LAND USE/LAND COVER CHANGES ASSESSMENT IN THE TAZLĂU HYDROGRAPHIC BASIN

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Key-words: human activities; environment; landscape; land use/land cover; DPSIR model.

Abstract. The purpose of our research is to identify changes in land use/land cover in the Tazlău Basin, Romania, which play an important role in environmental quality. The results of the research indicate changes in the study area, consisting of the fragmentation and changes in the agricultural and forest occupied lands. These transformations occurring in land use in the Tazlău Basin require land re-organization measures tailored to the current needs of the population. Lacking these, dysfunctions and imbalances in landscape will occur. The spatial expansion of rural settlements, the evolution of the population, the increase in resource consumption and the diversification of the population's needs required many changes in land use. At the same time, the landscape components provide several population services, among them the use of land. With a view to highlight the spatial dynamics of the land use in the researched area, we have created a database containing a series of data obtained from Corine Land Cover for the period 1990–2018 processing correlated with those existing in the agricultural registers and the statistical data provided by the National Institute of Statistics. While correlating the data, we identified areas that suffered greatly from human intervention and which led to significant changes in landscape structure and functionality.

1. INTRODUCTION

While December 1989 marked the fall of Communism in Romania, major changes affected the national economy during its transition from a centralized state-controlled system to a liberal-market one. All this has triggered quite a number of changes in agriculture, the economic area of capital importance to Romania, considering both the contributions to the economy but also, the percentage of employed population. The main changes were: property type (from state-owned to private-owned), agriculture type (from intensive to subsistence agriculture), land conversion from one class to another. Most of these quick and chaotic changes led to several issues, such as: the appearance of numerous small individual family farms, whose role was mainly for daily subsistence and on which people worked using inadequate agricultural tools and methodologies; land degradation; the excessive fragmentation of agricultural fields (Bălteanu and Popovici, 2010). The general trend in Romania was to extend the agricultural and build-up areas by reducing the forest and pasture lands (Popovici, Bălteanu and Kucsicsa, 2013).

In theory, land use should reflect the correlation between social needs, between economy and environmental issues (such as housing, transportation infrastructure, agriculture and environmental protection). However, a European Commission report over the land use showed that the decisions concerning land use are made without performing any impact studies (European Commission, 2011). For example, the increase in land used for housing units has a negative impact over the ecosystems which play a part in hydrographic equation and flooding control (European Environmental Agency, 2016).

In order to analyse land use dynamics in Romania, we must refer to certain factors that have influenced it, among which we count: politics, be it of a socio-economic or natural nature (Bălteanu and Popovici, 2010; Soler and Verburg, 2010; Grigorescu *et al.*, 2012). Land use is influenced by

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several factors, such as: an increase in housing units (m^2/person), infrastructure development, and economic growth (Vlad-Şandru *et al.*, 2017). Land use has a spatial and temporal evolution, as influenced by local and regional development, by the density of developed areas/the anthropic factor and by the need of land access stemming from its economic importance.

The current study aims to bring new insight into the matter and to explain several changes in land use from the Tazlău Basin region, as triggered by the factors listed above.

2. STUDY AREA

The Tazlău Hydrographic Basin is situated in the NE part of Romania, covering Neamţ and Bacău counties. The basin has an elongated shape with the main axis aligned NW–SE, overlapping major topographic features, such as Goşmanu and Tarcău Mts., Tazlău Subcarpathian hills and Tazlău-Caşin Depression, with the altitudes between 184–1260m (Fig. 1).

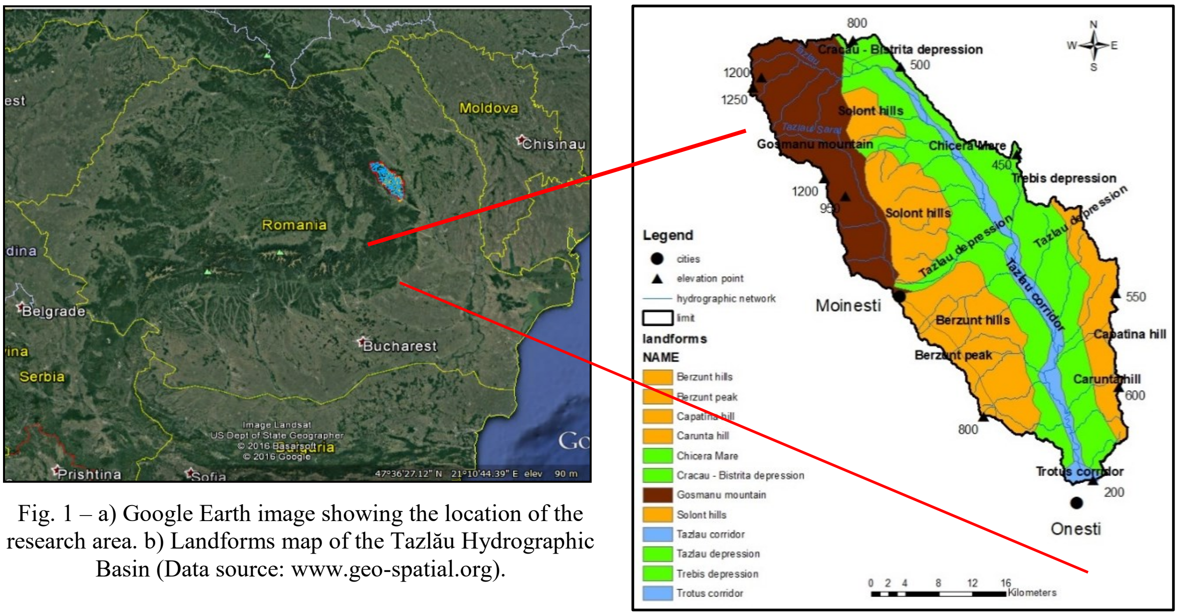

Fig. 1 – a) Google Earth image showing the location of the research area. b) Landforms map of the Tazlău Hydrographic Basin (Data source: www.geo-spatial.org).

