ADDRESSING ENVIRONMENTAL AND ECOLOGICAL CHALLENGES THROUGH THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS IN A METROPOLITAN CONTEXT. CASE STUDY: CLUJ METROPOLITAN AREA

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ABSTRACT. − Addressing environmental and ecological challenges through the implementation of sustainable development goals in a metropolitan context. Case study: Cluj Metropolitan Area. In recent years, the ongoing rapid urbanization increases the vulnerability of cities to the impacts of climate change and threatens the existence of environmental assets. Therefore, the sustainable development of urban areas has become a real challenge for local governments. The 2030 Agenda for Sustainable Development adopted by the United Nations (UN) is also an instrument that holds governments accountable to achieve the targets set within its framework. The purpose of this study is to analyze the condition and determine the progress towards achieving SDG 13 (Climate Action) and SDG 15 (Life on Land) in the case of Cluj Metropolitan Area, Romania. Official statistical sources gave the base to our calculation and analysis, that were selected in terms of their availability and integrity on the level of local authorities situated in the study area. The results indicate that the CMA made a trifling progress in implementing both of the analyzed SDGs.

Keywords: SDG indicators, local sustainable development, Cluj Metropolitan Area, environmental sustainability

1. INTRODUCTION

The acceleration of climate and land-use issues, the overexploitation of natural resources and contamination of natural ecosystems present demanding challenges in the acceleration of sustainability transitions. The rapid growth experienced by the urban areas and the human pressure on the peri-urban

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ecosystems (Sevianu et al., 2021) have flawed natural environmental resources (Jabbar et al., 2021), led to the disruption of natural temperature fluctuations, to air pollution and prompted environmental degradation. Therefore, as cities have become pivotal agents for sustainability, they also face numerous challenges in providing healthy environments and improving the well-being of their inhabitants. Moreover, metropolitan areas are considered to be large consumers of land, food, energy and producers of carbon dioxide (OECD, 2013; Benedek, 2006; Riffat et al., 2016) experiencing continuous pressure on providing environmental sustainability.

The transformation towards sustainable and liveable places demands the integration of social demands for healthy natural environments and the preservation of main ecosystem structures, processes and protection of biodiversity (Cebotari and Benedek, 2017; Benedek et al., 2018; Sevianu et al., 2021). Nevertheless, when discussing of what actions should be taken to preserve the diversity of life, alleviate degradation and reduce equity concerns of climate change, we also need to consider the question of how this is to be measured. Monitoring and measuring sustainability related aspects through the use of indicators goes back in the 1960s when the increasing impact of industrialization started to raise higher environmental awareness in society (Zinkernagel et al., 2018).

Nevertheless, addressing environmental sustainability reached a global importance not only in 1992 at the United Nations Environment and Development Conference through the Convention on Biological Diversity (CBD) or later on through negotiations towards a post-Kyoto Agreement in Paris but also with the launch of the Millennium Development Goals (MDGs) with a target date of 2015 and with the Sustainable Development Goals (SDGs) to be achieved by 2030. The latter one brought a new stage of global cooperation on addressing sustainability related concerns by extending the focus of MDGs of the Global South to the entire globe and taking a universal approach by including the Global North as well (Sachs et al., 2016).

Consequently, with the adoption of the 2030 Agenda by the United Nations (UN) in September 2015, the member states committed themselves to enhance global sustainable development. A total of 17 SDGs have been set which represent a Global Action Plan that integrates and addresses socioeconomic and environmental aspects. Next to this, in order to monitor progress towards achieving these goals, a wide set of indicators have also been defined.

In response to the commitment to implement the SDGs and monitor progress, Romania is also one of the countries that established a national framework and adopted the National Strategy for Sustainable Development of Romania 2030 (NSSD) in December 2018. In this respect, as pointed by Firoiu et al. (2019) over the last decade Romania presented varied efforts in safeguarding sustainable development in several areas, fact that underpinned the positive resonance of the NSSD's implementation report.

Nevertheless, several recent analyses (Firoiu et al., 2019; Benedek et al., 2021) show that the implementation of the SDGs in Romania is trifling and while the better performances concentrate in specific geographic regions, several rural areas or even regions experience low performances.

