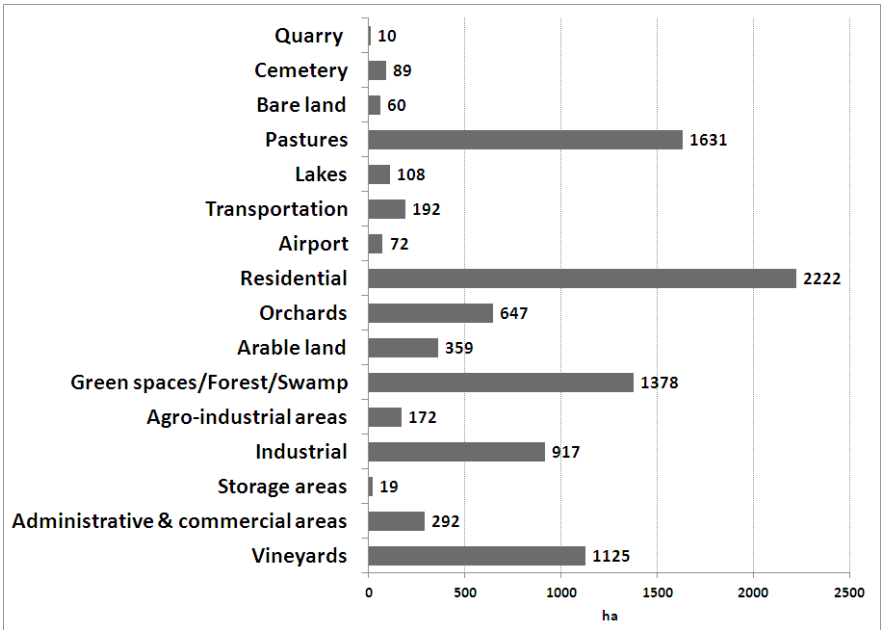

Fig. 1 Land-use categories

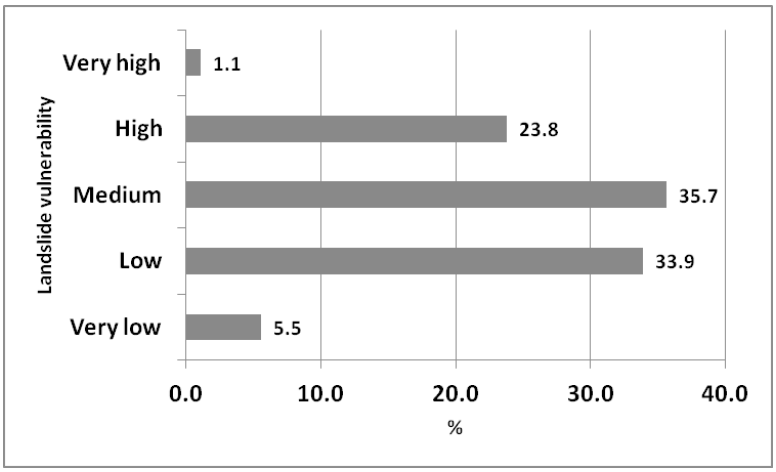

Fig. 2 Landslide vulnerability categories

zones of landslide hazard such as very high, high, moderate, low, very low 39.4% of studied area is included in very low and low categories, and 24.9% in high and very high categories (figure 2), representing areas where new buildings raising should be restricted, causing landscape pattern changes in the future if the authorities would take into account the current estimation of landslide hazard. This thematic layer was included due to the relevance in city sprawl, useful in further studies to make predictions.

3.3. Critical areas

Critical areas were defined by the correlation between spatial distribution of green areas and population within Iaşi city collecting date from several sources, including personal field observations and Normalized Difference Vegetation Index for a better understanding of the distribution of critical areas. The final result for green spaces data extracted from different materials and studies was divided by population, showing the critical grids describing areas with high population and less vegetation surface are located. For that reason higher populated districts were considered critical areas, most of them being located in the south-western and western part of the city. The conclusions of the study reveal that 23.4% of the studied area is vulnerable or critical, with important amount of inhabitants inside that represents 87% of the total population of the city, revealing a major problem located in the south-western, western and north-eastern parts of the city.

