

THE ASSESSMENT OF SOME SUSTAINABLE LAND USE INDICATORS (CASE STUDY: CHIȘINĂU MUNICIPALITY)

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Summary: Land use structure is a product of human activities and local natural conditions. This structure consists of area proportion, space distribution and the influence of relationship between all land use types. Land use structure indicates the status of natural and socioeconomic development which affects the development of all aspects of society. Land use structure optimization involves activities to organize the land use structure more rationally, which primarily includes area proportioning and space distributing. Furthermore, optimization facilitates the coordination and sustainable development of the economy, society, and ecology (Herold, Couclelis, Clarke, 2005). Therefore, in the paper are presented and quantified several indicators of sustainable use of suburban lands in Chisinau municipality, Republic of Moldova. The described indicators were selected taking into account the required primary data (availability and accessibility): Land Cadastre of the Republic of Moldova, Geoportal, Statistical Data Bank, normative acts, etc.

Keywords: Land, Suburban Area, Sustainable Land Use Indicators, The Naturalness Index of the Landscape, Human Pressure on Landscapes through Agriculture, The Environmental Transformation Index.

INTRODUCTION

Land is the terrestrial foundation of society; it is the platform for infrastructure and for residential, commercial and industrial areas, and is a source of economic growth. However, an increasing share of our planet's land area is in some way modified by human activities, leading to unsustainable changes in our landscapes. Ever-increasing demands on the land from economic development, burgeoning cities and growing rural populations are driving unprecedented land use change. In turn, land use change is driving land degradation: soil erosion, nutrient depletion, salinity, water scarcity, pollution, disruption of biological cycles, and loss of biodiversity (Global Assessment of Land Degradation and Improvement (GLADA), UNCED 1992, UNEP 2006).

The municipality of Chisinau was selectet for the research because here the interest on land is quite high, especially due to the intense suburbanization process in recent decades. The special importance of Chișinău municipality is determined by its political, social, economic and administrative functions which are extended throughout the territory of the country. During the last several decades in the process of municipality development is an increasing tendency of its integration with the suburban areas, in this way consequently, activating the agglomeration formation process, and also there are changes in land use.

Thus, according to the general principles of formation of the exposed suburbanization process (Hesse, Siedentop 2018), the Republic of Moldova follows the Eastern European model. In the same vein the effects of urbanization can vary greatly due to the diversity of economic, industrial, land and expansionist policies. It should be mentioned that data need to be quantified therefore practical evaluation indicators are most suitable for a general overview.

MATERIALS AND METHODS

As mentioned above, the indicators for which the initial study data are accessible have been selected for this article. Studying the literature, we identify a multitude of indicators of land analysis depending on the interest or the problem to be solved, both internationally (Sustainable Land Use Indicators, by Ulrike Eppler and Leire Iriarte, in GLOBALANDS, Working Paper 3.2: the proposed set is composed of 7 themes/criteria and 17 indicators; Harbel, Shandl, 1998) and nationally (Bejan, Țițu, 2013; Boboc et al., 2020; Cujbă et al., 2021).

For the first indicator the Decision of the Government of the Republic of Moldova no. 667 of July 23, 2010 for the approval of the Regulation on grazing and mowing was used. In the document we can find the stipulations, the conditions and methodology, as well as the allowable pressure on the grazing land and the conditions for its optimal provision. In this context, the methods and recommendations for determining the allowable pressure on pastures, as well as the area required for grazing of different groups of animals, were used to highlight the impact of different types of animals on pastures. In determining the values of these indicators were used the conversion coefficients per head conventional for cattle -1.0 (i.e. sheep and goats of all ages - 0.14) when calculating the pressure on the pastures, the recommended load norm for the Central Region of the country was used, namely 8 conventional units per 10 ha of pasture. The destination and use of grazing land is an important factor in maintaining the ecological balance, especially when it is located next to human and/or technological settlements. Knowing the general condition of the pastures and / or the degree of pressure on them, but especially the regular monitoring of these indicators is a decisive factor in the sustainable use of these lands.

