Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

THE USE OF THE GIS TECHNIQUE IN HIGHLIGHTING THE HUMAN PRESSURE ON THE ENVIRONMENT IN OLTEȚ PIEDMONT (SOUTHERN ROMANIA)

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Abstract

This study represents an assessment of the spatio-temporal dynamics of anthropic pressure in the Olteț Piedmont (a subdivision of the Getic Piedmont), located in the southern part of Romania. With the help of ArcGIS 10.5 software, we managed to process the statistical data provided by Dolj, Olt, Gorj and Vâlcea County Statistics Offices (for 2004 and 2014) by creating a vector database and calculating the following environmental indicators: population density, human pressure through arable land use (0.68 ha/inh. - 2014), landscape naturality (0.29 ha/ha - 2014), environmental change (12.91 ha/ha - 2014) and landscape artificialization (0.053 ha/ha - 2014). By comparing the results, for the two reference years (2004 and 2014), we managed to identify some areas were the anthropogenic impact on the environment of the Olteț Piedmont is significantly. Thus, the southern part of the piedmont is the most affected especially by the expansion of rural areas around the major urban areas (such as Craiova, Filiaşi, Balş, Piatra-Olt, and Drăgăşani cities); built-up area increased from 17,110 hectares to 17,248 hectares. The central and northern part of the piedmont, widely forested, is very little affected by the impact of human activities.

Key words*: human pressure; environmental change; naturality index; Olteț Piedmont, Romania.*

INTRODUCTION

In Romania, the excessive fragmentation of croplands remains prevalent even in areas with high agricultural potential. This persistence is the result of a combination of factors related to both land governance and farm-level characteristics (Dogaru et al., 2024).
Land cover and land use changes play a critical role in the sustainable development of local communities, as well as in shaping natural systems (Hooke et al., 2012; Marin et al., 2023). The expansion of cropland has been one of the primary drivers behind the widespread transformation of natural landscapes into anthropogenic ones. The intensification of anthropogenic impact, beginning in the late 19th and early 20th centuries, led to a significant imbalance in the natural environment. This was largely due to extensive deforestation aimed at converting land for agricultural purposes - such as crop cultivation, orchards, vineyards, pastures, and hayfields - as well as for the expansion of rural and urban settlements (Bălteanu et al., 2011)
Human activities have significantly influenced the environment and landscape, contributing to increased land vulnerability and ecological imbalances (Mi et al., 2016). Vegetation, as both an indicator and regulator of human impact, plays a crucial role in modulating carbon, water, and energy cycles (Huryna et al., 2014). It also influences climate by sequestering greenhouse gases and affecting the distribution of solar energy (Huryna & Pokorný, 2016). However, vegetation is increasingly sensitive to climate change, largely due to ongoing anthropogenic pressures.
Following the fall of the communist regime in Romania in December 1989, the country experienced profound transformations across all sectors, particularly in agriculture. One of the major consequences of Law no. 18/1991

was the excessive fragmentation of agricultural land and the shift in ownership from the state to private individuals. This led to the emergence of small-scale subsistence farms characterized by inadequate agricultural practices, including poor fertilization, unregulated use of fertilizers and pesticides, and limited mechanization. As a result, the land use system became more vulnerable to extreme environmental disturbances - marked by notable land use/land cover changes - and less resilient to both climatic and anthropogenic pressures (Grigorescu et al., 2012).

MATERIALS AND METHODS

The use of GIS software has proven its usefulness and functionality in various studies, with diverse themes such as: assessing green urban infrastructure (Wu et al., 2025), road infrastructure assessment and traffic dynamics (Freulda et al., 2025), risk assessment in the transportation of dangerous goods (Tomasoni et al., 2025), enhancing spatial interpretability of fluoride in groundwater (Singh et al., 2025), illegal abandoned waste sites (Ragazzo et al, 2025) and also the assessement of human pressure on the environment (Filimon et al., 2024; Fan et al., 2017; Sencovici & Pehoiu, 2016; Ekim et al., 2021; Mammides, 2020).

Study area

The Olteț Piedmont, a subdivision of the Getic Piedmont (Figure 1), with a surface of approximately 3771 km^2, whose altitudes decrease from north to south, from the contact with the Getic Subcarpathians towards the contact with the Oltenia Plain.

