Using multi-criteria analysis for the identification of spatial land-use conflicts in the Bucharest Metropolitan Area

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1. Introduction

Because indicators represent a form of conscious connection to the environment (Golusin and Ivanovic, 2009) and the resilience of nature (Passeri et al., 2013), society uses indicators to simplify reality or for comparison with a normal or reference state (EEA, 2010). Indicators measure the characteristic values of perceived realities (Kurtz et al., 2001) to produce information and describe phenomena relative to other parameters (Antrop and Van Eetvelde, 2000; Caeiro et al., 2012; de Leeuw, 2002; Hasse and Lathrop, 2003).

In the context of the increasing human pressure on the environment, especially in urban and metropolitan areas (Pătroescu et al., 2009), indicators represent instruments that can be used to reduce information gaps (Uuemaa et al., 2013), analyze environmental impacts (Iojă et al., 2007), compare scenarios (Petrov et al., 2011), communicate results to the public (Li et al., 2009) and aid in the decision-making process (Jaeger et al., 2010).

Abbreviations

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Indicators of land-use changes in metropolitan areas have varied over time, from informal methods to formal methods (i.e., cost-benefit analysis or multi-criteria analysis) (Kamruzzaman and Baker, 2013). The chosen indicators should allow intuitive interpretation based on mathematical simplicity and modest data (Jaeger et al., 2010) and should be quantifiable, sensitive to changes in land cover, temporally and spatially explicit and scalable (Larondelle and Haase, 2013); they should be able to reflect not only the analyzed phenomena but also the particular needs and goals represented by the diversity in a chosen study area (Shen et al., 2011). International institutions and organizations have developed their own sets of indicators for monitoring environmental aspects, e.g., the core set indicators of the European Environment Agency (EEA, 2011) or the sustainability indicators of the Organization for Economic Co-operation and Development.

Urbanization promotes rapid social and economic development, but at the same time, it leads to many environmental problems (Li et al., 2009) that are becoming increasingly contentious. Therefore, the need exists for instruments aimed at better understanding and management of these issues (Asah et al., 2012). Frequently, these environmental problems lead to the emergence of environmental conflicts (Kamruzzaman and Baker, 2013) between various resource owners and users.

One of the most important environmental conflict sources is land-use changes (Sleeter et al., 2012) due to their effect on the
natural energy and material cycles of ecosystems (Tong et al., 2012), the local climate conditions, biodiversity, and water resources (Liu et al., 2011). Conflicts over land uses represent a characteristic of urban development, especially in the context of metropolitan areas (Pacione, 2013), which are confronted with a high degree of pressure from various developers (Pătroescu et al., 2009).

As a result, conflicts emerge either between various land uses (residential vs. industrial or agricultural) or between different economic or social groups (residents, farmers, developers, etc.) (Darly and Torre, 2013). Land-use conflicts involve multiple parties who choose terms that favor their respective positions (Shmuely, 2008) and frequently exceed the community scale (Sze and Sovacool, 2013) to involve a range of societal actors, governmental bodies, non-governmental organizations, and private interests (Saarikoski et al., 2013).

The spatial component of land-use conflicts has shown a high manifestation in the last two decades in the countries of Eastern Europe, where the shift from a centralized planning system to an uncontrolled urban development (Pătroescu et al., 2009) has facilitated the emergence of these types of conflicts in various forms and places.

Land-use conflicts are increased by the fact that decisions on projects and developments for different land uses are still made based on incomplete information (Uuemaa et al., 2013); ideally, these situations would require accurate and high-quality decision-making to resolve these complex issues (Kamruzzaman and Baker, 2013); therefore illustrating the need for adequate indicators to measure the relevant driving forces and impact factors (Mubareka and Ehrlich, 2010).

