"BABEȘ-BOLYAI" UNIVERSITY CLUJ-NAPOCA
FACULTY OF GEOGRAPHY
DOCTORAL SCHOOL OF GEOGRAPHY

DOCTORAL THESIS

SUMMARY

SCIENTIFIC COORDINATOR,
Prof. Univ. Dr. IOAN-AUREL IRIMUȘ

DOCTORAL STUDENT,
GEORGE-MIHAI RUS

CLUJ-NAPOCA, 2022

"BABEȘ-BOLYAI" UNIVERSITY CLUJ-NAPOCA
FACULTY OF GEOGRAPHY
DOCTORAL SCHOOL OF GEOGRAPHY

DOCTORAL THESIS

IARA HYDROGRAPHIC BASIN.

APPLIED GEOMORPHOLOGY STUDY

SUMMARY

SCIENTIFIC COORDINATOR,
Prof. Univ. Dr. IOAN-AUREL IRIMUȘ

DOCTORAL STUDENT,
GEORGE-MIHAI RUS

CLUJ-NAPOCA, 2022

CONTENT

INTRODUCTION

The present work studies of applied geomorphology, with the Iara river basin as the subject of analysis. The study aims to develop a spatial planning model of the Iara river basin in relation to the morphological offer of the area, identifying geomorphological factors and geomorphological components of favorability and restrictiveness in the development of the territory belonging to the Iara river basin.

The scientific research aimed to the following objectives: application of applied geomorphology concepts to the integrative study of mass movement processes; soil erosion; tourism infrastructure in the morphodynamic analysis of the Iara watershed; analysis of the role of morphography, morphometry and morphology of the depression space in the implementation of regional development programs; argumentation of the correlation between the morphology of the territory and the development of the settlement network; identification of vulnerable areas in relation to mass movement processes and elaboration of the risk map.

Located in the southern part of Cluj County, at the contact of the Muntele Mare massif with the Iara Depression, the Iara hydrographic basin is a well individualized geographical unit, little explored scientifically from the point of view of a complex and complete geomorphological study. It has a high geomorphological and tourism potential, which is currently little exploited, with a few exceptions (e.g. the resort of Muntele Băișorii, the Buscat tourist complex).

The analysed territory reveals a complex geographical landscape, the defining component being the fluvial axis of the river Iara, which becomes the main genetic promoter of the functionality of the mountain and depressional space.

The Iara river basin overlaps the territory of three administrative-territorial units, namely the communes of Băișoara, Iara and Valea Ierii. Our research aims to make a geomorphological radiography of the Iara morpho-hydrographic basin and to design a viable development model for 2030-2050.

Based on these considerations, we delimit the following areas in the study area: (1) areas susceptible to geomorphological processes that associate risk and (2) areas in which there are no geomorphological processes that induce vulnerability to the socio-economic systems and associate risk.

The main underground resources of the region (e.g. dacite, silver, lead, quartz sands, skarn, etc.) played a major role in the economic development of two of the three surrounding

T.A.U.s, namely Băișoara and Iara, until 1996. Thus, while until 1996 there were several mining sites in the Iara river basin, there is currently only one industrial dacite quarry in the commune of Băișoara, which is used as raw material for the construction and rehabilitation of the road infrastructure (roads and motorways).

Soil resources have been a determining factor in the economic development of Valea Ierii, along with forestry resources. Thus, if in the past, Valea Ierii was an important point on the map of logging and processing of wood products through the local sawmills, today the locality is increasingly famous through tourism and agrotourism practiced here, being called by some authors as the "*Switzerland of the Apuseni*".

Given the above, our aim in this paper is to carry out an "X-ray" of the morphodynamics of the Iara river basin, in order to identify the areas susceptible to geomorphological processes associated with risk (mass movement processes - landslides, soil collapses; gullying, soil erosion, etc.), and subsequently to identify and implement a set of measures to prevent and stop the effects of these destructive geomorphological processes.

Achieving the proposed objectives was a major scientific challenge, and the arguments can be found in the five chapters: methodological arguments of the study, palaeogeographical evolution of the region and the controlling factors of landform modelling, morphology and morphodynamics of the Iara hydrographic basin, land use in the Iara basin, rehabilitation measures of the degraded lands in the Iara hydrographic basin.

The theme of the paper covers the complex problems of the region, focusing on the natural offer of the territory (mining resources, agricultural resources, tourism resources, human resources) and how to manage them (associating risks) in a mountainous morpho-hydrographic basin, with old mining traditions, nowadays in a state of pronounced rhexistency, and the analysis allowed us to offer a set of measures to mitigate their effects and the economic recovery of the localities, by shifting from mining to an economy based on activities specific to the tourism sector.

We are convinced that an applied geomorphology study is more necessary than a separate analysis of each component, but this also involves several risks that we have taken a priori.

The scientific research is based on consistent cartographic material (geomorphological maps, thematic maps, cartodiagrams and orthophotos, profiles), together with graphs, tables and bibliographical references, all supporting the complexity of the study in the mountainous and depressional "Apusean" area, respectively in the Iara hydrographic basin.

