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# Implications of Relief Configuration in the Socioeconomic System. The Case of Mara Basin, Maramureş Land, Romania

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## ABSTRACT

Mara Basin in the Maramureş Land, a natural space for water management, is engrafted on a complex relief structure, presenting specific features and landforms that are morphologically conditioned by structure and tectonics. Being bordered in the west and south by the edges of an imposing residual volcanic relief, constituted by the Igriş-Gutâi and Văratec Mountains, the relief structure emphasizes a double petrographic zoning, with strong asymmetric markers as against the rest of Maramureş Land's physical characteristics. The drainage is ensured by the Mara and Cosău rivers, vectors of energy and matter in the territorial system. Over centuries, their primary denudation function has been doubled by the implementation of a rural habitation network, organized into a socioeconomic matrix (agro-pastoral), with multiple secular and archetypal elements. The current study highlights the bearings and influences of relief's physical characteristics upon the socioeconomic development of the communities in Mara Basin by assuming a scientific approach that integrates elements of geospatial analysis performed at a scale of 1:50.000, with an accent on the essential physical characteristics, stressing the favourable and restrictive aspects of the territory with an impact upon the socioeconomic development.

## 1. INTRODUCTION

Mara River, covering an area of over 400 km<sup>2</sup>, is a water course that belongs to the category of northern rivers, having a western Carpathian drainage pattern. It drains the west of Maramureş Land almost entirely (fig. 1), a region situated in the north of the country and identified, functionally speaking, as a peripheral region. The complex and composite petrographic relief structure, tectonically conditioned presents, at an interface level, the conspicuous markers of an intense human influence, resulted through the perpetuation of secular economic activities. Compared with the rest of Maramureş Land, the relief's asymmetry in the Mara Basin, along with various independent habitat characteristics, come as a statement that justify a distinct geographical approach over the implications

of relief's characteristics in the socioeconomic matrix of the area. One has to keep in mind that, at an interface (landscape) level, the unique and specific social and economic traits of a territory reflect its internal organization and functional capacity, traits that are influenced by the physical bearings of a territory [1]. The intensity of the human intervention is also reflected by the local community's level of perception over the bearings of physical elements of geographic space [2], entitling a geospatial analytical approach that can highlight the influences played by the physical characteristics of Mara Basin upon the socioeconomic development of its communities. Of course, the presence of specific indicating traits encompassed in the peripheral status of the analyzed area, features common for the entire region of Maramureş, furthermore blend its specific habitat profile.



Fig. 1. Relative location of the area under study – Mara Basin.

The scientific approach over the relief's influences in the evolution and development of a territory it is not by far a tiding breakthrough. The study over relief's representative aspects and their impact in the human development are paramount in the geographic science, constituting the very bottom of geographic reasoning. The quantitative tendency in the analysis of the influences played by relief's characteristics have included, among others, iterations over classical research encompassing the role of relief as a support for human development [3], analyses with contributions to spatial planning [4], the integrated management of water catchments [5] or in highlighting the susceptibility of human communities to geomorphic / hydrologic hazardous phenomena [6].

In direct or indirect relation with the territory of Mara Basin, its physical characteristics were also studied in the middle of 2000, from a point of view that reflect its influences over the functional properties of the territory, in a series of scientific works common in the field of Regional Geography, performed at an appropriate scale over the land type functional entities – Maramureș, Oaș, Lăpuș [1], [7], [8]. Aspects regarding the improvement of peripheral effects over the entire Land of Maramureș (extending over the entire old medieval voivodship of Maramureș, now a separate entity situated in two countries), have been studied in scientific works emphasizing the amendments in the functional properties of cross-border regions [9].

The working hypotheses assert that the relief's morphologic and morphometric characteristics reflect themselves in the structure and dynamic of rural settlements, the quality of the territory being influenced by the intensity of exchange relations between physical and anthropogenic elements, with respect to flow of matter, energy and information in the territorial system. Moreover, it is asserted that the rural communities display a certain level of awareness over

the geographical space that reflects their dependency to local natural resources and the correlated limits imposed by relief into the economic activities, details emphasized by land use profiles expressed on landscape units of 500 by 500 m. The study also follows the morphologic and socioeconomic intra basin asymmetry characteristics, accented by the commune of Ocna Șugătag, the expression of alteration in the Mara Basin, a settlement engrafted on a discordant morphologic unit – The Ocna Șugătag Anticline.