Authorities and planners should find a compromise to accommodate all of the land uses needed for a specific region (Helbron, 2011) by controlling urban sprawl, preventing environmental degradation and addressing the difficulties posed by transport and the provision of public services (Darly and Torre, 2013; Pacione, 2013; Koschke et al., 2012). At the same time, these authorities and planners must continue to provide the minimum amount of buildable land in response to demands for housing and services in rural areas (Darly and Torre, 2013; Pătroescu et al., 2011) and maintain the balance between current and future needs (Sze and Sovacool, 2013; Koschke et al., 2012). The large volume of spatial data that lends geographical expression to the economic, social, cultural and ecological aspects of society (Jeong et al., 2013) requires analysis methods that integrate these aspects according to their impact on the final outcome (Saaty, 1990).

Multi-criteria analysis (MCA) is one method that can be used in spatial planning to aid decision-makers in exploring and solving multiple and complex problems (Jeong et al., 2013). The MCA represents decision-making analysis based on decision-science theory that is able to quantitatively evaluate alternatives by taking into account different perspectives and priorities to produce a common output (Barfod et al., 2011; Convertino et al., 2013). Choosing the MCA algorithm that best fits the research problem is challenging, however, because the subjective scaling of the clear quantitative numbers needed for pair-wise comparison of elements in the same hierarchy may lead to losses in accuracy (Kowalski et al., 2009).

Various studies (Jeong et al., 2013; Koschke et al., 2012; Convertino et al., 2013) have used MCA to assess the spatial distribution of environmental problems, whereas others have combined the MCA with cost-benefit analysis (Barfod et al., 2011; Gühnemann et al., 2012). All MCA analyses have a common pattern: define the alternatives to be ranked, identify the criteria that will influence the outcome, assign “weights” to the criteria and normalize them, and determine the final values (Convertino et al., 2013). Uncertainties exist with respect to the impact levels and weights, but in most cases, neither the time nor resources exist to follow the full construction of the model (Gühnemann et al., 2012).

The assessment criteria are chosen to a greater or lesser extent by how well they relate to the functional and livable dimensions of land uses (Sze and Sovacool, 2013; Gühnemann et al., 2012). The MCA is employed in land-use conflicts analysis to classify the risk levels of significant impacts on the affected area (Helbron, 2011) in the establishment of public policy contexts (Kowalski et al., 2009) or as applied to conflict resolution (Kamruzzaman and Baker, 2013).

Spatial conflicts have a high incidence in the Bucharest Metropolitan Area due to this region’s administrative heterogeneity (98 local administrative units from five counties with a reduced degree of law enforcement by local administrations) and its dynamic characteristics (increasing proportion of constructed surfaces, appearance of environmental degradation sources, modification of functional areas, reduction of green areas, fragmentation of properties) specific to the Eastern European countries (Zolin, 2007; Iojă and Tudor, 2012).

The current study develops a methodology for identifying areas prone to spatial land-use conflicts by focusing on a post-communist area in which phenomena such as the abandonment of agricultural activities, increasing attractiveness for residential areas and changes in the profile of industrial activities have a large incidence. The aim of our study is to provide a tool for integrating land-use conflicts into strategies of territory planning at the metropolitan level.

The main objectives of our paper are the following: (a) to derive a set of indicators with spatial distributions that are useful for analyzing the spatial land-use conflicts in the Bucharest Metropolitan Area and (b) to integrate these indicators into a multi-criteria assessment that will allow (c) the spatial identification of areas characterized by a high incidence of land-use conflicts at the metropolitan level.

2. Methodology

2.1. Study area

The Bucharest Metropolitan Area (Fig. 1) is situated in the southeastern region of Romania and contains 98 local administrative units (cities and communes corresponding to EU NUTS 5) included in five counties (Niță, 2012) with a total surface of 5080 km². We removed Bucharest, the capital city of Romania from our study area, because its characteristics and range of issues are of a completely different type (urban phenomena) than the remainder of the metropolitan area (rural side mixed with urban functions). The land use is mainly agricultural (76.8%), with the built-up environment representing only 4.65% of the metropolitan area’s total land (Pătroescu et al., 2011).