It's an intensely populated area (93 administrative-territorial units from four counties - Gorj, Vâlcea, Dolj and Olt, overlap over the piedmont) with an attractive natural and economic potential, that led to a steady population growth and expansion of the settlement network (Bălteanu et al., 2003). Human activities have a major impact on the environment, due to land cover/use changes, which amplify the degradation of the land through geomorphological processes (gullying, rilling, sheet wash, surface erosion and sometimes landslides). Activities like deforestation, excess grazing, plowing along the slope line etc. are an important factor in the development of gullying (Popovici et al., 2010).

Beside land cover and land use changes, among the activities with negative impact on the biodiversity (conservation status of protected habitats and species of plants and animals) are: the construction of mineral aggregate sorting stations, extraction of gravel, sand, clay, kaolin, uncontrolled expansion of accommodation units (hotels, guesthouses), the removal from the forest fund of some terrains intended for construction, expansion of mineral aggregate mining quarries, the expansion of the urban areas.

In this study, we aim to evaluate the spatio-temporal dynamics of human pressure in the Olteț Piedmont - a subdivision of the Getic Piedmont - located in the southern Romania. Using GIS techniques, we processed the statistical data provided by the County Statistics Offices of Dolj Olt, Gorj and Vâlcea for the years 2004 and 2014.

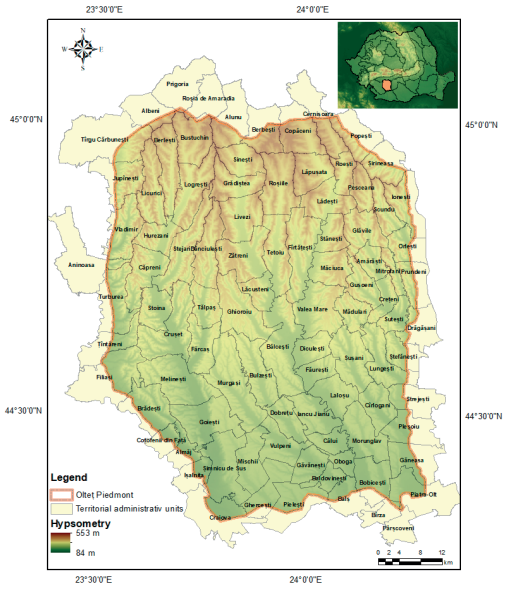

Figure 1. Study area - Olteț Piedmont (Romania)

The evaluation was conducted using a set of environmental indicators, including population density, human pressure through arable land, the landscape naturality index, the environmental change indicator and the landscape artificialization indicator.

With the help of ArcToolbox feature Extract, we managed to identify and draw out all the 93

administrative-territorial units that overlap our study area. In the newly created layer, we added multiple fields and inserted the statistical data collected from the four County Statistics Offices for 2004 and 2014. In addition, in the Attribute Table of this layer we used the Field Calculator function to insert the equation for each environmental indicator and calculate the values for each parameter for every administrative-territorial unit. The results were displayed in cartographic materials, for a better a better view of the areas that are most vulnerable to human activities.

For our study we chose the datas from 2004 and 2014. Prior to 2004, some of the settlements that overlap the study area were part of different administrative territorial units (ATU). In that year, the Law No. 84/2004 led to the administrative reorganization of several communes throughout Romania and the emergence of new administrative territorial units, whose limits have not changed until now. In 2014, The National Cadastre and Real Estate Advertising Agency started.

The national cadastre and land register program in order to intabulate all the terrains from Romania, and because of that, until the ending of this program no newer data available regarding land cover/use at administrative territorial unit level. Therefore, because of these two restrictions we couldn't expand our study and focused only on the 2004-2014 period.

In order to give an overview of the impact of human activities on the environment in the Olteț Piedmont, for each of the two statistical years we calculated human pressure on the environment indicators like:

- *population density* (P_d = *No. inhabitants/ Total area);*
- *indicator of human pressure through arable use of land* (P_a = Arable area/No. inh.);
- *naturality index* (N_i = *Forest area/Total area);*
- *environmental change index* (E_{ch} = Forest+pasture+hayfield area/Built-up area);
- *landscape arficialization index* (Ai = Built-up+industry+communication roads/Total area).

Several Romanian researchers have published studies (Bălteanu et al., 2010; Pătroescu et al., 2010; Ionuș et al., 2011; Zarea et al., 2012; Popovici, 2010; Petrișor & Petrișor, 2021) in which they successfully employed human pressure indicators to assess the impact of anthropogenic activities on the environment across various regions of Romania. These regions include the Getic Piedmont, the Romanian Plain, the Oltenia Plain or the Bâsca Chiojdului River basin.