I want to thank Prof. PhD Ioan-Aurel Irimuș for his support in the elaboration of this study of applied geomorphology, which was materialized by numerous and pertinent scientific and methodological observations that proved essential for the good preparation of the work and also for the generous amount of time given to clarify delicate issues. I also thank the professors of the doctoral supervision committee, namely Prof. PhD Dănuț Petrea, Prof. PhD Adina-Eliza Croitoru, Associate Prof. PhD Ioan Rus. I would also like to thank Associate Prof. PhD Cristian Nicolae Boțan, Lecturer PhD Viorel Gligor and Prof. PhD Nicolae Ciangă for the useful advice and materials provided for the study, as well as Prof. PhD Nicolae Ciangă, Associate Prof. PhD Nicolae Boțan, Lecturer PhD Viorel Gligor and Prof. PhD Nicolae Ciangă for the helpful advice and materials provided for the study, also lecturers PhD Horvath Csaba and PhD Fonogea Silviu-Florin for their support in the cartographic material. Special thanks to PhD Horea Cacovean for his support (numerous field trips together, many advice and the pedological analyses). I would also like to thank the people who work in the Local Councils of the communes in the study area, the Cluj County Council, the people from OSPA (Office of Soils and Anti-erosion Protection), and the Cluj County Directorate of Statistics. Last but not least, I would like to thank my family, who has provided me with an understanding environment for my scientific work, encouraged me to overcome the difficulties inherent in any research and to whom I owe a great deal for the completion of this PhD thesis.

Keywords: Iara Hydrographic Basin, doctoral thesis, applied geomorphology study, geomorphological processes, landslides, Iara river, territorial development, tourism.

CHAPTER I.
METHODOLOGICAL ARGUMENTS OF THE STUDY

I.1. The motivation for choosing the theme

Located in the southern part of Cluj County, at the contact of the Muntele Mare massif with the Iara Depression, the hydrographic basin of the Iara River has a high geomorphological and tourist potential, but unfortunately it is little and improperly exploited.

The relief is a support for the territorial development, thus the numerous areas with tourism potential in the Iara river basin, such as: the Surduc gorge (mixed protected area), Bondureasa reservoir (protected landscape area), Șoimului valley and Ierii valley (protected areas for hunting, of natural origin), water mills - currently inactive or the tourist resort of Muntele Băișorii, together with the Buscat tourist complex (locations for winter sports) of anthropic origin, have begun to provoke our interest. Thus, the desire to research the hydrographic basin of the Iara river emerged - an initiative suggested, supported and encouraged by my PhD thesis coordinator.

Even if the study area has modest territorial dimensions, it is complex from a geological and geomorphological perspective and fully justifies a detailed profile analysis.

The present study aims to analyse the geomorphological potential of the Iara River basin and to identify rural development and spatial planning opportunities for local human communities, with a view to the ephemeralization of the rural economy through the development of tourism-related activities.

Assuming a research theme that focuses on identifying land degradation processes in the river basin and understanding the influence of these processes on land use and spatial planning can bring significant scientific contributions in the field of applied geomorphology and spatial planning based on the sustainable and regional development paradigm.

The design of optimal solutions, valid at least for the 2030-2050 time horizon, for better exploitation of the natural and man-made resources present in the area, has been correlated with the current situation (2015-2022).

I.2. The boundaries of the river basin and the spatial relations with the neighbouring units

The Iara river basin is located in the central-eastern part of the Muntele Mare massif and the Iara Depression, functioning as a sub-basin of the Arieș river, located in the central-southern part of the Apuseni Mountains. From an administrative point of view, the Iara river

basin overlaps with the territory administered by the communes of Băișoara, Iara and Valea Ierii, located in the south of the county of Cluj.

We note that the residences of the three administrative-territorial units of the Iara river basin, namely Valea Ierii, Băișoara and Iara, are located along the Iara river, on the meadows, terraces and adjacent slopes.

The Iara River has a number of nine tributaries, of which right tributaries are Șoimu, Valea Calului, Caprei Stream, Agriș and left tributaries Măruț, Huza, Săvulești, Ierța, Almășeni.

The Iara River is the most developed river axis in the catchment area, seconded by the Ierța River valley, a river axis that is the access area of the Muntele Băișorii village, the homonymous resort and the Buscat tourist complex, via the county road DJ107 R.

The soil and subsoil resources of the Iara river basin have played a significant role over time in the localities' economic development and the flow of materials between the area in question and the neighbouring areas.

It is well known that the Iara catchment area was the site of numerous mining operations until 2006, where many people worked. The resulting raw material was supplied to the neighbouring areas and subsequently used in various industries. For example, the quartz sands mined at Făgetu Ierii were transported to Turda to produce glass.

In conclusion, we can state that, within the Iara river basin, numerous intra-regional as well as inter-regional (between the analysed region and those in the immediate vicinity) interrelationships take place.

I.3. Research history of the Iara river basin

The Apuseni Mountains have been the subject of numerous scientific studies by specialists in various fields (e.g. geomorphologists, pedologists, geologists, ethnographers, sociologists, historians, etc.).

It is well known that the Apuseni Mountains are divided into several mountain units (e.g. Bihor Mountains, Gilău-Muntele Mare Mountains, Trascăului Mountains, Metaliferi Mountains, Zarandului Mountains, Codru Moma Mountains, Meseș Mountains) and depressions (e.g. Iara, Beiuș, Vad-Borod, Brad, Zarandului, Almaș-Agrij, etc.).), but many specialized studies have treated the mountain unit as a whole, with the divisions of each sub-unit, but at the same time there have also been studies that have treated some units individually (e.g. volcanic relief in the north-east of the Metaliferi Mountains, Trascău Mountains - geological study, etc.).