The formula of Naturalness Index (Ni) was used, which is calculated at the level of administrative-territorial units, and represents the ratio between the area of forest landscapes and the total area (Bejan, Țițu).

$$\text{The Naturalness Index of the Landscape} = \frac{\text{Forest's area}}{\text{Total area}} \dots\dots\dots 1$$

Another researched indicator is the human pressure on landscapes through agriculture (Boboc et al., 2020) which is assessed in relation to:

$$\text{Agricultural Pressure} = \frac{\text{Agricultural area}}{\text{habitants}_{\text{commune}}} \dots\dots\dots 2$$

Next, we can mention that, the calculation of Environmental Transformation Index allows to assess the degree of ecological stability, starting only from the correlation of the surface of different categories of land. Even if it can be considered superficial, it highlights the irrational use of land, after which we can proceed to qualitative analysis (land organization, intensity of use, their degree of degradation, etc.) (Bejan Iu., Țițu P., 2013).

$$\text{Environmental transformation Index} = \frac{\text{Area}(\text{forest}+\text{meadow}+\text{water})}{\text{Area}(\text{built-up}+\text{arable}+\text{vineyard}+\text{orchards})} \dots\dots 3$$

It is known that the ecological stability of land decreases with increasing human impact, especially in the case of such categories of use, such as arable land, buildings, roads, etc.

In order to highlight the distribution of information from a spatial point of view, Geographic Information Systems were used, through free and open software QGIS, version 3.16 - Hannover.

RESULTS AND DISCUSSIONS

Suburbs are areas that are adjacent to the main urban area, being characterized by mixed land use that includes urban and rural areas, with a mediate construction and population density as compared with urban and rural areas and accessible commuting distance to a city. As the transitional area between urban and rural areas, land-use change in suburbs is drastic, which generates negative effects on the environment.

The effects of urban expansion have been discussed widely in existing studies, of which the urban sprawl catches most concerns (Feltynowski, 2015; Hamilton et al., 2005). Despite the many studies on urban sprawl, little attention has been paid to suburban expansion. The measurement of urban expansion usually relies on measuring the land transition that occurs beyond the built-up urban area. However, the boundaries of suburbs are usually larger than the scope of urban areas, and the land-use change in suburbs includes urban expansion.

Referring to the fist assessed indicator, we can mention that in the Republic of Moldova the development and use of lands and pastures of localities is carried out based on the provisions of the Constitution and in accordance with the Law on Environmental Protection, Land Code, Law of the Republic of Moldova No. 591-XIV of 23.09.1999 on the green spaces of urban and rural localities, the Regulation on grazing and mowing and other normative acts.