Whether applied to smaller or larger territorial units, these studies have demonstrated the effectiveness of such indicators in improving our understanding of the ways in which human activities influence the natural environment.

RESULTS AND DISCUSSIONS

Population density

Population density is the first indicator that was determined and represents the number of inhabitants that live in an area of 1 ha (Figure 2).

The total number of inhabitants living in the 93 administrative territorial units is 618113 persons (2014), with the highest number of 308114 inhabitants in Craiova Municipality and the lowest number of 940 inhabitants in Mitrofani commune.

The average population density of the study area is 1.08 inhabitants/hectar, the lowest value is 0.21 inh./ha in Ghioroiu commune and the highest value is 37.85 inh./ha in Craiova Municipality.

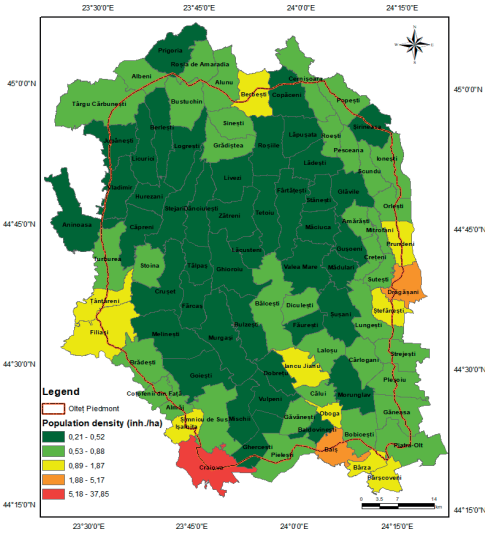

Figure 2. Population density in the Olteț Piedmont (2014)

Higher values are registered in towns like Balș (5.17 inh./ha), Drăgășani (4.43 inh./ha), Filiași (1.87 inh./ha) and Berbești (1.04 inh./ha).

The lowest values of the population density are registered in communes: Ghioroiu (0.21 inh./ha), Bulzești (0.23 inh./ha) and Murgași (0.25 inh./ha).

Human pressure through arable use of the land

This indicator represents the intensity of anthropic activities on the environment through arable use of the land. The main use of the lands in the study area is agricultural use. The total arable surface in the study area in 2004 is 180306 ha and 178447 ha in 2014.

In 2004 the mean value of this indicator was 0.66 ha/inh., with the highest values recorded in the communes of Ghercești (2.52 ha/inh.), Mischii (2.21 ha/inh.), Bulzești (1.72 ha/inh.), Baldovinești (1.68 ha/inh.), Dobrețu (1.68 ha/inh.) and the lowest values in Craiova (0.01 ha/inh.), Drăgășani (0.11 ha/inh.), Balș (0.12 ha/inh.), Berbești (0.22 ha/inh.) towns (Figure 3).

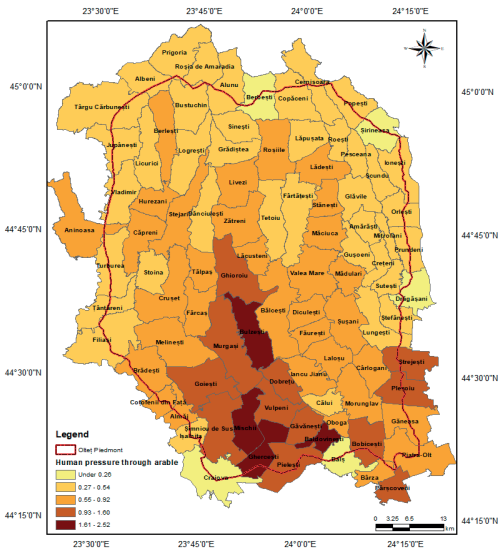

Figure 3. Human pressure through arable use of the land (2004)

The biggest changes of the values for this indicator (from 2004 to 2014) were recored in the administrative territorial units of Orlești (from 0.35 to 0.40), Fârtățești (from 0.46 to 0.50), Lungești (from 0.49 to 0.53), Tetoiu (from 0.52 to 0.56), Vladimir (from 0.51 to 0.57), Glăvile (from 0.53 to 0.60), Dănciulești (from 0.54 to 0.66), Stănești (from 0.55 to 0.66), Stejari (from 0.60 to 0.71), Morunglav (from 0.64 to 0.78), Lăcusteni (from 0.57 to 0.83), Vulpeni (from 1.13 to 1.44), Bulzești (from 1.72 to 1.92).

