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SPATIAL PLANNING OF MĂRULUI VALLEY BASIN DEPENDING ON RELIEF PARTICULARITIES

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ABSTRACT. – Spatial Planning of Mărului Valley Basin Depending on Relief Particularities. Mărului Valley is a left tributary of Someșul Mic River that crosses the Cluj Hills along about 17 km, creating a drainage basin of 75 km^2. The Mărului stream flows NW-SE and confluences with the collector river in Iclod village. It is an asymmetrical valley of cuesta type (Savu, 1963), carved in Miocene deposits (Ciupagea et al., 1970). The morphology of the hillside-valley system bears the imprint of Pleistocene periglacial modelling, on which the post-glacial Holocene shaping is creeping over. The physiognomy of the five settlements in the study area attests the adjustment of their functions to the relief specificity. Being peripherally located towards the convergence axis Cluj-Dej, the study area presents a raised obscurity from the development point of view (PATR, 2004). With the purpose to remove the relative isolation to which the mentioned localities belong, this research aims at creating a model of territorial planning focused on the relief particularities, being able at the same time to answer some of the most important residents' current necessities, such as access to communication networks and quality services (social, medical, economic, leisure), coupled with high well-being standards.

Keywords: *spatial planning, landslides, soil erosion, geomorphological risk, agriculture.*

1. INTRODUCTION

The left hillside arrangement of the Someșul Mic Valley between Cluj-Napoca and Dej was largely made up before 1990. The Cluj Land Development Agency provided toward consultation 15 projects of execution. In this way it was found out that some basins, such as Mărului Valley, Orman Valley, Băița Valley, Buneşti Valley have not benefited yet of territorial systematization works, unlike the neighbouring river basins. The existing projects focused mainly on

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soil erosion works, drainage and flood prevention. The probable reason for which these basins have never been arranged before is that, in comparison with other left tributaries of Someşul Mic, the frequency of the recent and contemporary geomorphological processes of the hillside-valley system is lower. Although the number of inhabitants of the five localities along Mărului Valley has known a continuous downtrend, an adequate spatial planning is undoubtedly necessary at least for two reasons, both related to Romania's European Union membership. The first reason aims at bringing all administrative-territorial units, including the villages, at a minimum community level of service provision. The second one derives from the union policy concerning the long-term development of the rural areas in Romania through predominantly agricultural activities, guided and supported by qualified entities such as the Agency for Payments and Intervention in Agriculture (APIA). The land management control factors are multiple, but the main factor that guides the purpose of the spatial planning remains the relief itself. Considering this fact, we intended through this research to answer a series of questions, as follows: Does the relief have an active role in the territorial shaping of the commune? Is the geomorphological risk a factor to take into consideration when constructing new buildings? Should the dwellers, the local authorities and the possible investors pay attention to it?

The framework of the present paper is divided into three parts. In the first section the methodology and the data collection are presented. Next, in the second part, a brief physical-geographical characterization of the study area is highlighted, while the last part emphasizes the results and discussions, plus the conclusions of the research.

2. METHODS AND DATA

The data collection consisted of fieldwork in all five villages that took place during April and May 2016 through which observations and groundwater level measurements in 31 different wells of Aluniș commune were performed. In addition, a semi-structured interview was conducted with the Mayor of the commune, Mr. Mihai Sav. Furthermore, a part of the data was obtained from the Cluj Land Development Agency, Transylvania North Regional Meteorological Centre (climate data), and also data published by the National Statistics Institute, specifically demographical data.

The methodology consists of two distinct categories. On the one hand, the geomorphological part includes a physical-geographical analysis of the study area and the creation of the geomorphological risk map, whereas the spatial planning segment contains a demographical reasoning, as well as the land suitability analysis for new buildings, on the other hand. It is relevant to mention that all the maps were created by using GIS software.

The land suitability for new buildings indicator takes into consideration four fundamental factors, as follows: the slope, the hypsometry, the categories of land use and the distance routes towards the communication paths, respectively. The first step was the conversion of the land use categories into raster format. Further, the four raster images subsequently obtained were reclassified in five distinct classes (from 5 - highest favourability to 1 - minimum favourability). In the end, the four raster images were multiplied and thus the land suitability map for new buildings was generated, the obtained results being reclassified into the five standard classes of favourability - unfavourable, less favourable, medium favourable, favourable and very favourable.

The geomorphological risk was calculated by using the formula developed by Bessis (1984, cited by Haidu, 2000, and by Mureșan and Surdeanu, 2004).

$$Risk = Probability \times Consequences$$

$$R = \Sigma 1 \ldots nP \times C$$

where,

R= risk
P= probability
C=consequences

$$P = F/n$$

where,

P=probability
F=frequency of an event
n=total number of events
C=consequences of the event
Po=number of affected population

The risk factors analysed were the landslides and the soil erosion. The occurrence probability of the events with a valence of risk was calculated on a scale from 0 to 1. The probability classes were established as follows:

0 to 0.20 very low probability - Class 1
0.21 to 0.40 low probability - Class 2
0.41 to 0.60 average probability - Class 3
0.61 to 0.80 high probability - Class 4
0,81- 1 very high probability - Class 5

$$C = T \times Po \times S$$

where,

S = affected surface.