The study area includes 18 administrative units, 2 cities and 16 communes, most of which belong to Bacău county, with the exception of Tazlău commune of Neamţ county. The Tazlău Mare river originates in this village. The area has been inhabited by humans since the time of the Pre-Cucuteni civilization, as proven by archaeological finds. Oneşti and Moineşti are the two towns within the study area (Fig. 1b.). Located at the foothills of the Eastern Carpathians Belt, at the confluence between Trotuş River and its Tazlău tributary, Oneşti is the second largest urban area in the county of Bacău. Until the mid-nineteenth century, only small-scale farming operations took place here. The growth of the village took place after the development of small food, textile, and woodwork industries and even the production of oil; the small village gradually became a major commercial centre (Stoica, 2008).

In the XX century, the abundance of raw material available from the NE part of Romania led to the construction of the Borzeşti petrochemical plant, one of the most important in the country. Employing more than half of the town's working force, the industry become the main economic activity for the city, to the detriment of agriculture. In the past 10 years the rapid growth of services coupled with the decrease in industrial activities altered once again the workforce distribution in favour of the former. With all of these changes Oneşti town is still one of the key centres of the North-East Development Region, being a net contributor to the economy of Bacău county. With the lowest unemployed rate and the highest wages in the area, Oneşti town paints an entirely different picture from that of most areas in Moldavia, where poverty is widespread.

Moineşti town is the third largest township in Bacău county after Bacău City and Oneşti, situated at the foothills of the Eastern Carpathians in the Tazlău-Caşin Depression. The area is rich in natural resources, such as oil and gas, in mineral therapeutic waters, forests, grassland and spectacular landscapes. The Moineşti-Lucăceşti area is the oldest historical oil-producing province in Romania, where natural seeps were registered in 1440 (Anghel, 2002). Here is also the stratotype for Lucăceşti Sandstone, a well-known hydrocarbon reservoir in the area (Paraschiv, 1979). With its manufactures and workshops, the Moineşti commercial and production centre was the meeting place for the inhabitants of the Trotuş and Tazlău valleys and the others people that have come over from Transylvania. Presently, Moineşti plays an important role as the cultural traditional centre for the NE Development Region.

The main human activities have been linked to agriculture and especially to animal husbandry, among many others. A gradual increase in economic activities has led to an accentuated anthropic pressure over land use, by modifying: the land use, the land cover, the vegetation type and the soil.

3. DATA AND METHODS

In order to highlight the spatial dynamics of the land use in the present area of interest, a database was created containing a series of data obtained from the Corine Land Cover (CLC) for the period of 1990–2018, as well as statistical data provided by the National Institute of Statistics.

The creation of the CORINE (Co-Ordinated Information on the Environment) database is under the supervision of the European Commission, and provides a standardized and comparable geospatial database for all EU countries (Vlad-Şandru *et al.*, 2017). The first data were extracted from the Landsat TM images acquired between 1986–1995, covering 13 countries in Central and Eastern Europe. Subsequent vintages, 2000, 2006, 2012 and 2018 included Landsat and Spot satellites data.

The CLC has 5 major classes for land use/land cover identified in Romania: artificial surfaces, agricultural areas, forest and seminatural areas, wetlands and bodies of water.

The approach is to compare subsequent data sets, from 1999, 2000 and 2018, with findings displaying parallels and changes of the land use/cover (Finifter, 1993).

The results of Corine Land Cover (CLC) analysis were compared with the data base of the Romanian National Institute for Statistics (INS), to demonstrate the spatial dynamics of land use in the Area of Interest (AOI). In addition, it was possible to establish the areas most affected by human intervention, having significant changes in the structure and functions of the landscape.

The variety and dynamics of the main classes of land use/cover and socio-economic processes are evident from inter-regional disparities (Grigorescu *et al.*, 2018). It should be noted that areas with growing construction activities are close to cities, serving as an economic and social axis, attracting the population due to increased job opportunities and services.

For this study we have compiled and analyzed the population evolution in the period 1992-2019, for each administrative unit of the Tazlău Basin and the evolution of developed areas and land use, for the years 1990, 2000 and 2018. Based on Corine Land Cover data (1990, 2000 and 2018) and information regarding the population as provided by the INS, the following specific indexes have been computed and analyzed: human stress by arable land use, environmental transformation and natural transformation. The human factor is seen as the main driving force behind environmental changes.

The **Environmental transformation index,** implemented in Poland by Maruszczak (1988) and Pietrzak (1998), reflects the ratio between forest and grassland areas and developed areas (Costache, 2013). The basic concept behind this index is that the forest and grasslands areas represent the original, natural part of the landscape (a lack of anthropic factors), while the developed areas reflect landscape changes (an anthropic influence). Lower values show a large anthropic impact on the environment, while the higher values of this index show a scaled-down impact on the environment.

The **Naturality index** (Ionuş *et al.*, 2011), measures the ratio between the forest area and the total surface area, in percentages, indicating the originality of the landscape. Higher values indicate an ecologic balance, closer to the original status quo, while lower values indicate an imbalance in environment.

The human stress by arable use index (Dumitraşcu, 2006) is defined by the ratio between arable land (expressed in ha) and the number of inhabitants. This index plays an important role in the understanding of the connection between the rise in population and its impact on the environment, by triggering a rise in developed areas and a decrease in arable land area.

For this study we used the SPSS 22.0, a very popular computer program among the academic community, because of its user-friendly architecture and multifactorial capabilities.

Unless the H_0 null hypothesis is validated by the **Pearson correlation coefficient**, the opposite H_1 hypothesis would be accepted (Leech, Barrett, 2005). In order to analyse the Pearson correlation coefficient, we used the *Analyse- Correlate- Bivariate Correlation* module. The Pearson (r) correlation coefficient may vary between – 1 and 1 (Rumsey, 2016), showing the strength and direction of linear correlation between two variables. The negative sign indicates an inversely proportional correlation between the two variables and the positive sign indicates a directly proportional correlation. The work hypothesis is true and valid only if correlation coefficients are between 0.05 and 0.01.