3.4. Population density

The current state for the density of population in Iaşi Municipality is a result of numerous factors (geographical, political, economical or historical). The actual shape the city has been determined by commercial routes according to geographical conditions and the settlements that were already defined. Being the fourth largest city in Romania and the main regional pole (Central comission for population census, 2012) is defined by a complex faces of inhabitants pressure. The result of this complexity is the uneven distribution of population and their consequences that are arising. The highest density of population is located in W and S-W side of the city. The industrialization politics had a major role in the structure of the present state of urban territory through the construction of a large industrial platform (in the south – eastern part of Iasi) and of the workers' districts endowed with all the socio-economic utilities necessary for the rural population attracted by the Iasi factories (Stoleriu & Stoleriu, 2004). Originally built during the communist regime due to fast industrialization and artificial urbanization in the late '70, these districts (Alexandru-Dacia, Păcurari-Canta, Nicolina-Cug-Podu Roş, Tătăraşi) are concentrating more than half of the population. The city is divided into 39 districts (Stoleriu O, 2008), most of them being more mentally build. Interesting in this case is that the first 10 populated districts accumulate 56% of the total population while their area is only 12% of the built-up territory (Roşu & Oişte, 2013). The highest density in concentrated in 3 districts (Dacia-Alexandru, Canta-Păcurari, Tătăraşi), mainly formed by 11 levels blocs, having only basic facilities (markets, public transportation and educational facilities) nearby. The mental perception for this districts is determined by their main functions (dormitory), not having other facilities inside them (recreational or cultural amnesties). The demands for a high density of population are growing due to the direction of a social equity exigency. Therefore, in the last years several facilities have occurred (markets, churches, sports facilities) for minimizing the cost distance to attend them. This emphasis a growth of the built space density, as consequences of the immovable market's pressure (Stoleriu & Stoleriu, 2004). In the same time, the present trend of the city is so-called demographic distension creating the periurban areas and the residential districts (and a socio-professional segregation). Most of the changes (demographic) are determined by the expansion of the city and ,in the same time, a stagnation of population inside due to a high density of the buit-up space.

3.5. Connectivity

Defined as the density of connections on road network and the directness of links (Carr, Fahrig, & Pope, 2002), these facilities are built for improving the movement of passengers and to enable transfer of goods. These amnesties are planned to improve the quality of life by being safer, more efficient and linked to the economical

engines of the city (Viafara, 2009). The transformation of Iaşi city is mainly related to connectivity of roads (due to increasing of motorized vehicles in the last decade). Roads affects the urban economical activities by reshaping the acces to different facilities.Communication lines are the "power lines" of the economical increase, as they polarizing axes interact with the neighbouring space (Rusu, Man, & Moldovan, 2013). As connectivity increase, the time-distance to reach a point decrease. In the same time route options varies, allowing more direct travel between destinations, creating a more accessible and resilient system. Connectivity can apply both internally (streets within area) and externally (connections with arterials and other neighborhoods) (Institute Victoria Transport Policy, 2012). In the same time, aaccessibility is the main "product" of a transport system. It determines the locational advantage of an area (i.e. a region, a city or a corridor) relative to all areas, including it. Indicators of accessibility measure the benefits that the households and firms in an area enjoy from the existence and use of the transport infrastructure relevant for their area (Spiekermann & Neubauer, 2002).

Low connectivity (typically for Industrial district) is characterized by a low density of streets, most of them similar to *sac-de-cul* ending at the former industrial sites. Road network is used mainly for transit from one sit to another. On the other hand, the connectivity poles of Iaşi city are situated to the economical engines (Podu Roş, Tudor and Palas Mall). The main intersection of Iaşi (Podu Roş) is having the highest degree of accessibility and therefore connectivity. In the same time, the new emerged Palas Mall project is situated in the heart of the city, having a good access due to it's position and quality of infrastructure. Comparing the density of population (Figure 1.) and the connectivity it is obvious that there is a lack of accessibility for the populated districts (Alexandru-Dacia has a peripheral status due to obstruction of the railroad having only two connections with the center of the city). In the same time road network of the city center (even if has high connectivity) is characterized by narrow and arched streets framed as *sac-de-cul*