The time received two values: T = 1, if it is not important in the evolution of the risk factor and T = 2, if it is important in the evolution of the phenomenon. The population received three values: Po = 1 in uninhabited areas; Po = 2, for areas with sparse population; Po = 3, for permanently inhabited areas. The affected surface received three values: S = 1, when the consequences are felt near the generator factor; S = 2, when the consequences are felt at regional level; S = 3, if the consequences are felt inside and outside the region as well.

The control factors analysed were: the slope, the aspect, the depth of fragmentation, the drainage density, the land use and the soils, all presented in table 1. The control factors were adjusted, obtaining in this way five classes in all the cases. For each class of each factor the specific risk was calculated, the risk of each control factor being obtained by summing up the five values of risk for each class. The total risk was calculated by using *Spatial Analyst Tools->Map Algebra-> Raster Calculator.*

$$R=P\times T\times Po\times S$$

Table 1. Weight of control factors in the calculation of the geomorphological risk

Control factor	Partial risk value	Weight in total risk (%)
Slope	91	17
Aspect	72	13
Depth of fragmentation	120	22
Drainage density	120	22
Land use	80	14
Soils	66	12

3. PHYSICAL-GEOGRAPHICAL CHARACTERIZATION OF THE STUDY AREA

Mărului Valley is a left tributary of Someșul Mic river, flowing NW-SE and meeting the collector river in Iclod, its main tributary being Ghirolt, on the left side. Located in the northern part of the Cluj County, 75% of its area covers the territory of Aluniș commune – composed by five villages, as follows: Aluniş, Corneni, Ghirolt, Pruneni and Vale - while the remaining 25% belong to Iclod commune (see fig. 1). If Iclod commune has a greater development level due to its position onto a European road traffic axis (E60), Aluniș commune requires more attention and a more intensified focus of the specialists.

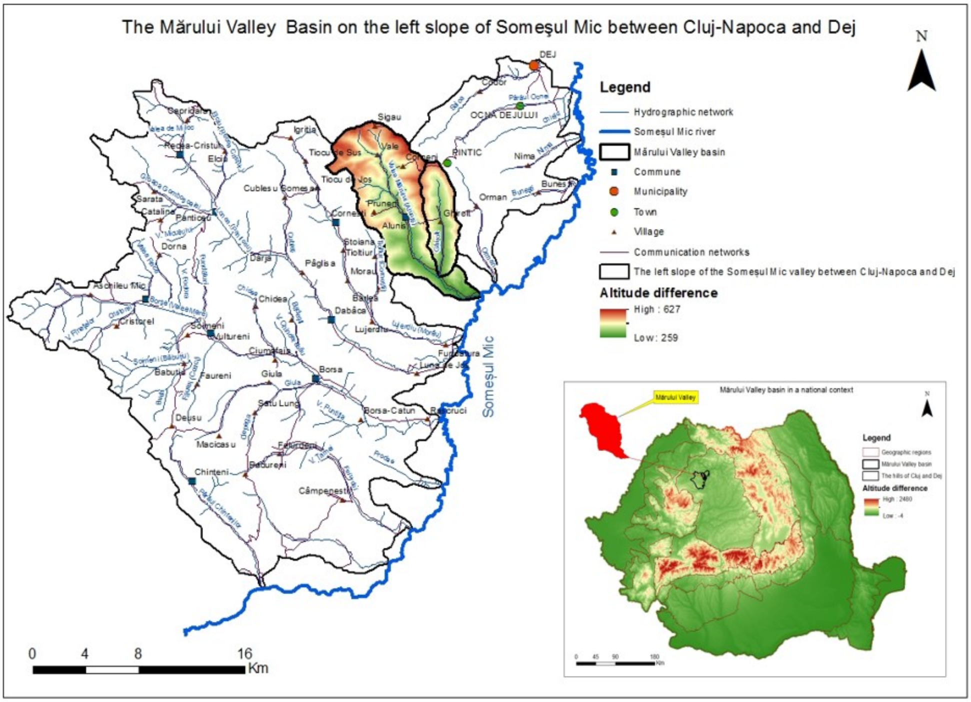


Fig. 1. Mărului Valley - territorial contextualization

3.1. Geological composition

The geological composition of rocks of different roughness and permeability is specific for Cluj and Dej Hills, which fosters the installation of surface erosion, deep erosion and mass movements surface slopes. From the lower Miocene (Burdigalian) is kept the Dej tuff alternating with layers of marl (Ciupagea et al., 1970). In the Middle Miocene are deposited layers of Hida (parts of the 'Helvetian' stage), composed by conglomerate, sandstone and marl clay (Anca Suciu, 2001). The upper Miocene (Tortonian) layers predominate at surface and consist of clay, sandstone coal, marl and shale tuffs – e.g. Iclod tuff (Meszaros, 1991; Falk Isabela, 2007), while Quaternary sands and gravels are found in the bottom third of the Mărului Valley (see fig. 2).