We applied the **DPSIR** (Driving-Pressure-State-Impact-Response domain) model which describes the interactions between environment and human society (landscape), in order to emphasize the complex correlation/causation relationships between the environment and the human activities that impact it.

The DSPIR concept – the analytic framework developed by the European Environmental Agency (EEA, 1999) for the description and understanding of the relationships unfolding between economic activities and the environment – offers the possibility of integrating the analysis of the environment in the framework of different economic activities; a conceptual model designed for capturing the key factors involved in the agriculture/ environment relationship reflects the complex chain of causality between these factors; reality simplification.

By developing this research, it is intended to acknowledge the importance balance between human capital, economic growth and natural resources. As long as one of these elements does not agree with the development opportunities in the study area, we cannot discuss sustainable development. Sustainable development is a process of local interest, implying gaining wealth and raising the standard of living in a small space where natural resources and entrepreneurship plays a vital role (Ungureanu, 2003).

The reference framework for establishing the urban environment indicators is the famous Pressure-state-response framework (PSR), introduced in the ’70s by the Organisation for Economic Cooperation and Development (OECD, 1993) and later developed by the EEA into the Driver-Pressure-State-Impact-Response conceptual framework.

Even if the selected indicators are not able to offer a complete image of all the environmental aspects, they are essential for the identification of tendencies, and represents the first steps in consolidating the indicator sets capable of measuring the progress regarding environmental sustainability at local level (Cammarrota, 2005).

The combination of quantitative and qualitative analysis of various data sources increases the interpretability of the anthropic impact. This approach should improve quantitative spatial analysis (screening). The screening tends to be adequate for the understanding of anthropic evolution and changes in time series (Podobnikar, 2009). The statistical analysis provided a better understanding of the human impact on the landscape and the emergence of environmental instability.

4. RESULTS AND DISCUSSIONS

The current study focuses on changes in land use that occurred after 1990, during the so-called post-Communist era in Romania. Over the 1990–2003 transition phase, drastic changes in spatial dynamics and the quality of land use/land cover categories took place (especially regarding agricultural land), with the emergence of a new form of land property/use during that time (Popovici, 2010). A big effort was made during the following period (from 2004 until present-day), pre- and post-integration into the European Union (2007), for the implementation of EU common agricultural policies.

One of the most negative impacts of Law 18/1991, was the significant fragmentation of agricultural land and the large-scale deterioration of agricultural techniques, services and land quality (Bălteanu and Popovici, 2010). Adding to this: population decrease, inefficient farming methods, the inappropriate use of crops and the resulting products; it should be noted that there is a significant decrease in land quality, and not its quantity.

We have used the Corine Land Cover data base (Fig. 2 and Fig. 3) for the study and quantification of landscape fragmentation, for the period 1990–2018. The Corine Land Cover is one of the few well-organized land status and land use development data sets that allow for long term quantitative evaluation of the human/nature interaction, and subsequently forecasting patterns. Particular attention has been paid to the issue of the complex relationship between man and nature, and to the opportunities yielded by the forecasting of this interaction (Veldkamp and Lambin, 2001; Briassoulis, 2002).

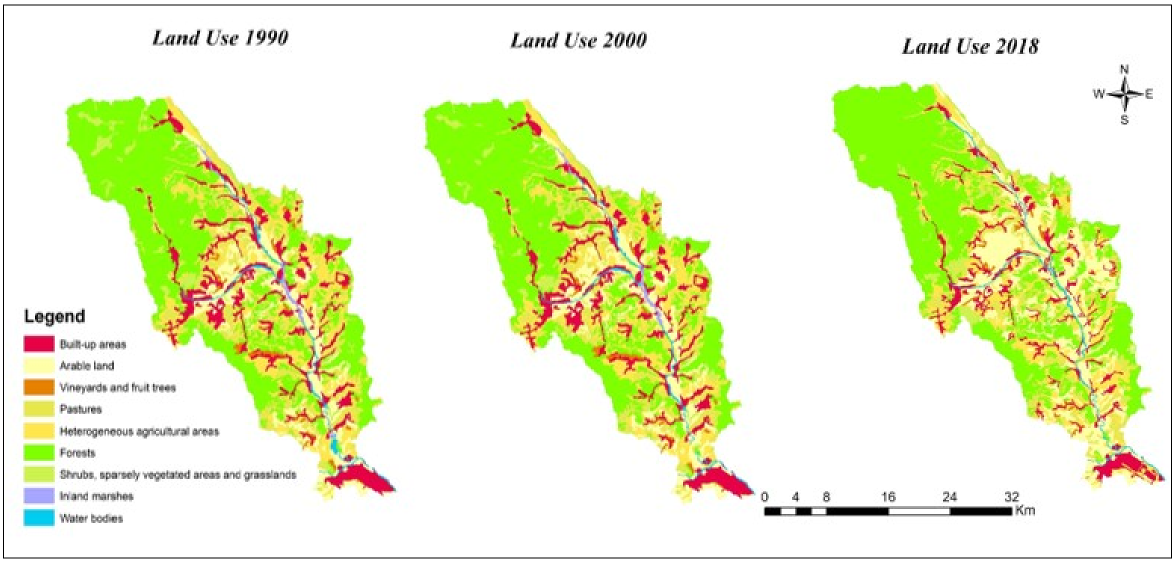

Fig. 2 – Land use/land cover in the Tazlău Basin.
Data source: Corine Land Cover 1990, 2000, 2018.

In order to better understand the pattern of land use, we have condensed and divided into main groups, as outlined in Table 1.

A comparative analysis of the Corine Land Cover data from 1990, 2000 and 2018, reveals certain aspects: in 1990 out of a total of 119,637.48 ha, the developed areas took up 13,734.75 ha (accounting for urban and industrial continuous areas, rural/urban areas and industrial/commercial units), 4,490.03 ha more than in 2018, when only 9,244.72 ha of developed areas were registered.

