

## **THE DYNAMICS OF LAND USE CHANGES AND THEIR IMPACTS ON THE QUALITY OF THE ENVIRONMENT IN THE AREA OF BRĂDULEŢ AND MUŞĂTEŞTI COMMUNES**

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**Keywords:** dynamics, land use, human impact, landscape, Brăduleţ, Muşăteşti

**Abstract.** The location of the area of the two communes in the interference space of Getic Subcarpathians with Făgăraş Mountains imposed along time a variety regarding the land use. Because in the last decades it has produced the accentuated spatio-temporal dynamics of different categories of the land use from this area, the present paper aims to analyze which are the factors upon which these modifications were based, and especially what type of mark has been left in the quality and functionality of the environment.

The evaluation modality of the land use dynamics due to the human impact, consists in the application of some synthetical indexes which characterize the degree of environmental transformation from a historical perspective. The application and analysis of the indexes in two different periods, 1980 and 2005, have been possible by obtaining and comparing the data and information from different sources (digitization on topographical maps and orthophotomaps, statistical data, informations from the data set geo-spaţial and Corine Land Cover). This analysis led to the spatialization and intensity of the transformations induced by the dynamics of land use changes in the Subcarpathian rural landscape, as well as the establishment of landscapes' artificiality from this area.

### **General aspects**

From a geographical point of view, the territory of the two communes overlaps for the most part, on the Getic Subcarpathian area, with the exception of Brăduleţ commune northern part, overlapped on the eastern area of the Frunţii-Ghiţu crystalline mountain alignment, an important part of Făgăraş Mountains. More exactly, the regional study corresponds to the Subcarpathian hydrographic basin of Vâlsan river, basin which is situated in Muscelele Argeşului, between Argeş basin in the west and Râul Doamnei basin in the east (Osaci, 2007). From an administrative point of view, the analyzed territory of the two communes is situated in the central-northern part of Argeş county (fig. 1).

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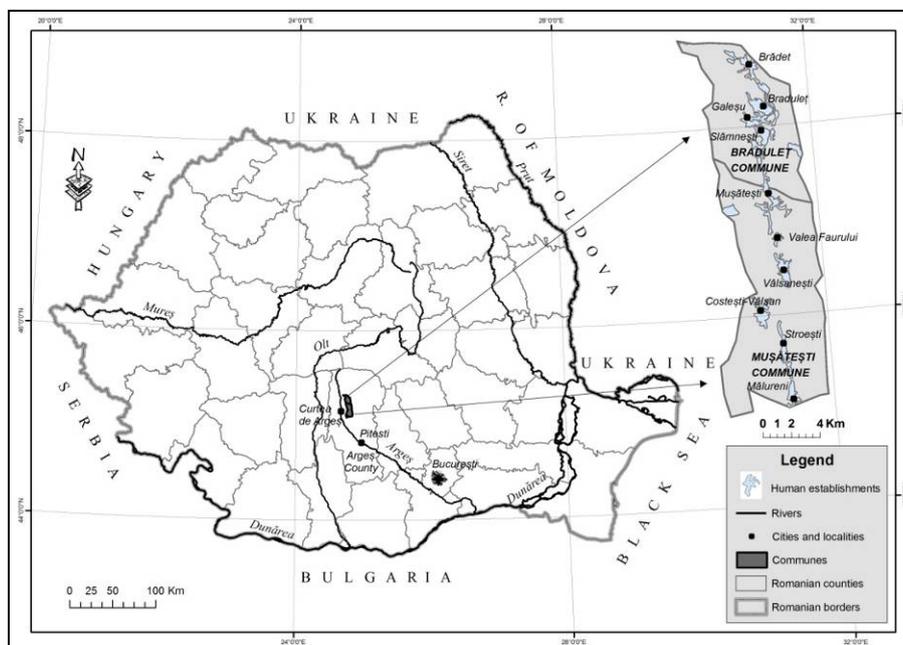


Fig. 1 - The localization of the Brăduleț and Mușătești communes in the central-northern part of Argeș county (Source: elaboration of data from geo-spatial.org)

The relief's altitudinal amplitude of approximate 500 m hall-marks over the climatic, hydrologic régime and over the biotic layer. The climatic conditions characterized by the annual precipitation of 742 mm (1901-1990) and by the annual average temperatures of 8.9 °C (1901-1990) (Osaci, 2007) influence directly both the environmental components and those which concern the different categories of the land use, the analyzed object of the present study. The hydrologic regime of Vâlsan River, the main fluvial organism on the analyzed territory, stands out by a maximum of spring due to the mixed supply, next to numerous summer and winter floods (Osaci, 2007).