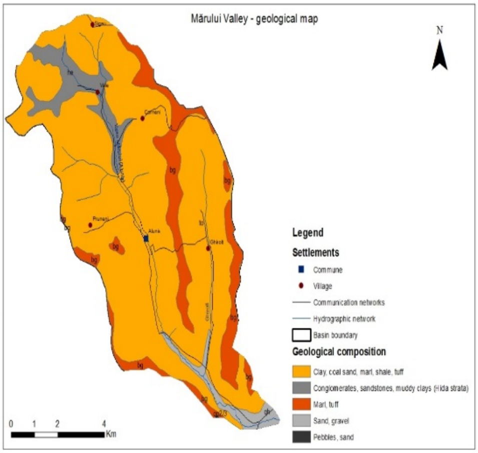


Fig. 2. Mărului Valley – Geological map

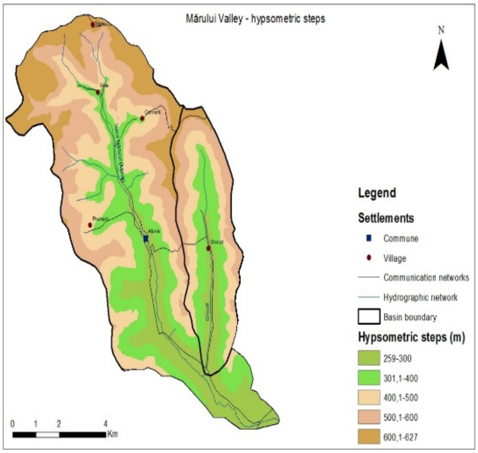


Fig. 3. Mărului Valley – Elevation map

3.2. Morphology

According to Savu (1963), Mărului Valley is a subsequent valley for the most of its part, but also oblique and mixed at the same time. It flows NW-SE, between Măgurița Peak, at 627 meters altitude and the confluence of Mărului Valley with Someșul Mic in Iclod, at 259 meters, there is a difference in altitude of 368 meters (fig. 3). The valley is asymmetric because of the differential erosion of the Mărului stream and its tributary, Ghirolt. The cuesta fronts are placed on Dej tuffs and are oriented S, SW and W, marked into relief by structural steps. On Dej tuffs, portions of the ancient erosion platform of the Someșul Mic river were preserved, arranged on two levels: the lower one, at an altitude between 450-550 m (Mihăilescu, 1963, 1967) - Ghirolt Hill, 496 m, Ciuhat Hill, 507 m, La Poiene Hill, 524 m, and another one higher in elevation, between 550-650 m – Șigău Hill, 603 m, Măgurița Hill, 626 m. The tuff roughness and its position highlight critical slopes between 6-17º and 17-32º, prone to erosion processes and land mass displacement (fig. 4). The obverses of the cuestas were formed on the alternations of inclined/monoclinal Tortonian layers. These hillsides have higher dimensions, but belong to the category of highly susceptible to erosion processes (6-17º).

The average slope of the valley in the longitudinal profile is 21.6 ‰. The slope in the springs sector, from the hydrographic slope to the village of Vale (404 m absolute altitude), is very high, of 74.3 ‰. The 223 meters difference is recorded at just 3 km of valley length, resulting in a remarkable relief energy.

One notices the sharp narrowing of the valley, upstream from Aluniş village, due to the deepening of the stream in toughest Helvetian deposits (particularly sandstones and conglomerates). The valley has an aspect of gorge, upstream from Aluniş village and in many sectors within the villages of Vale, Corneni and Pruneni. The tributaries of Mărului Valley create quite narrow depression basins in the source area. The gorge sectors are characterized by sharp slopes between 17-32º, favouring especially the bank erosion.