An important aspect is the lack of specialist works dealing separately with the Iara catchment area, this area is included only in more extensive territorial studies. Thus, among the most representative works, which have had the Apuseni Mountains as their object of study, the following stand out:

1) Treaty on the Geography of Romania (vol. III - Romanian Carpathians and Transylvanian Depression)[1], 2) Mureșan, I.[2], 3) Mititean, R., Kadar, A.[3], 4) The Relief Units of Romania, II. Apuseni Mountains and Transylvanian Plateau [4], 5) Constantin, Veronica[5], 6) Moldovan, S. C.,[6] 15) Minodora Susana Luca[7] ș.a.m.d.

I.4. The aim of the research

The proposed study is an applied geomorphology study of the Iara watershed. The research aims at outlining a territorial model for the development of the Iara watershed in relation to the morphological offer of the area, identifying the geomorphological factors and geomorphological components of favorability and restrictiveness in the development of the depressional space.

I.5. Research methodology

The working methodology used in elaborating this scientific approach was based on several stages: bibliographic documentation stage, field stage, systematization stage, interpretation and analysis of the data taken from the field and from bibliographic sources and writing stage.

---

[1]Oancea, D., Velcea, Valeria (coordonatori) &colab., (1987), *Geografia României, Carpații Românești și Depresiunea Transilvaniei* , Edit. Academiei Republicii Socialiste România, pag.453-458.
[2]Mureșan, I. (1980), *Geologia și petrografia bordurii de nord-est a Munților Gilău*, Edit. Republicii Socialiste România, București, pag.63.
[3]Mititean, R., Kadar, A., (1996), *Zona turistică Băișoara și Masivul Muntele Mare. Ghid turistic*, Edit. Fundației Soros Pentri o Societate Deschisă, România.

[4]Badea, L., Buza, M., Niculescu, Gh., Sandu, Maria, Schreiber, W., Șerban, Mihaela, Kadar, A. (2006), *Unitățile de relief ale României II. Munții Apuseni și Podișul Transilvaniei*, Edit. Ars Docendi, București, pag. 28, 29, 160, 162, 163.
[5]Constantin, Veronica, (2011*), Așezările din arealele miniere din Munții Apuseni. Studiu de geografie aplicată,* Teză de doctorat, Universitatea Babeș-Bolyai Cluj-Napoca, Facultatea de Geografie, pag. 3, 4, 168, 174.
[6]Moldovan, S.C., (2014), *Depresiunea Iara-Hășdate. Studiu de planning teritorial*, Teză de doctorat, Universitatea Babeș-Bolyai Cluj-Napoca, Facultatea de Geografie, pag.29.
[7]Luca, Minodora-Susana (2015), *Băișoara. Locul sufletului nostru*, Edit. Casa Cărții de Știință, Cluj-Napoca, pag. 15, 41, 43, 44, 45.

CHAPTER II. PALAEOGEOGRAPHIC EVOLUTION AND CONTROLLING FACTORS OF LANDFORM MODELLING

II.1. Geology and paleogeographic evolution

The analysis of the paleogeographic evolution of the Iara river basin allows tracing over time the evolution of landforms, the changes and modifications. The nature of the geological formations has had an impact on the economic activities and influences the economy of the territory

Based on the above, we have analysed in detail the prominent geological landmarks of the Apuseni Mountains, both at a general level and those specific to the Gilău-Muntele Mare massif and the Iara Depression (part of the Transylvanian Depression).

II.2 Physico-geographical factors modelling the present relief

II.2.1. Geomorphological factor

Situated in the contact zone between the Gilău-Muntele Mare Massif and the Transylvanian Depression, the Iara river basin corresponds, from a geomorphological point of view to complex areas, in which the specific attributes of mountainous areas composed of metamorphic rocks and magmatic rocks are combined with those dominated by the sedimentary petrographic component, characteristic to the depressional areas. This results in a great diversity of landscapes imposed by the relief.

II.2.1.1. Structural relief

Of the whole range of possible landforms that can exist as a result of the action of external agents on the various types of geological structures (horizontal, sloping, undulating, folded, faulted, etc.), those associated with folded structures clearly predominate in the area analysed, accompanied by those specific to monoclinal and faulted structures.

II.2.1.2. Petrographic relief

Of the whole pleiad of landforms associated with the various types of rock, the area under analysis is characterised by the presence of those developed on granites (in the magmatic category), crystalline schists (in the metamorphic category) and clays, sandstones and conglomerates (in the sedimentary category).

II.2.1.3. Fluvial relief

As in most temperate climate regions, the main shaping agent in the Iara catchment is water, its shaping capacity being determined by the amount of precipitation, the composition of the substratum and the configuration of the relief.

II.2.1.4. Anthropic relief

Complex human economic activity has generated a plethora of anthropogenic landforms, which requires the identification, description and analysis of such geomorphological processes and the study of landforms generated by the human activity.

The geomorphological processes (activities by which man directly shapes the earth's crust) in the Iara river basin include rerouting of watercourses; damming of valleys; construction of settling ponds; laying out and construction of roads; exploitation of useful minerals and rocks; development of land for agriculture and other activities; construction of civil and industrial buildings, etc.

II.2.2. Climatic factor

The catchment area of the Iara River fits, from a climatic perspective, into the pattern of mountainous depressional areas positioned east of a mountain unit, east of the Gilău and Muntele Mare mountain massifs. As such, the climate is generally temperate with obvious foehnization influences due to the warm adiabatic winds that descend the slopes of the mountain massifs. In the depressional valley floor, there is also a sheltering phenomenon, with thermal inversions at certain times, which are evident in the landscape through vegetation inversions.

II.2.3 Hydrological factor

The Iara River is the defining functional axis of the Iara River basin. Along the riverbed and on its terraces are located the residences of the three administrative-territorial units of the area under investigation, namely Valea Ierii, Băișoara and Iara.