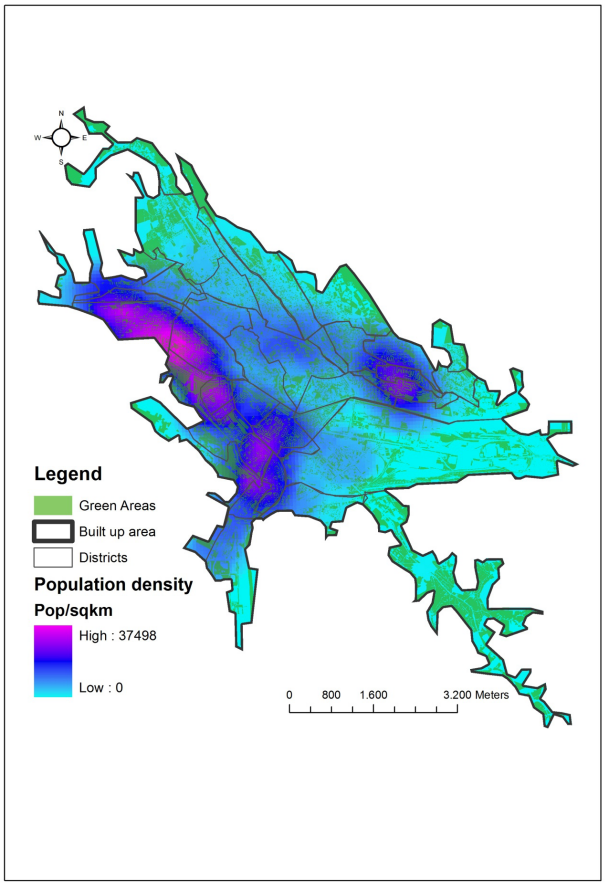

Fig. 3 Population density in Iaşi city

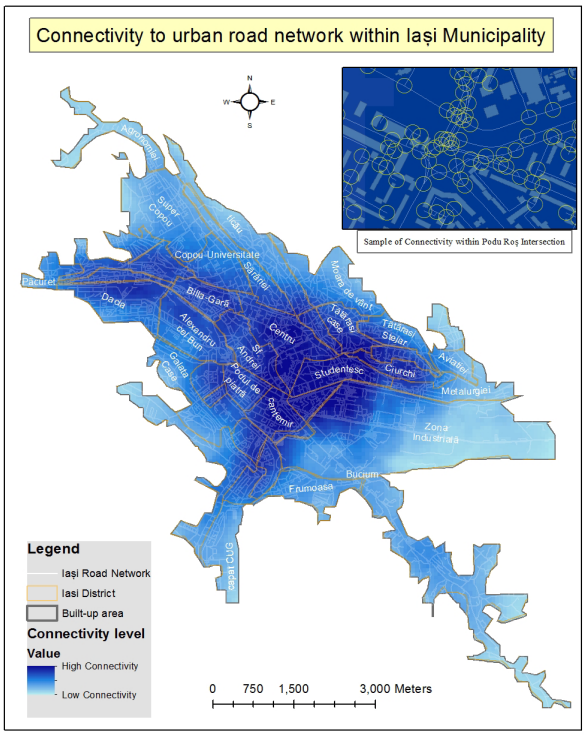

Fig. 4 Connectivity to urban road network within Iaşi Municipality

(transformation of the road network is difficult due to historical buildings). The result is a deconcentration of services and activities, being relocated where accessibility has higher values (Palas Mall, Podu Roş).

3.6. Urban facilities

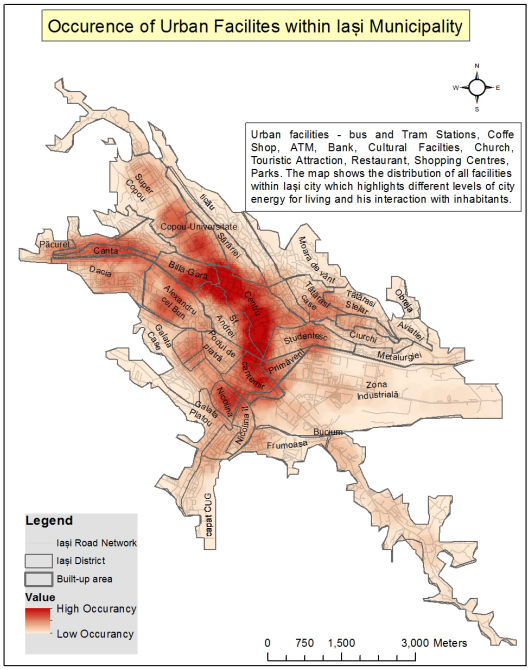

Fig. 5 Occurence of Urban Facilities within Iaşi Municipality

The expansion and modifications of urban facilities in a complex process due to its factors that generate it. In the same time, the occurrence of urban facilities highlights the location of urban engines of the city. The more central a place is regarding the existing services (stable), the more attractive (which mean he has a diversified and important offer) and accessible to other places becomes (Groza, 2005). Therefore, the activities should tend to be located to a more central point, but in the same time should take into consideration other factors (landscape features, prices, availability of space or accessibility).