The vegetation frames to the nemoral level, with *Fagus sylvatica*, *Quercus petraea*, and mixed forests (in the north of the Braduleț commune) and open woods such as *Carpinus betulus*, *Betula pendula*, *Salix capraea*, etc. type of glades (Donisă et al., 2005). Also, in the grass land areas appear the grassy vegetations with species of *Agrostis capillaries*, *Trifolium repens*, *Cynosurus cristatus*, *Festuca rubra* etc (Donisă et al., 2005).

All of these geographical particularities hall-mark on the land use by the existence of some benefic conditions such as the favourable climatic conditions for

the development of the fruit-growing areas, by the existence of Vâlsan flood plain which allowed the development of a fertile arable area along the 2 administrative unities. Also, the existence of some extended grasslands surfaces transformed afterwards in hay-fields, fruit trees and arable lands, thus in the second half of the 20<sup>th</sup> century creates the premises of the agricultural areas extension, to the general detriment of the grasslands and not of the forests by deforestation (Osaci, 2010).

### **1.Methodology**

The utilized methodology for the realization of the present article consists of taking data from different sources and the elaboration of it with different software programs, but also of the utilization of a specialized literature simultaneously with the observations on the field, owing to the itinerant campaigns in the perimeter of the studied areal.

The extracted and elaborated data regarding the land use by the agricultural, the artificial and forest surfaces (tab. 1) were obtained by the digitization of the respective surfaces on the 1:25.000 topographic maps, 1980 edition, and the 1:5000 orthophotomaps from 2005, from the National Agency of Cadastre and Real Estate Advertising.

By the utilization of the spatial analysis software it was possible to obtain the maps, these being projected in the national projection system Stereo 70, meanwhile the data elaboration (those which concern the land use) has been realized by means of tabular calculation software. Also, the utilization of geo-spațial database and Corine Land Cover ([eea.europa.eu](http://eea.europa.eu)) for the comparison of the data, led to the graphical and implicitly scientific completion of the present study.

The elaboration of the respective data allowed the execution of a historical spatial analysis regarding the dynamics of land use changes (fig. 2), as well as the establishment of some logical and legal interrelations between the different dynamic forms of the land use in time and the mark left by these on the quality and functionality state of the environment.

### **2.Obtained results**

The spatio-temporal dynamics analysis of land use changes represents a modality of evaluation of the natural degree of the landscapes, this being extremely useful in the strong specifically human intervention in the sub Carpathian areas in Romania (Pătroescu and Niculae, 2010).