The hydrographic network of the Iara river basin is tributary to the Mures river basin (1st order basin), with the Arieș river as collector.

II.2.4. Biotic factor

The biotic component (represented by vegetation and fauna) has a major influence in the manifestation of some geographic processes and phenomena, not so much through its diversity, but especially through the consistency and extent of the vegetation cover. The lack of vegetation cover can amplify the occurrence of processes and phenomena with a higher degree of risk (e.g. floods, landslides, washouts), as this cover acts as a buffer in terms of the intensity of these phenomena and processes.

The floristic elements and plant associations existing in the perimeter of the Iara river basin require that this territory (as part of the Apuseni mountain group) be placed within the parameters of the Central European phytogeographic region, i.e. in the Apuseni Mountains subprovince.

II.2.5. Pedological factor

Soil cover is an essential territorial component, both in terms of the favours or restrictions it imposes on a community's existential approaches and from the perspective of applied geomorphological scientific analysis.

Thus, in terms of the weighting of the territory under analysis, the cambisols, which account for 53% of the total surface area of the region, stand out for their characteristics and their regional specificity. They are followed by spodisols, which account for 23% of the region's area, then luvisols (15%), antrisols (7%), cernisols and hydrisols (each with an insignificant 1% of the region's area).

IV.2.6. Anthropogenic factor

Man, as an active factor in the modification of the natural environment and, implicitly, of geographical landscapes, has left his mark on the mountainous and depressed areas of the Iara river basin, with varying degrees of intensity, depending on the social-historical and economic conditions that have given this area its own pace of anthropisation, with effects that have been felt differently over time.

CHAPTER III.
MORPHOLOGY AND MORPHODYNAMICS OF THE IARA HYDROGRAPHIC BASIN

III.1. Morphography of the Iara river basin

The Iara basin overlaps the central-eastern side of the Muntele Mare Massif, the south-eastern end of the Gilău Mountains and the Iara depression. Other units (partially) included in the study area are: the Hășdate Ridge, the Agris Hill, the Ocoliș-Poșaga Depression and the Vlaha-Hășdate Depression.

The V-shaped valley profile demonstrates the youth of these tributaries of the Iara River, which is economically exploited, considering that in the upstream area, i.e. on the Valea Șoimului and Valea Calului respectively, there are underground intakes that lead water to the Someșul Mic (at Tarnița) reservoirs, where the water is used for hydropower purposes.

The morphographic relationships between the sloping surfaces of the slopes and the interfluvial surfaces influenced the settlement system within the study area. They are located along the valleys (Iara and its tributaries) as well as in the depression area. This typology of settlements is specific to the Muntele Mare Massif, where most settlements are located on the periphery of the massif or are grafted along the valleys.

III.2 Iara basin morphometry

The catchment of the Iara River has a complex geographical landscape. The study area presents multiple morphogenetic steps, namely: meadows, terraces and contact glacises, valley shoulders, Feneș-Deva levelling surface, Măguri-Mărișel levelling surface and the levelled mountain slopes and ridges.

III.2.1 Hypsometry

It should be noted that in the catchment area of the Iara river there is an altimetric difference of 1 301 m (fig.40), the maximum altitude being recorded in the Buscat peak (1 676 m), and the minimum altitude being recorded in the Iara river meadow (375 m).

III.2.2 Geodeclivity

The geological component of the Iara river basin and the geomorphological-hydrological processes surrounding the contact area between the Gilău-Muntele Mare mountain area and the Transylvanian depression have determined the specificity of the relief, in terms of the slope of the land surfaces. Thus, the geodeclivity of the slopes in the catchment

area of the Iara river corresponds to five steps, between 0°-2°, the lower step, and 35.1°-51.1°, the upper step.

The lowest geodeclivity values characterize the central sector of the Iara Depression, corresponding to the main riverbed of the Iara river, while the slopes with geodeclivity higher than 35.1° are present in the western part of the Iara catchment area, corresponding to the Gilău and Muntele Mare Massifs, composed of both magmatic rocks (andesite, pegmatite) and metamorphic rocks (mica schist and paragnaise).

III.2.3. Horizontal and vertical fragmentation

Horizontal and vertical fragmentation is an important parameter, revealing the constitution of the substratum and its susceptibility to erosion.

III.2.4. Aspect

In the Iara River basin, the south-east and north-facing slopes predominate. This last aspect (north-facing slopes) has been exploited from a tourist point of view, through the creation of ski areas in the tourist resort of Muntele Băișorii and the Buscat tourist complex. It is well known that it is advisable that the ski slopes have a northern orientation, thus extending the duration of the snow cover and the period of winter sports (skiing, sledging, etc.), and from this aspect the ski slopes in the surveyed territory fall within this parameter

III.3. Land degradation processes and associated risks

Land degradation processes and associated risks

The catchment area of the Iara River, overlapping the central part of the Muntele Mare Massif and the Iara Depression, is geomorphologically marked by morphodynamics, reflected in the dynamics of contemporary processes (e.g. landslides, cave-ins, collapses, gullies, soil erosion, etc.).

Landslide processes are either natural or anthropogenically induced. It is well known that the Iara catchment has been the site of numerous mining sites, which are now closed. The only centre still operating is the one in Băișoara, where industrial dacite (raw material used in road and motorway construction) is mined.

All these mining sites have had several negative effects as well as economic benefits for the region.

The areas affected by geomorphological processes are spread over several points in the Iara river basin, particularly in the perimeter of the Iara depression and the Agris hill, i.e. the area above the homonymous municipality. This is understandable, as the substratum of the area is mainly composed of clays (lower Eocene clays).