Amneties tend to be located according to customers shortest route to reach them. Hence, this facilities will agglutinate forming poles of attractivness or so called district centres. The urban energy that derives from this poles is directly related to increasing of quality of life, having more opportunities, safer places or a better image upon that place. In the same time, the disadvantages are related to more noise pollution cram or traffic jam.

Analysing the results of facilities density, at the scale of the city there are two major poles of attractivness (Piaţa Unirii square and Palas centre). The openning of the real estate project (palas) has reshaped the city centre, being the "heart of the city" due to it's intense promotions and (re)location of anmeties inside of it. A high occurrence of facilities has an alignment towards N-W (University) and towards S (Podu Roş-Iulius Mall due to high connectivity).

To the contrary, dormitory districts have a lack of amneties and do not have a clear neighrorhood centre. Larger districts are trying to delineate this centres (Esplanda Oancea for Tătăraşi, Esplanada Minerva for Alexandru) but are at the initial stages, being paternalized by city centre suply. As a conclusion, access to amneties has a uneven distribution, being located not according to population distribution but according to connectivity to the road network.

3.7. Hierarchical cluster analyses for urban landscape of Iaşi Municipality

Using factorial analyses, all the previous thematic maps have been taken into analyses. The Hierarchical Ascendant Classification (HAC is a method of cluster analyses which seek to group a hierarchy of classes) groups all the statistically units (250 m grids) according to a pattern model. The dendogram reveals the position of each statistical unit to each group highlighting a typology of urban morphology.

During the last decade's changes in urban morphology occurred, mainly because of changing or regime. This situation has led to a chaotic change in urban morphology, which permitted the retrocession of the seized fields during the communist regime and the liberalization of the land prices, permitting transactions of the properties, the growth of accessibility in far areas (due to the growth of the number of cars and extension of the public transport network), liberalization and diversification of construction materials market.

These changes generated a more heterogenic territory. Our analysed area highlights some patterns which show the changes that occurred