In 2014 the mean value was 0.68 ha/inh. A decrease of the values of this indicator can be seen in Baldovinești, Oboga, Pârșcoveni and an increase of the values in Găneasa, Vladimir, Dănciulești, Tetoiu and Găvile (Figure 4).

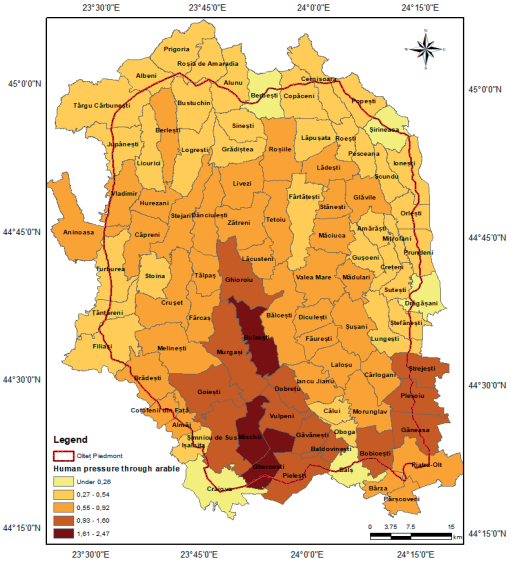

Figure 4. Human pressure through arable use of the land (2014)

Landscape naturality indicator

The landscape naturality indicator represents the ratio between the forest area and the total area (thus determining the degree of afforestation), being calculated at the level of administrative-territorial unit.

The total surface of the forests increased from 147186 ha in 2004 to 147361 ha in 2014. The mean value of this indicator, for both reference years was 0.29 ha/ha.

Because the values didn't change very much, in both years, the highest value was recorded in Jupânești (0.62 ha/ha), Șirineasa (0.61 ha/ha), Morunglav (0.59 ha/ha), Călui (0.58 ha/ha) and the lowest values in Drăgășani (0.01 ha/ha), Mischii (0.02 ha/ha), Ghercești (0.02 ha/ha), Pielești (0.02 ha/ha).

Some changes of the values for this indicator were recorded in Vulpeni (from 0.15 to 0.2), Găneasa (from 0.18 to 0.16), Diculești (from 0.30 to 0.28), Sinești (from 0.43 to 0.38).

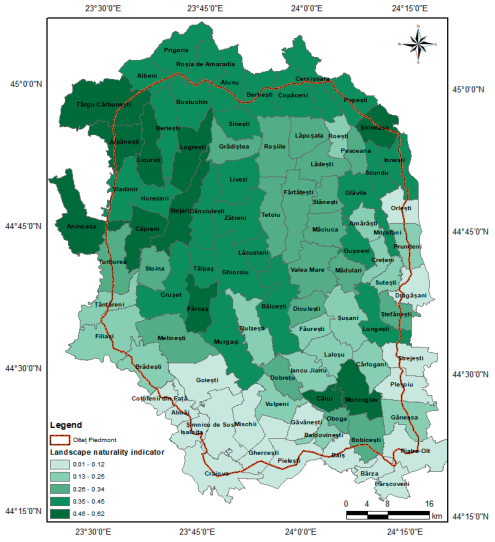

Figure 5. Landscape naturality indicator (2004)

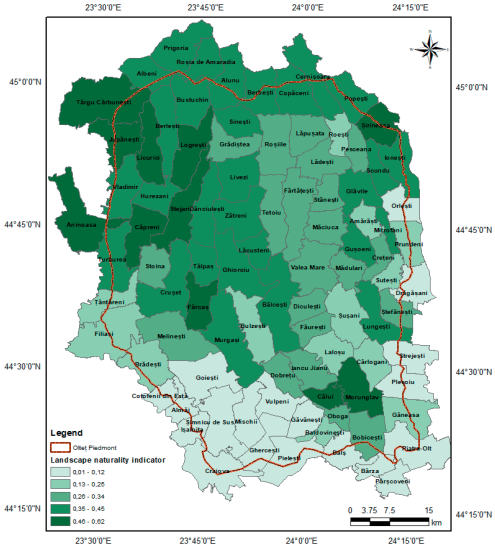

Figure 6. Landscape naturality indicator (2014)

The territorial administrative units with values of the landscape naturality indicator unde 0.10 are considered to have a landscape with very strong affected ecological balance, and those with the values of the indicator between 0.45-0.60 to have a landscape with relatively stable ecological balance (Figure 5, Figure 6).