### 1.1. Territory and geographical peripherality – structural features with applicability in Mara Basin

Peripheral regions distinguish through a number of linked features that cast an impact upon its economic development [10]. The following traits have a strong applicability in the area under investigation: *susceptibility* under the impact of globalization and economic reorganization, with clear demographic indicators related to the abatement of social capital due to the emigration phenomena of work force in western countries and demographical ageing; *the loss of intellectual capital* through the migration of “brains” in areas with attributes of centrality, is another important element acutely experienced in the research area. The loss of basic social services in health and education for example, or even administration (emigration backlash) and the need for detrimental assistance in those areas from the part of settlements with a status of urban growth poles (Sighetu Marmăției, Baia Mare in the case of Mara Basin), further deepen the effects; *dependency* over local natural resources, intensified by the community's level of spatial economic awareness describe the leading agro-pastoral economic profile; *limitation* in developing local incentives, feature that triggers an influx of energy, products and services in the area; *the pronounced interventionist role* of the central government and regional financial institutions.

Demographically speaking, Mara Basin, same as almost the rest of Maramureș Land (Maramureș, as a region, has small to medium sized urban settlements), presents a social structure comprising a strong rural habitation network, a common feature for all peripheral areas. However, the rural settlements in the Mara Basin are medium sized, with a density of 74 inhabitants/km<sup>2</sup>, on the contrary to the accepted statements that peripheral regions have low population densities [11]. According to the 2002 demographic census, the 15 inner basin communities accommodate just over 30.000 inhabitants.

At the same time, through its agro-pastoral economy, Mara Basin is the area that concentrates the maximum of architectural elements that are representative for the Maramureș wooden architectural style, preserving aesthetic attributes with a high level of



Mara and Gutâi - Văratec Piedmonts, superficially fragmented by small river channels that flow over the diluvial deposits containing andesitic blocks. The Oligocene grounded sedimentary stratigraphy in the depression sector presents a monocline structure, with a general eastern inclination. The monocline structure is highlighted especially in the eastern part of the basin, on the Cosău Valley, next to the villages of Călinești and Cornești, where the river has a strong subsequent character emphasized by sandstone steep. The Neogene depression stratigraphy bears two important stratigraphic markers. The volcanic tuffs and the Badenian salts are highlighted solely in an atypical landform for the entire Mara Basin. The Ocna Șugătag Anticline, a diapiric dome the shape of a parallelogram, presents itself as a discordant landform in the area.

**3.2. Relief's favourability and restrictiveness for anthropogenic activities in Mara Basin**

For Mara Basin, the relief has a general N-N-E orientation, a characteristic determinable through the observation of the river network set out. The general western atmospheric flow over the area, discharges important amount of rainfall in the west of Igniș Mountains [1]. The western air masses, descending over the basin and influenced by a decreasing rainfall gradient, have lead to the occurrence of the Foehn effect.

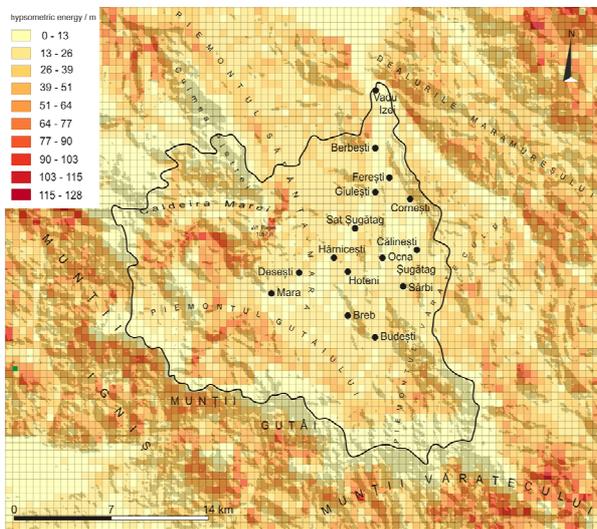


Fig. 3. Relief energy index for Mara Basin expressed on land units of 500 by 500 m.

Analyzing two important morphometric indicators (relief energy index and relief roughness index – fig. 3 and fig. 4), the Mara Basin relief subscribes to a mature and denudational relief, which, from a geomorphological point of view, is close to its equilibrium phase in terms of systemic geography. The landforms represent degraded and residual geological physical structures. The relief energy index registers maximum values only in the gorges of rivers Mara and

Runc, were the rivers “penetrated deep into the Neogene eruptive” [8, pp. 64] and in the threshold sector of the Igniș Plateau, with up to 130 m amplitude. The compact depression sector registers reduced relief energy, with amplitudes up to 50 m.