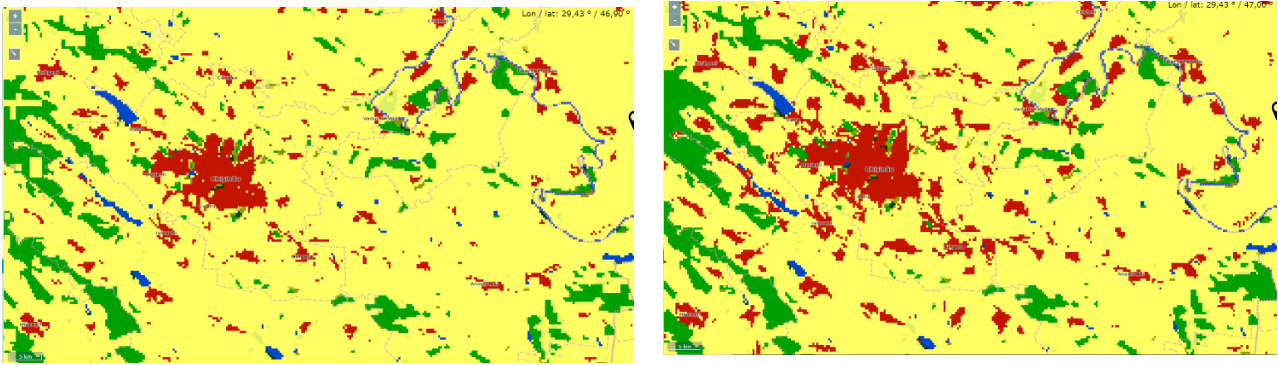


Figure 1: Expansion of built-up area (red) and areas covered with forest vegetation (green) 1992 compared to the 2015 year

Source: <https://maps.elie.ucl.ac.be/CCI/viewer/>

In accordance with the Decision of the Government of the Republic of Moldova no. 667 of July 23, 2010 for the approval of the Regulation on grazing and mowing, pasture users must ensure compliance with the allowable pressure on pasture, which is expressed per head of conventional animal per hectare.

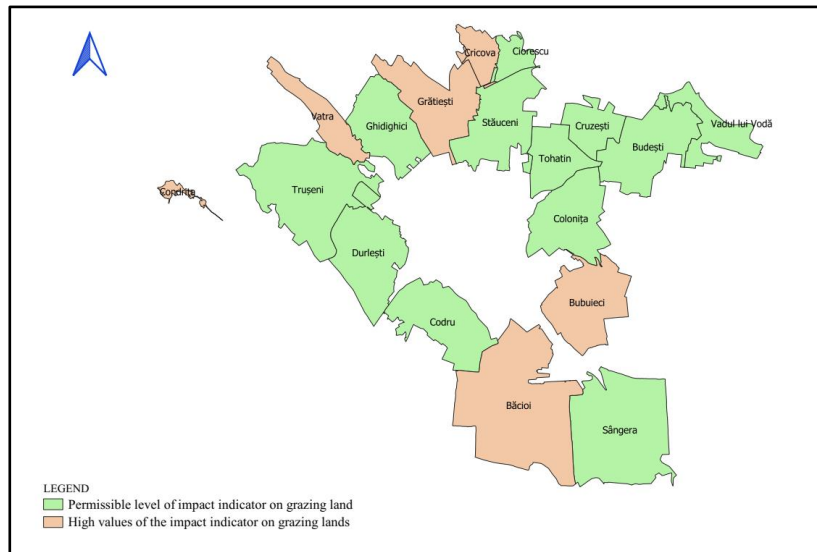


Figure 2: The pressure of the herd on the pastures

Source: developed by the authors

Thus, according to the data, cattle have a major impact on pastures for the whole period analysed. The impact of sheep and goats in 2016 was about 30 and 18.5% respectively compared to that of cattle. But over the years there has been an increase in pressure from the goat livestock throughout Chișinău municipality (Figure 2).

The data in the table show that on average the impact of the existing livestock in the localities of Chisinau municipality is at an admissible level (0.9), at the same time this indicator records very high values in some suburbs of Bubuieci - 2.0; Băcioi 2,3; Condrița 4.1; Cricova - 6.1; Vatra - 12.3, as observed after analyzing the data in Table 1.

Table 1: Parameters of the impact indicators on the grazing lands in the localities of Chisinau municipality (year 2020)

		The surface of the pastures (ha)	Area required (calculated) for livestock categories (ha)	Impact indicator (Area required, ha /Existing area, ha)
1.	Chișinău city	2870	2699	0,9
2.	Sângera town	752	566	0,8

3.	Băcioi commune	172	393	2,3
4.	Durlești town	141	85	0,6
5.	Vatra town	1	12	12,3
6.	Condrița commune	9	37	4,1
7.	Ghidighici commune	169	120	0,7
8.	Trușeni commune	244	150	0,6
9.	Codru town	107	35	0,3
10.	Vadul lui Vodă town	94	56	0,6
11.	Bubuieci commune	232	453	2,0
12.	Budești commune	144	90	0,6
13.	Colonița commune	222	163	0,7
14.	Cruzești commune	84	22	0,3
15.	Tohatin commune	67	82	1,2
16.	Cricova town	14	85	6,1
17.	Ciorescu commune	64	54	0,8
18.	Grătiești commune	203	226	1,1
19.	Stăuceni commune	151	47	0,3

Source: calculated by the authors based on the data of the Land Cadastre of the Republic of Moldova and the Regulation on grazing and mowing.