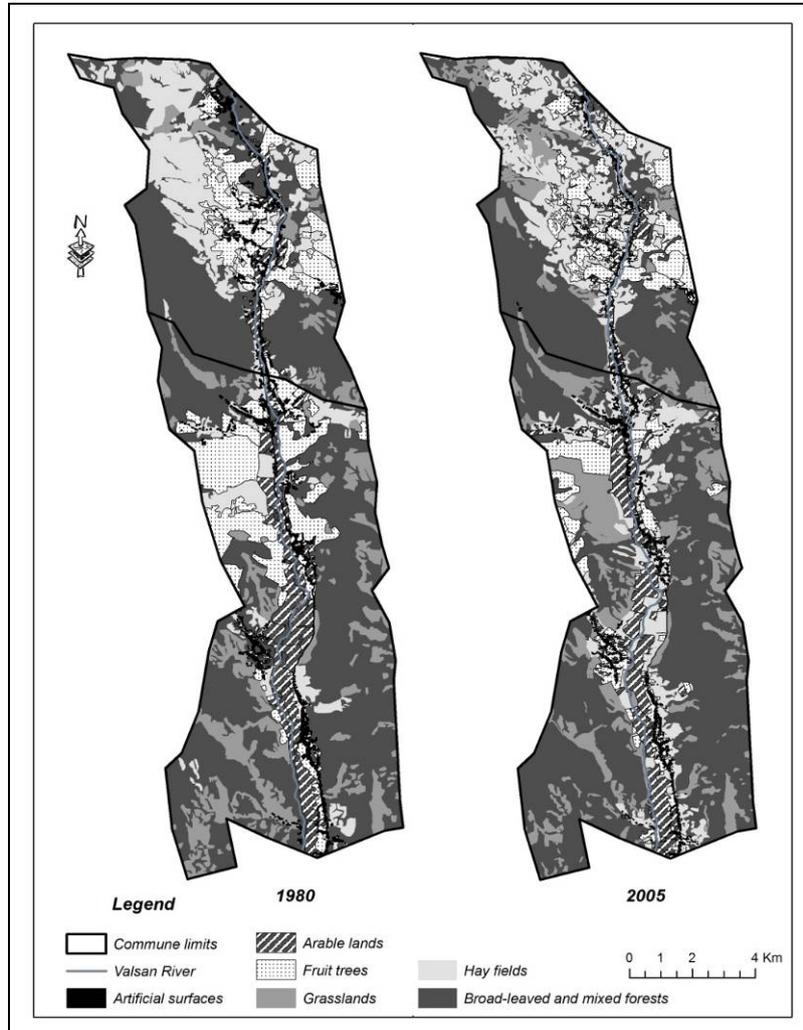


Fig. 2 - The spatial and temporal dynamics of land use changes in the area of Brăduleț and Mușătești communes (1980 and 2005)

Also, recognition and understanding of landscape dynamics as a historical legacy of disturbances are necessary for sustainable management of forest ecosystems (Başkent and Kadiogullari, 2007).

In relation with the environment, the landscape represents a vital component for the maintaining of the natural and functional balance of the ecosystems from a certain region, meanwhile, in relation with human, this represents a cultural

heritage and an extremely important identity value, hence there is a continuous relational interpenetration between the biotic, abiotic components and the environment, all these contributing to the completion of the geographical landscape concept.

Due to the anthropic intervention at different stages of impact at the environmental level, it is produced an artificiality which proves to be mostly aggressive, the negative implications are noticed at the environmental and social level. Thus, an estimation of the artificiality degree of the environment in the studied areal is necessary, this estimation being rendered with the help of some synthetic indexes. Although there is a great number of indexes that can be applied in a territorial unit for the quantization of the degree of human intervention in the natural landscapes, their election is selective and representative from case to case.

Being that the analyzed territory is situated in a sub Carpathic area, the essential component of natural environmental functionality, namely the forest, is very important, this being permanently modified by the anthropic component through the dynamics of the constructed surfaces, of the surfaces occupied with different categories of land use, etc.

Tab.1. The surfaces covered with land use categories in the area of Brăduleț and Mușătești communes (1980 and 2005)

Area (ha)	Communes				Differences in land use surface between 2005 and 1980 (%)		
	1980		2005		Brăduleț	Mușătești	
<i>Forests</i>	2582.8	4940.7	2487.5	5190	-3.68	5.04	
<i>Artificial surfaces</i>	187.8	285.1	109.8	219	-41.53	-23.18	
<i>Total</i>	2726.7	4034.4	2914.2	3876.9	6.87	-3.9	
<i>Agricultural</i>	<i>Arable</i>	203.6	827.7	171.8	774.5	-15.61	-6.42
	<i>Grasslands</i>	286.9	1363.9	571.4	1523.6	99.16	11.7
	<i>Hay fields</i>	1306.9	520.9	1297.7	938.9	-0.7	80.24
	<i>Fruit trees</i>	929.3	1321.9	873.3	639.9	-6.02	-51.59
<i>Total commune</i>	5507.5	9286.8	5507.5	9286.8			

In order to analyze the interaction of the 2 mentioned components, there have been utilized two great categories of indexes (tab. 2), namely: functional and natural environmental indexes (Manea, 2003) and human stress indexes (Dumitrașcu, 2006) through different categories of land use.

In the first category were calculated the landscape naturality index, the environmental change index and the landscape artificiality index, these being the most utilized in the specialised literature (Ionuș *et al.*, 2005).