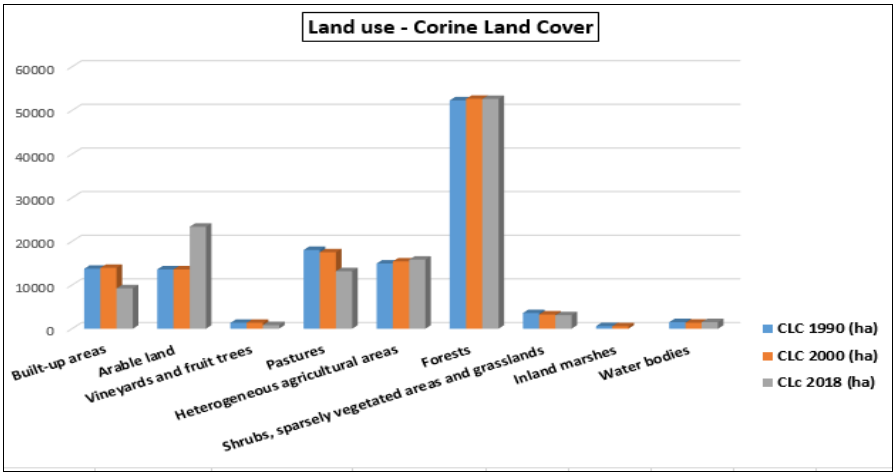

Fig. 3 – Land use/land cover in the Tazlău Basin. *Data source*: Corine Land Cover.

Table 1

Corine Land Cover classification

CLC LEVEL I code	*CLC LEVEL II code*	*CLC LEVEL III code*	*Name of reclassified code*
1. Artificial surfaces	*11.*	*111. Continuous urban fabric* *112. Discontinuous urban fabric*	*Built-up areas*
	12	*121. Industrial or commercial units* *122. Road and rail networks and associated land*	
	13	*131. Mineral extraction sites*	
	14.	*141. Green urban areas*	
2. Agricultural areas	*21.*	*211. Unirrigated arable land*	*Arable land*
	22.	*221.Vineyards* *222. Fruit trees and berry plantations*	*Vineyards and fruit trees*
	23.	*231. Pastures*	*Pastures*
	24.	*242. Complex crop patterns* *243. Land mainly occupied by agriculture, with significant areas or natural vegetation*	*Heterogeneous agricultural areas*
3. Forest and semi-natural areas	*31.*	*311. Broad-leaved forests* *312. Coniferous forests* *313. Mixed forests*	*Forests*
	32.	*321. Natural grasslands* *324. Transitional woodland-scrub*	*Shrubs and sparsely vegetated areas*
	33.	*332. Bare rocks* *333. Sparsely vegetated areas*	
4. Wetlands	*41.*	*411. Inland marshes*	*Inland marshes*
5. Bodies of water	*51.*	*511. Water courses* *512. Bodies of water*	*Bodies of water*

The largest increase in urban areas has been recorded in Oneşti and Moineşti towns, due to the population migration from villages to towns, which leads to an increased demand for housing. In 1990, the developed area of Oneşti town was 2,029.04 ha, and 1,702.7 ha in 2018, while in Moineşti town, in 1990 the developed area was 999.27 ha and 818.45 ha in 2018 – according to CLC data.

For the statistical purposes we have taken into account the reference years 1990, 2000 and 2018, which make it possible to examine the evolution of land use at longer periods with a more reliable outcome.

The analysis of developed areas during the period 1990–2000 shows: no significant changes for Tazlău; a marginal increase for the vast majority of localities (Ardeoani, Berzunţi, Bereşti-Tazlău, Livezi, Poduri, Sănduleni, Moineşti, Bârsăneşti, Helegiu, Solonţ); significant changes have been reported in the case of the locality of Zemeş, from 329,771 ha in 1990 to 502,180 ha in 2000; decreases for Oneşti, Balcani, Strugari, Scorţeni, Pârjol and Măgireşti.

The situation is entirely different for the 2000–2018 period with a sharp decrease in developed areas, and for the majority of localities, the values are below those of the year 2000, even half of that for Ardeoani, Bereşti-Tazlău, Helegiu, Măgireşti, Strugari, Solonţ, Sănduleni, Poduri, Pârjol, Livezi, Berzunţi and Oneşti. This reduction in developed areas can be explained by the complete demolition of industrial or agricultural constructions (the former Collective agricultural property = CAP) with full land-clearing, which may increase their real estate value.

As regards the arable land evolution, during the 1990–2000 period we can observe: a significant decrease for Oneşti, Livezi, Sănduleni, Scorteni, Pârjol and Măgireşti; a reduced decrease for Moineşti, Tazlău, Scorţeni and Măgireşti; a small increase for Ardeoani, Balcani, Poduri and Bereşti-Tazlău.

During the 2000–2018 period one may notice an increase in arable land for all localities, including those in urban areas, such as Oneşti and Moineşti. The highest increase was recorded in Berzunţi, from 1 ha (2000) to 698 ha (2018).

The peculiar situation for Zemeş is that it has no arable land due to its geographic location at higher altitudes in the Carpathians Mountains.

For pastures areas, a general downward trend can be observed after 1990. In more depth we can see that there has been a significant rise in the 1990-2000 period for the following localities: Oneşti, Zemeş and Tazlău; a significant drop for Ardeoani, Bârsăneşti, Bereşti-Tazlău, Helegiu, Livezi, Poduri, Sănduleni and Solonţ; and a relative decrease for Moineşti and Balcani. For the 2000–2018 interval, the pasture areas increased for Oneşti, Moineşti, Berzunţi, Tazlău; and decreased for all the others.