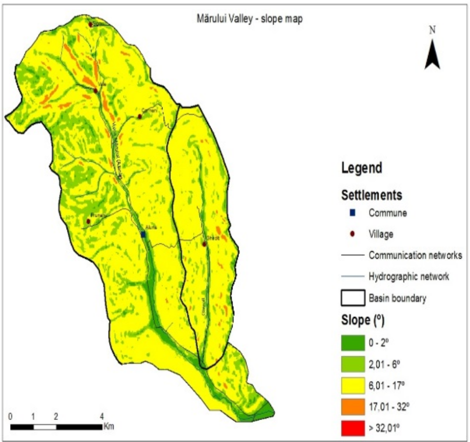


Fig. 4. Mărului Valley – Slopes

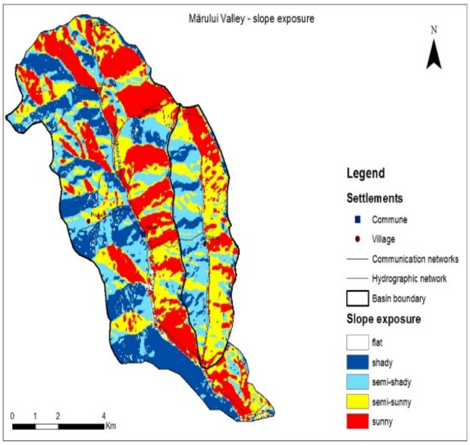


Fig. 5. Mărului Valley – Slope aspect

Towards the entrance to Aluniș from the Vale village, the valley is already widening. Its slope is reduced to 10.3 ‰, the difference in height between the village of Vale and the confluence with Someşul Mic is 145 m, spread along 14 km. Under these conditions, Mărul River does not have the capacity to transport entirely outside the basin the deposits from the slopes, thus the stream creates a wide meander way, where most of the transported materials are deposited. The floodplains and the watersheds are horizontal and quasi-horizontal (0-2º) and favour the seasonal flooding of the land and the alteration crust formation through weathering processes. The glacises link the flatted lands and the sloping lands, having gentle slopes, between 2-6º. There are situations in which the glacises are parasitized by the material originated from alluvial cones torrents or colluvial deposits of landslides (Surdeanu and Goțiu, 2008).

3.3. Hydrology and hydrogeology

As a result of the groundwater level measurement, it was observed that the phreatic waters are close to the surface. The aquifer was intercepted at depths between 1.80-5.40 m. Its position favours the movement of the superficial deposits onto the hillside, in the form of their reestablishment process creep or of their submission in the form of landslides.

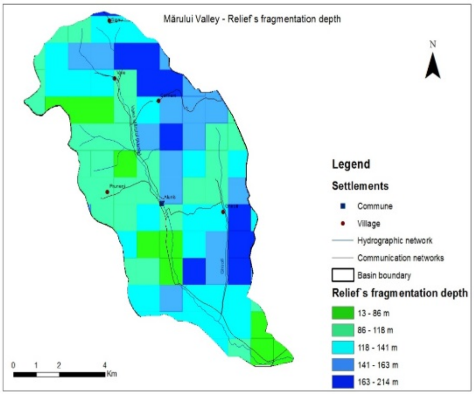


Fig. 6. Mărului Valley - Relief's fragmentation depth

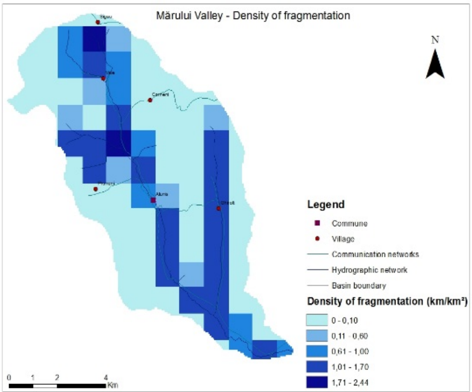


Fig. 7. Mărului Valley – Density of fragmentation

3.4. Climate

The small size of the Mărului Valley Basin, and not its diversity, dictates the uniformity of the weather phenomena in the entire area. The average annual temperature is 8.3º C, with negative temperatures in December, January and February. The average annual rainfall has the value of 566.5 mm. This value matches up the Mărului Basin in the sub-humid areas, where the rainfall exceeds the evapotranspiration only between November and April, and the hydrological regime of the soil is periodically percolative (Dîrja and Budiu, 2006).

According to the results of the *Angot index* calculation, the hillsides susceptibility to erosion and landslides is higher in the rainy months (generally April, June, July, September), while during the other months of the year the probability of triggering the slope processes is lower. The climatic characteristics along with the soil types draw the categories of the land use, given that it is a rural area. If the Mărului Valley fits an overall extensively mixed arrangement profile (PATR Nord-Vest, 2004), the organization details of this territory will be given by the geomorphology.

3.5. Land use

The land use map (see fig. 8) and the fieldwork demonstrated that in the territory of Aluniș commune about half (50%) of the area is covered by agricultural lands, specific to this region of Transylvania. The agriculture is the main occupation of the inhabitants, but the production potential of the agricultural land is not used to its maximum capacity. Currently, the agriculture is practiced only in subsistence or rarely semi-subsistence systems. The main agricultural products encountered in this area are cereals (maize, wheat, barley) and vegetables (potatoes, beans, peas and so on). The fruit growing, the brandy production or even the viticulture are important related agricultural activities, but they are practiced only in reduced/ small systems.