Even though the sustainable development indicators designed within the framework of the 2030 Agenda were initially directed at nations, there is a growing number of studies that recognize the need to measure progress towards sustainable development through these indicators on a local scale, be that at the level of municipalities or metropolitan regions (Barnett and Parnell, 2016; Corbett and Mellouli, 2017; Klopp and Petretta, 2017; Nagy et al., 2018; Zinkernagel et al., 2018, Lafortune et al., 2019; Ivan et al., 2020a; Ivan et al., 2020b; Salem et al., 2020). As pointed above, the reduction of greenhouse gas (GHG) emissions, decrease of land degradation and secure provision of natural resources and ecosystem services are some of the most important and current environmental issues faced by urban areas. Consequently, there is an urgent need to monitor progress towards the achievement on local level of SDG 13 and SDG 15 which aim to "Take urgent action to combat climate change and its impacts" and respectively, to "Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity". Hence, the objective of our study was to analyze the environmental and ecological challenges in achieving the SDG 13 and SDG 15 set within the framework of the 2030 Sustainable Development Agenda, on the level of local authorities situated in the Cluj Metropolitan Area (CMA) Romania. The results of the study give a valuable insight on implementing SDG 13 and SDG 15 at local level and contribute to the continuously evolving academic debate regarding the implementation of the 2030 Agenda on the level of urban and metropolitan areas.

2. MATERIALS AND METHODS

2.1. Study Area

Cluj Metropolitan Area is located in Cluj County, Romania and represents 24 percent of the county's total area and its population equals to about 59.8 percent of the county's total population (ISCMA, 2017). It was formed in 2008 and composed by the urban core, Cluj-Napoca and its neighboring 18 rural localities at the time of its formation (the commune Sânpaul joined the metropolitan area in 2009, yet our study is based on the initial setting) that are situated in a 30 km distance from this. The metropolitan area is extended on two rings and the initial setting was as follows: Florești, Feleacu, Ciurila, Apahida, Chinteni, Baciu and Gilău in the first ring, whereas Bonțida, Borșa, Căianu, Cojocna, Gârbău, Jucu, Petrești de Jos, Săvădisla, Tureni and Vultureni in the

second. As shown in Table 1. below, the greatest share of the total area of CMA is rural area (88%), whereas more than 75 percent of its population lives in the urban core. In an urban planning and economic context, the CMA is a heterogenous one, being composed by communes with strong urban aspect (such as Florești, Baciu, Apahida) and on the opposite side, by several communes such as Borșa, Vultureni and Petrești de Jos, with strong rural characteristics (Baciu, 2013).

Table 1. Area share of Cluj Metropolitan Area and population in 2018

Cluj Metropolitan Area	Administrative Area		Population	
	Area (km2)	%	thousand	%
Urban Core	179,56	11.20	323,631	75.82
The surrounding first and second rings of rural areas	1423,39	88.00	103,196	24.18
Total CMA	1602,95	100	426,827	100

Source: NIS, 2019

2.2. Data selection and determination of indicators

As the UN has already established a set of indicators in order to homogenize the calculation criteria for measuring performance towards achieving the SDGs (Martínez-Córdoba et al., 2020), in the phase of data selection our purpose was to identify indicators that were identical or closely similar to those established by the UN, yet also applicable on the scale of local authorities. Therefore, based also on our previous study (Nagy et al., 2018; Nagy, 2019) and some recent research (Benedek et al., 2021) in the selection of indicators we searched data considering the following criteria: availability, measurability, statistical reliability, accessibility and representativity (official data). However, in the case of SDG 13 for example the datasets within this goal were not available or did not exist on the level of local authorities, therefore we only used one indicator (percentage of green areas) in order to construct and visualize the performance of localities towards achieving this SDG.

For the outputs, we considered the most approximate way to evaluate SDG 13 and SDG 15 in the context of local governments with the following variables (see also Table 2.): the percentage of green areas (Green areas %) for SDG 13, the change of the forest area for the 2006-2012 period (Change in forest area %); the percentage of Natura 2000 sites (Natura 2000 sites %); the percentage of terrestrial sites with protected biodiversity (Terrestrial sites of biodiversity that are protected %) for SDG 15. In terms of data sources, we used the European Copernicus Land Monitoring Services that provided us with

geographical information on land use and land cover (Corine Land Cover) and information obtained from the open database of the Romanian Ministry of Environment (MOE). Based on the information extracted from the Corine Land Cover (CLC) dataset, the "green areas" and the "change in forest area" indicators were calculated for each local authority. It is also important to mention that it was part of the selection criteria to obtain data that is available for each of the analyzed localities of the CMA. To complete our analysis, we also used data gathered from Eurostat (2022), information from strategic planning documents such as the Integrated Strategy of Cluj Metropolitan Area (ISCMA) or reporting documents on progress towards achieving the SDGs provided by the Eurostat or by Romania's Ministry of Environment.