The Naturalness Index of the Landscape thus determines the degree of afforestation. Taking into account the values obtained from the calculation of this index, the degree of landscape damage was classified into 6 categories, being represented in Figure 3.

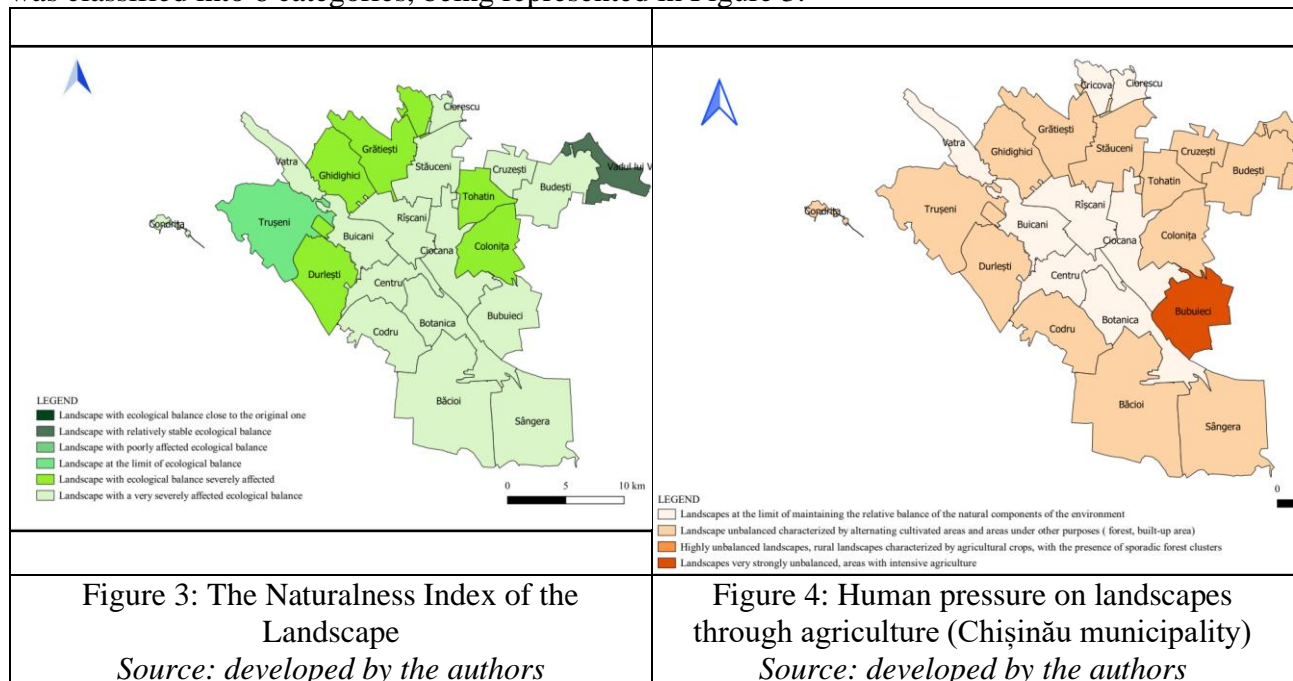


Figure 3: The Naturalness Index of the Landscape

Source: developed by the authors

Figure 4: Human pressure on landscapes through agriculture (Chișinău municipality)

Source: developed by the authors

We mention that the result of calculating the formula above mentioned, on the first positions are the Vadul lui Vodă (it is the most attractive), later Trușeni, Cricova, Grătiești, Ghidighici, Durlești, Tohatin and Colonița.