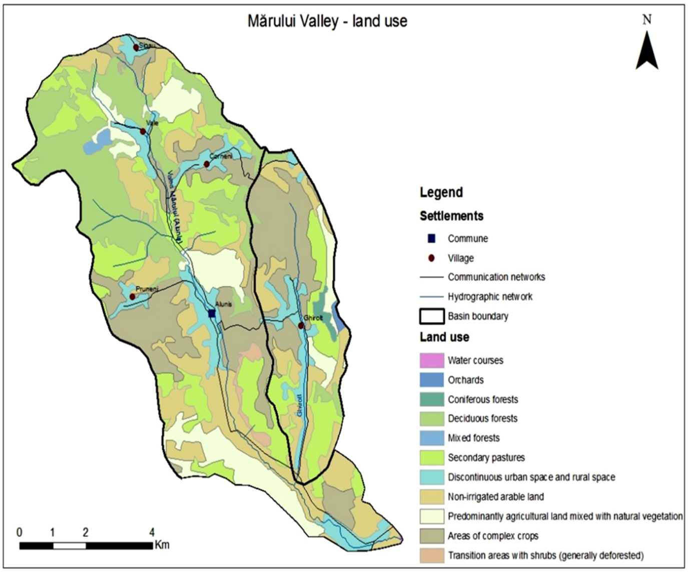


Fig. 8. Mărului Valley – Land use

The river meadow is covered by vegetable gardens and hoeing weeds. The glacises and the first terrace of the meadow are covered by hoeing weed crops, sometimes alternating with cereals and fodder crops (Lucerne/alfalfa). These mixed cultures extend outside the village, on the lower half of the hillsides. The following is a portion of land used for hay, raising up on two-thirds of the hillside. The crops normally are irrigated, but even so the practiced agriculture type is the subsistence one. The forestry covers about 20% of the territory, less than 1% is deciduous forest planted between 1970-1980 in the areas presenting landslides. The upper third of the hillsides is commonly used for pasture resulted from deforestation in the previous centuries and the watersheds were used as well for this purpose. The built-up area covers about 10% of the territory, while the inhabitants´ lifestyle is a traditional one for most of the people with few differences and restructures compared to the period before 1990.

4. RESULTS AND DISCUSSIONS

4.1. Demographical trends

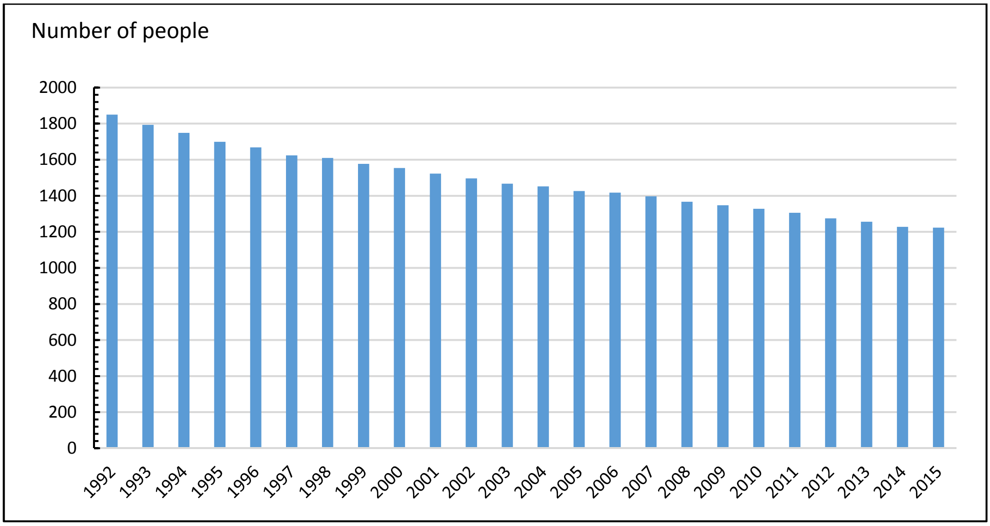


Fig. 9. Population's numerical evolution between 1992-2015

Besides the natural conditions, the man has had a vital contribution to the arrangement of this area since ancient times. Between 1992-2015, the population of the commune has decreased steadily from 1850 inhabitants in 1992 to 1496 in 2002, 1306 residents in 2011, and 1223 inhabitants in 2015, respectively. The causes that produced this phenomenon are easily deductible, such as: deindustrialization after 1990, external migrations in search for a job, adopting a modern demographic behaviour, women's empowerment and so forth. In parallel with the present population evolution at national level, the population of this area recorded a significant decrease over the last years, more than 600 people in less than 25 years (see fig. 9). Using the formula of the population growth rate developed by Thomas Robert Malthus in the 19th century, it was found that if the population evolution of these five villages would have the same trajectory in the future, it will come around to 1092 inhabitants by 2020 and only 831 inhabitants in 2030. This is also evidenced by the population structure by age and gender in 2015, which attests an aged population, that is, a regressive type of population evolution (see fig. 10).