The areas occupied by vineyards and fruit trees have remained stable, with a small rise during between 1990 and 2000. A special situation can be seen for Moineşti, Balcani, Livezi, Pârjol, Sănduleni, Zemeş and Tazlău, where there are no such areas, although the Subcarpathian region is ideal for such crops, with argillaceous soils and sunny slopes. The lack of such crops can, therefore, be linked to the lack of experience regarding this type of activities in the mentioned areas. A different situation can be observed for the 2000–2018 interval, with a dramatic decrease in Oneşti, Bârsăneşti and Măgireşti; a complete absence in Bereşti-Tazlău, Berzunţi and Helegiu; and an expansion in the case of Poduri, Scorţeni and Strugari. A special circumstance is noticed for Pârjol commune, where the vineyards and fruit trees appear after the year 2000 and occupy an area of 120 ha by 2018. This can be explained by the positive change in the economic values of such crops, with fruit and vineyard processing activities becoming a new and profitable occupation for the villagers.

No major changes can be noticed for heterogeneous agricultural areas between 1990 and 2000 with only a slight increase for Ardeoani, Bârsăneşti, Bereşti-Tazlău, Livezi, Poduri, Sănduleni and Solonţ. The picture is quite different for the 2000–2018 interval, when these areas doubled in Oneşti and increased 10 – fold in Măgireşti. A significant increase can be noticed for Balcani, Helegiu and Poduri, while a decrease can be documented for Berzunţi, Pârjol, Sănduleni, Tazlău etc.

Forest-occupied areas have seen significant differences over the analysed periods. An initial decline pattern has been observed in Oneşti, Bereşti-Tazlău and Solonţ; however, this was followed by a recovery and a rise in the subsequent period. In the case of Moineşti, Ardeoani, Bârsăneşti and

Poduri a steady decrease can be observed, while a constant rise can be noticed in Bereşti–Tazlău, Livezi, Pârjol, Solonţ and Tazlău.

The inland marshes class has been removed from the 2018 Corine Land Cover list, which accounted for 560 ha in 2000. As far as forest areas are concerned, the changes are minor; the surfaces are constant over time. The key findings of the study are: no major changes in woodland and forested areas, a decline in grassland areas and a rise in agricultural land.

The evolution of population – the continuous growing number of inhabitants in the Tazlău Basin reached a maximum in 2002, as it was influenced by the demographic police of the communist regime which had started in the '60s (Fig. 4). Until 2002, at local level, one may note different trends in demographics growth, especially in the case of the two towns, while a decreasing tendency may be noted in the surrounding villages as a direct consequence of population aging and migration from the rural to the urban environment. After 2002, as a direct consequence of a drop in economic activity and of the major migration and aging of the population, a constant decrease in population can be observed.

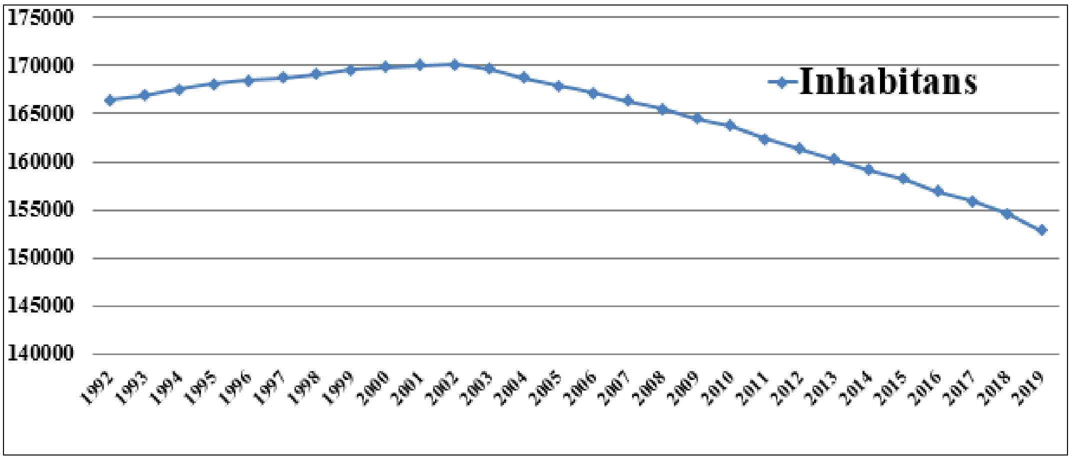

Fig. 4 – The evolution of population in the Tazlău Basin, data from INS 1992–2019.

Nevertheless, a steady rise in population can be seen in the communes of Livezi, Poduri, Sănduleni and Zemeş (Fig. 5). That can be explained by an increased natality in the Livezi and Sănduleni communes, even though they are underdeveloped and isolated. Instead, the positive demography was influenced by the rise in the oil industry, in both Zemeş and Poduri communes, as well as by their proximity to Moineşti town, with the migration of higher education and the higher classes (doctors, lawyers, industry works).

Human stress via arable use index is the ratio between arable areas (ha) and the number of inhabitants (inh.) as specified by the Food and Agriculture Organization of the United Nations (FAO). For the Tazlău Hydrographic Basin the extreme values of this index are as low as 0.0001 for the 1990–2000 period in Berzunţi commune; and a maximum value of 0.967 in Strugari commune for 2018. These values indicate a low human stress on arable areas. An overall increase in this index can be observed in all administrative units between 1990 and 2018. In 1990 the lowest values were recorded in: Moineşti – 0.004, Oneşti – 0.031, Balcani – 0.05, Berzunţi – 0.0001 and Tazlău – 0.084. The higher values for the index during 2018, for the majority of the localities, can be explained by the increase in arable areas, coupled with a decline in population; hence the following values have been calculated: Moineşti – 0.006, Oneşti – 0.036, Balcani – 0.076, Berzunţi – 0.13 and Tazlău – 0.148. The largest value, 0.967 was recorded in: Ardeoani, Bereşti – Tazlău, Bârsăneşti, Helegiu, Scorţeni, Solonţ and Strugari communes, where the largest arable areas can be found.

