BABEȘ-BOLYAI UNIVERSITY, CLUJ-NAPOCA

F A C U L T Y O F G E O G R A P H Y

D O C T O R A L S C H O O L O F G E O G R A P H Y

PhD THESIS

(Summary)

THE MORPHOLOGY AND SPATIAL PLANNING IN THE SOMEȘ RIVER CORRIDOR (THE GURUSLĂU DEPRESSION)

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CONTENTS

KEYROWDS: *relief morphology, spatial planning, soil erosion, landscape, land use, Someș river, Guruslău Depression*

1. INTRODUCTION

The present paper aims to analyze the physical-geographical features, relief typology, current geomorphological processes and anthropic interventions in the Someș River Corridor (Guruslău Depression). The focus of this study in on the interrelationships between the above-mentioned elements and the spatial planning process, in order to identify their interconditioning elements and to formulate suggestions for harmonious spatial development.

The previous studies referring to the analyzed ensemble approach the territory from the perspective of physical-geographical aspects, being oriented towards the morphology and morphodynamics of the relief, while the issue of spatial planning is a little researched field. The novelty of the present work lies in its focus on the applied side, since both physical-geographical features and anthropic elements, related to land use or the landscape of the study area, are analyzed.

The topicality of the present work lies in the integration of concerns related to spatial planning in recent years, both in national and European studies, in the context of paradigm shifts and the pronounced orientation of current research towards the identification of opportunities for optimal exploitation of endogenous potential for harmonious development. The proposed study aims to analyze the physical-geographical peculiarities of the Someș river corridor within the Guruslău Depression from the perspective of exploiting the relationship between relief and spatial planning, in order to establish the current dysfunctions and to identify the opportunities to stimulate the harmonious development of the study area.

2. GURUSLĂU DEPRESSION. GEOGRAPHICAL LANDMARKS

2.1. Geographical location and boundaries

The study area represented by the Guruslău Depression is located within the middle course of the Someș river, in Sălaj County (47°13'- 47°25' N; 23°12'- 23°21' E) (Figure. 1). It is 23 km long in a south-north direction and 8 km wide and is well delineated in relation to the surrounding area. Its delimitation was established according to the main peaks that facilitate its individualization as a distinct unit within the Someș Corridor.

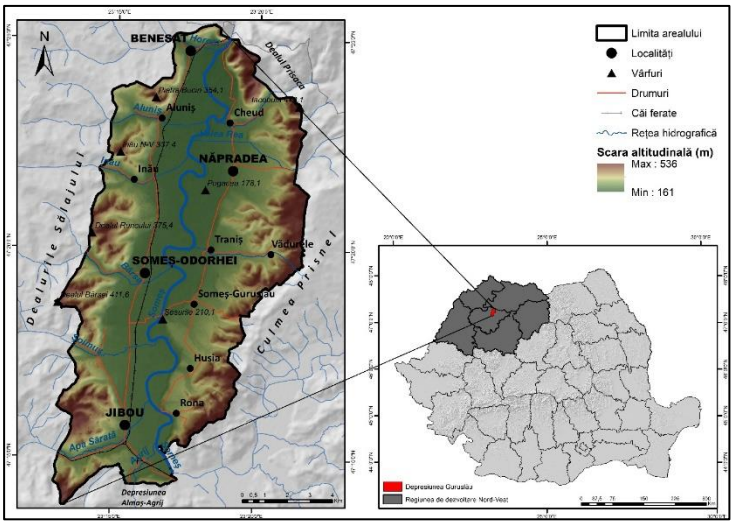


Figure 1. *Geographical position of the Guruslău Depression in Romania*

In the western part, the boundary is represented by the Western Hills, through the Sălaj Hills subunit, within which overlaps the Runcului Hill (375.4 m), the Bârsei Hill (411.6 m), the Chicera Hill (437.7 m) and ends in the vicinity of the Dumbrava Brebi Hill (557.4 m), located in its south-western part. In the east, the area is bounded by Prisnel Peak, through the Secătura Hill, Iacobula Peak (473.1 m), Voinicului Hill, Țicla Peak (454.7 m) and Rona Peak (437.4 m). In the northern part, the boundary is marked by the Dealul Mare-Prisaca massif, the Strâmtorii Bridge (418 m) and the Țicău Gorge.

2. STUDY METHODOLOGY

3.3. Agreed methodology

The methodology used in order to achieve the objectives proposed in the present thesis aims at using both classical and modern methods. The classical methods require first of all a thorough bibliographical documentation, by consulting specialized scientific papers. By documenting studies on geological, geomorphological, climatic, hydrological, pedological etc. aspects of the study area, the general research guidelines were established, taking into account both consecrated works in the literature and recent ones.

The methods of analysis and synthesis contributed to the establishment of general research milestones, together with bibliographic documentation. The direct observation method involved field trips to identify aspects related to present geomorphological processes, with the purpose of mapping them and assessing the potential induced risk. These trips also aimed at comparing the aspects found by applying spatial analysis techniques using geoinformation software with the reality, in order to validate the results obtained.

The cartographic method is materialized by the elaboration of the maps of the analyzed territory, based on the information obtained from bibliographic documentation, analysis of previously elaborated materials and direct observations. In this regard, the geoinformational software ArcGIS (ArcMap, version 10.6.1) was used, which facilitated the development of integrated spatial analysis models. In addition, the methodological set-up used in the present study involved the use of the comparison method, which was materialized through the comparative analysis of the 1:25 000 and 1:50 000 topographic maps of the territory with the maps obtained through GIS.

4. RELIEF MORPHOLOGY AND MORPHODYNAMICS IN THE GURUSLĂU DEPRESSION

4.1. Geographical prerequisites of relief modelling

4.1.4. Geomorphological prerequisites

4.1.4.1. Structural landscape

The Guruslău Depression is presented as a whole as an old side slope valley (syncline part, anticline part) (Savu, 1963). The relief developed on monoclinal structures, with alternations of hard and soft rocks, is materialized in the study area by the presence of forms from the category of cuestas. Of particular note in this respect is the Rona Peak, whose cuesta front forms the boundary of the analyzed system. It overlaps the deposits of Lower Miocene age, it is 23 m thick and contains deposits related to the Rona Limestone in the cuesta front, while the cuesta backslope shows the presence of Racoți Sandstone.