Tab. 2 - Categories of indexes for the dynamics of land use changes temporal analysis in the area of Brăduleț and Mușătești communes (1980 and 2005)

<i>Indexes</i>		1980		2005	
		<i>Brăduleț</i>	<i>Mușătești</i>	<i>Brăduleț</i>	<i>Mușătești</i>
<i>Human stress indexes (Area/Population)</i>	<i>Agricultural</i>	0.96	0.73	1.45	1.02
	<i>Arable</i>	0.07	0.15	0.08	0.2
	<i>Grasslands</i>	0.1	0.25	0.28	0.4
	<i>Hay fields</i>	0.46	0.09	0.64	0.24
	<i>Fruit trees</i>	0.32	0.24	0.43	0.16
<i>Functional and natural environmental indexes</i>	<i>The landscape artificiality index (Artificial area/Total area*100)</i>	3.40%	3.06%	1.99%	2.35%
	<i>The environmental change index (Forest area/Artificial area+ Arable area+ Grasslands area+Hay fields area+Fruit trees area)</i>	0.88	1.14	0.82	1.26
	<i>The landscape naturality index (Forest area/Total area*100)</i>	46.90%	53.20%	45.16%	55.88%

**The landscape naturality index**, obtained from the relation between the natural surface (considered the surface occupied with forests) and the analyzed surfaces, it is very representative for this area of study because generally, in the Subcarpathian area, the forest areas are extremely endangered by deforestations. To be mentioned the fact that the index has been applied by the classical formula, because it was considered the inexistence of another category of natural or quasinatural surfaces, as in the case of natural grasslands taken into consideration in different specialised articles, in this case, these being the results of human pressure by deforestation with the purpose of the extension of grassland surfaces.

For the analysis of the temporal irregularity of the naturality index (fig.3), there have been mapped the forest surfaces from the topographic maps of the area, 1980 edition, as well as those from the orthophotomaps from 2005 (tab. 1). Thus, the values of the index in 1981 of 46.9% in comparison with the one in 2005 of

45.1% for Brăduleț commune, respectively 53.2% and 55.8% at the level of Mușătești commune, highlights a slight restriction of the surfaces occupied with forests at the level of Brăduleț commune, but an increase at the level of Mușătești commune. In the last decades, the loss of the forest surfaces with 3.7% in Brăduleț commune are due to the deforestations around the localities (Brăduleț commune centre, Alunișu, Poienarei, Slămnești and Ungureni villages), subsequently, the deforested surfaces being replaced with grasslands and hay-fields.

However, it must be mentioned the fact that, the forest surfaces, the most important factor of maintaining the ecological balance, have met at the same time a slight expansion in time, especially in the areas from the communes' centre (even in the case of Brăduleț commune, even if it has been deforested more than it has been expanded on natural ways, by abandoning some agricultural lands, in fallow), areas with the most important distribution of the localities, and, thus, with the most expanded agricultural surfaces, represented by arable, grasslands, hay-fields and fruit trees. Therefore, significant extensions of the surfaces occupied with forests have been registered, mainly in the case of Mușătești commune, especially in the interference areas between forests and grasslands.

In this case, the slight extension of the forest surfaces is due mostly to the abandon of some agricultural lands by the local population, because of some demographical phenomena, such as the migration, in the last two decades, or the ageing of the population, therefore small surfaces of forests extending by natural ways towards the central areas of the communes, which are adequate for the agricultural areas.

From the categories of utilization of the terrains replaced with small forest surfaces, the most representative are the fruit-growing ones, situated between localities and sylvan ecosystems. Therefore, nowadays, it is being observed an expansion of the sylvan surfaces towards the flanks' surfaces, previously occupied with fruit trees, generally, in the immediately contiguity of the villages from the Mușătești commune territory (Mușătești communal centre, Valea Faurului, Vălsănești, Costești - Vălsan, Stroești and Mălureni).

**The landscape artificiality index** represents, in a certain way, the opposite of the naturality index, this highlighting the weight occupied by the surfaces highly affected by the human intervention, obtained by the report between the artificial surfaces and the total of the analyzed surfaces. For the analysis of its percentage variation, there have been digitized the constructed surfaces (generally the households represented by houses and interior yards), as well as communication ways represented by the main roads (generally, those asphalted).

Regarding the temporal dynamics analysis of this index, nowadays, at the level of the two communes, there are observed significant differences in comparison with the reference year 1980. If until the level of 1990's it is observed

a slight increase of the surfaces built in a directly proportional relation with the demographical increase, in the transition period starts a slight decrease of these, this being due mostly to the decrease in time of the population number.

Although the artificiality index values have dropped in the last decades, at the level of 2005, the constructed surfaces being more reduced with approximate 41.5% at the level of Brăduleț commune, respectively with 23.1% at the level of Mușătești commune in comparison with 1980, nowadays there are observed great artificialized surfaces by means of constructions at the level of some localities such as Brădeț, Brăduleț, Slămnești, Mușătești, Vălsănești, Costești-Vâlsan and Stroiești.