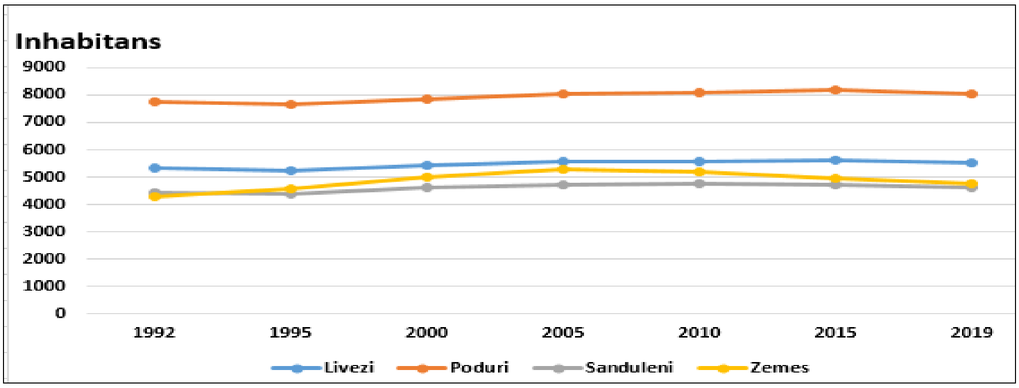

Fig. 5 – The evolution of population in the communes of the Tazlău Basin, data from INS 1992–2019.

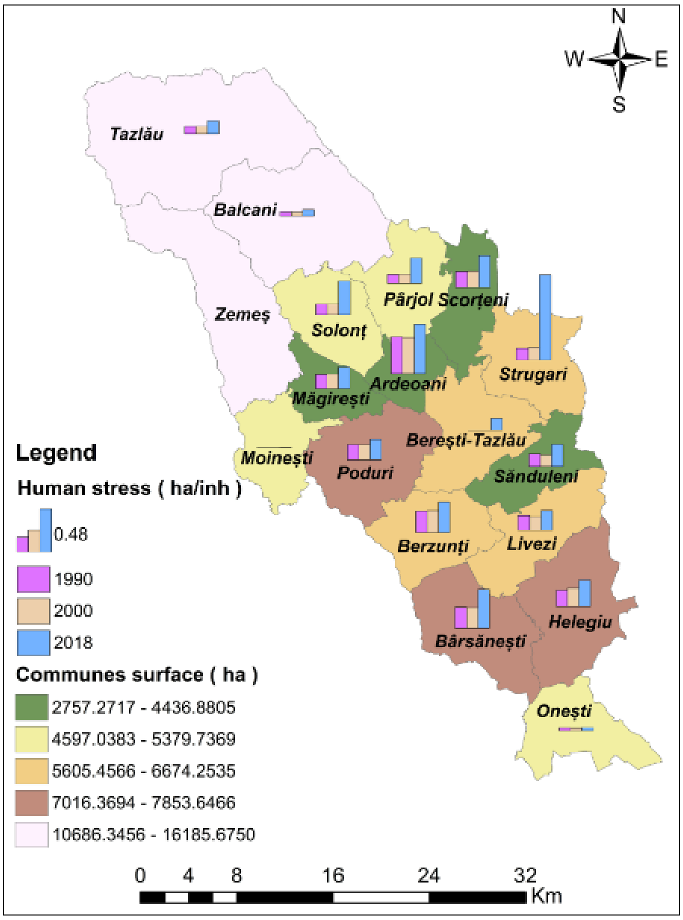

Fig. 6 – The human stress via arable use index in Tazlău Basin.
Data source: Corine Land Cover 1990, 2000, 2018.

The environmental transformation index is based on the formula S (land + grassland) /developed S. The results show the administrative areas suffering from a strong impact of anthropic activities on the environment**.** Values closer to 0 correlate with a stronger impact on the environment.

The lowest values for the environment transformation index were registered in the Oneşti – 0.126 (1990); 0.123 (2000) and 0.089 (2018).

A higher value for the environment transformation index can be observed for the mountain towns Zemeş, Balcani, Tazlău, where the higher relief hinders the growth of anthropic activities, and the landscape balance is less affected in these areas (Fig. 7).

The ***Naturality index*** is calculated using the formula forest S/entire S*100(%). As a matter of fact, it represents the weighted average of the forest areas from the total administrative areas.

Six landscape types have been defined based on the average weight of the forest from the total administrative area of the village, defining the state of balance of the ecosystem (Table 2, Ionescu and Săhleanu, 1989). As predicted, the most affected ecosystem is the one from Oneşti, while the ecosystems of Zemeş, Balcani and Tazlău are close to their natural state (Fig. 8).

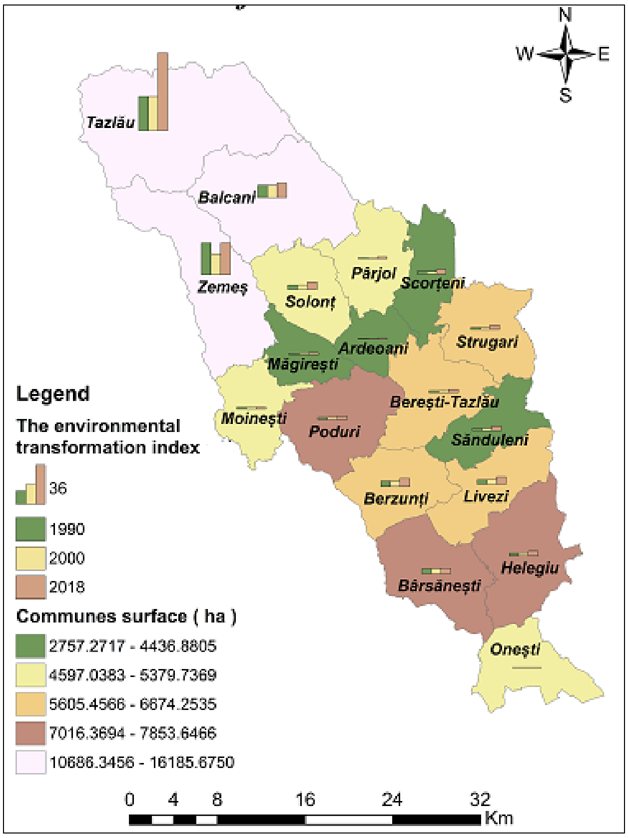

Fig. 7 – The environmental transformation index in Tazlău Basin.
Data source: Corine Land Cover 1990, 2000, 2018