4.1.4.2. Petrographic landscape

The karst relief is materialized by the presence of Rona Limestone formation, spatially identified in the west of the homonymous village located in the south-eastern end of the area, in the Someș River meadow area. It is composed by intercalations of white-gray freshwater limestones belonging to the Jibou Formation, which are about 250 m thick in the area of the village of Rona, while in the proximity of the village of Cuceu the limestone lens reaches up to 400 m.

The relief developed on sandstones and conglomerates is identified by the Racoți Sandstone formation, located in the southeast of the study area. It is formed on calcareous

sandstones and is visible on the western slope of the Rona Peak, forming a cuesta of about 23 m thick.

The relief formed on clays is well developed in the Guruslău Depression, due to the appreciable distribution of these rocks in the area, being spatially identified mainly on the Someș slopes. This relief is materialized by the appearance of torrential erosion forms, with a significant development in hot-spot type points within the study area.

4.1.4.3. Fluvial landscape

In the Guruslău Depression, the Someș riverbed has a typical transverse profile, materialized by the stream channel, the minor riverbed and the major riverbed. The Someș meadow is well developed within the Guruslău depressional corridor, having an asymmetric development, so that its width oscillates in a wide range, between 70-110 m and 2.7 km. The river terraces are well represented in the study area, being present the eight steps of the Someș river, which have an appreciable extension.

4.2. Relief morphometry

4.2.1. Hypsometry

The analysis of the hypsometry of the Guruslău Depression reveals that the area has altitudes ranging from 161 m to 536 m, with an average value of 227.9 m.

A hypsometric peculiarity of the analyzed depressional corridor is represented by the increase of the altitudinal values from the central part towards the periphery (Figure. 21), this imprinting the same spatial distribution also for other analyzed parameters (depth of fragmentation, slope). Therefore, the lowest altitudes are located in the Someș meadow, with a minimum of 161 m, increasing towards the main peaks delimiting the study area.

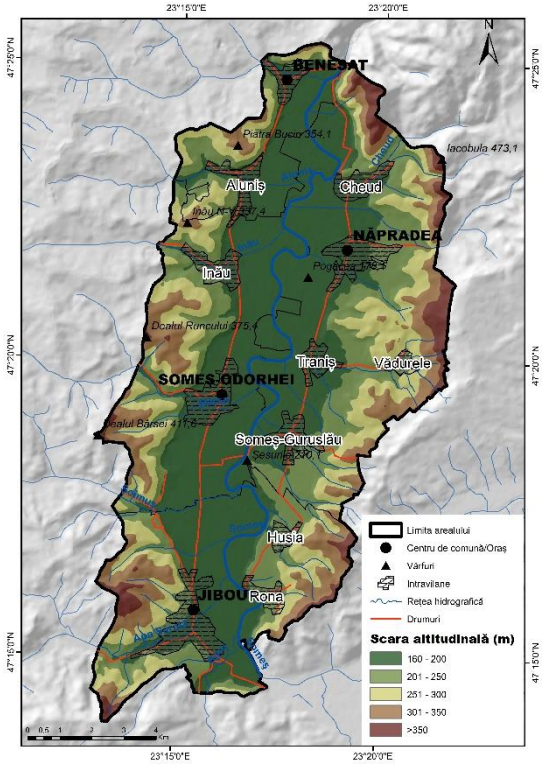
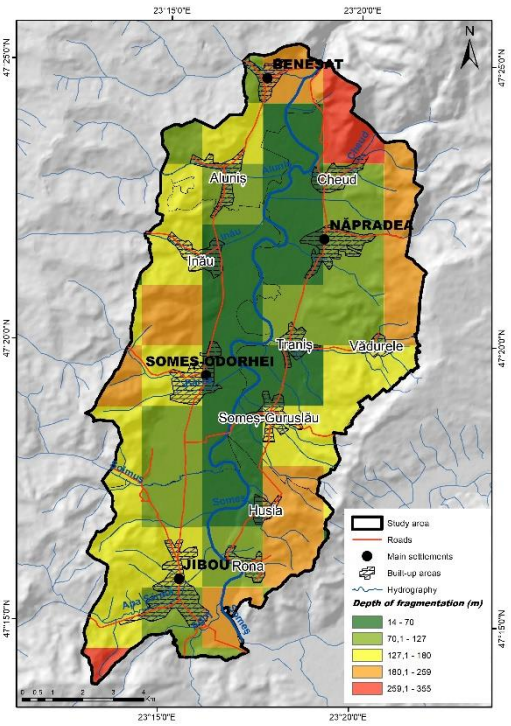
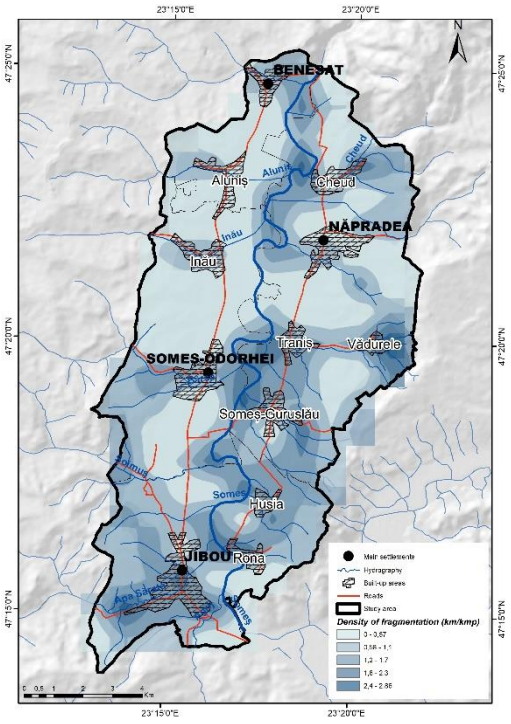