III.3.1. Surface erosion

The Iara catchment is marked by an accelerated intensity of erosion at the surface, mainly through weathering processes, as well as depth erosion through gullying. The lithological component of the Iara Depression, mainly composed of lower Eocene clays mixed with quartz sands, favours the initiation of surface scouring processes (pluviodenundation and erosion) in the absence of compact, protective vegetation and also climate change.

From the point of view of this indicator (soil erosion rate), several areas can be distinguished at the level of the analysed territory, falling within different value ranges, namely:

a) areas where the soil erosion rate reveals low values (0.0-5 t/ha/year), hold a share of 56% of the surface area of the analysed catchment.

b) areas where the soil erosion rate shows average values (5.1-10 t/ha/year), account for 38% of the total area of the territory analysed.

c) areas with high soil erosion rates (10.1-82.4 t/ha/year) account for only 6% of the total area of the territory analysed.

The main factors behind the triggering of landslides are: the substrate/geological composition of the Iara Depression (predominantly Eocene lower striped clays), lack of vegetation, overgrazing, periods of excessive rainfall, etc.

III.3.2 Erosion in depth

In the catchment of the Iara River, deep erosion is manifested through simple and complex gullies.

Ravines occur in the perimeter of the Iara depression and at the contact of the Iara depression with neighbouring units (in the Agris Hill, where they still occur). Simple and compound ravines occur within the torrential bodies developed in the upper area of the Iara catchment, in perimeters where deforestation has taken place (e.g. Valea Ierii administrative-territorial unit).

III.3.3. Mass movements

It is manifested through a diverse range of geomorphological processes and phenomena belonging to this category, i.e. collapses, landslides, sinkholes, subsidence, agradations of riverbeds and meadows, etc.

III.3.3.1. Collapses

Within the Iara catchment occur mainly in the depressional area, being detectable at the level of steep banks and steep slopes, especially in the sector of transition from the mountain crystalline area to the Paleogene, depressional deposits.

III.3.3.2. Landslides

The main geomorphological process affecting the study area are landslides. They occur throughout the analyzed territory, the areas most strongly affected by such geomorphological manifestations being located within the Iara depression, in the administrative-territorial units of Băișoara and Iara.

The main triggering causes of this geomorphological process are both natural and anthropogenic. As mentioned above, the mining activity carried out until 2006 in many parts of the Iara river basin has influenced the contemporary geomorphological processes.

III.3.3.3. Soil subsidence and compaction

Soil subsidence and compaction occur in areas where the geological constitution and anthropogenic activities have favoured the development of the present geomorphological processes, namely in the Iara depression area.

III.3.4. Aggradation of meadows and river beds

Within the Iara river basin, the aggradation of riverbeds and riverbeds occurred mainly in the lower part of the Iara river, in locations where sediment transport was higher.

III.3.5. isks associated with geomorphological processes

Geomorphological processes in the Iara river basin present a number of associated risks, including: displacement of various agricultural lands, change of land use, degradation of road infrastructure, damage to the water table, degradation of household annexes, landscape changes, etc.

CHAPTER IV.
LAND USE IN THE IARA HYDROGRAPHIC BASIN

The study conducted in the Iara River Basin contributed to identifying land use types according to the presence of geomorphological and technological processes in the post-industrial phase (1996-2016).

IV.1. Structure of the land fund

The focus of the study required an interdisciplinary approach, so we proposed to assess the main landforms in the Iara catchment and then to calculate the spatial distribution of land use. For GIS evaluation, we used various methods, such as bibliographic, cartographic, direct field observation, photogrammetric, statistical and mathematical methods. The cartographic material produced using ESRI ArcGis ArcMap 10.8, Global Mapper and QGis 3 allowed the identification of land use types and major landforms in the Iara basin.

IV.2. Types of agricultural land use

The Iara depression represents the perimeter of the territory used for various agricultural land uses, while the rest of the land is almost entirely mountainous and is occupied by forests, meadows, hay meadows, etc.

IV.3. Land affected by industrial activities

The tailings ponds resulting from mining activities in various areas of the Iara river basin (e.g. Iara, Băișoara, Făgetu Ierii, Mașca, Cacova Ierii.), represent the geographical areas affected by anthropogenic activities, especially industrial ones, namely the exploitation of quartz sands, iron ore, granite, limestone and various other construction rocks.

These sites require greening and can be returned to the tourist circuit by developing related facilities.

IV.4. Land affected by erosion processes

Within the catchment of the Iara river, many lands are affected by erosional processes. The main types of erosion occurring in the perimeter of the area under investigation are: surface erosion (gullies), depth erosion (gullies), rain erosion, landslides, fluvial erosion and thermal fragmentation.

IV.5. Land returned to economic use for other purposes

This category of land includes former lands occupied by various subsoil resource developments. At present, most have been abandoned, but there are some exceptions. A good example is the quartz sand exploitation in Făgetu Ierii, where in recent years, following the

cessation of exploitation, the land has been covered by a carpet of vegetation and a large part of the land is now grazed by animals (sheep in particular), with negative effects in terms of soil erosion.

The current Buscat ski area was until 2008 occupied by forest vegetation, and after 2008 it was used for tourism. It should be noted that, unlike the ski area in the tourist resort of Muntele Băișorii (built during the communist period with state funds), Buscat is a private investment.

CHAPTER V.
REHABILITATION MEASURES FOR DEGRADED LAND IN THE IARA RIVER BASIN

V.1. Naturalistic solution - removal of causes

Contemporary geomorphological processes have negatively influenced many lands within the Iara river basin, especially within the Iara and Băișoara territorial units.