The dominant relief is characterized by low elevation plains and river floodplains (Pătroescu et al., 2009). The main rivers are tributaries of the Danube (which represents the southern limit of the metropolitan area and the border to Bulgaria). Forests once covered most of the study area, which is fragmented by lakes and rivers (4.9% is covered by aquatic surfaces), but centuries of human activities (mainly agricultural) have reduced the forests to a small proportion (10.5% covered by forests) (Pătroescu et al., 2011). The study area has a total population of 571,315 inhabitants, but numerous inhabitants of Bucharest have second homes in this area that are inhabited for a smaller or larger period of time (Pătroescu et al., 2009). The average population density is 111.5 inhabitants/km² (Rey et al., 2007) with notable territorial variations (range: 21–1010).

The changes in land properties after 1989 (shift from public to private owned lands) has increased the pressure of land-use changes according to individual purpose (Golusin and Ivanovic, 2013).
regardless of the public interests, impacts on productivity and the efficiency of the surrounding areas (Pătroescu et al., 2009). These new areas have lost viability and suffered processes of abandonment or losses of productivity (Iojă et al., 2011). Many land uses have appeared in areas that were not able support them, and external functions (by definition) have entered the built-up areas of human settlements (Nijă, 2012).

We obtained statistical data for several indicators (accessibility of the inhabitants to public infrastructure) from the National Institute of Statistics and City Halls of the Local Administrative Units of the metropolitan area and extracted demographic data from the 1992 and 2011 national census. Spatial data for the dynamics of residential areas were obtained from the analysis of topographical maps (at a scale of 1:25,000) published in 1977 and aerial images from 2008 using the ArcGIS 9.3 software from ESRI. We obtained data on the surface areas of agricultural land, built-up areas and semi-natural surfaces that provide ecological services from a combination of sources, including aerial images and the locality’s statistical charts.

2.2. Selection of indicators

We based our selection of indicators on their relevance to the objectives of the study and the availability of data. Based on the statistical criteria, we selected ten indicators (Table 1) in two categories: spatial indicators and urban development indicators. Our indicators are intended to assess the potential for the appearance of land-use conflict and not to assess the current distribution of land-use conflicts.

Spatial indicators (X1–X4) express the direct relationship between the presence and absence of certain land uses (agricultural, forestry, aquatic, built-up) at the metropolitan level. Agricultural surfaces account for the highest percent (76.8%) among the land uses in the Bucharest Metropolitan Area and represent a main direction for the development of built-up areas. Residential surfaces represent the function with the highest vulnerability to land–use conflicts and have significant importance for quality of life. Semi-natural surfaces, in addition to providing much-needed ecological services (air cleaning, climate regulation, water management), also represent buffer areas between potential conflicting land-uses.

Urban development indicators (Y1–Y6) are an indirect expression of the pressure on or needs of the population from each local administrative unit for certain elements of public infrastructure. Population tendencies and density are indicators of the magnitude of the conflicts and the potentially affected inhabitants, whereas aging expresses the dimension of a sensible age group that is among the first affected by the negative externalities of land-use conflicts. Aging also expresses the resilience of the inhabitants of certain localities to changes. By their presence, the indicators of public infrastructure (water, gas, sewage) display a high potential for urban development because areas that benefit from these infrastructures are preferred by developers for their planned projects.

Scores of indicators with different measurement scales (percent, inhabitants/surface, rate of growth) cannot be compared directly and must be standardized to a dimensionless value (Sudhakaran et al., 2013). We standardized the data using Mathematical Programming (Munier, 2004) via transformation to percent in a process that considers the worst value equal to 1 (the minimum data value for indicators X1, X3, Y4, Y5, Y6 and the maximum data value for indicators X2, X4, Y1, Y2, Y3) and the best value equal to 100. The standardized values were determined based on formulas (1) and (2):

\[
f(Z) = \frac{1 - 100}{\text{max} - \text{min}} \times Z + \frac{100 \times \text{max} - 1 \times \text{min}}{\text{max} - \text{min}}
\] (1)

if maximum represents the worst value, and

\[
f(Z) = \frac{100 - 1}{\text{max} - \text{min}} \times Z + \frac{1 \times \text{max} - 100 \times \text{min}}{\text{max} - \text{min}}
\] (2)

Table 1
Selected indicators used in the analysis.