Figure 21. *Hypsometric map*

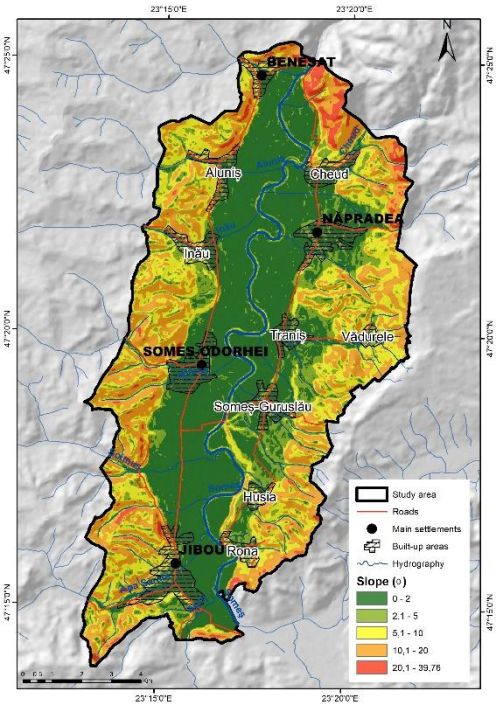
4.2.2. Depth of fragmentation



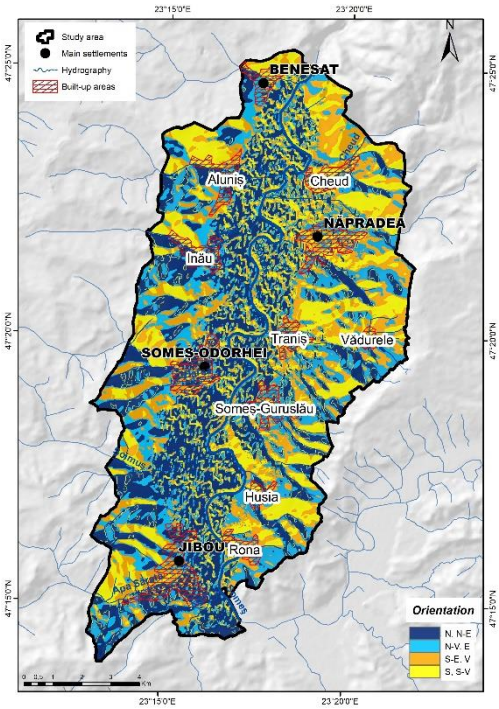
4.2.3. Density of fragmentation



4.2.4. Geodeclivity



4.2.5. Surface exposure



4.4. Relief morphodynamics and associated geomorphic risks

4.4.1. Surface erosion processes

The assessment of the annual soil erosion rate in the Guruslău Depression was based on the implementation of the USLE model in the GIS environment and was achieved by integrating

databases representing climatic factor, pedological factor, topography and land use. The values of the annual soil erosion rate in the Guruslău Depression range between 0-33.3 t/ha/year (Figure. 34), averaging 0.06 t/ha/year, and are grouped into 6 classes (Costea et all, 2022).

The analysis of the spatial distribution of the soil erosion rate at the level of the whole area shows that about 92% of the territory has very low values, between 0-0.2 t/ha/year, followed by the ranges 0.21-0.5 t/ha/year and 0.51-1 t/ha/year, which are about 4% and 2 % respectively. The highest values, above 1.5 t/ha/year, occupy the smallest area, about 0.6% of the total, which means that this process does not significantly affect very large areas.

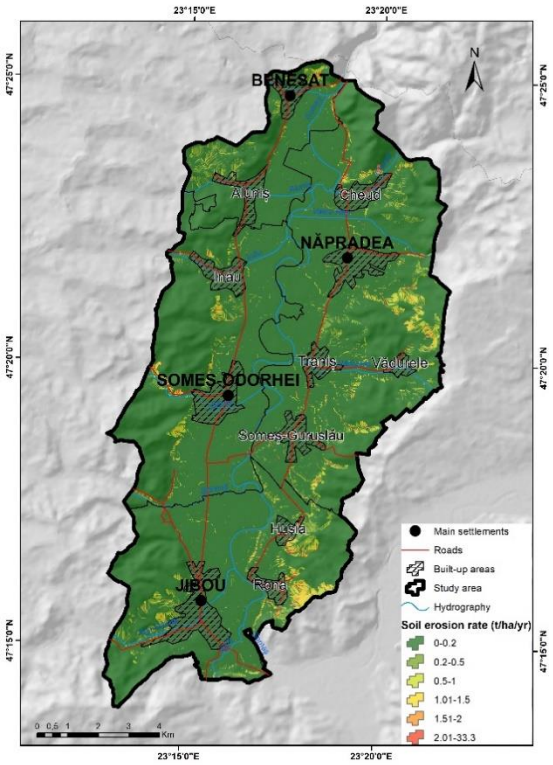


Figure 34. *Soil erosion rate in the Guruslău Depression (pursuant to Costea et all, 2022)*

4.4.4. Land vulnerability and risks associated to relief morphodynamics

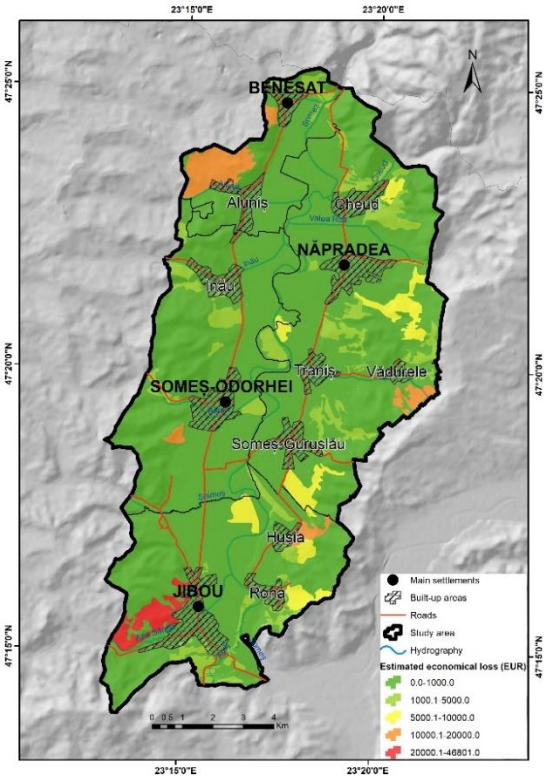


Figure 39. *Risk calculated as financial loss (pursuant to Costea et all, 2022)*

The estimation of the risk induced by surface soil erosion was achieved by developing a qualitative model to assess the financial losses in relation to the degree of soil erosion associated with the land use. Thus, it is noted that the impact of soil erosion has effects on five land use categories, namely vineyards, orchards, pastures, complex cultures, and agricultural land mixed with natural vegetation (Figure. 39). The first two categories record losses of 30% and 20% respectively, while in the case of the last three the decrease of the value is by 10%; the remaining land use categories do not have financial losses caused by surface soil erosion.