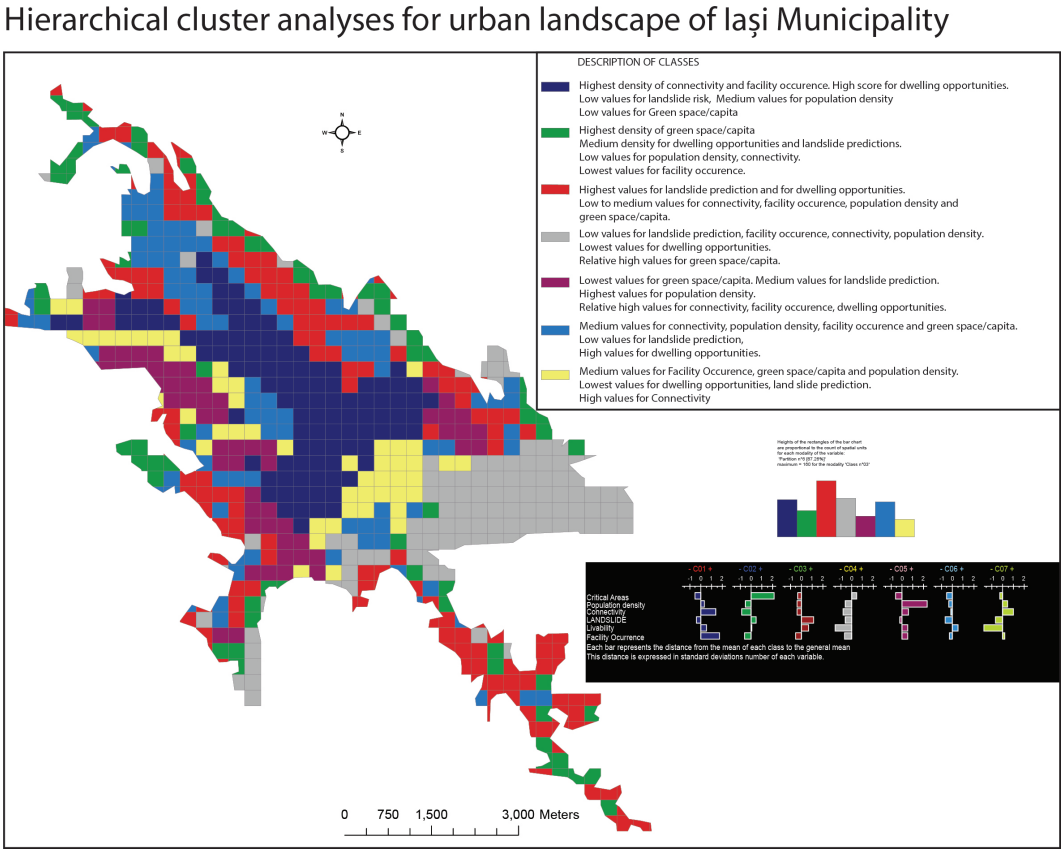

Fig. 6 Hierarchical cluster analyses for urban landscape of Iaşi Municipality

in Iaşi city. Based upon functionality, there can be found the main typically urban patterns:

The class representative for the city center is characterized by the highest values for connectivity and facility occurrence and a high score for dwelling opportunities. In the same time, the values for landslide risk and green space/capita are low while density of population has medium values. It is specific for the city center, where most of facilities are located. It has the highest demand for dwellings, being the active part of the city, the place where things happen, people interact and economic growth is obvious

This category highlights the potential areas for new residential dwellings (gated communities). It has the highest density of green space/capita, medium values for dwelling opportunities and landslide prediction while the values for population density, facility occurrence and connectivity are the lowest. The area is located at the outskirts of the city, where the process of periurbanisation did not start yet, but the landscape allows it.

The existing residential areas (individual houses) are represented by the red color. It has the highest values for landslide prediction but also for dwelling opportunities and has low to medium values for connectivity, facility occurrence, population density and green space/capita. This area is overlapping over the individual house districts of Iaşi city (1) (Ţicău and Sărăriei) and over the new residential districts (Bucium, Breazu or Miroslava outskirts).

The locating of industrial area (brownfield) (grey color) has conducted to lowest values for facility occurrence, connectivity, density of population and dwelling opportunities. In the same time, it has the lowest values for landslide prediction and relative high values for green space/capita due to no habitation. Relocating of industry is an effect of liberalization of land prices and the shortness of time-distances. Shopping malls have risen in place of some closed factories.

Dormitory districts are highlighted (cherry) in the S-W (Dacia-Alexandru) and N-E (Tătăraşi) being characterized by dwellings with high den-

sity of population, lack of green space, crowded commercial sites, vertical development of new real estate projects, relative high values for connectivity and facility occurrence with medium dwelling opportunities. Although it has the highest density, more real estate projects (developed on vertical) are planned due to its relative low land prices in this districts.

The most changeable class (blue) is represented by transition areas, having a changeable pattern due to numerous modifications of urban functionality. Representative for this class are low values for population density, connectivity, facility occurrence and medium values for landslide predictions and dwelling opportunities.

Transit area (railways and major road axes) represented with yellow is specific to transport infrastructure (train station and railway services, road infrastructure). Is characterized by high values for landslide prediction and dwelling opportunities and low values for connectivity.

CONCLUSIONS

The study explored a set of quantitative variables used to characterize urban form by distinguishing patterns using a GIS and remote sensing framework.

These indicators provided insight into urban dynamics, a deeper understanding of the patterns and processes associated with urban dinamics. The results from the study show that spatial characteristics of the city can be objectively analyzed and meaningfully quantified.

Transitional areas are the one sensitive to future changes in the dynamics of the city and are well highlighted.

The highest ranked areas for residential have major advantages but are available only for a small amount of population.

The environmental indicators across with social dimension reveals an global image upon urban patterns of Iasi Municipality and hold potential for evaluating land use planning and urban management strategies, being a necessary documentation for decision makers and stakeholders.

Our hypothesis is that variation of components and landscape patterns created by inhabitants pressure can be explained in relation with all other variables described (infrastructure, environmental quality, land use, functionality). Creating a pattern of urban landscape reveals different scales of population liveability. The obtained data and maps can be used for curing this situation and for being taken the best specific measures for the particularities of the analysed area.