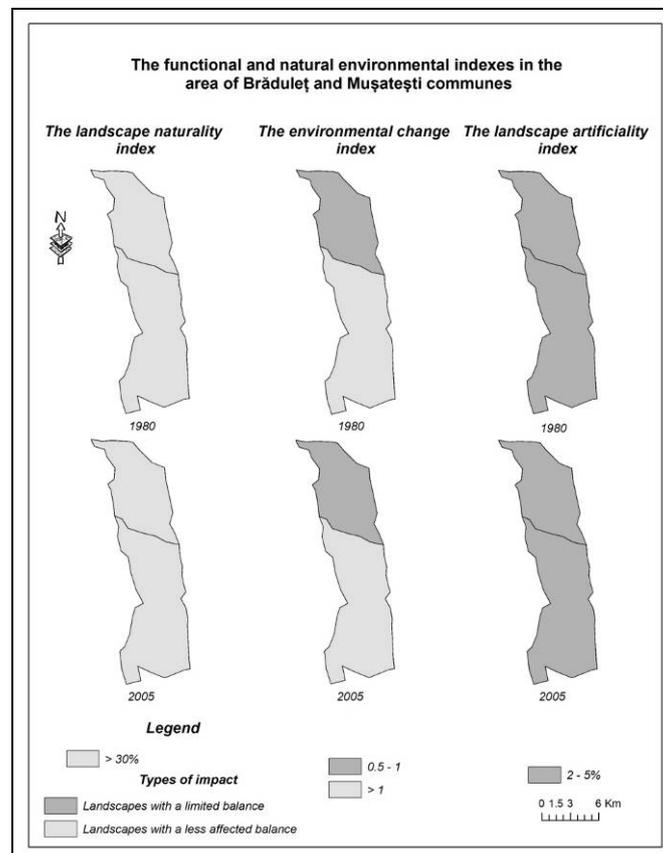


Fig.3 - The spatial and temporal dynamics of landscape naturality and functionality indexes values in the area of Brăduleț and Mușătești communes (1980 and 2005)

**The environmental change index**, utilized for the first time by Maruszczak in Poland in 1988 and taken subsequently by Pietrzak in 1998 for the evaluation of the state of the landscapes under anthropic influence in Poland's Subcarpathians (Manea, 2003, Dumitraşcu, 2006), it is calculated relating the natural surface to the constructed one, hence trying to estimate the anthropic impact over the environment. At the level of Romania, this index has been taken and applied by Manea on Natural Park *Porțile de Fier* area in (2003), Dumitraşcu in Oltenia Plain (2006), Vijulie in Boianu Plain (2010), etc.

In the majority of the specialized papers from Romania, the environmental change index has been adapted depending on the characteristics of the studied areas, for the most part of the cases, the agricultural surfaces being taken into consideration at the nominator along with the constructed surfaces. The reasoning which sustains this correction starts from the hypothesis according to which the agro ecosystems represent artificialized entities of the landscape, being incapable of self-adjustment, these being permanently modified and influenced by the human activity (Manea, 2003).

In the case of the present study, this index has been adapted, for its calculation relating the natural surfaces, represented by forests, to the artificial surfaces (constructions, communication ways) and agricultural.

According to this index, at the level of the studied area, both at the level of 1980, and at level of 2005, the landscapes from Brăduleţ commune were at the limit of maintaining the balance in comparison with those from Muşăteşti commune, where the natural and functionality of the landscapes is higher, the latter ones being landscapes with less affected balance.

Even if the agricultural and constructed surfaces are greater at the level of Muşăteşti commune in comparison with those from Brăduleţ commune level, this situation is due to the forest surfaces much more expanded, present on the territory of Muşăteşti commune, this fact compensating the big surfaces occupied by constructions and agro ecosystems.

**The human stress trough agricultural use** (fig. 4) represent another modality of synthetic estimation of the quality and the artificiality degree of the landscapes, these being obtained by the relation of the surfaces occupied by different land use categories to the number of inhabitants from the studied area. Thus have been calculated indexes of human stress trough the agricultural, arable, grasslands, hay-fields and fruit trees, the reference limit regarding the intensity of the anthropic pressure being of 0.4 ha/place arable terrain, limit imposed by FAO for the maintain of the environmental balance (Dumitraşcu, 2006).