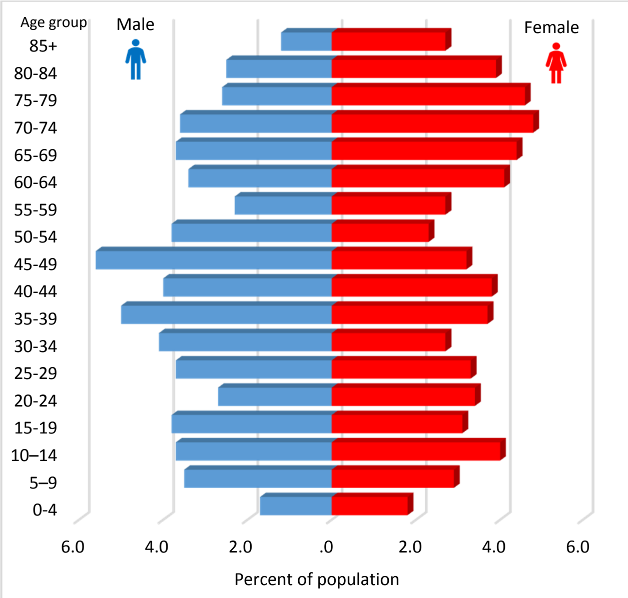


Fig. 10. Age pyramid at 1st of July 2015

The monthly evolution of the unemployed people between 2010-2015 shows a considerable decrease from 58 unemployed inhabitants in January 2010 to 14 unemployed residents in January 2015. In December of 2010 there were 38 unemployed inhabitants while in December 2015 there were only seven. Instead, the evolution of the number of employees in Aluniş commune, excepting those working in agriculture, oscillates between 1991 and 2015, mainly because of the population's downward evolution and the national economic restructuring that were felt in the commune. Thus, in 1991 there were 95 people employed, in 2003 only 22 employees, while in 2014 the number of employed inhabitants increased to 46 people. Another important aspect of the demographical structure is the increasing number of young residents from this area who completed higher education cycles in the recent years, nevertheless it is unknown whether they will continue to live in this area, considering that the upcoming perspectives they would take advantages of the local development level are rather uncertain and unattractive.

4.2. Existing situation

The local authorities' efforts have resulted in an increased orientation towards the remediation of infrastructure problems, which, in their opinion, were the biggest impediment for the economic expansion of the commune. Thus, since 2002 the local authorities started to attract and absorb grants from the county, national or European budgets. According to the semi-structured interview conducted with the mayor of the commune Mr. Mihai Sav, the biggest investment in the last decade is considered the introduction of the water supply networks through the SAPARD programme - *Special Accession Programme for Agriculture and Rural Development*, worth 1 million Euro, totalling 22 km of distribution networks and 10 km of culverts/adductions, plus two pumping water storage stations, but also the connection to the sewerage system, through the EAFRD programme - European Agricultural Fund for Rural Development, worth 2.5 million Euro, the network length totalling 18.5 km and, in addition to this, a wastewater treatment plant was constructed. These two major projects implemented are enriched by the construction of the Tourist Information Centre in Aluniș, through the measure *3.1.3. "Encouragement of tourist activities"*, but also by the construction of a series of amenities, such as sport halls in Aluniș and Ghirolt, a children playground in Ghirolt, the rehabilitation of the schools, culture houses and churches in all the villages, all of them through the measure 3.2.2 *"Basic services and village renewal in rural areas"* from the National Rural Development Plan, 2007-2013.

The ongoing and upcoming projects aim at asphalting all the streets in Aluniş (EU funds), the connection to the sewerage network in Aluniş and Ghirolt (local funds) and the connection to the water supply of the other three villages - Corneni, Pruneni and Vale (local funds).

With the opening of borders for non-reimbursable European funds, several residents of the commune applied for agricultural projects, exclusively in Aluniş and Ghirolt. The main measures through which they managed the funds attraction and absorption were the measures 1.4.1 *Supporting semi-subsistence agricultural holdings undergoing restructuring* and 1.1.2 – *Setting up of young farmers,* both as parts of the National Rural Development Plan 2007-2013 and 2014-2020 versions. It must be added that many of the locals who emigrated abroad early at the beginning of the 21st century, came back and invested in private housing reconstruction.

4.3. Risks and prospects

The geomorphological risk mapping analysis revealed the following aspects: the very low risk land covers 0.08% of the area, while the low risk - 10.18% of the whole. Basically, these are sectors of meadow and partly flat watersheds amongst the main valley tributaries. No restrictions on the location of new buildings in these areas are required. The medium-risk areas represent 71.07% of the total surface and are less suitable for new buildings. These predominantly overlap onto the hillsides with slopes between 6^0-17^0. On these slopes, one notices the existence of several areas affected by ravination after their use as pasture or agricultural land. The depth erosion extinction can be stopped by transforming the respective sectors into orchards grasslands composed by plants consisting of a well-developed root system, taking into consideration that it absorbs excess moisture from the ground and restores the disturbed structure thereof. The areas with high geomorphological risk represent 18.10%, and those with very high risk, 0.57% of the catchment area.