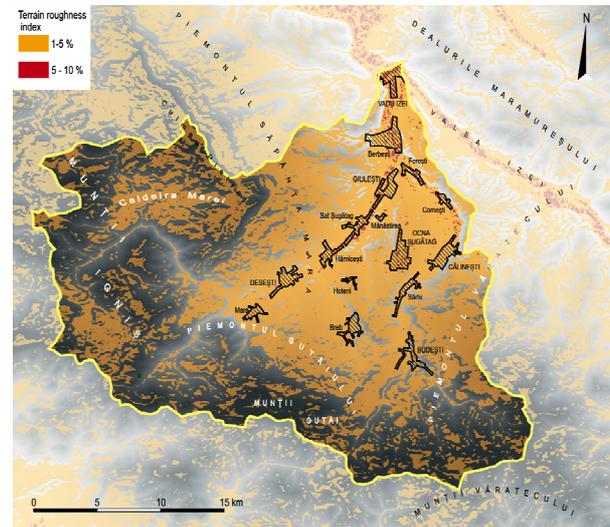


Fig. 4. The expression of relief's roughness index in Mara Basin

Looking at the index for relief roughness, over 70% of the basins topography falls in the 10% roughness class. The mentioned topographic gradient covers almost the entire depression sector, being favourable for the development of Luvic and Cambic soils, suited for agricultural take over. Due to moderate fertility, the local communities practice the rotation of agricultural crops.

**3.3. Hydrographical network as a flow convergence factor in the territory**

The relief characteristics play a vital role in the hydric flow type [16]. The hydrographical network, individualized at the end of Pliocene – beginning of Pleistocene, directs the flow of energy, matter and information in the territorial system through the valleys of the two main rivers: Mara and its main tributary, Cosău River, denudation and structuring axes for Mara Basin. The upstream sector of the rivers is the Neogene mountain belt and continues their drainage over sedimentary deposits on a trajectory with no major morphological discontinuities, especially in the petrographic alternation zones. The low stream gradient enforces the topographic roughness index. The general direction of flow is influenced by the regional base level of the Tisa River, the main collector in the area and Maramureș Land's main structural axis. Tectonics subdued the direction of river channels. In the upper mountainous sector, river Mara and its tributary Runc, present a channelling with 90 degrees turns, revealing a tectonic engraftment. The entire hydrographical network flows from within the basin, a

situation met for example in the Land of Oaş, with no river in transit [1]. The entire amount of water in the system comes from the atmospheric environment, suggesting the direction of runoff. The superficial stream alimentation is made up to 60% of rain and snow fall, 40% coming from infiltrated subterranean sources. The superficial flow sums up to approx. 28 million m<sup>3</sup>/year. Corroborated with a sediment transport of just 9.5 m<sup>3</sup>/year [8], a value registered for the Mara River, have made this water course attractive for hydro power plant construction. On short time perspective, projects for 6 hydro micro power plants are designated on this river and some of its tributaries, projects that, if approved and built, could induce dysfunctions in the local ecosystems.

The dam on the Runc River, a project still to be completed, will allow the transfer of important water quantities into the Someş water catchment. Even now, through a water pipe system, ap. 1 m<sup>3</sup>/s flow of water is transferred into the Firiza Lake, the main fresh water source for the Baia Mare municipality.

### 3.4. Hydrographical network's favourability and restrictiveness for anthropogenic activities in Mara Basin

In the development process of every region, supplying energy and fresh water is of vital importance. The lack of fossil fuels in the entire Maramureş Land, have determined the communities to capitalize the rivers hydro energetic potential, along the exploitation of rich forestry resources in satisfying their energetic needs. One of the most common forms of water energy capitalization is represented by the peasantry technical installations, used for processing textiles, agricultural products, moulding wood or washing up gold gravel [17]. In the study area, 14 water mills functioned up the middle '60s, 8 on river Mara at Deseşti, Sat Şugatag and Giuleşti, with another 6 on tributary Cosău in the Călineşti and Budeşti villages [16].

The hydrographical network has sustained specific anthropogenic activities, the profile of peasantry technical installation being self-evident.

### 3.5. The impact of relief and water network on the structure of rural settlements

The Mara Basin settlements are exclusively situated inside the depression, with no settlement penetrating the mountainous sector. The geographic position of the Mara Basin rural settlement network mirrors a dependency connection, especially toward water resources. The inexistence of major morphological discontinuities in the way of hydrologic flow have supported the build-up and development of a settlement network positioned in dodged placed, safe from flash floods, silting processes or changes in the

river bed. Upstream settlements have capitalized the low topographic index, such that settlements like Budeşti, Mara and Deseşti, extend on the piedmont stage. Breb village for instance, is situated exclusively on the Gutâi Piedmont. The road network superimposes the hydrographical network, having as a road junction the village of Fereşti, the most important convergence and distribution point for the inner and outer anthropogenic flows in the basin. The road network provides a north to south connection with the main urban growth poles of Baia Mare and Sighetu Marmăţiei through DN 18, DJ 109 F and DJ 186 B main roads, transiting the southern orographic barrier of Gutâi Mountains on the Gutâi (987 m) and Neteda (1054 m) passes, flanking the mountain on west and east respectively.