Table 2. Summary of indicators used for the analysis and mapping

Studied SDG	Indicators	Score	Year of data used for the analysis	Source
SDG 13	Green areas (%)	3.79	2012	CLC, 2018
SDG 15	Change in forest area (%)	2.16	2006-2012	CLC, 2018
	Natura 2000 sites (%)	2.13	2015	MOE, 2018
	Terrestrial sites of biodiversity that are protected (%)	2.45	2017	MOE, 2018

Source: Nagy et al. (2018).

2.3. Measuring and mapping performance

After extracting the data, the process to determine the progress of each local authority towards achieving both of the analyzed goals, to classify and map the analyzed local authorities based on their performance in sustainability indicators, involved three phases (Nagy et al., 2018):

1. normalization of indicators: in order to make data comparable we used the normalization method where each variable received a value between 0 and 10; in the case of our analysis 0 indicated the worst performance and 10 indicated the best performance and the used normalization method was the min–max ($\hat{x}$) normalization method: $\hat{x} = \left(\frac{x-min(x)}{max(x)-min(x)}\right)$ x 10

2. aggregation of the normalized data into one composite index within both, SDG 13 and SDG 15 using arithmetic mean; we used the same procedure to calculate the overall performance of the CMA towards both SDGs

3. visualizing the performance of each local authority within the analyzed SDG on one map and placing it in the context of the CMA; we used the ArcGIS software classifying the local authorities depending on their performance within the analyzed SDG by using the Jenks Natural Brakes optimization method; the aim was to obtain an optimal data classification as suggested by Hogan et al. (2018).

2.4. Limitations of the study

Few limitations need to be considered regarding the study. First, the older data from the Corine Land Cover dataset (2012) makes the reflection on the actual situation more difficult. Second, because of data availability issues on the level of Local Authorities, in this study the evaluation of both SDG 13 and SDG 15 in a local context is more limited and focuses on selected indicators that are identical or closely similar to those established by the UN. From this reason, in the case of SDG 13 for example only one indicator was used and shows a partial situation in the analyzed area. Third, the process of data normalization reduces the accuracy in comparing data and results obtained on the level of local authorities situated in other countries.

3. RESULTS AND DISCUSSION

3.1. Performance under the goal of taking climate action (SDG 13)

Addressing climate change became a major challenge for cities, as urban activities are major contributors to greenhouse gas emissions. Global warming and urban land-cover change escalate the impacts of climate change on the health and well-being of citizens and make metropolitan areas responsible for the negative implications of these processes. Therefore, the UN's goal to "Take urgent action to combat climate change and its impacts" seeks to improve resilience and capacity to adapt to climate-related hazards and reduce greenhouse gas emissions. To achieve this, there is a need to integrate climate change adaptation approaches into the planning frameworks of governments at various levels but also to raise awareness and improve education on climate mitigation topics (Nagy, 2018).

Although, the EU's support and financial contribution to climate action increased in recent years and the GHG emissions were reduced with 19.8% in the 2004-2019 period, it is likely that it will not meet its 2030 reduction target (Eurostat, 2021). According to the same source, a high proportion of emission reductions is due to lower use of energy and heat generation activities on one hand

and increased use of renewable energy sources on the other. Nonetheless, in spite of the total emission reductions, more than half of the EU's countries experienced an increase in the per capita emissions. Based on estimated data of Eurostat (2022), in 2019 Romania had the third lowest greenhouse gas emissions per capita (tonnes/capita) in the EU-28 with almost 29% less tonnes per capita than the EU average and according to the country's report on climate action, it achieved 24.3% share of renewable energy sources in 2019 (Jensen, 2021). Nonetheless, Romania was the fifth lowest contributor to climate finance in the 2014-2019 period. In terms of climate mitigation and adaptation responsiveness, Romania is on the 13th place in the EU-28 having almost 40% of the population covered by the CoM for Energy and Climate signatories[4], which reflects on an average level of awareness and participation in such initiatives (Eurostat, 2022). On a country level, according to a study that was based on the analysis of six indicators selected under the SDG 13, it is likely that Romania will reach the European average for half of the analyzed indicators by 2030 (Firoiu et al., 2019). Nonetheless, its capacity to resilience and adaptation to climate change and natural disasters demands increasing efforts. The progress within the SDG 13 raises concerns on a county level as well as according to the analysis of Benedek et al. (2021) Cluj County received only a slightly higher score than the average (5.94). According to the study, the negative impacts of urbanization on one hand and the high share of people working in agriculture using degrading practices (such as excessive use of pesticides) on the other, make the progress within this goal, difficult.