<table>
<thead>
<tr>
<th>Categories of indicators</th>
<th>Indicator code</th>
<th>Indicator name</th>
<th>Worst situation expressed by</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial indicators</td>
<td>X1</td>
<td>Agricultural land</td>
<td>Minimum value</td>
<td>Percent of agricultural areas from the total surface in 2008</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>Built-up areas</td>
<td>Maximum value</td>
<td>Percent of built-up areas from the total surface in 2008</td>
</tr>
<tr>
<td></td>
<td>X3</td>
<td>Semi-natural surfaces providing ecological services</td>
<td>Minimum value</td>
<td>Percent of forests and water bodies from the total surface in 2008</td>
</tr>
<tr>
<td></td>
<td>X4</td>
<td>Residential area tendency</td>
<td>Maximum value</td>
<td>Rate of growth for the surface of residential areas between 1977 and 2008</td>
</tr>
<tr>
<td></td>
<td>Y1</td>
<td>Population tendency</td>
<td>Maximum value</td>
<td>Rate of growth for the number of inhabitants between 1992 and 2011</td>
</tr>
<tr>
<td>Indicators of urban development</td>
<td>Y2</td>
<td>Population density</td>
<td>Maximum value</td>
<td>Density of population for each locality in 2011</td>
</tr>
<tr>
<td></td>
<td>Y3</td>
<td>Aging</td>
<td>Maximum value</td>
<td>Percent of elderly population (age above 60) in 2011</td>
</tr>
<tr>
<td></td>
<td>Y4</td>
<td>Sewage</td>
<td>Minimum value</td>
<td>Percent of inhabitants with access to public sewage systems in 2008</td>
</tr>
<tr>
<td></td>
<td>Y5</td>
<td>Water</td>
<td>Minimum value</td>
<td>Percent of inhabitants with access to the public water network in 2008</td>
</tr>
<tr>
<td></td>
<td>Y6</td>
<td>Gas</td>
<td>Minimum value</td>
<td>Percent of inhabitants with access to the public gas distribution network in 2008</td>
</tr>
</tbody>
</table>

if minimum represents the worst value. In these equations, \( \text{max} = \) the maximum value of a data set, \( \text{min} = \) the minimum value of a data set, and \( Z = \) the value of indicators \( X_i \) and \( Y_i \) for each local administrative unit.

2.3. Multi-criteria analysis

The identification of areas with spatial land-use conflicts was conducted based on a multi-criteria analysis (MCA) (Beinat and Nijkamp, 1998; Munier, 2004). The general outline of the methodology can be described by the following stages (Fig. 2), similar to those of other studies (Jeong et al., 2013):

- Constructing a GIS database containing all of the spatial information on the Bucharest Metropolitan Area and connecting it to the data available for each local administrative unit.
- Selecting the representative indicators and transforming them into elements of the multi-criteria analysis.
- Using a method of pair-wise comparisons to determine the relative importance of each criterion in the form of a criteria weight.
- Aggregating the data with the criteria weights and obtaining the scores of each area.
- Spatially representing the distribution of the scores obtained for each local administrative unit.

For the analysis, we considered 10 main criteria as defined above and 98 cases corresponding to the local administrative units from the Bucharest Metropolitan Area. We selected the criteria for consistency, transparency and ease of understanding as required in a MCA analysis (Gühnemann et al., 2012).

Using the Analytical Hierarchy Process (Saaty, 1990), we established the weights of each of the 10 criteria \( g_i \) by considering the sum of weights equal to 1 for the purpose of aggregating them into a single overall value and producing a ranking. The weights reflect the importance of each criterion and were assigned based on a pair-wise comparisons (Table 2), although the weight value defined for each one can still be considered arbitrary (Kong et al., 2012; Gühnemann et al., 2012). We established the weights of each criterion based on an expert opinion applied by the authors of the present study.