They are inserted on the fronts of cuesta which mark the watershed between Mărului Valley and the neighbouring valleys, onto slopes with gradients between 17^0 and 32^0. Thus the preservation of the existing forests and the afforestation of the sectors with reactivated landslides on these slopes is required.

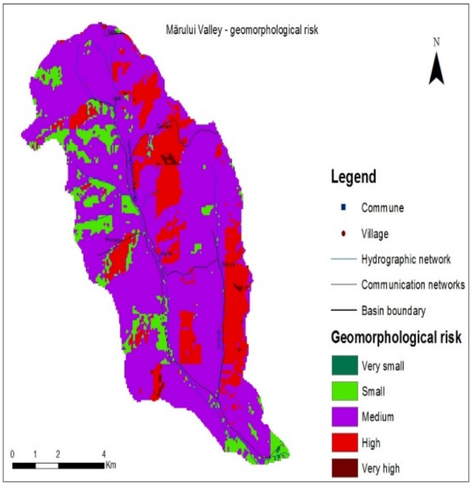


Fig. 11. Geomorphological risk map

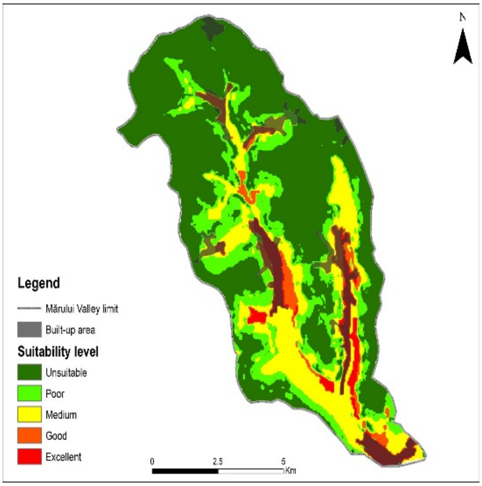


Fig. 12. Land Suitability map

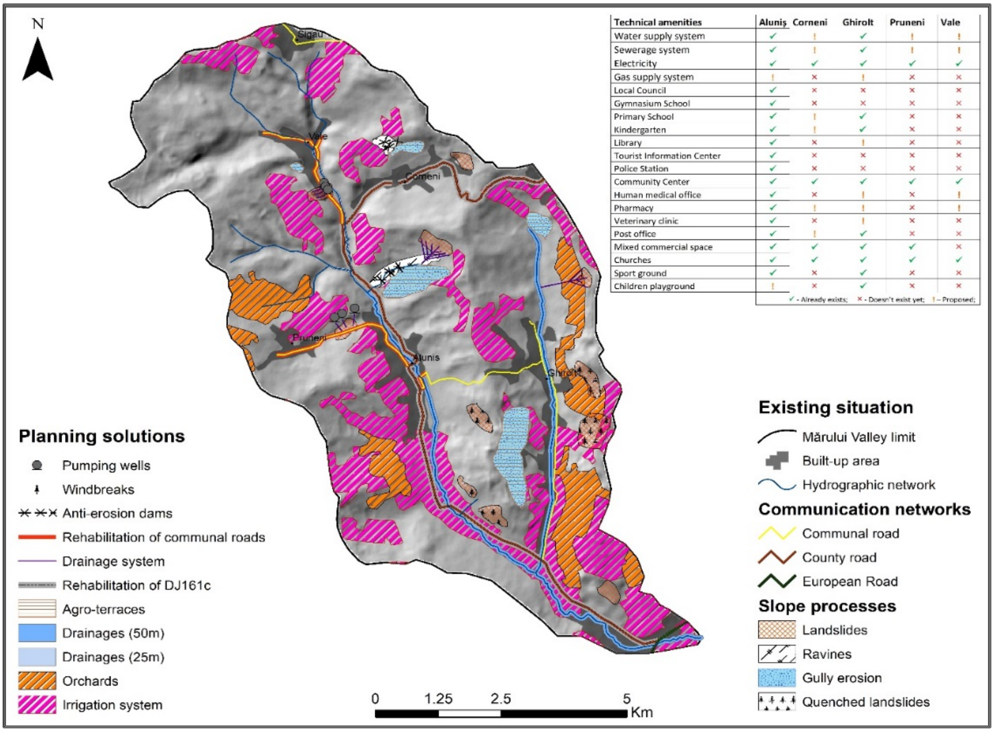
This spatial planning of Mărului Valley Basin according to morphology embraces two categories of principles. On the one side, the scale time is gradually prevailing in both risk assessment and in proposing planning solutions. The cyclical time scale is less relevant in this case, given the limited duration of human life. While stationary type phenomena are resorbed, their effects are integrated into the dynamic evolution of the considered system (Schumm and Lichty, 1965). On the other side, the general principles of spatial planning (Bădescu, 1972, apud Surd et al., 2005) are based on the existence of an element of stability represented by the relief. The following principles are noteworthy in this regard: a) the land economy principle, b) the principle of structural and functional stability of the territory, and c) the principle of optimal space-maximum yield. The other elements evaluated on the human life scale have a random character (climate change, population fluctuation, crops structure, capital insertion and so on), thus the relief could be considered the territorial component which defines the general direction of arrangement, the other factors printing lower taxonomic peculiarities.