Because of data availability issues on local level, in order to analyse SDG 13 in the context of the CMA, we used the indicator that indicates the size of the green areas in relation to the total area of each locality situated in the Cluj Metropolitan Area (see Figure 1).

According to the study of Benedek et al. (2021), under the goal of Climate Action, Cluj County with a score of 5.9 is about halfway from to the optimum outcome, yet still at an increased distance from this. Results from our analysis of the CMA show that the metropolitan area scores 3.79 within SDG 13 this meaning that it did not reach halfway of the distance to the maximum of 10.00 across this goal and performs worse than Cluj County. As visualized in Figure 1. below, the localities situated in the western side of the CMA have more green areas in relation to their total area than those situated in the eastern side. The maximum score of 10.00 was achieved by Gilău, being the only commune that manages to position itself within the first tier. This is also due to its mountainous morphology that delays

[4] Covenant of Mayors (CoM) for Climate and Energy signatories is a movement that focuses on climate concerns and energy actions on a local level. It is a bottom-up approach launched in 2008 in Europe, with the aim to gather regional and local authorities from various countries (not only European countries) who voluntarily commit themselves to apply EU climate and energy goals through practical measures and projects (Covenant of Mayors, 2022).

land take related initiatives. This is followed by another commune from the second ring Gârbău with a score of 7.12 yet, performing with 30% lower than Gilău and falling into the second tier within SDG 13. More than half of the analysed localities achieve scores above 5.00 within this goal nonetheless, the performance of the municipality of Cluj-Napoca is 15% lower than the metropolitan average and falls into the third tier achieving a score of 2.24.

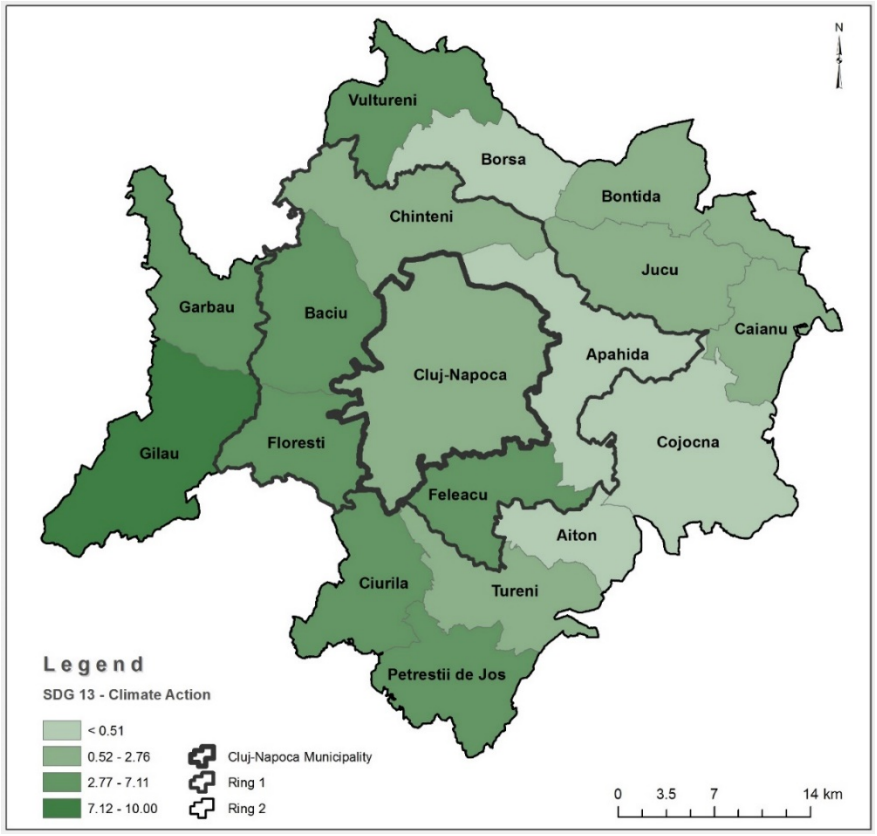

Fig. 1. SDG 13 in CMA
Source: Nagy (2019)