The highest financial loss in the Guruslău Depression is of 46.801 EUROs (Costea et all, 2022) and was spatially identified at the level of an extended area with orchards, located in the west of Jibou. The

average value of the financial losses in the study area is of 1.797 EUROs, which is exceeded in Jibou and Benesat, while the rest of the units have much lower values.

5. LAND USE AND SPATIAL PLANNING

5.1.1. Land use structure in the Guruslău Depression

The study area has a spatial extension of approximatively 14500 ha, being identified within it 13 categories of land use, which are not present in all of the territorial-administrative units. Of these, the agricultural land occupies about 8248 ha (57%) and the non-agricultural land, about 6252 ha (43%) (Figure. 40).

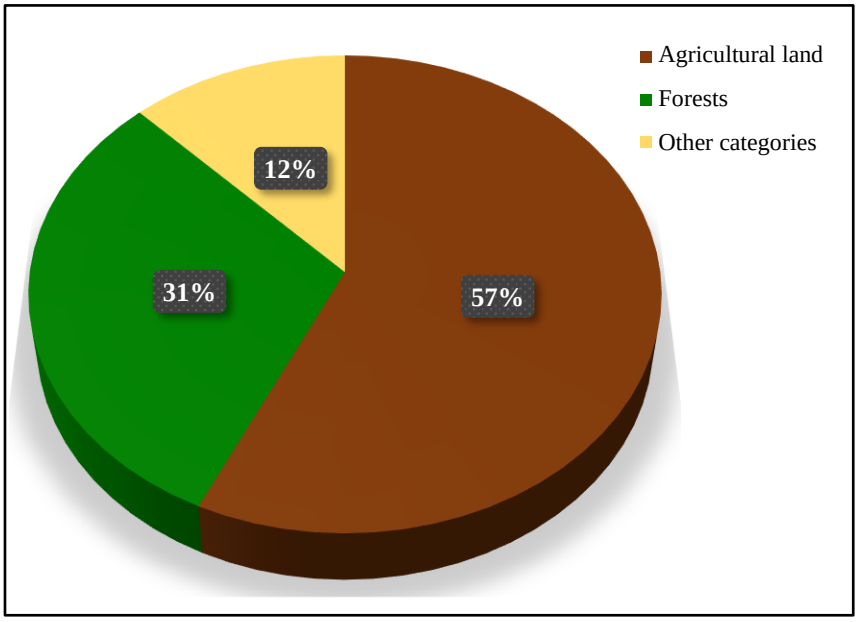


Figure 40. *Land use structure in the Guruslău Depression*

5.2. Land use dynamics between 1990-2018

The analysis of the land use dynamics within the Guruslău Depression involved comparing information provided by Corine Land Cover databases for the years 1990, 2000, 2006 and 2018 (Figure. 58).

From the perspective of the spatial distribution of the land use categories in the 5 reference moments, it is noticed that their hierarchy is preserved throughout the whole period, with a slightly pronounced evolution. The main feature of the dynamics of the land use is represented by the increase in the area occupied by arable land, on the background of the decrease in the extension of categories such as pastures, industrial areas (Someș-Odorhei commune), marshes, areas of complex cultivation or agricultural land with significant areas of natural vegetation, and the integration of some surfaces related to the mentioned categories into the agricultural circuit.

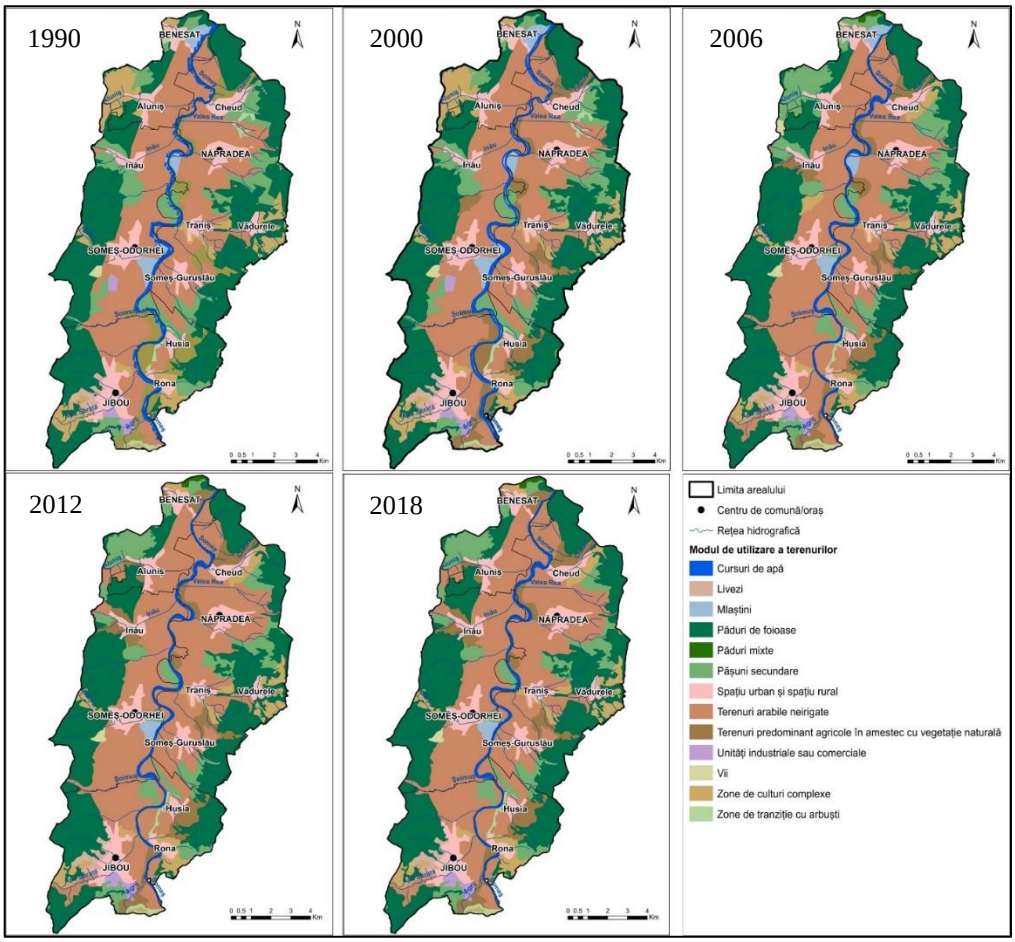


Figure 58. *Land use in the Guruslău Depression in the interval 1990-2018 (pursuant to Costea et all, 2022a)*

5.3. Suitability for spatial planning

The implementation of a spatial analysis model for assessing suitability for spatial planning in the Guruslău Depression was based on the integration of relief morphometric parameters and additional analysis criteria, namely land use, geology and annual soil erosion rate.