According to the FAO/UNESCO classification published in "La carte mondial des sols" (1964), 4 categories of lands were established, being represented in Figure 4. This indicator was used to analyze the occupational character of the suburban population, thus demonstrating that the population lives in cities but still practice agriculture, therefore agriculture also has a detrimental impact (Boboc et al., 2020) on suburban lands.

Very less analyses are focused on environmental effect of land take on ecosystem services. The goal of reducing land takes with an integrative approach between analysis and policies of local land regulation need to be supported by a deeper consideration of two crucial aspects: land-use detection and the development of synthetic indicators for a multidimensional approach to land-take evaluation (Salta, St., Gardi C. 2015).

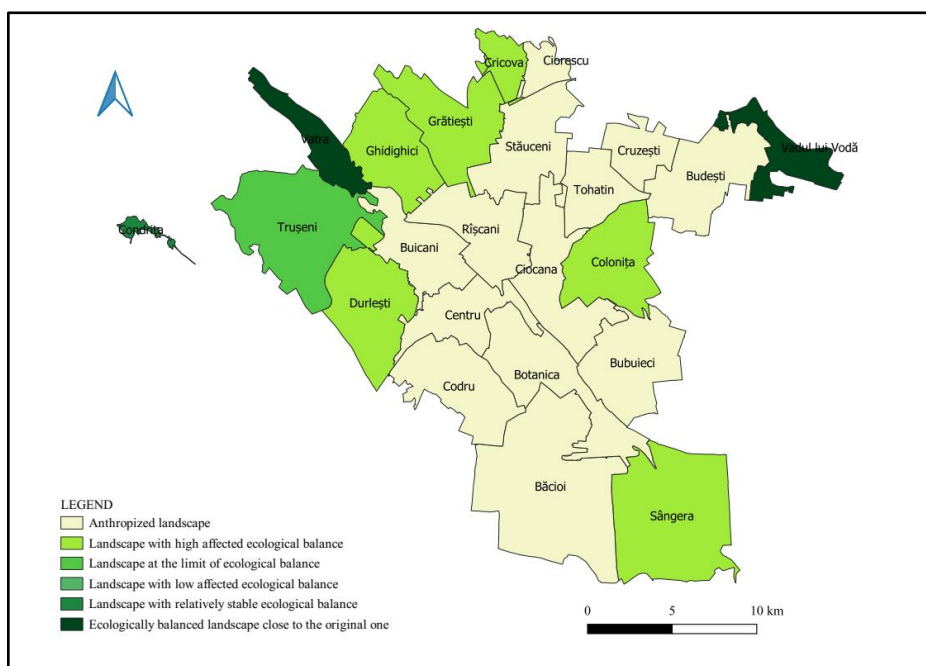


Figure 5: Distribution of the values of the environmental transformation index within the localities of Chisinau municipality.

Source: developed by the authors based on research: Bejan Iu., Țițu P., 2013.

In order to develop an optimal system for the use of natural resources, including land, it is necessary to carry out quantitative assessments. In this regard, the study method through the Environmental Transformation Index of land is interesting, which is calculated as a ratio between the area occupied by the forest compared with the built-up and cultivated areas, expresses the degree of artificialization of the natural environment. The initial formula, developed initially by Maruszczak (1988) as a ratio between the surface of forests and meadows and the built surface, gives information on the intensity of anthropogenic change of the landscape.

CONCLUSIONS

Land use assessment indicators ensure the quick information regarding the state of the land, the differences concerning permissible levels, as well as the identification of transformation processes. They represent synthetic values resulting from measuring the impact factors. Based on these indicators can be developed decisions, forecasts and strategies for sustainable exploitation of the land especially with respect to suburban territories.

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