Table 1. Structural details of Mara Basin settlement network.

Settlement	Landform	Medium altitude (m)	Altitude range (m)	Structure
<i>Mara Valley</i>				
Mara	Gutâi Piedmont Mara river terraces and flood plain	483	66	dendritic
Deseşti	Mara Piedmont Mara river terraces and flood plain	466	141	dendritic
Hărnicieşti	Mara Piedmont Mara river terraces and flood plain	426	140	dendritic
Sat Şugatag	Mara Piedmont Mara river terraces and flood plain	395	99	dendritic
Giuleşti	Mara river terraces and flood plain	341	39	linear
Berbeşti	Mara Piedmont Mara river terraces	315	48	dendritic
Vadu Izei	Mara and Iza rivers terraces and flood plain	290	21	dendritic
<i>Cosău Valley</i>				
Fereşti	Ocna Şugatag anticline Cosău river terraces	327	40	linear
Corneşti	Cosău river terraces	349	25	linear
Călineşti	Cosău river terraces and flood plain	407	67	rectangular
Sârbi	Cosău river terraces and flood plain	476	70	linear
Budeşti	Gutâi Piedmont Văratec Piedmont Cosău river terraces	585	139	dendritic
Ocna Şugatag	Ocna Şugatag anticline	481	52	rectangular
Breb	Gutâi Piedmont	538	91	dendritic

The 15 rural settlements present a structure adapted to the topographic characteristics (Table 1), prevailing the ones with a dendritic structure. The lane textures are drawn in the upper river bed, beginning

with the second river terrace, at an average altitude of 420 m, following the same pattern as the rest of Maramureș settlements situated on the main river corridors and not exceeding 500 m in altitude.

Where the topographic index has allowed it, the settlements extend on the piedmont stage, covering amplitude up to 150 m. This feature indicates the appliance of an “unwritten code of laws” in the process of traditional spatial planning that takes into account the restrictive hydrological variables in combination with the overall relief characteristics [8, pp. 74].

The river corridors are susceptible to hydrologic hazards, especially in late spring, when the snow melt down corroborates with increased quantities in rain fall. The river flood plains are only lightly cultivated. The accentuated land fragmentation is another indicator of adaptation to landform conditions. The 1-2 ha parcels are distributed on various types of landforms. Also as a prevention method, we mention the agro-terracing process, started in the 10<sup>th</sup> century, fulfilling a double purpose: preventing slope erosion and increasing the agricultural surface [18].

Also, the Mara and Cosău watersheds correspond to the structure and extension of the former Mara and Cosău valley cnezships. This type of spatial division for administrative purposes is still in use today, the majority of the communes having their territory divided on the limits of sub watersheds [8].

**3.6. Economic activities conditioned by relief**

The agro-pastoral and agro-forestry economic profile emphasized at landscape level reveals the dependency over local resources (forestry, water and soils) and implicitly, the level of perception over space. The average quality of the lowland Cambic and Luvic soils, suited especially for pasturelands, contributes to the outlining of the subsistence economic profile of the area.

An assessment of Mara Basin’s landscape character based on an adaptation of Linton’s landscape evaluation method, expressed on land units, 500 by 500 m, lead to the standardization of 20 landscape classes in accordance with the major supporting landform [2]. The economic profile distinguishes a spatially fragmented and complex pattern, with the depression sector intensively capitalized.

The land use spatial dynamics for the 2001-2010 interval show a general withdraw of forests, in favour of increased agricultural surfaces. Like it was stated above, Mara Basin concentrates the maximum of wooden architectural elements from the entire Maramureș Land.

The case of Ocna Șugătag commune has to be studied as a different situation. The service based economic profile of this settlement implies a different

approach towards resources and their potential. Ocna Șugătag is leading the spa tourism in Maramureș.

As a direct consequence of the peripheral status, in 2009, the migratory flow mobilized approx. 8% of the active population in the phenomena of international migration for work [20].