The percentage distribution of the values obtained in the Guruslău Depression shows the predominance of the high favorability class (30%), which, together with the very high favorability class, account for more than 40% of the total analyzed. Besides, a significant share belongs to the medium suitability class, which accounts for more than 25% of the total, while the unfavorable areas account for

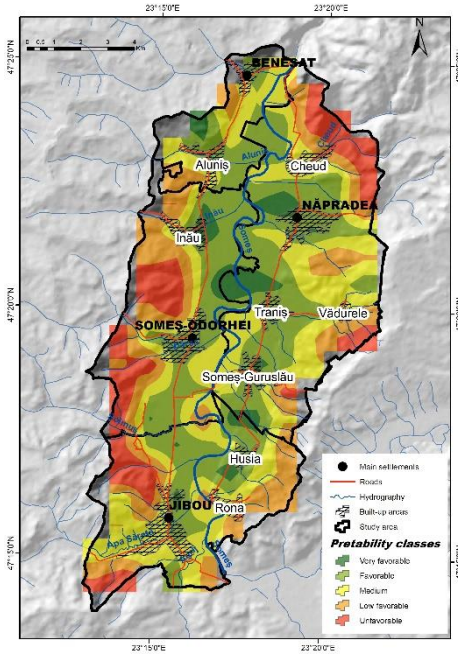


Figure 62. *Suitability for spatial planning in the Guruslău Depression (pursuant to Costea et all, 2022b)*

only 14%. The most restrictive suitability class has a weight of less than 20%. Thus, it can be deduced that most of the analyzed territory is favorable for spatial planning in terms of the indicators considered.

5.4. Proposed spatial planning models

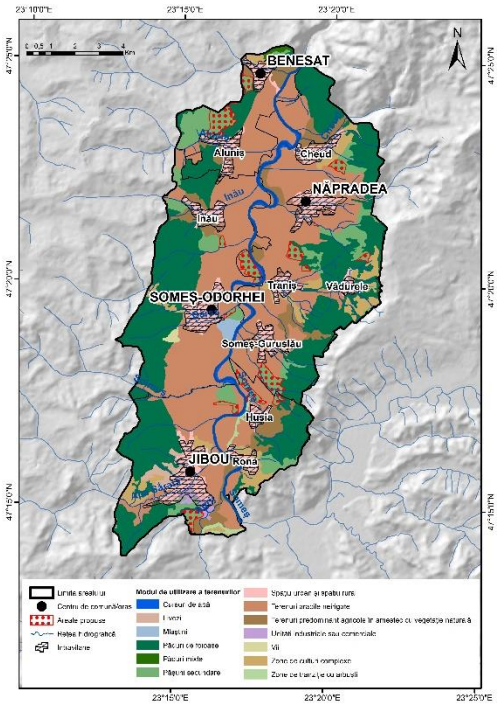


Figure 63. *Areas proposed for the expansion of the cultivated land in the Guruslău Depression*

The interventions realized in the study area should have as a main objective the increase of the productivity of agricultural land, in order to develop a market-oriented agriculture, leading to a sustainable economic growth. To this end, a first step is to identify at the level of each territorial-administrative unit the surfaces where the cultivated land, which currently accounts for approximatively 48% of the total area, could be expanded. Thus, through the implementation of the integrated analysis model, on the basis of the multi-criteria analysis of the morphometric parameters of the relief and other relevant criteria, there were identified in the territory the areas of the upper classes of favorability (”very favorable” and ”favorable”), which overlap categories such as pastures or marshes, where the cultivated land could be expanded (Figure. 63).

6. LANDSCAPE IN THE GURUSLĂU DEPRESSION

6.2. Analysis of elementary landscape units

The identification of landscape types in the Guruslău Depression involved the processing of information provided by the Corine Land Cover (CLC) databases and the processing of satellite images/orthophotoplans, along with field observations. Overall, the study area belongs to a multi-layered traditional landscape, characterized by the dominance of centuries-old agricultural practices, which brings together a morphological, structural and functional complexity resulting from the long transformation of human-nature relations through the successive adaptation of

settlement forms and agricultural, forestry and pastoral practices to the existing geographical conditions.

In the first stage, there were identified 13 categories of land use, which were subsequently transformed into seven elementary landscape units: landscape of cultivated land, forest landscape, agro-pastoral landscape, residential landscape, industrial landscape, viticultural landscape, landscape of marshes and rivers. The analysis of the distribution of the seven landscape units shows the predominance of the categories of the landscape of cultivated land and forest landscape, which account for more than 75% (77.6) of the total (Figure. 65).