By multiplying the weights of each criterion with the standardized values, we obtained ten partial scores. We obtained the final score for each local administrative unit by aggregating the partial scores with the aid of formula (3). The overall score is represented by the weighted average of its scores on all of the criteria.

\[
S = \sum_{i=1}^{10} (g_i \cdot f(Z_i))
\]  

As a result, the partial and total scores can vary between 1 and 100. In the final stage, we represented the score for each criteria and the total scores on maps of the Bucharest Metropolitan Areas using a division of classes (Adler et al., 2010; Dixon et al., 2009) to express differences between the magnitudes of spatial land-use conflicts.
Table 2
Relative importance of pair-wise comparisons and numerical values – after Jeong et al. (2013).

<table>
<thead>
<tr>
<th>More important intensity</th>
<th>Definition</th>
<th>Less important intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance or preference</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>More or less equal to moderate importance or preference</td>
<td>1/2</td>
</tr>
<tr>
<td>3</td>
<td>More or less moderate importance or preference</td>
<td>1/3</td>
</tr>
<tr>
<td>4</td>
<td>More or less moderate to strong importance or preference</td>
<td>1/4</td>
</tr>
<tr>
<td>5</td>
<td>More or less strong importance or preference</td>
<td>1/5</td>
</tr>
<tr>
<td>6</td>
<td>More or less strong to very strong importance or preference</td>
<td>1/6</td>
</tr>
<tr>
<td>7</td>
<td>More or less very strong importance or preference</td>
<td>1/7</td>
</tr>
<tr>
<td>8</td>
<td>More or less very to extremely strong importance or preference</td>
<td>1/8</td>
</tr>
<tr>
<td>9</td>
<td>More or less extreme importance or preference</td>
<td>1/9</td>
</tr>
</tbody>
</table>

Table 3
Statistical parameters of the raw data and intermediate standardized values.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Raw data</th>
<th>Intermediate standardized values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Max</td>
</tr>
<tr>
<td>X1</td>
<td>76.42</td>
<td>93.60</td>
</tr>
<tr>
<td>X2</td>
<td>6.10</td>
<td>42.39</td>
</tr>
<tr>
<td>X3</td>
<td>0.11</td>
<td>0.43</td>
</tr>
<tr>
<td>X4</td>
<td>55.72</td>
<td>433.50</td>
</tr>
<tr>
<td>Y1</td>
<td>–10.11</td>
<td>151.47</td>
</tr>
<tr>
<td>Y2</td>
<td>150.59</td>
<td>1009.94</td>
</tr>
<tr>
<td>Y3</td>
<td>24.73</td>
<td>41.65</td>
</tr>
<tr>
<td>Y4</td>
<td>16.83</td>
<td>74.50</td>
</tr>
<tr>
<td>Y5</td>
<td>7.03</td>
<td>105.00</td>
</tr>
<tr>
<td>Y6</td>
<td>13.81</td>
<td>129.90</td>
</tr>
</tbody>
</table>

3. Results

The differences between the values of the raw data for each indicator were significant (Table 3), with certain of them showing a spread of values (Y2 – range of 21.38–1009.94, ±155.33) while others presented a more concentrated pattern (X3 – range of 0.04–0.43, ±0.10). Using the standardization method, we normalized the values to a common level (all standard deviations of the intermediate values ranged in the 10.36–23.65 interval).

We obtained the weights for each criterion from the pair-wise comparisons conducted by each author of the present study (Table 4). It is notable that although the number of spatial indicators is smaller than that of urban development indicators, their total weight is larger (0.53). Indicators with the highest weights tend to represent residential surfaces (X4 – 0.19), the tendency of population (Y1 – 0.16) and the total surface of built up areas (X2 – 0.15). The lowest weights were assigned to indicators representing the infrastructure development (Y4–Y6). The sensitivity analysis in the expert weighting process has been assessed by constructing scatter plots of the output variables against a randomly selected input variable. The scatter plots revealed reasonable results across the analysis, and no significant differences were recorded.