Environmental change indicator

The environmental change indicator was calculated as the ratio between the natural and the anthropic surfaces.

In 2004 the mean value of this indicator was 12.83 ha/ha with the highest values recored in Ghioroiu (35.49 ha/ha), Copăceni (33.59 ha/ha), Berlești (27.32 ha/ha), Aninoasa (25.15 ha/ha) and the lowest values in Craiova (0.34 ha/ha), Işalnița (0.93 ha/ha), Drăgășani (1.13 ha/ha) and Pleșoiu (1.69 ha/ha) (Figure 7).

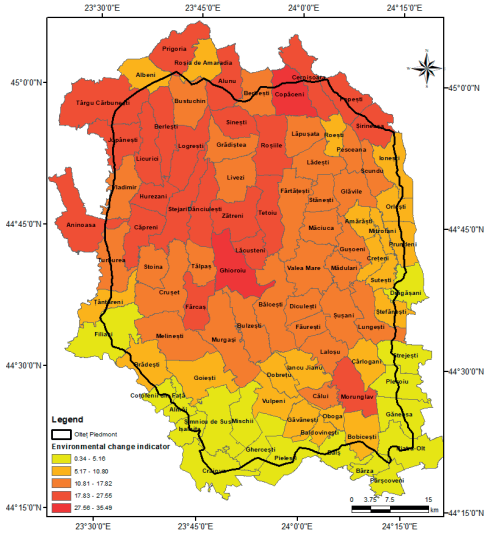

Figure 7. Environmental change indicator (2004)

In 2014 the mean value was 12.91 ha/ha with the highest values in Ghioroiu (36.41 ha/ha), Copăceni (33.59 ha/ha), Berlești (27.55 ha/ha), Aninoasa (25.15 ha/ha) and the lowest values in Craiova (0.34 ha/ha), Işalnița (0.93 ha/ha), Drăgășani (1.13 ha/ha) and Pleșoiu (1.45 ha/ha) (Figure 8).

Important changes of the values of this indicator were recorded in Almăj (from 3.67 to 2.67), Vulpeni (from 6.48 to 4.64), Bobicești (from 7.38 to 5.16), Lăcusteni (from 22.72 to 17.82) and Sinești (from 20.53 to 19.01).

The territorial administrative units with a high value of the environmental change indicator are located mainly in the northern and north-

western part of the Olteț Piedmont and have the least affected landscape.

In the eastern, southern and south-western part of the piedmont, the territorial administrative units have a lower value of this indicator; they are located near big cities like Craiova, Filiași, Balș, Piatra-Olt, Drăgășani and therefore subjected to the influence of the development of these urban areas.

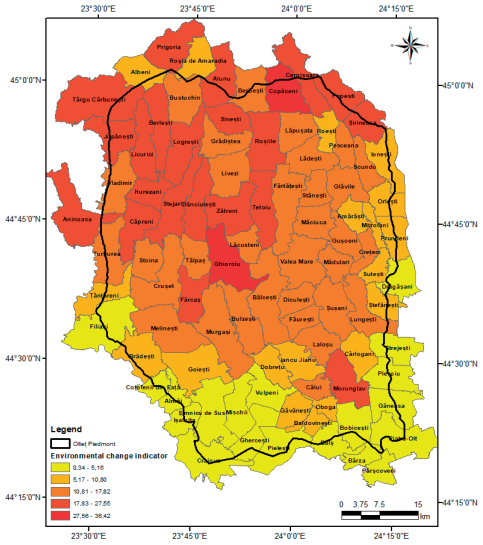

Figure 8. Environmental change indicator (2014)

Landscape artificialization indicator

The landscape artificialization indicator represents the ratio between the built-up areas and the total area of the administrative-territorial unit and is often used to complete the landscape naturality indicator.

The mean value of the landscape artificialization indicator in 2004 was 0.052 ha/ha with the highest values recorded in Craiova (0.47 ha/ha), Işanița (0.17 ha/ha), Drăgășani (0.15 ha/ha), Balș (0.12 ha/ha) and the lowest values in Ghioroiu (0.02 ha/ha), Copăceni (0.02 ha/ha), Pârșcoveni (0.03 ha/ha), Morunglav (0.03 ha/ha).