Secondly, the land suitability analysis for new buildings construction (fig. 12) highlights the importance of the relief in the spatial planning context, expressing the land favourability degree of the placement of new buildings.

Thereupon, the most favourable areas for the location of new buildings in the studied territory are underlined over the communication paths or along the main valley or the secondary ones collected by the main valley. Overlapping the built-up area of the settlements with the areas of restrictiveness and favourability, one may notice that the buildings are largely located in areas with high favourability, but also normal or medium favourability. However, there are some buildings located over unfavourable or less favourable lands.

4.4. Proposals

First, the development of the study area has been achieved so far with difficulties due to the lack of accessibility, as it does not have direct access to major European or national communication routes. There are some resources, yet inappropriately used – the landscape, the forestry, the pastures, the meadows, the construction materials (especially tuff), the agricultural land, as well as a number of



Technical amenities	Aluniș	Corneni	Ghirolt	Pruneni	Vale
Water supply system	✓	!	✓	!	!
Sewerage system	✓	!	✓	!	!
Electricity	✓	✓	✓	✓	✓
Gas supply system	!	×	!	×	×
Local Council	✓	×	×	×	×
Gymnasium School	✓	×	×	×	×
Primary School	✓	!	✓	×	×
Kindergarten	✓	!	✓	×	×
Library	✓	×	!	×	×
Tourist Information Center	✓	×	×	×	×
Police Station	✓	×	×	×	×
Community Center	✓	✓	✓	✓	✓
Human medical office	✓	×	!	×	!
Pharmacy	✓	!	!	×	!
Veterinary clinic	✓	×	!	×	×
Post office	✓	!	✓	×	×
Mixed commercial space	✓	✓	✓	✓	×
Churches	✓	✓	✓	✓	✓
Sport ground	✓	×	✓	×	×
Children playground	!	×	✓	×	×

Fig. 13. Mărului Valley - Existing situation and proposals

heritage buildings, such as the Protestant churches in Aluniş and Ghirolt, both dating from the 17th century, the wooden church „Înălțarea Sfintei Cruci" in Pruneni dating from the 18th century and the Schirling mansion in Corneni with a real architectural value, built up between the 17th and the 19th centuries, or even the local traditions and customs. However, the limited resources in conjunction with the poor technical infrastructure, often blurred the upward trend of the commune. Consequently, the infrastructure of the commune, as the local authorities pointed out too, is the main driving force that could bring the desired development, since it would attract investors, new residents and tourists. In this way, to increase the efficiency of the project team responsible for writing projects and attracting funds becomes an indispensable condition, in parallel with the necessity of a strict local development strategy.

Secondly, the works of soil erosion, drainage of the wet areas with excessive moisture, irrigation of some areas, arrangement of the pastures and fertilization of the farmland, as well as the joint agricultural farms of the stakeholders would lead to a significant increase in crop production and livestock, therefore an overall economic development.

Thirdly, the tourism sector represents an unequalled resource that could be exploited. The rural tourism and the ecotourism are increasingly more important at European level as well as at global level. The high degree of conservation of this area creates opportunities for the local communities to better perform in this field, perhaps in conjunction with the neighbouring communes.

5. CONCLUSIONS

The most significant community amenities started to appear in 2002 by attracting and absorbing grants from the county, national or European budgets by the local authorities. The ongoing projects rely more on European funds than on the local budget, but face difficulties in achieving the desired results due to the poor efficiency of the project writing team. Mărului Valley morphology largely displays medium and low risk areas, but there are also significant areas which present high geomorphological risks, requiring in this way a set of specific planning methods for the degraded land. The agriculture, along with the tourism sector, remains a sustainable development perspective of the commune in terms of spatial planning, aiming to reintroduce into the agricultural circuit a series of degraded surfaces, to stabilise the affected land by active landslides and to introduce certain means of increasing agricultural production. The farmers play an important role in stimulating an improved territorial arrangement as they have succeeded to attract and absorb European funds through specific measures from the National Rural Development Plan, 2007-2013 and 2014-2020, but their total number is still low.

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