We aggregated the weights of each indicator with the intermediate standardized values, thus obtaining the scores for each criterion and for each local administrative unit from the Bucharest Metropolitan Area.

The spatial indicators (Fig. 3) show a relatively similar distribution in the metropolitan area, with certain areas of concentrations according to the characteristics of each indicator. Indicator X1 – agricultural land displays heterogeneous values in the metropolitan area, with the lowest values found in the eastern part. Indicator X2 – built-up areas shows the highest values concentrated in localities situated in close proximity to Bucharest, and intermediate values in certain regional poles of development. Indicator X3 – semi-natural surfaces providing ecological services shows a reversed homogenous distribution, with the majority of values distributed to the worst-case scenarios due to the lack of both forests and water bodies and with low values corresponding to localities from the north and western regions characterized by large forest areas and water bodies. Indicator X4 – residential areas tendency presents a dominance of two medium classes of values, both characterizing increases in the surface of residential areas in the respective localities.

The total aggregation of spatial indicators (Fig. 4) shows localities with a high probability of land-use conflicts incidence situated particularly in proximity to Bucharest and in local administrative units that have a legal urban status. The scores range between 7.19 (lowest values in the eastern portion of the metropolitan area) and 52.48 (Voluntari, which neighbors Bucharest in the northeast), with four other local administrative units recording scores between 25 and 50 (all small cities situated in proximity to Bucharest).

The urban development indicators (Fig. 5) vary correspondingly: Indicator Y1 – population tendency and Indicator Y2 – population density show a small number of localities with high values for the worst situation (characterizing localities that suffered important developments of residential areas in the past 20 years) while the others recorded medium values. Indicator Y3 – aging shows a concentration of high values in the eastern portion of the metropolitan area, and smaller values are recorded in the center. All of the infrastructure accessibility indicators, i.e., Indicator Y4 – sewage, Indicator Y5 – water and Indicator Y6 – gas, show a reversed homogenous distribution, with the majority of values distributed to the worst situation case, and only a small number of local administrative units present the best scenario.

The total aggregation of urban development indicators (Fig. 6) in the Bucharest Metropolitan Area reveals a scattered distribution of a small number of local administrative units characterized by the existence of spatial land-use conflicts. The scores range between 10.00 (Joita) and 30.01 (Chitila), with the small values located in the periphery of the metropolitan area, and high values characterizing localities that represent poles of development.

The variability of the total score for the spatial indicators is greater than that of the urban development indicators (standard error 0.64 > 0.30). The total aggregation of indicators characterizing land–use conflicts in the Bucharest Metropolitan Area are presented in Fig. 7 with scores ranging between 17.53 (Gurbeanesti in the eastern portion of the metropolitan area) and 76.01 (Voluntari in
Fig. 3. Scores of the spatial indicators in the Bucharest Metropolitan Area.

Fig. 4. Aggregated scores of spatial indicators in the Bucharest Metropolitan Area.
the north-eastern area of Bucharest, and small values characterizing areas with a high rural degree. One local administrative unit exhibits a value greater 75 (Voluntari) and three present a value above 50 (Bragadiru, Chiajna and Chitila); all are small cities located in proximity to Bucharest.

4. Discussion

The distribution of scores for the spatial indicators in the Bucharest Metropolitan Area can be explained using the characteristics of the environment and socio-economic aspects. Agricultural lands (X1) show heterogeneous scores that directly related to the total surface of the local administrative areas and their position in the metropolitan area, with peripheral and large localities showing an availability of agricultural lands for further development (Golusin and Ivanovic, 2009) and thus mitigating the spatial conflict role of other land uses. Built-up areas (X2) and the tendency toward residential areas (X4) have a direct connection to the position of the local administrative unit in the metropolitan area. High values characterize areas in close proximity to Bucharest.

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and the northern area, which is a pole of growth for residential development (Nită, 2012) due to the large proportion of semi-natural surfaces providing ecological services (as expressed by indicator X3).