First, we mention that the geomorphological processes in the investigated area had both natural and anthropogenic causes. Regarding the geomorphological processes generated by natural causes (lithological substrate - lower Eocene striped clays) - here it is impossible to intervene on the bedrock, but it is possible to avoid activities that could intensify the geomorphological process (e.g. animal grazing). With regard to geomorphological processes caused by anthropogenic causes, laws/amendments can be issued to prohibit economic activities in the affected areas and also to restrict the extension of the urban area of localities in order to avoid risk situations, such as, for example, the issuing of building permits, or to maintain the safety and integrity of the inhabitants.

It is also necessary to afforest land affected by geomorphological processes, pine being recommended.

V.2. Technical solution - removing the effect through engineering works

In this chapter, we come up with a series of engineering proposals to remove the adverse effects on degraded lands caused by various economic activities (mining in particular).

The mining activity, exploiting the subsoil and soil resources of the Iara river basin, has resulted in numerous tailings ponds. The tailings ponds in the Iara river basin are in a state of conservation, but there is a need for greening.

The resulting tailings ponds represent a danger of contamination and pollution of the environment (through tailings). As a result, several lands have been removed from their original use and their use has been changed (from productive land to abandoned land in most cases). The best solution is therefore to green them and then include them in tourist circuits. Recently, former mining sites, which are classified as 'badlands', have been increasingly visited for tourism purposes. A similar example can be found in Upper Silesia, where former mining sites have been included in tourist circuits.

V.3. Resilience of the Iara river basin

V.3.1. Territorial diagnosis of mining activity. Other social aspects (unemployment)

Within the Iara River basin, mining was one of the main areas of economic activity until 1996, when most underground resource exploitation sites ceased their activities. At present, there is still one industrial dacite quarry operating in Băișoara.

Regarding the studied area's economic activities, a transition from industrial activities (extraction and processing of minerals) to tourism and agriculture can be observed.

V.3.2. Proposals for the development of the territory through the development of tourism

The Iara river basin holds the tourism resources (natural and man-made) necessary for tourism development.

The hydrographic basin of the Iara River has a complex geographical landscape, which includes mountainous areas (Gilău-Muntele Mare Massif), the Iara Depression, gorge areas (Buru gorge, another narrowing sector being on the upper course of the Iara River, between Băișoara and Valea Ierii). The valley of the Iara river (in the mountain sector), together with the valleys of the Iara tributaries in the mountain area, is also spectacular, as the valleys are very deep and V-shaped. In the upper part of the Iara valley the slopes are wooded, which is another tourist attraction element.

The tourist potential of the mountain area has been exploited through the creation of ski areas in Muntele Băișorii and Buscat, both located within the municipality of Băișoara. Also, the number of tourist accommodation units (especially guesthouses) and restaurants has increased, given the constantly growing tourist demand.

CONCLUSIONS

Through the work entitled "Iara Hydrographic Basin. Applied Geomorphology Study", we proposed, through the structuring of the study in five chapters, with related sub-chapters (considered to be the most suggestive) to achieve more reliable and accurate radiography of the main geomorphological processes that occur in the researched area (ex. Thus, after the history of previous research on the hydrographic basin of the Iara river and extrapolated on the Apuseni Mountains, we made a presentation of the researched area (both from a physical-geographical and tourist point of view). Having identified the main geomorphological processes (using both modern and classical techniques), we succeeded in identifying them, and then followed the necessary step of carrying out the geoturistic prospecting and designing the ideas for land use planning. Thus, we consider that during the PhD years we have tried to make a study of applied geomorphology as useful and current as possible within the limits of our possibilities. We would like to mention that, after the public defence of the PhD thesis, the research process of the Iara river basin will continue and will be improved. In the study we paid more attention to landslides, and they require a longer monitoring period in order to observe their evolution over time. Thus, the previous claim of postdoctoral continuation of the present applied geomorphology study is reinforced.

We hope that the present work will be useful in terms of spatial planning policies and, of course, will be a support for the local authorities of the three municipalities that overlap with the researched area (Băișoara, Iara and Valea Ierii). The work is also helpful in terms of the soil and subsoil resources of the Iara river basin. Thus, given the current situation, when only one other exploitation is operating in the area under investigation (at Băișoara - industrial dacite exploitation), it is possible to consider the reopening of old subsoil resources (skarn, stone, quartz sands), depending, of course, on market requirements, which fluctuate very frequently. This would be a significant advantage, given that the Iara depression was a renowned mining area prior to 1996. It should be noted that the necessary infrastructure for mining exists but needs to be repaired and upgraded to align with current European standards.

Preparing a PhD thesis in applied geomorphology involves the analysis of an extensive list of bibliographical works of different natures (including related fields).

Thus, during the three years of my PhD, I have gone through a series of bibliographical works from the literature, following the following aspects: general scientific works in the field of geomorphology (including applied geomorphology), theoretical works of a methodological

nature, works focused totally or partially on the territory under analysis and practical works in the field of territorial planning (including tourism). Therefore, this chapter has been essential for the good drafting and, subsequently, for the techno-writing of this PhD thesis.

It should be noted that among the titles found in the bibliography there are topical works of importance also in spatial planning policy, i.e. works on protection measures for areas affected by geomorphological processes. Thus, we hope that the present work will be useful in terms of the control of geomorphological processes (through protection measures), and in terms of spatial planning policies and tourism development. The present study will also be improved and continued over the years, depending on the evolution of the geomorphological processes mapped and evaluated. As a result of the present study, we hope that the local authorities of the three municipalities in the catchment area of the Iara River Basin will take advantage of the development projects and will exploit the tourism potential (natural and man-made) and the potential of the young population as much as possible.