Another estimation, underlines the fact that an adult from the temperate region, for the assurance of an optimal standard of life, needs a surface of approximate 2 ha, of which 40% (0.8 ha) natural surface uninfluenced by the

anthropic activities, 30% (0.6 ha) agricultural surface, 20% (0.4 ha) wood and cellulose producing surface and 10% (0.2 ha) surface destined to the constructions (Dumitraşcu, 2006).

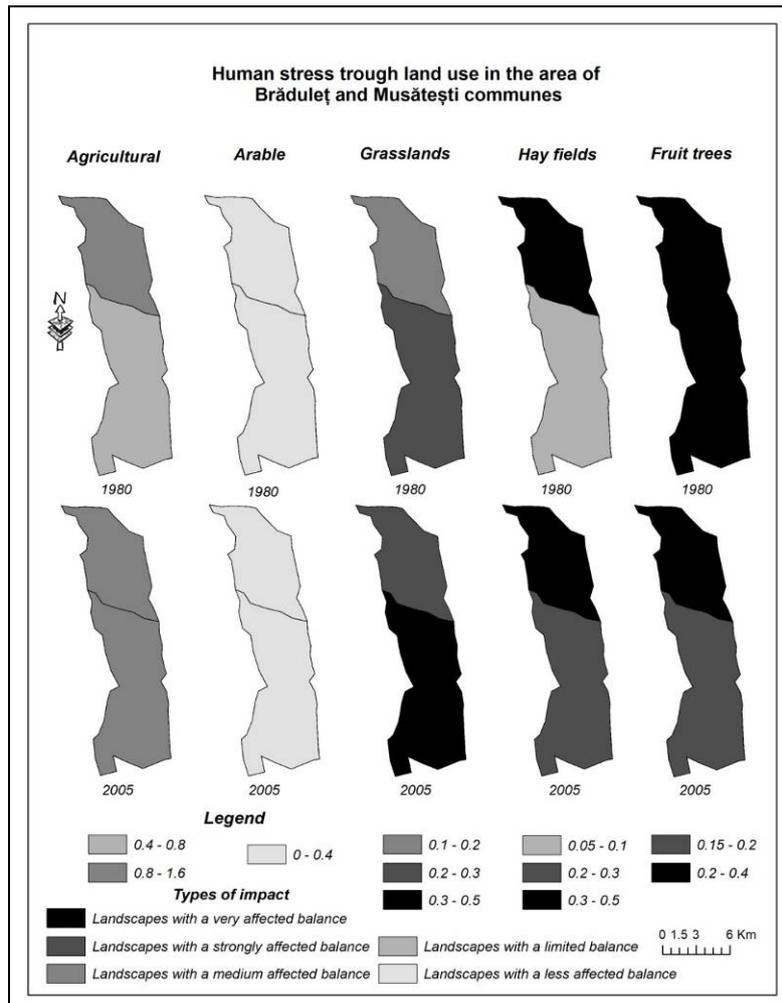


Fig. 4 - The spatial and temporal dynamics of human stress trough agricultural use indexes values in the area of Brăduleţ and Muşăteşti communes (1980 and 2005)

Because the agricultural areas at the level of the two communes occupied in 2005 important surfaces from the total surface, namely 53% in the case of Brăduleţ

commune (2914 ha from the commune total surface of 5507 ha), respectively 41% in the case of Mușătești commune (3877 ha from the total of 9285 ha), it is very important to analyze the way in which the spatio-temporal dynamics of the land use mode hall-marks on the environment.

*The agricultural utilization* in the two analyzed years presents small differences at the level of the two communes. In the case of Brăduleț commune, in relation with 1980, in 2005 it is observed a slight increase of the agricultural by the loss of some forest surfaces through deforestations with approximate 3.7% and of the constructed surfaces with 41.5%, therefore leaving place to the expansion of the grasslands with a percent of approximate 100%, in favour of the agricultural.

In the case of the land use categories which belong to the agricultural category, they have also registered fallings of the surfaces due to the decrease of the number of inhabitants in time, a part of the lands being abandoned and transformed in grasslands (the arable in 2005 decreased with approximate 15% in comparison with 1980, orchards with 6%, and hay-fields with 1%). In other words, in reality, the agricultural surface decreased, with the exception of the grasslands which have expanded due to the causes reminded earlier, this fact finally leading to the expansion of the agricultural, taken as a whole.