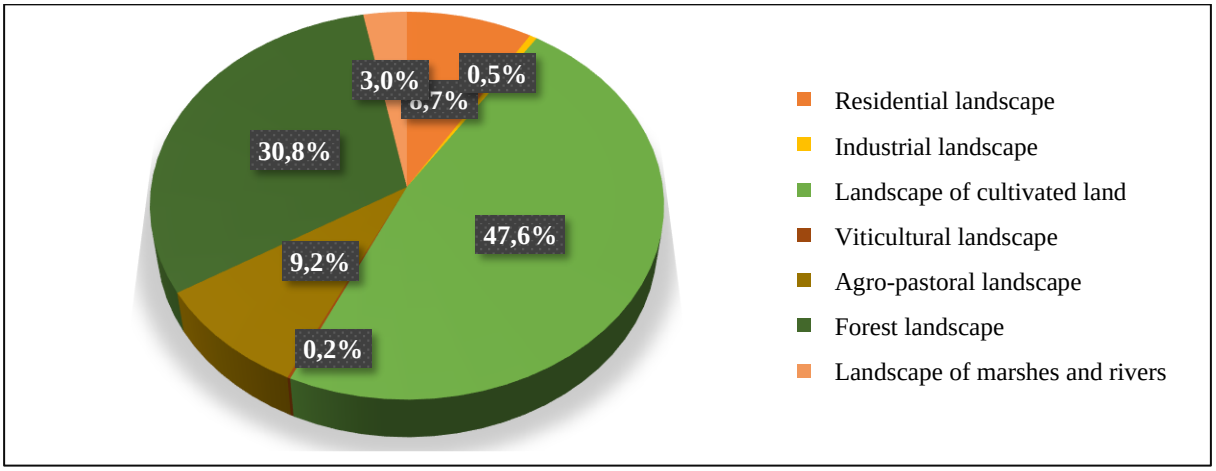


Figure 65. *Percentage distribution of landscape types in Guruslău Depression*

6.3. Landscape dynamics

The analysis of landscape dynamics within the Guruslău Depression was performed by comparing the maps of elementary landscape units for the years 1990 and 2018, in order to highlight the transformations that have occurred in an interval of about 30 years and to identify some evolutionary patterns in the spatial organization of the study area. The changes observed are slightly pronounced but are identified at the level of all the categories in the area.(Figure. 72). The landscape of cultivated land has the largest spatial distribution in both reference moments, being the only one that has increased in the analyzed period, while all the other categories are characterized by decrease of the areas.

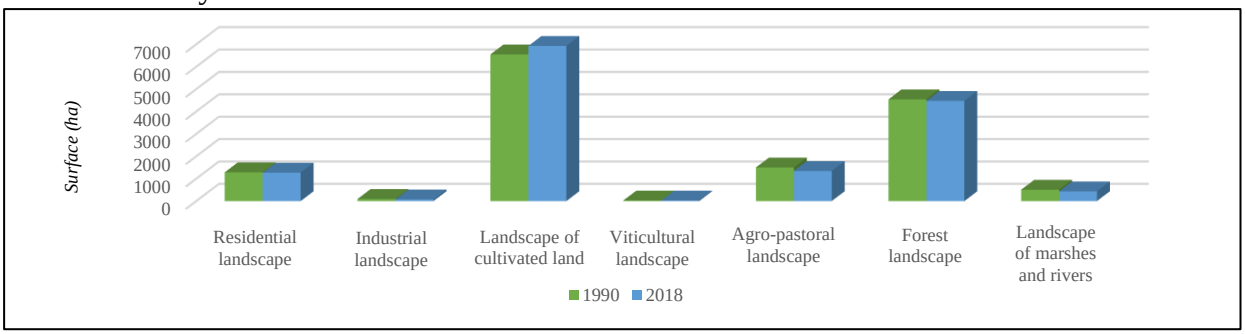


Fig. 72. *Surfaces of the landscape types in the Guruslău Depression (1990, 2018)(pursuant to Costea et all, 2022a)*

6.5. Landscape dysfunctions

The main landscape dysfunctions in the Guruslău Depression are those associated with the dynamics of geomorphological processes, which have an impact on land degradation and may cause long-term consequences on agricultural productivity and, implicitly, on the economic development of the area. From this category, the surface soil erosion has the most significant territorial imprint, mainly in isolated hot-spot areas, spatially identified in all the territorial-administrative units.

The negative impact of the anthropic factor on the landscape of the Guruslău Depression is manifested through a more diversified range of interventions and actions. Intensive grazing in areas with high slope and clay substrate is one of the main causes of land degradation, having a significant territorial distribution at the level of the analyzed system, in all the component territorial-administrative units. Another causal factor of landscape dysfunctions is the depopulation of the rural space, which leads to the emergence of numerous abandoned households in an advanced state of degradation. Such situations can be identified in several villages in the area, such as Vădurele, Traniș or Husia, where the negative impact on the landscape is evident. Besides, elements that induce a negative impact on the landscape are the abandoned buildings belonging to the former Agricultural Production Cooperatives (CAP), to which are added the dysfunctions caused by deforestation and pollution caused by improper waste disposal.

7. CHOREMATIC MODEL OF THE GURUSLĂU DEPRESSION

7.1. S.W.O.T. analysis of the Guruslău Depression

The assessment of the potential of the study area and development perspectives was performed by S.W.O.T. analysis, taking into account aspects related to internal attributes (strengths, weaknesses) and external attributes (opportunities, threats). This allowed the identification of vulnerabilities from a spatial planning perspective, while facilitating the subsequent prioritization of the interventions that would contribute to the development of study area.

7.2. Opportunities in spatial planning and local development

7.2.1. Natural and tourist resources

The Guruslău Depression has a slightly varied range of resources, but their optimal exploitation can contribute to the economic development of the area and to the improvement of the life quality. The raw material resources are represented by ballast aggregates from the Someș riverbed, which are currently exploited in ballast pits.

The tourist resources are spread in all the four units of the study area, among which the Botanical Garden ”Vasile Fati” Jibou, which is knows regionally and is the main attraction within the territorial analyzed system, stands out. In addition, there are several other attractions, such as the Wesselenyi Castle complex, the Beldy Castle, the Reformed Church of Jibou, the archaeological site of Jibou - the former CAP, the wooden church ”St. Archangels Michael and Gabriel” in Husia, the natural reservation ”Rona Limestone”.

7.2.2. Human resources

According to the most recent census (2011), the population of the Guruslău Depression sums up 17266 inhabitants, approximatively 7.7 of the total population of the Sălaj County. The city of Jibou is located in the south-west of the analyzed system and is the only urban unit in the area, with a population of 10407 inhabitants. At the level of the communes included in the study area, their demographic size is: Benesat - 1536 inhabitants, Năpradea - 2652 inhabitants, Someș-Odorhei - 2671 inhabitants.

7.2.3. Opportunities in spatial planning and local development

The physical-geographical and anthropic particularities of the settlements located in the Guruslău Depression allow the successful implementation of interventions in the field of spatial planning, with the purpose of local development of the analyzed ensemble and increasing the life quality. The analysis of the relief suitability for spatial planning (Costea et all, 2022b) reveals a high degree of suitability in order to apply specific measures in this domain, while the identification of elements with risk potential highlights the fact that a large part of the area has low susceptibility to processes associated with geomorphological hazards.