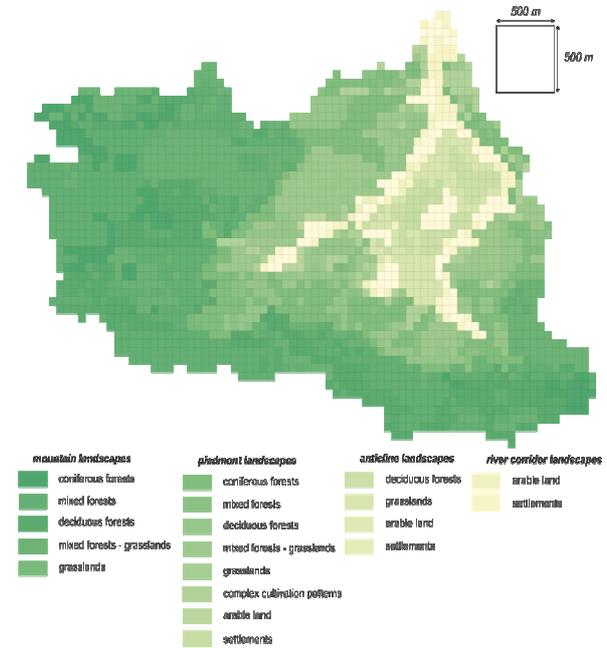


Fig. 5. Types of landscapes in the Mara Basin based on 4 structural elements (geology, landforms, land use and settlements).

Table 2. The dynamics of agricultural surfaces for the year 2010 in the area of Mara Basin (data processed after [8], [19]).

Territorial administrative units	Estimated agricultural surfaces			
	Total administrative units (ha)	Agricultural surfaces (ha) 2010	Agricultural surfaces (ha) 2010	+/- agricultural surfaces (ha)
Desești	14409	6271	6152	-119
Giulești	8280	6995	7421	+426
Vadu Izei	1685	1226	1162	-64
Călinești	6612	4708	4562	-146
Budești	8526	5341	5882	+541
Ocna Șugătag	8520	5757	5878	+121

**3.7. Ocna Șugătag Anticline – the expression of alterity in Mara Basin**

The presence of the diapiric dome attests recent Pleistocene – Holocene tectonic tensions and subscribes as a discordant relief sub unit. The SE-NV transversal Breboia Valley, that flanks the dome on the

south, individualizes the entire anticline. The salt deposits overlay thick Eocene bedrock.

The piedmont proluvial deposits of the Quaternary stratigraphic sequence in the dome's cap layers enforce the above statements. Of utmost importance for the migration of the Cosău Valley are the proluvial deposits surrounding some of the salted lakes surface mine craters that support the hypothesis of a river bed migration toward north-east. The Cosău Valley has, in the sector intersecting the monocline of Călineşti Hills, a strong subsequent character, crossing perpendicularly the Oligocene strata with the river bed erosion reaching the bedrock. In the same sector we signal an intense right back lateral erosion.

The elongated parallelogram shape [21] of the anticline can point out the existence of pressure gradients with a stronger intensity on a N-E direction. The active diapiric activity can be traced indirectly through the observation of topographic relief. The extensional dilatation of cap ductile strata led to the formation of a button shape negative landform on the anticline axis. The northern edge is pierced by the Pârâul Sărat water course that drains the salted lakes into the river Mara.

Despite water scarcity on the top of the anticline, the settlement developed over centuries as an important salt extraction site, institutionalized as a professional and methodical activity in the late 18<sup>th</sup> century. After the collapse of mining activities in the area, due to water infiltration in the mine galleries at the half of the 20<sup>th</sup> century, the settlement transitioned its economy towards a more elaborated salt exploitation, becoming an important centre for spa, adding exponential value to this important natural resource.

The lane texture presents a rectangular model. Ocna Şugătag is the only settlement situated on top of a positive landform in the entire Maramureş Land (the village of Bocicoiel is another exception) with no permanent water course in sight. It is still unclear how the community managed to satisfy the fresh water necessities over centuries, considering the contemporary challenges in supplying fresh water to the village now days, that impose the adduction of water from the Mara and Gutâi Piedmonts, via a kilometres long piping and pumping system. Large amounts of water are consumed during the summer touristic season when the centralized system is often overcome by a high demand. The resort receives over 25.000 tourist a year [22], putting a high pressure on the water supply network.

#### 4. CONCLUSION

The study emphasizes the bearing of relief's characteristics over the Mara Basins social and economic traits. Studying its morphology by taking into account

morphometric and hydrologic indicators, the research was able to indicate the way relief influenced the structure and dynamic of rural communities, and the way the community perceives relief's configuration as a support for their daily activities. The paper reveals also the community's level of dependency to local resources by outlining the spatial characteristics of its landscape interface. The agro-pastoral economic profile highlights signals that appoint a peripheral status to the area.

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