SELECTIVE BIBLIOGRAPHY

1. Almăşan, B. (1984), *Exploatarea zăcămintelor minerale din România*, vol. I-II, Edit. Tehnică, Bucureşti.
2. Anton, A., Cosma, I., Popa, V., Voișanu, Gh. (*Ghid turistic al Județului Cluj*, Edit. pentru turism, Cluj-Napoca
3. Arghiuș, V. (2008), *Studiul viiturilor de pe cursurile de apă din estul Munților Apuseni și riscurile asociate*, Edit. Casa Cărții de Știință, Cluj-Napoca,
4. Badea, L., Buza, M., Niculescu, Gh., Sandu Maria, Schreiber, W., Şerban, Mihaela, Kadar, A. (2006), *Unităţile de relief ale României II. Munţii Apuseni şi Depresiunea Transilvaniei*, Edit. Ars Docendi, Bucureşti.
5. Băcăuan, V., Donisă, I., Hârjoabă, I. (1974), *Dicționar geomorfologic cu termeni corespondenți în limbile: franceză, germane, engleză și rusă,* Edit. Științifică, București.
6. Băloiu, V. (1980), *Amenajarea bazinelor hidrografice și a cursurilor de apă,* Edit. Ceres, București.
7. Bătinaș, R. H. (2006), *Studiul calității apelor de suprafață din bazinul Arieșului,* Teză de doctorat, Univ. Babeș-Bolyai, Facultatea de Geografie, Cluj-Napoca.
8. Benedek, J. (2004), *Amenajarea teritoriului și dezvoltarea regională*, Edit. Presa Universitară Clujeană, Cluj-Napoca.
9. Bilașco, Șt. (2008), *Implementarea GIS în modelarea viiturilor de versant*, Edit. Casa Cărții de Știință, Cluj-Napoca
10. Bilașco, Șt, Csaba, H. (2006), *Cartografierea digitală a benzilor de inundabilitate pe baze statisticii, a calculelor hidraulice și a analizei spațiale Gis*, Edit. Casa Cărții de Știință, Cluj-Napoca.
11. Boțan, C. N. (2008), *Țara Moților. Studiu de geografie regională,* Edit. Casa Cărții de Știință, Cluj-Napoca.
12. Cocean, P.(1992), *Modele de amenajare turistică a unor regiuni muntoase din România*, Studia UBB, 1-2, Cluj-Napoca.
13. Cocean, P., Mititeanu, C., Pleşa, C., Schreiber, W. (1992), *Masivul Gilău-Muntele Mare. Hartă turistică,* Edit. Focul Viu, Cluj-Napoca.
14. Coteț, P. (1971), *Geomorfologie cu elemente de geologie,* Edit. Didactică și Pedagogică, București.
15. Croitoru Adina-Eliza, (2006), *Excesul de precipitații în Depresiunea Transilvaniei*, Edit. Casa Cărții de Știință, Cluj-Napoca

16. Dezsi, Șt., Cocean, P. (2009), *Geografia Turismului*, Edit. Presa Universitară Clujeană.
17. Drăgan, Magdalena (2011), *Reziliența sistemului regional Munții Apuseni*, Teză de doctorat, Facultatea de Geografie, Universitatea Babeș-Bolyai,Cluj-Napoca
18. Drăguț, L.(2000), *Geografia peisajului*, Edit. Presa Universitară Clujeană, Cluj-Napoca.
19. Gherțoiu, D.M, Boțan, C.N. (2014), *Bazele geografice ale turismului de nișă*, Edit. Risoprint, Cluj-Napoca.
20. Grecu, Florina (1985), *Clasificări și tipuri de alunecări de teren din Depresiunea Transilvaniei,*Terra, anul XVII (XXXVII), NR.2, București.
21. Grecu, Florina, Palmentola, G. (2003), *Geomorfologie dinamică,* Edit. Tehnică, București.
22. Grecu, Florina (2009), *Hazarde și riscuri naturale*, Edit.Universitară, București.
23. Horvath Cs. (2008), *Studiul lacurilor de acumulare din bazinul superior al Crisului Repede*, Edit. Casa Cărții de Știință , Cluj-Napoca
24. Ielenicz, M. (2007), *Geografie fizică. Climă, ape, vegetație, soluri, mediu*, volumul 2, Edit. Universitară, București.
25. Ioniță, I. (2000), *Geomorfologie aplicată.Procese de degradare a regiunilor deluroase*. Edit. Universității Alexandru Ioan Cuza,Iași.
26. Irimuș, I.A. (1997), *Cartografiere geomorfologică*, Edit. Focul Viu, Cluj-Napoca.
27. Irimuş, A. (2003*), Geografia fizică a României*, Edit. Casa Cărţii de Ştiinţă, Cluj Napoca.
28. Irimuș, I.A, Vescan, I., Man,T. (2005), *Tehnici de cartografiere, monitoring si analiza GIS*. Edit. Casa Cărţii de Ştiinţă, Cluj-Napoca.
29. Irimuș, I.A, (2010*), Relieful - potențial și valorificare turistică*, Edit. Risoprint,Cluj-Napoca.
30. Josan, N. (2014), *Antropizarea reliefului. Geomorfologie antropică,* Edit. Universității din Oradea, Oradea.
31. Josan, N., Petrea, Rodica, Petrea, D. (1996), *Geomorfologie generală,* Edit. Universității din Oradea, Oradea.
32. Mac, I. (2000), *Geografie generală,* Edit. Europontic, Cluj-Napoca.
33. .Mihăilescu, V. (1963) *Carpații Sud-Estici*, Edit. Științifică, București.
34. Moldovan, S.C., (2014), *Depresiunea Iara-Hășdate. Studiu de planning teritorial*, Teză de doctorat, Universitatea Babeș-Bolyai Cluj-Napoca, Facultatea de Geografie
35. Petrea, D. (1998), Pragurile de substanță, energie și informație în sistemele geomorfologice, Edit.Universității din Oradea, Oradea.
36. Petrea, Rodica, Petrea, D., *Turism rural* (2000), Edit.Presa Universitară Clujeană, Cluj-Napoca.