The integration of the territorial-administrative units of the Guruslău Depression into the LAG ”Samus Porolissum” facilitates the stimulation of cooperation and the attraction of funds for the economic development of the study area. Another opportunity for the local development of the settlements within the Guruslău depression corridor is represented by the possibility of associating the owners of cultivated land in agricultural cooperatives. This can facilitate increased productivity through investment and the optimization of production costs, contributing on the long term to the sustainable development of the study area.

The diversification of the economic activities within the rural space of the Guruslău Depression is another necessary measure for the development of the area and spatial planning. In this respect, the orientation towards tourism and especially agri-tourism can create the premises for a harmonious development of the territory.

7.3. Flows choremathics

The systemic-functional characteristics of the study area are conditioned by the depressional corridor morphology, which imprints several elements of specificity (Figure. 85). First of all, it is noted the presence of a main axis located parallel to the Someș river, which favors the flows of mass, energy and people. This is doubled by the presence of a parallel secondary axis on the right bank of the Someș, which serves the villages belonging to the commune of Năpradea.

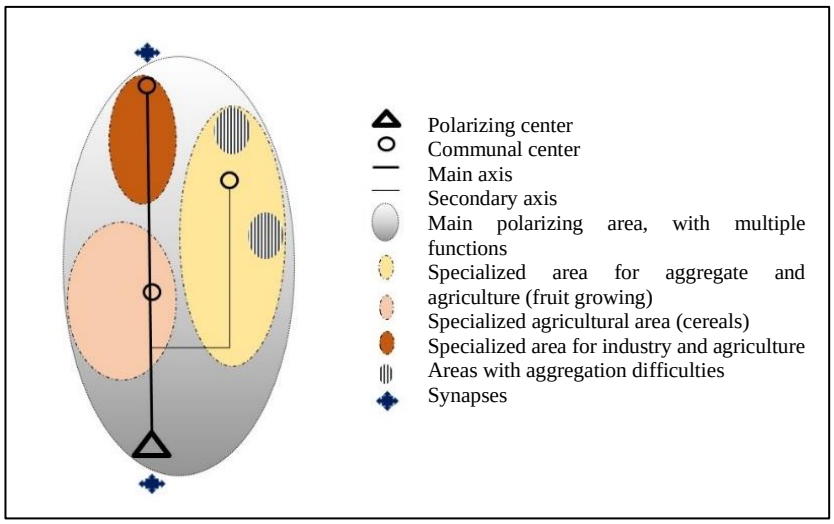


Figure 85. *The chorema of the Guruslău Depression*

Another defining feature of the study area is the location of the city of Jibou on the outskirts, in the extreme south, which induces several peculiarities. Its peripheral position causes difficulties in the diffusion of flows towards the interior of the system and especially towards the peripheral areas, leading to the formation of areas with aggregation difficulties (Cocean, Filip, 2011), spatially identified in the north-eastern part of the Guruslău Depression.

In addition to the polarizing area of the city of Jibou, three other areas of flows convergence are identified within the analyzed system, developed around the commune centers. These are distinguished by the specific nature of their economic activities, despite an obvious specialization in agriculture. The three commune centers also polarize the belonging villages through their administrative and educational functions. The presence of synapses in the northern (towards Maramureș county) and southern (towards the Almaș Valley) extremities contributes to a better integration of the whole area at regional level and to the development of intra- and extra- county cooperation relationships.

CONCLUSIONS

The study area represented by the Guruslău Depression presents a series of specific elements that outline the premises of a harmonious territorial development. The physical-geographical peculiarities, together with those associated to the anthropic factor (development of the settlement system, land use etc.) are favorable elements for the implementation of efficient spatial planning measures.

The present work aimed at analyzing the study area from the perspective of the relief-spatial planning relationship, taking into account aspects related to location, hydro-climatic conditions, relief morphology and morphometry, land vulnerability, land use, landscape types and opportunities in local planning and development. The Guruslău Depression benefits from attributes that make it highly favorable for spatial planning, due to its morphological and morphometric features and low vulnerability to risks. The study area also has significant agricultural potential, due to the predominance of the agricultural land, which is the basis for economic support.

The processes associated with geomorphological risk have been identified in small areas within the Guruslău Depression, so that they do not have a significant impact on spatial planning interventions. The soil erosion is the most widespread process, being identified in all the component territorial-administrative units. However, the assessment of the spatial distribution of the annual soil erosion rate, performed by implementing the USLE model in GIS environment, shows that about 92% of the total area has low values, which represents an important element of favorability for specific interventions.

The S.W.O.T. analysis revealed the strengths of the Guruslău Depression, including: favorable position within the North-West development region, the presence of the connecting axis associated to the Someș river, low susceptibility to processes associated with geomorphological risk, relief morphology favorable to spatial planning, the presence of an important urban center from the county of Sălaj, traditional agriculture etc. In addition, the study area is part of the Samus Porolissum Local Action Group, which represents an important advantage in terms of attracting European funds.

The implementation of land use planning in the agricultural domain in the study area has favorable conditions from the perspective of the advantageous structure of the land use categories, materialized by the predominance of the agricultural land. The extension of these types of interventions is facilitated by the presence of fertile soils and the morphological attributes of the

analyzed system, materialized by the extension of the Someș meadow and terraces on appreciable sectors.

In conclusion, the Guruslău depression corridor is characterized by numerous specific elements, both natural and anthropic, which outline the premises for sustainable development, under the conditions of optimal exploitation of existing opportunities.