Table 2

Landscape type based on the ecosystem naturality index, according to Ionescu and Săhleanu – 1989

Value (%)	**Landscape type**
>60	– ecological balance close to its initial state
45–60	– ecological balance in relative stability
35–45	– very low impact on ecological balance
20–35	– low impact on ecological balance
11–20	– impacted ecological balance
<11	– highly impacted ecological balance

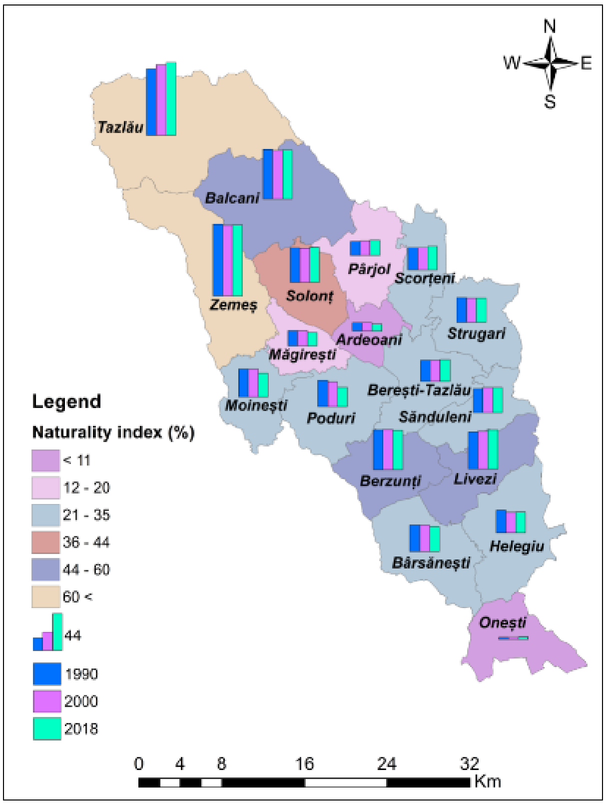

Fig. 8 – The naturality index in the Tazlău Basin.
Data source: INS 2011.

5. WORKING HYPOTHESIS

H_0 – there is a correlation between the number of inhabitants and land use for the following years: 1990, 2000 and 2018. If the Pearson correlation coefficient is out of the correlation window (interval), then the H_0 hypothesis is invalid, hence we accept the H_1 hypothesis, which states that there is no statistic correlation between the two variable sets.

Our statistics analysis shows that for the year 1990 the only strong positive correlation is between population number and developed area and bodies of water with a Pearson coefficient of 0.000 per developed area, and 0.004 for bodies of water (Table 3), which means that an increase in the number of inhabitants leads to an increase in area in both variables. Hence the number of inhabitants becomes a predictive factor and developed areas as well as bodies of water dependent variables.

Table 3

The coefficient for determination for the significant Pearson correlation to examine the relationship between land use/land cover and demographic statistical data, for 1990

		Developed areas	Arable land	Vineyards	Pastures	Heterogeneous	Forests	Shrubs	Marshes	Water
Population 1990	Pearson Correlation	.858**	0.376	-0.002	-0.294	-0.115	-0.239	-0.052	-0.098	.643**
	Sig. (2-tailed)	0.000	0.124	0.995	0.236	0.651	0.339	0.838	0.700	0.004
	N	18	18	18	18	18	18	18	18	18

Our statistics analysis confirms the working hypothesis for the year 2000, with a Pearson coefficient of 0.01 for dependent variables, developed areas and bodies of water, which shows their strong correlation with the predictive factor (e.g. number of inhabitants in Table 4).

Table 4

Coefficient of determination for significant Pearson correlation to examine the relationship between land use/land cover and demographic statistical data, for 2000

		Developed	Arable	Vineyards	Pastures	Heterogeneous	Forests	Shrubs	Marshes	Water
Population 2000	Pearson Correlation	.865**	0.359	-0.001	-0.279	-0.127	-0.230	0.010	-0.094	.641**
	Sig. (2-tailed)	0.000	0.144	0.998	0.262	0.616	0.358	0.969	0.711	0.004
	N	18	18	18	18	18	18	18	18	18

For the year 2018, the working hypothesis is confirmed for all the 18 analysed localities, with a value of 0.01 for the Pearson coefficient (Table 5), showing again the strong correlation between the 3 variables, even though a decrease in population is observed for this year.

Table 5

The coefficient of determination for significant Pearson correlation to examine the relationship between land use/land cover and demographic statistical data, for 2018

		Built-up areas	Arable land	Vineyards and fruit trees	Pastures	Heterogeneous agricultural areas	Forests	Shrubs and sparsely vegetated areas	Inland marshes	Bodies of water
Population 2018	Pearson Correlation	.961**	0.048	-0.219	-0.115	0.116	-0.233	-0.038	.a	.586*
	Sig. (2-tailed)	0.000	0.849	0.382	0.648	0.646	0.353	0.880		0.011
	N	18	18	18	18	18	18	18	18	18

No correlation can be found for all the other variables in any of the three analysed years: 1990, 2000 and 2018 (Tables 3–5). Hence, we can't see any correlation between increase/decrease in population number and variation in land use/land cover areas.

6. DPSIR MODEL

The DPSIR model indicates that any social and economic growth (driven by population growth and necessities, which define the main environmental pressure) has an impact the environmental balance (Bicik, 2001).