The municipality had 25,37 m^2 /capita of green space in 2014, slightly lower than the average of 26 m^2 /capita in the European Union (ISCMA, 2017). According to the same source, in terms of climate change, in Cluj County the annual average temperature increase varies between 1.13 °C and 1.22 °C compared to that registered within the 1961-1990 period. Next to this, in the ten-year period between 2010 and 2020 the municipality registered a loss of 106 ha of green area representing more than 11% decrease in this period (NIS, 2022) and

in 2011 the energy consumption caused almost 1 million tonnes of CO2 emissions (APDE, 2013). In relation to the quality of the air, the North West region has the highest natural gas emissions out of the eight Romanian development regions which come from polluting activities such as waste-disposal (98,3%), water treatment units and poultry as well as porcine production (ISCMA, 2017). On a national level in 2020 the public administration investments had the greatest share (54.5%) in total investments for environmental protection and the expenditure for the environment and climate protection represented 20.5 % of the total investments (NIS, 2022). With regard to the awareness and participation in climate action initiatives, not only on metropolitan but also on County level, the municipality is the only locality that signed a commitment to the CoM for Energy and Climate signatories. It also submitted an action plan, yet the monitoring report has not been finalized (CoM, 2022). Conclusively, the municipality is the greatest pollutant in the metropolitan area, the main sources of air quality degradation being the road traffic, the construction sector, various industrial activities and CO2 emissions from the electricity and heat sectors, causing low achievement levels under the Goal for Climate Action. Nevertheless, the stronger rural profile especially in the second ring localities of the CMA and the existence of protected areas, forests, do contribute to better achievement levels of several localities within SDG 15. On a metropolitan scale however, the fact that the climate action performance of the CMA did not reach halfway of the distance to the optimum outcome across this goal and performs worse than Cluj County calls for urgent climate actions and additional initiatives that build climate resilience.

3.2. Performance under the goal of protecting life on land (SDG 15)

Human health and wellbeing are in strong connection with the terrestrial ecosystem as they are extensively dependent on a healthy natural environment. Nonetheless, the negative effects of deforestation, land degradation, the expansion and extensive use of agricultural land, loss of biodiversity caused by human activity and climate change, places us further away from the welfare that we wish to achieve. Therefore, the SDG 15 (Life on land) focuses on ending deforestation, better managing the forest areas, halting biodiversity loss and including biodiversity concerns and ecosystem approaches into the planning and development processes of national and local governments. Assessing the EU's situation concerning SDG 15, it is noticeable that even though progress has been made in decreasing pollution levels in rivers and increasing the EU's share of forest area, continued decline has been registered in biodiversity and species abundance and more visible forms of land degradation have been recorded (Eurostat, 2021). According to the same source, slight progress has been made in increasing the EU's share of forest and other wooded land areas achieving a 0.9%

increase in the 2015-2018 period. The conservation of its terrestrial ecosystem has also been supported by extending its Natura 2000 network.

On the other hand, land take continued to increase and kept pressures on biodiversity. For example, in the 2006-2018 period the areas of sealed soil surface increased with 8.3% and in meantime the common bird species declined by 1.7 percentage points in the EU. Within these terms, in 2018 Romania had 35.5% of its total area covered with forests and other wooded land compared to 42.3% European average which positioned the country on the 19th place in the EU-28 (Eurostat, 2022). As a proportion of total land area, Romania's share of forests and other wooded land increased slightly by 3% between 2012 and 2018.

On the other hand, the area of sealed soil continued to increase in Romania registering an 8% increase between 2006 and 2018 (Eurostat, 2022). Even though Romania is a country with rich biodiversity and having Europe's largest wetland, the Danube Delta, it experiences negative consequences of increasing polluting activities and economic pressures. These are connected to the overexploitation of natural resources, conversion of wetlands to agricultural use, pollution coming from industrial activities but also the expansion of cities that affected the biological diversity not only on local but also on a general level (Romania's Voluntary National Review, 2018).