Selected Bibliography

Antrop, M., (2018), *A Brief History of Landscape Research,* The Routledge Companion to Landscape Studies, edited by P. Howard, I. Thompson, E. Waterton, & M. Atha, (2nd ed., pp. 1-15), London, UK: Routledge, DOI: https://doi.org/10.4324/9781315195063, eBook ISBN9781315195063, pp.650;

Bătucă, D., Duma, Didi, Ichim, I., Rădoane, M., (1989), *Morfologia şi dinamica albiilor de râu,* Editura Tehnică, București;

Benedek, J., (2004), *Amenajarea teritoriului şi dezvoltarea regională,* Ed. Presa Universitară Clujeană, Cluj-Napoca;

Bilaşco, Șt., Roşca, S.-M., Păcurar, I., Moldovan, N., Boţ, A., Negrușier, C., Sestras, P., Bondrea, M., Naș, S., (2016), *Identification of Land Suitability for Agricultural Use by Applying Morphometric and Risk Parameters Based on GIS Spatial Analysis*, Notulae Botanicae Horti Agrobotanici Cluj-Napoca 44, 302–312. doi:10.15835/nbha44110289;

Cocean, P., Filip, S., (2011), *Geografia regională a României (ediția a II-a)*, Ed. Presa Universitară Clujeană, Cluj-Napoca;

Hosu, Maria, (2009), *Valea Someșului între Dej și Țicău,* Ed. Presa Universitară Clujeană, Cluj-Napoca;

Irimuș, I.-A., (1997), *Cartografiere geomorfologică*, Ed. Focul Viu, Cluj-Napoca;

Irimuş, I.-A. (1997a), *Modele de organizare a spaţiului geographic în perimetrul judeţului Cluj,* în vol. „Referate şi comunicări de Geografie", Deva, vol. IV, p. 97-103;

Irimuş, I.-A., (2002), *Riscuri geomorfice în regiunea de contact interjudeţean din nord - vestul României*; Rev. Riscuri şi catastrofe, Editor Sorocovschi, V., Editura Casa Cărţii de Stiinţă Cluj Napoca, ISBN 973-686-296-8, p.77 – 90;

Irimuș, I.-A., (2003), *Geografia fizică a României,* Ed. Casa Cărții de Știință, Cluj-Napoca;

Irimuș, I.-A., Vescan, I., Man, T., (2005), *Tehnici de cartografiere geomorfologică, monitoring și analiză GIS,* Edit. Casa Cărții de Știință, Cluj-Napoca;

Irimuș, I.-A., (2006), *Vulnerabilitate şi riscuri asociate proceselor geomorfologice în planningul teritorial*, Rev. Riscuri și catastrofe, Anul V, nr.3/2006, p.21-33, ISSN 1584-5273, Editura Cărţii de Ştiinţă, Cluj-Napoca;

Irimuș, I.-A., Roșca, S.-M., Rus, M., I., Marian, F., L., Bilașco, Șt., (2017), *Landslide susceptibility assessment in Almas basin by Means of the Frecquency Rate and GIS Techniques.* Geographia Technica, Vol.12, Issue 2, pp.97-109/2017. Doi: 1021163/GT_2017.122.09. Accession Number: WOS: 000419795100009;

Koirala, P., Thakuri, S., Joshi, S., Chauhan, R., (2019), *Estimation of Soil Erosion in Nepal Using a RUSLE Modeling and Geospatial Tool.* Geosciences, 2019, 9, 147. https://doi.org/10.3390/geosciences9040147;

Mac, I., (1982), *Analiza unui sistem geomorfologic din Valea Someșului în vederea amenajărilor teritoriale,* B.S.G.G. din R.S. România, VI (LXXVI);

Mitran, M., (2008), *Legislația amenajării teritoriului în România în secolul al XX-lea,* Teză de doctorat, Cluj-Napoca;

Moțoc, M., Munteanu, S., Băloiu, V., Stănescu, P., Mihai, Gh., (1975), *Eroziunea solului și metode de combatere,* Editura Ceres, București;

Naveh, Z., Lieberman, A., (1994*), Landscape ecology. Theory and application* (2nd ed), Springer, New York, Berlin, Heidelberg;

Orghidan, N., (1969), *Văile transversale din România. Studiu geomorfologic,* Editura Academiei București;

Posea, G., Grigore, M., Popescu, N., Ielenicz, M., (1970), *Geomorfologie generală*, Editura Didactică și Pedagogică, București;

Renard, K., G., Foster, G., R. Weesies, G., A., McCool, D., K., Yoder, D., C., (1997), *Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE),* U.S. Department of Agriculture, Agriculture Handbook No. 703;

Roșca, S.-M., (2015), *Bazinul Nirajului: studiu de geomorfologie aplicată,* Editura Risoprint, Cluj-Napoca;

Roșca S.-M., Bilașco, Șt, Petrea, D., Vescan, I., Fodorean, I., Filip, S., (2015*). Application of landslide hazard scenarios at annual scale in the Niraj River basin (Transylvania Depression, Romania),* Natural Hazard 77(3):1573-1592;

Rudraiah, M., Govindaiah, S., Vittala, S. S., (2008), *Morphometry using remote sensing and GIS techniques in the sub-basins of Kagna river basin, Gulburga district, Karnataka, India*, Journal of the Indian Society of Remote Sensing 36, 351–360; doi:10.1007/s12524-008-0035-x;

Rus, M., (2015), *Bazinul Almașului. Studiu de geomorfologie aplicată*, Editura Risoprint, Cluj-Napoca;

Rus, M., Irimuș, I.-A., Ilieș, M., (2015), *Land use in the Hydrographical Basin Almaș,* Romanian Review of Regional Studies, Nr. 1/2015, Cluj-Napoca;

Savu, Al., (1963), *Podișul Someșan: studiu geomorfologic,* Teză de doctorat, Universitatea Babeș-Bolyai, Facultatea de Științe Naturale – Geografie, Cluj-Napoca;

Soni, S., (2017), *Assessment of morphometric characteristics of Chakrar watershed in Madhya Pradesh India using geospatial technique.* Applied Water Science 7, 2089–2102. doi:10.1007/s13201-016-0395-2;

Thomas, J., Joseph, S., Thrivikramji, K., P., (2018), *Assessment of soil erosion in a tropical mountain river basin of the southern Western Ghats, India using RUSLE and GIS,* Geoscience Frontiers 9, 893-906.. doi:10.1016/j.gsf.2017.05.011;

Wischmeier, W., H., Smith, D., D., (1978), *Predicting rainfall erosion losses - a guide to conservation planning,* U.S. Department of Agriculture, Agriculture Handbook no. 537;

***(1987), *Geografia României III. Carpații Românești și Depresiunea Transilvaniei,* (sub redacția D. Oancea, Valeria Velcea, N. Caloianu, S. Dragomirescu, Gh. Dragu, Elena Mihai, Gh. Niculescu, V. Sencu, I. Velcea), Ed. Academiei Române, București;

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