37. Pop, Gr. P. (2007), *Județul Cluj*, Edit. Academiei Române, București.
38. Posea, Gr. (2002), *Geomorfologia României,* Edit. Fundației România de mâine, București
39. Posea, Gr. (2006), *Geografia Fizică a României*, partea a II –a, *Clima, apele, solurile, biogeografia, hazardele naturale,* Edit. Fundației România De Maâine, București.
40. Posea, Gr. (2012), *Relieful. Resursa de bază a turismului. Geomorfodiversitate și geomorfosituri*, Edit. Fundației România de mâine, București.
41. Rădoane, Maria, Rădoane, N. (2006), *Geomorfologie aplicată*, Edit. Universității din Suceava.
42. Rădoane, N. (2002), *Geomorfologia bazinelor hidorografice mici*, Edit. Universității din Suceava.
43. Roșca, Sanda (2015), *Bazinul Nirajului. Studiu de geomorfologie aplicată.* Edit.Risoprint, Cluj-Napoca
44. Roșian, Gh., (2011), *Modele de geomorfologie funcțională ale sistemului vale-versant din Deprsiunea Transilvaniei,* Edit. Presa Universitară Clujeană, Cluj-Napoca
45. Rus, G.M, I.A.Irimuș, Roșca, Sanda(2018) *The Susceptibility of the Iara Depression to Contemporary Geomorphological Processes,* în Riscuri și Catastrofe, nr. XVII, vol. 23, nr. 2, pp. 79-88, http://riscurisicatastrofe.reviste.ubbcluj.ro/..
46. Rus, G.M., Irimuș, I.A., Horvath, C., Roșian, Gh. (2021), *Land Degradation in the Iara Hydrographic Basin*, în Revista Riscuri și Catastrofe, vol.29,nr. 2/2021, pp.121-132
47. Strahler, N.A. (1973), *Geografie fizică*, Edit. Științifică, București.
48. Tufescu, V. (1966). *Modelarea naturală a reliefului și eroziunea accelerată,* Edit. Academiei, București.
49. Turcu, Mioara (2002), *Noțiuni fundamentale în studiul hazardelor naturale*, Edit. Presa Universitară Clujeană, Cluj-Napoca.
50. Zotic, V. (2005), *Componentele operaționale ale organizării spațiului geografic,* Edit. Presa Universitară Clujeană, Cluj-Napoca.
51. ***(1987), *Geografia României, III. Carpații românești și Depresiunea Transilvaniei,* Edit. Academiei, Bucureşti.
52. *** Harta geologică a R.S.R., 1:1 000 0000, Institutul de Geologie și Geofizică, București.

Hărti topografice (scara 1:25 000) cu următorul nomenclator:

L-34-59-B-a (Valea Ierii)

L-34-59-B-b (Lita)

L-34-59-B-c (Muntele Băișorii)

L-34-59-B-d (Băișoara)

L-34-59-C-a (Balomireasa)

L-34-59-C-b (Muntele Mare)

L-34-59-D-b (Ocoliș)

L-36-60-A-c (Iara)

Web resources:

Luca, E., Livia Naghiu, M. Chintoanu, Cecilia Roman, Laura Luca (2007), *The sources of pollution in the Iara Basin*, Revista journals.usamvcluj.ro, nr.3-4 (63-64) /2007, accesat la 12.02.2018

World Ecological Facets Landform Classes (2016) http://www.arcgis.com/home/item.html?id=cd817a746aa7437cbd72a6d39cdb4559 Accesat la 26.05.2017

Landforms I: Hammond (2016) http://gis4geomorphology.com/hammond-landforms/ Accesat la 26.05.2017

EU-DEM dataset adapted or modified (re-projected) by the author *"Produced using Copernicus data and information funded by the European Union - EU-DEM layers.*" CORINE Land Cover http://land.copernicus.eu/pan-european/corine-land-cover /Accesat la 26.05.2017

Corine Land Cover For Europe (1990-2006) https://www.arcgis.com/home/item.html?id=b5cbf63906584ef2ac5d29d627faf923 Accesat la 31.05.2017

http://www.insse.ro/cms/, Accesat la 25.05.2017

Strategia de dezoltare locală a comunei Valea Ierii, accesat la 20.10.2016

Strategia de dezvoltare locală a cumunei Iara 2014-2020, accesat la 21.10.2016

http://www.e-primarii.ro/primaria-valeaierii/info_generale.php., accesat la 11.03.2016

Strategia de dezvoltare locală a comunei Iara 2019-2027, accesat la 05,01,2020

http://buscat.ro/despre/, accesat la 25.11.2018

https://ideipentruvacanta.ro/mocanita-din-valea-ariesului-si-a-reluat-traseul-turistic-prin-muntii-apuseni/, accesat la 21.11.2018