1) Driving forces:
   - political decisions and their effects over the conditions of the properties, exploitation type, land use or its reconversion.
   - population growth until the year 2000, followed by continuous decline until the present day due to an active population migration and a drop in birth rates (Fig. 2);
   - a decrease in agricultural and industrial production (e.g., oil).
   - different relief types identified in the study area may explain the predominant agricultural land use, either arable, pastures, vineyards, fruit trees, or forest.

2) Pressure – over the landscape, exercised by the dynamics of land use, the dimension, fragmentation, degradation and soil erosion, loss of biodiversity and land abandonment.

3) State – landscape fragmentation and alterations in land use (Fig. 2 and Fig. 3), can be observed as a consequence of anthropogenic pressure, intensive animal husbandry and landslides (Figs. 9 and 10).

Fig. 9 – Area affected by landslides due to intense grazing, Dealul Roşu, Poduri Village, 3 May 2016. *Source*: Personal Archive.

Fig. 10 – Forest affected by landslides, Zemeş Village, 26 November 2016. *Source*: eng, Leonard Ardeleanu, Moineşti Forest District.

4) *Impact* – the evaluation and monitoring of the processes having a negative impact, in order to prevent landscape degradation.

5) *R*esponse – for diminishing or even curtailing the negative trend: increasing field actions for limiting illegal wood cutting and deforestation; prosecuting by law limit overpassing, including those regarding unproductive land in agricultural areas, promoting 3 protected areas (Fig. 11).

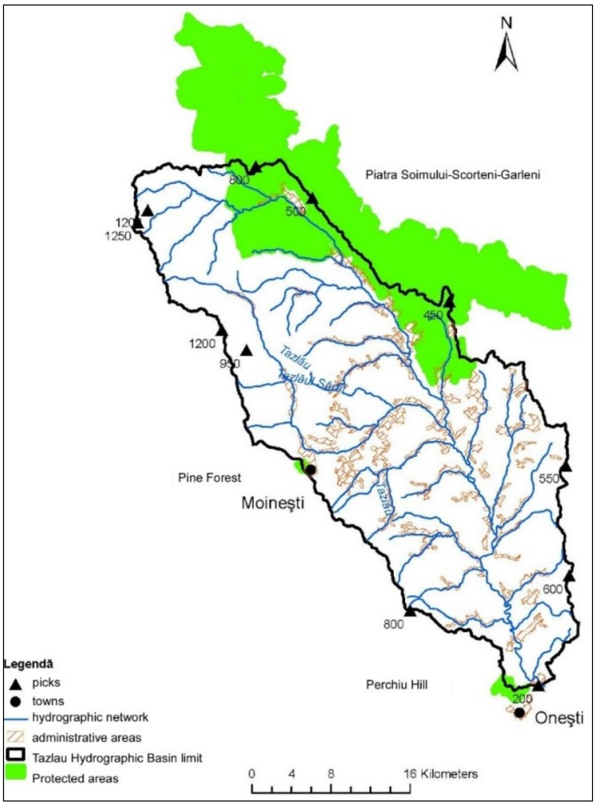

Fig. 11 – Nature 2000 protected areas in the Tazlău Basin.

- Piatra Şoimului-Scorţeni-Gârleni (37,445 ha – extends outside of the study area) – corresponds to the continental and alpine biogeographic areas, important for the protection of certain birds species;
- Pine forest (15 ha, Moineşti town) – planted in 1930 by the oil company "Steaua Română", in order to stabilize local landslides; protective for black pine;
- Perchiu hill (185 ha, Oneşti town) – has the purpose of protecting the biodiversity and to maintain the conservation of spontaneous flora, wild fauna and natural habitats.

7. CONCLUSIONS

The increased anthropic activity had a significant impact on the natural environment. The most obvious pertains to the changes in natural landscape, which has been modified, re-organized and even relocated by anthropogenic factors. These effects are the inevitable consequence of urbanization and economic growth (Mazurek, 2015).

The switch from a centralized to a free market economy post – 1989, from a state-owned property or cooperative to private property, resulted in the large fragmentation of the agricultural landscape with noticeable effects, such as:

- the expansion of private property over agricultural and forest areas;
- the dismantling of large farms and the development of small family farming, while fragmenting land into small patches of land, usually less than 2ha, which led to a sharp drop in productivity and rentability, and finally the failure of this subsistence type of agriculture;
- the decrease in developed areas, taking into account urban and industrial continuous areas, rural/urban areas and industrial/commercial units;
- developed areas can be found all over the Tazlău hydrographic basin, with a lower density in the upper basin due to the higher altitude;
- the increase in pasture areas to the detriment of the more profitable orchards and vineyard areas, probably due to poorer investment rates and to the maintenance level required by the former.

The situation improved slightly with the development of land owners associations and APIA subventions. The establishment of local action groups (GAL), where all the communes in the area of interest are associated, and joining the EU, had a positive effect over land use. These types of associations allowed farmers to access grants for the purchase of agriculture machinery, production systems or to switch to new and profitable crops (colza, lavender, blueberry, etc). Moreover, joining the EU and implementing common agriculture policies led to a step forward being taken in terms of agriculture development with the setting up of agro- environmental, action and investment plans, as well as sustainable development and actions regarding the usage of natural resources.

We would put forward the following possible improvements:

- at local level – public local authorities can contribute to the implementation of local development plans for efficient land use, either arable, pasture, or otherwise. The sustainable development of local communities must be in agreement with specific land use from the area, with the development of traditional activities that may have gone extinct, but which can be revitalised by the locals. Efficient land use has several economic, cultural and ecologic benefits. Biodiversity conservation can only be achieved through sustainable land use, statistical analysis being the tool that can show the dramatic reduction in different land use.
- at regional and national level – rural communities can access European funds and grants for agriculture through APIA, the national agency. These financial aids can stimulate agricultural activities at local level and can increase the living standards of farmers.

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