Population tendency (Y1) shows an evolution similar to that of the residential areas (X4), whereas population density (Y2) is relevant for local administrative units with small surfaces (generally urban) that are situated in proximity to Bucharest. Aging (Y3) and indicators of the accessibility of population to public infrastructure (i.e., sewage systems (Y4), drinking water (Y5) and natural gas (Y6)) express the rural degree of the metropolitan area, especially in its eastern and peripheral areas. The lack of such basic infrastructure is a situation that characterizes a large proportion of rural areas in Romania (Rey et al., 2007).

The total aggregation of spatial indicators allows the identification of spatial land-use conflicts in two categories of local administrative units: urban areas situated in proximity to Bucharest (Otopeni, Butea, Chiajna, Voluntari) and those characterized by elements of attractiveness for developers (Snagov). The total aggregation of urban development indicators follows the same
pattern as the spatial indicators but at a smaller scale. The difference between the standard error of the spatial indicators (0.64) and the urban development indicators (0.30) could indicate the uncertainty of the comparison and might require a refinement of the indicators included in the analysis. The total scores reveal local administrative units characterized by a critical (Voluntari) or high (Bragadiru, Chitila, Chiajna) incidence of spatial-land-use conflicts.

The identification of spatial land-use conflicts allows managers and planners to promote sustainable use of lands at both the local and the regional levels (Li et al., 2009). When analyzing the location of new large-scale projects (public or private), the decision-makers must be aware of where unbalanced situations already exist due to conflicting land-uses and where there are reserves of space without such problems. In addition, because conflicting land uses often diminish the quality of life for inhabitants, any reduction in their distribution can help correct the uneven distribution of environmental conditions between poor and affluent residents (Romero et al., 2012) and between the resident population and real-estate developers due to differences in purchasing power between the two categories. However, this process does not represent an absolute solution because traditional planning should shift to an appropriate management of land that can integrate both public participation and private interest (Cerreta et al., 2012).

The use of MCA in analyzing spatial land-use conflicts in the Bucharest Metropolitan Area has shown that even if every land use conflict has its own particularities (Sze and Sovacool, 2013), our criteria can provide instruments (Jeong et al., 2013) to land planners and administration for decision-making processes aimed at coordinated urban and rural development between metropolitan urban and rural areas (Shen et al., 2012). The simplicity and speed of calculation of the MCA indicates that the method is effective in response to rapid land-use changes (Uuemaa et al., 2013).

The method identifies spatial land-use conflicts at the metropolitan level and the specific LAU involved or at the statistical level for which the administration can provide the necessary data. Additional in-depth analysis could be performed, provided that each LAU can offer more spatially detailed data.

It remains to be proved whether this method is convenient for the comparison of different regions and phenomena because it generally involves area-proportionate additive measures (Jaeger et al., 2010). Further attention should be focused on the structure of the weight sets (Günhämnn et al., 2012) because they could have a major impact on the final outcome of the study. Additionally, the method does not allow a clear differentiation of the nature of conflicts (Darly and Torre, 2013); in most cases, a variation of land-use conflicts would be expected for such a large area.

5. Conclusions

The presented sets of indicators of spatial land-use conflicts are useful instruments for improving planning policies and strategies, increasing the social awareness of the population and providing direct economic projections for developers. Their integration into a multi-criteria analysis allowed us to map the areas characterized by a high incidence of land-use conflicts, which can be further used for sustainable development of the metropolitan area. The use of multi-criteria analysis in identifying the areas of land-use conflicts can be of real help to policy makers and authorities in the decision-making process, especially in Eastern European countries, because this methodology can represent a starting point for these assessments.

The main limitations of the methods lie in the availability of data required for the construction of each criterion. In addition, no principles or guidelines are currently available to select the most representative criteria for the characterization of land-use conflicts; therefore, the authors chose them according to their own expertise and the availability of data. Improvements should be pursued via organizing expert–opinion sessions with specialists from different fields of study. Additionally, further research is necessary to analyze whether such a multi-criteria assessment can be applied based on other criteria or on other study areas.

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References