For example, the study of Firoiu et al. (2019) which analyzed three indicators under the SDG 15, found that according to the forecast for the 2030 horizon, Romania will only register progress for one indicator out of the three that were subject to their analysis. Next to this, according to the study of Benedek et al. (2021) even though some counties perform well under the SDG 15 mainly due to accommodate the largest wetland in Europe and several renowned national parks, almost 60% of the counties fell well-below the national average regardless the fact that they congregate developed areas.

To measure the progress towards SDG 15 on a metropolitan level, we used a total of three indicators which consist in the following: the change of the forest area for the 2006-2012 period; the percentage of Natura 2000 sites; the percentage of terrestrial sites with protected biodiversity.

In the ambition to protect, restore and promote sustainable life on land (SDG 15), Cluj County scores 1.5 reflecting on the fact that major challenges remain on county level in this perspective (Benedek et al., 2021). The Metropolitan Area of Cluj with a score of 2.24 has covered almost a quarter of the distance from the worst to the best possible outcome within SDG 15, yet it is still at an increased distance from the maximum outcome. Consequently, there is an urgent need for further actions in this perspective. As shown in Figure 2. below, the northern and upper eastern side of the metropolitan area perform better within the Life on Land (SDG 15) goal. Accordingly, less than a third of the localities managed to receive a score higher than 5.00 these being Borșa (7.09)

and Vultureni (5.42) from the second ring and Chinteni (5.10) from the first ring. The performance of Chinteni is also influenced by the fact that it is a locality with strong agricultural profile and the frequency of arable land represents 40% of the communes' surface (Baciu et al., 2020). Nevertheless, land take for conversion to residential areas continues to increase in the commune and compromises its future achievement levels under this goal. Just over a third of the communes fell into the first two tiers, these being the above mentioned Borșa, Vultureni and Chinteni followed by Apahida (4.64), Jucu (3.82) and Bonțida (2.93). On the other hand, more than a third of the analysed localities did not manage to achieve the score of 1.00. and just over a quarter such as Feleacu, Aiton, Cojocna, Cluj-Napoca and Petrești de Jos received a score above 1.00 yet, below 2.00.

The results are in strong connection with the fact that based on our data, the three best performing localities under this goal (Borșa, Chinteni, Vultureni), have the greatest share of Natura 2000 areas and terrestrial biodiversity sites. Next to this, according to our analysis, the following best performers such as Apahida and Jucu experienced the highest increase of their forest area (17% the first and 14% the latter one) in the metropolitan region, between 2006 and 2012. In contrast, in the 2002-2020 period, Apahida for example also experienced a 3.5% decrease of non-agricultural land mainly due to loss of a small amount of forest area and conversion of floodable lands into agricultural land due to the proximity of the Someș river (Baciu et al, 2020). From a spatial planning perspective, it is worth mentioning that according to the ISCMA (2017) the approximately 31 ha of protected area situated in Apahida (the Mole-Rats Natural Reserve from Apahida) is the only one in the metropolitan area that has an existing management plan. In the case of the first ring commune Feleacu for example, with a score slightly above 1.00 a similar trend to the one experienced by Chinteni is visible. Despite its stronger rural profile, the increasing infrastructural and real estate development led to a 20% increase of its non-agricultural area in the 2002-2020 period (Baciu et al., 2020). Another example is of Florești, a first ring commune that positioned itself second to last (with a score of 0.42) in the distance from achieving SDG 15 also experiencing a strong urbanization trend within the last two decades with a 70% increase of its non-agricultural land (Baciu et al., 2020). The municipality of Cluj-Napoca is the 8th best performing locality out of the eighteen analysed areas yet, with a score of 1.75 falls below the metropolitan average and has not covered a quarter of the distance to achieve SDG 15. Even though the municipality has several natural protected areas on its territory, the rapid urbanization and the chaotic real estate developments increased the loss of forest area, of green spaces and magnified the risk of environmental hazards (ISCMA, 2017).