In Mușătești commune, the situation is different because the agricultural surface registered fallings in the last decades with 4%, this time in the favour of the expansion of the forest surfaces with 5%. The greatest losses of the agricultural utilization between the two analyzed years have been registered in the case of fruit-growing, namely of approximate 50%, from 1322 ha in 1918 to 640 ha in 2005. Therefore, significant fruit trees surfaces have been replaced on one side with grasslands and hay-fields, and on the other side with arbustive or forest surfaces naturally regenerated by ecological line in the areas of agricultural-forest interference.

*Arable terrains*, present along Vâlsan flood plain, have developed generally in the disadvantage of some localities such as Brăduleț, Cosaci, Slămnești, Galeșu and Ungureni in the case of Brăduleț and Mușătești communes, Valea Faurului, Vâlsănești, Costești-Vâlsan, Stroești and Mălureni in the case of Mușătești commune. The temporal analysis highlights fallings of the human stress by arable with 16% for Brăduleț and almost 7% for Mușătești commune, the causes being related to the demographical component.

*The grasslands and the hay-fields* represent a very dynamic category of the agricultural, between the two years of comparison. If on the territory of Brăduleț commune the grasslands expanded in the last decades with approximate 100% (285 ha) in the case of disadvantage of the forests by deforestation, but especially of disappearance of the fruit trees, on the territory of Mușătești commune these have expanded with 12% (160 ha), generally in the disadvantage of the fruit trees

surfaces by their abandoning. In comparison with 1980, the most extended surfaces of grasslands in Mușătești commune were registered in 2005 in north-western part of the commune in the Culmii Muscelului area, Valea Bunești and Dealul Deleanca, here significant fruit-growing surfaces of apple and plum trees being abandoned and replaced with grasslands and hay-field intercalated surfaces.

The hay-fields have registered minor differences at the level of Brăduleț commune, but the big surfaces occupied by these at the level of the two years of comparison have unbalanced intensely the landscapes, enframing them in the category of those strongly off-balanced. In the case of Mușătești commune, these have registered significant spatio-temporal differences, increasing with approximate 80% (418 ha) in 2005 compared to 1980.

*The fruit trees* surfaces (along with nurseries, which occupy limited surfaces), represented especially by apple and pear plantations, represent the most dynamic category of the agricultural, from the modifying surfaces perspective, between the two years of comparison. If after the second half of the XIX<sup>th</sup> century it is observed an expansion of the forests and hay-fields in the disadvantage of the forests, and in the second half of XX<sup>th</sup> century, increasingly large surfaces of grasslands and hay-fields have been transformed into fruit trees surfaces (Osaci, 2010), the situation at the beginning of the XXI<sup>st</sup> century is starting to change, significant fruit trees surfaces being replaced with grasslands and hay-fields.

Therefore, at the level of 2005, in Mușătești commune, these are diminishing in proportion of approximate 50% compared to 1980, thus, from the point of view of the human stress trough fruit trees, the situation is improving. Although in the case of Brăduleț commune, the differences are minor, the landscapes at the level of the two years remain in the category of the very affected balance, due to the great surfaces of fruit trees related to the total of the commune.

### **Conclusions**

After the analysis of the spatio-temporal dynamics of land use changes on the analyzed period of 25 years, overall it is observed a slight improvement of the environmental quality in the analyzed areal. This situation is due on one side to the maintaining of a relative stable balance of the sylvan ecosystems' surfaces at the level of the two communes, and on the other side, to the decreasing of the agricultural surfaces, at least in the case of Mușătești commune, where there is an obvious re-establishment of the natural and functional landscapes by decreasing the agricultural and increasing the forest surfaces.

At the same time, nowadays it is observed the tendency of negative transformation of the landscapes from the area of Brăduleț commune, through the sensitive increasing of the agricultural surfaces, which is due to the grasslands' expansion. This situation is not a real one, because the expansion of the grasslands

has been possible in the disadvantages of the arable and fruit trees abandoned surfaces, thus being created the impression of some landscapes more intensely affected in 2005 compared to 1980, but the non-agricultural utilization of the lands has a much more reduced impact in relation with the proper agriculture represented by arable, fruit trees, etc., which remains the main disturbing factor in the balance of the landscapes.

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