REFERENCES

1. Ahmad F., Sulaiman N., Nordin L., Ab. Talib J., 2004 - *Landslide Hazard Zonation Using GIS*. Case Histories of Urban Geo-Informatics, by Asian Regional Technical Committee No.10 "Urban Geo-informatics" of the International Society of Soil Mechanics and Geotechnical Engineering. November 2004, Tokyo, Japan
2. Batty, M. (2007). Cities and complexity: Understanding cities with cellular automata, agent-based models, and fractals. *The MIT press*.
3. Batty, M. (2008). The size, scale, and shape of cities. *Science* , 769-771.
4. Batty, M., Longley, P., & Fotheringham, S. (1989). Urban growth and form: scaling, fractal geometry, and diffusion-limited aggregation. *Environmental Planning A*, 1447-1472.
5. Carr, L., Fahrig, L., & Pope, S. (2002). Impacts of Landscape Transformation by Roads. *Applying Landscape Ecology in Biological Conservation*, 225-243.
6. Central comission for population census. (2012). *Final results of the population census.* Bucharest: Central Comission for Population Census.
7. Forman, R., & Godron, M. (1986). *Landscape Ecology.* New York: John Wiley & Sons Inc.
8. Gewirtzman, F., & Blumenfeld-Liberthad, E. (2012). An agent-based model for simulating urban morphology: Sachnin as a case study. *SURVEY REVIEW, MANEY PUBLISHING*, 162-167.
9. Groza, O. (2005). *Bazele teoretice ale planificării teritoriale* . Iaşi: Universitatea "Alexandru Ioan Cuza".
10. Hawbaker, T., Radeloff, V., Hammer, R., & Clayton, M. (2004). Road density and landscape pattern in relation to housing density, land ownership, land cover, and soils. *Landscape ecology*, 609-625.
11. Henderson, F., & Xia, Z. (1997). SAR application in human settlement detection, population estimation and urban use pattern analysis: A status report. *EEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC*, 79-85.
12. Iacob, C., Roşu, L., & Blageanu, A. (2012). CELLULAR AUTOMATA FOR URBAN GROWTH. *Geographica Timisiensis*, 79-88.
13. Institute Victoria Transport Policy. (2012, January 5). *Roadway Connectivity*. Retrieved December 10, 2013, from Victoria Transport Policy Institute: http://www.vtpi.org/tdm/tdm116.htm
14. Qiu, D., & Zhang, J. (2011). Urban residential land suitability index system and its comprehensive evaluation- A case study of Wenzhou. *Procedia Engineering 21*, 439-445.
15. Roşu, L., & Oişte, A. (2013). Defining critical areas through dispersion and density of vegetation index in relation with population. Study case: Iaşi. *Present environment and sustainable development*, 136-142.

16. Rusu, R., Man, T.-C., & Moldovan, C. (2013). The road connectivity index applied to the settlements of Banat using GIS. *Romanian Review of Regional Studies*, 117-124.
17. Spiekermann, K., & Neubauer, J. (2002). *European Accessibility and Peripherality: Concepts, Models and Indicators.* Stockholm: Nordregio.
18. Stoleriu , O., & Stoleriu, C. (2004). The spatial evolution of Iasi city:tradition and. *Landscape Science: Tradition and Trends*, 363-367.
19. Stoleriu, O. (2008). *Evoluţia uman-geografică şi urbanistică a oraşului Iaşi în perioada postbelică.* Iaşi: Terra Nostra.
20. Tao, Z., & Xinqi, Z. (2000). Feasibility Evaluation for Urban Dwelling Land and Improvement of Urban Human Settlements. *China Population, Resources and Enviroment*, 77-78.
21. Viafara, J. (2009). Impact of Transportation Facilities in Urban Environment. *Transport Institute*, 474-484.
22. White, R., Engelen, G., & Uljee, I. (1997). The use of constrained cellular automata for high-resolution modelling of urban land-use dynamics. *Environment and Planning B: Planning and Design*, 323-343.
23. http://www.cpsa-acsp.ca/papers-2011/Teyssier1.pdf Identifying Ridings' Profiles. A Typology of Political Competition Configurations in Canadian Federal Elections Ronan Teyssier (Université Laval), Paper prepared for the 83rd Annual Meeting of the Canadian Political Science Association, May 16-18, 2011, Wilfrid Laurier University, Waterloo,