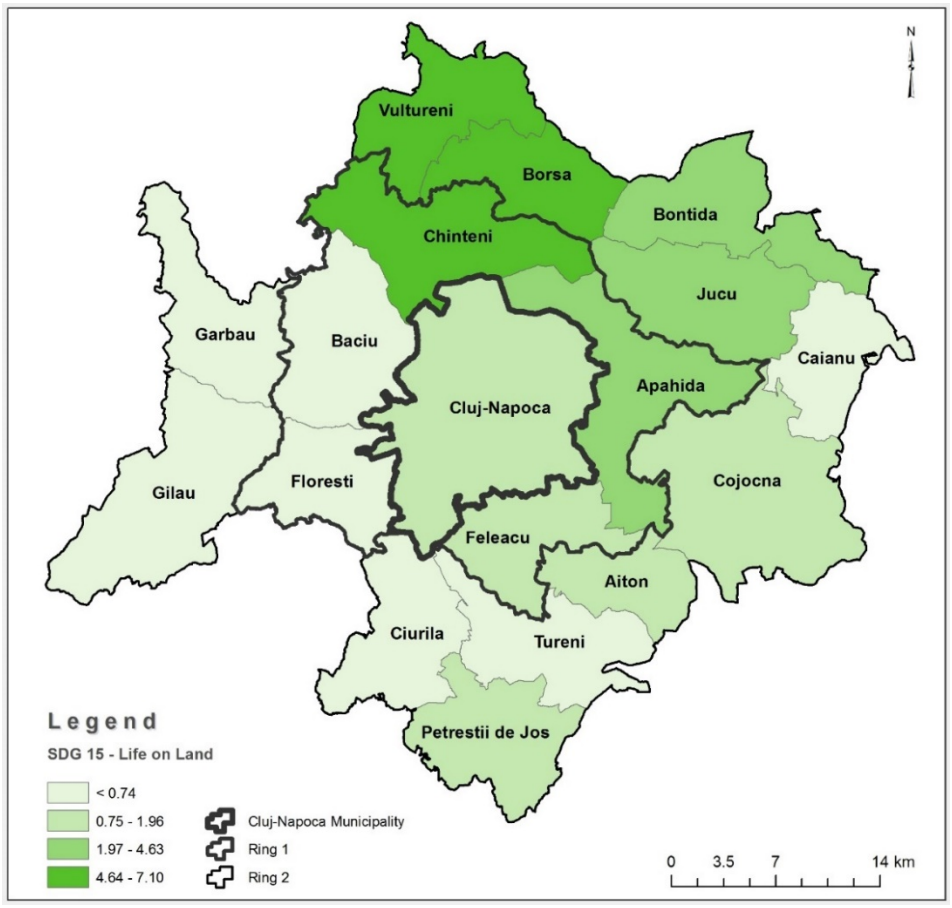

Fig. 2. SDG 15 in CMA
Source: Nagy (2019)

In overall, as highlighted by the ISCMA (2017) but also the results of our study visualized in Figure 2., clearly reflect on the fact that the thirty-two protected areas of the CMA are situated mostly in the northern and few in the southern part of the metropolitan region. Nevertheless, the harmony between nature and the city as well as the opportunity to increase the likelihoods to get closest achievement towards the optimum outcome within SDG 15 is largely dependent on the integrated planning approaches applied coherently in the metropolitan region.

4. CONCLUSIONS

Addressing environmental and ecological challenges in a metropolitan context employs a multidisciplinary approach which takes in consideration issues that arise as a result of the urban and rural development practices and needs an integrated approach in both monitoring and policy making. However, in order to capture the complexity of such metropolitan systems, monitoring and evaluation becomes pivotal in capturing the progress towards the local goals set in the view of sustainable development. In this article we compare local authorities situated in the CMA by measuring their progress within SDG 13 and SDG 15. Although we recognize the limitations of our study as gathering data on the local authorities' level presented great challenges, our calculations, the categorization and mapping of the results demonstrate that the current practices related to the SDGs concerning environmental sustainability, do not meet the objectives set in the 2030 Sustainable Development Agenda. The metropolitan area struggles with climate change, with various demographic effects and the continuous pressure on key resources is detrimental in terms of environmental sustainability. Consequently, under both of the analyzed SDG's the metropolitan average score is more than halfway from achieving the expected progress set in the framework of the 2030 Agenda for Sustainable Development. There is a need for innovative approaches and corresponding strategies that address specific situations to strengthen the CMA's resilience. To achieve SDG 13 and SDG 15 in 2030 an improved and better tailored metropolitan wide governance is needed, as the local governments are an essential component for the efficient implementation of the 2030 Agenda.

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