In 2014 the mean value of the indicator increased to 0.053 ha/ha with the highest values in Craiova (0.48 ha/ha), Işalnița (0.17 ha/ha), Drăgășani (0.15 ha/ha), Balș (0.13 ha/ha) and the lowest values in Ghioroiu (0.02 ha/ha), Copăceni (0.02 ha/ha), Morunglav (0.03 ha/ha), Berlești (0.03 ha/ha).

Small changes in the values of this indicator were recorded in Pârșcoveni (from 0.3 to 0.4), Turburea (from 0.4 to 0.5), Bobicești (from 0.4 to 0.6), Balș (from 0.12 to 0.13).

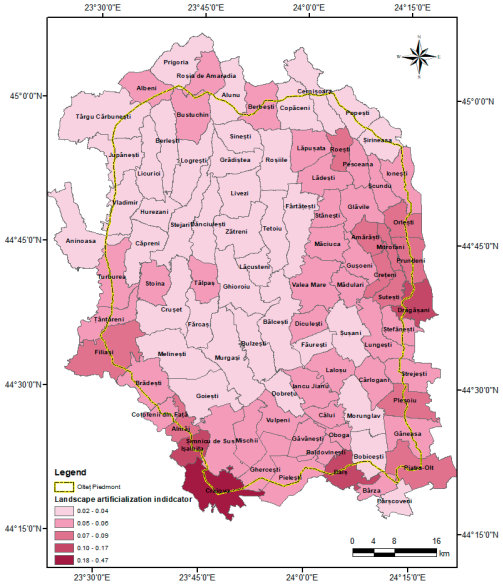

Figure 9. Landscape artificialization indicator (2004

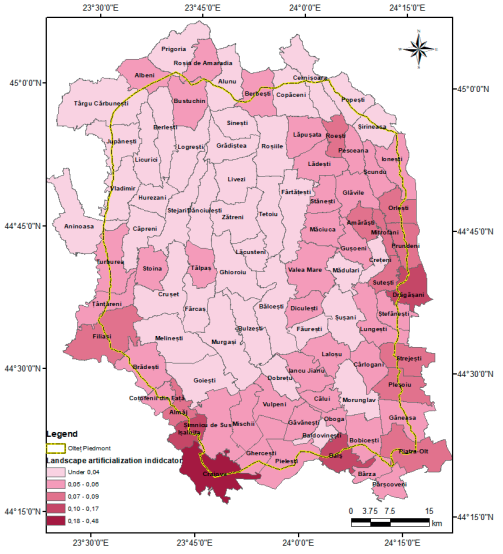

Figure 10. Landscape artificialization indicator (2014)

An analysis of Figures 9 and 10 reveals that the areas with the highest degree of landscape artificialization are located in the eastern, southern, and southwestern parts of the Olteț

Piedmont. This pattern is primarily influenced by the expansion of urban centers such as Craiova, Filiași, Balș, Piatra-Olt, and Drăgășani.

Between 2004 and 2014, the built-up area increased from 17,110 hectares to 17,248 hectares, while the area occupied by road infrastructure expanded from 8,701 hectares in 2004 to 8,904 hectares in 2014. This growth is largely attributable to residents of these cities seeking to escape urban congestion by relocating to nearby rural communes, where they constructed vacation or secondary residences.

CONCLUSIONS

In order to assess the impact of human activities on the environment, as well as to follow the evolution over time of the phenomenon of environmental degradation, there is a need to use a global assessment method of the state of health or environmental pollution at a given moment.

Anthropic activities exert pressure on the environment, which differs from one type of space to another and from one society to another.

Our study highlights the predominance of agicultural activities in the southern part of the Olteț Piedmont and built-up areas around urban areas, like Craiova, Balș, Piatra-Olt and Filiași cities, to be the main anthropic activities that exert a pressure on the enivronment. The constant expansion of these cities and of their periuban areas (many people have built a second home in the communes near the urban communities) define how the landscape is transformed every day.

Because we only managed to assess the changes between 2004 and 2014, we consider that a future study (when newer data will be available, having as a target the year 2024) is needed to determine a trend of the impact of human activities on the environment of the Olteț Piedmont. Also, new research regarding the land use/land cover changes in the study area, for a period of 20 years, is needed in order to have a better understanding of how human activities have transformed and will impact on the environment.

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