THE CORRELATIONS BETWEEN LAND USE AND LANDSLIDES IN THE TERRITORIAL ADMINISTRATIVE UNIT OF MINTIU GHERLII

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Abstract. The correlations between land use and landslides in the Territorial Administrative Unit of Mintiu Gherlii. Landslides are among the most important geomorphological processes in the Transylvanian Basin, particularly affecting agricultural land and decreasing its value for producing specific agricultural products. The Someşan Plateau and the Transylvanian Plain are the morpho-structural units most affected by landslides, accounting for 3% to 10% or more of the territorial and administrative divisions in the Transylvanian Basin, including Mintiu Gherlii. In this context, where geology and landforms are relatively consistent, land use is the primary factor that can produce changes. Our analysis indicates that arable land and pastures have the largest areas affected by landslides, and this suggests that the agro-techniques used so far may not have been the most suitable. Therefore, preventive and control measures should be implemented to reduce the surface areas affected by landslides and minimize their impact on the local economy.

Keywords: landslides, land use, distribution, spatial statistics

1. INTRODUCTION

Landslides, as geomorphological processes are noticeable at various levels of the Transylvanian Basin. On the one hand, they are the result of the conditions presented by the substrate, and on the other hand, the effect of the human component land use.

From a lithological perspective, the presence of friable rocks such as marl, clay and poorly cemented sands type etc. can be noticed, because of the sedimentation of eroded materials from the Carpathian Mountains. (Sanders 1999; Sanders et al., 2002; Krezsek and Filipescu 2005; Krezsek and Bally,

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2006). Only in some places, in the north-western part of the depressionary area, we find, more erosion-resistant rocks such as limestone, tuff, and sandstone.

The role of the human component has been decisive in triggering the geomorphological processes if we refer to land use. This happened under the conditions in which previously to any anthropic intervention over 90% of the land belonged to the forest area, whereas nowadays, the value is constantly at 40% (Roşian, 2011). The role of the forest, which also acted as a land stabiliser, was taken by pastures (used for grazing or as hayfields) and after that as mechanised agriculture developed, these were turned into arable lands in most of cases (Rusu et. al., 2014). Because of changing land use and given the sublayer build-on of friable rocks, geomorphological processes such as landslides were inevitable (Roşian and Hovarth, 2019). The immediate result, in the absence of control measures, was that landslide-affected land was abandoned or at best used as pasture after a relative stabilization (Rusu et al., 2014).

This has led to a decrease in the value of the land that could be used for agricultural production. This fact has remained with consequences, given that the territory studied is, in some places, profoundly rural, and agriculture is the main branch that provides the resources necessary for economic development and everyday life necessities.



Fig. 1. Localization of the study area

Among the morpho structural units of the Transylvanian Depression, a special situation in this regard is specific to the Someşan Plateau and the Transylvanian Plain. Between 3%-10% or more of their territorial and administrative units are affected by landslides (Roşian et al., 2018), as is the case in the municipality of Mintiu Gherlii (3.2%).

The territorial and administrative unit Mintiu Gherlii is on the North-Western side of the Transylvanian Basis. Regionally, it overlaps with the morpho-structural units of (fig. 1): the Someşan Plateau, Someşului Mic Corridor, and the Transylvanian Plain (Pop, 2001; Roşian, 2020). From an administrative perspective, it is a commune which belongs to Cluj County and includes six villages: Mintiu Gherlii (which acts as a "commune" seat), Buneşti, Nima, Pădurenii, Petreşti and Salatiu. There are 3.861 inhabitants grouped in 1.258 households.

2. METHODS AND MATERIALS

To achieve the results, we used a methodology that aimed to identify both the landslides affected areas and investigate the land use situation.

GPS and GIS technology were used to identify the landslides distribution and the areas occupied by various types of land use.

First, the landslides were identified and vectorized from satellite images using GIS (ArcMap 10.8) software. For the areas where the existence of landslides could not have been determined precisely by satellite images, the GPS (Global Positioning System) method was used; the information collected from the field was then downloaded and brought into a GIS software for processing.

In the second stage, based on field observations, analysis of existing databases (such as Corine Land Cover, topographic maps, cadastral maps, etc.), and tracking the existing situation on the satellite images, areas with various types of land use were digitized (Carrara et al., 1999; Dhakal et al., 2000; Sarkar and Kanungo, 2004). The calculation of areas for each land use category was performed using the Statistics function in ArcMap 10.8 software. Using the same methodology, the areas occupied by landslides were assessed for each land use category. The obtained data were then graphically represented using the MS Excel software.

3. RESULTS AND DISCUSSIONS

Based on the methodology mentioned above, we were able to identify in the territorial administrative unit of Mintiu Gherlii 108 landslides which represent 239 hectares. This represents 3,2% of the Mintiu Gherlii commune area which has a total surface of 7845 hectares. The medium surface area of a landslide is 2,2 THE CORRELATIONS BETWEEN LAND USE AND LANDSLIDES ...

hectares, the largest surface area is 27,7 hectares and the smallest surface area is 0,01 hectares.

These values suggest that the commune Mintiu Gherlii is unaffected by landslides. Considering that the most extensive surfaces are represented by arable land and pastures (table 1), which are more susceptible to such geomorphological processes, in the absence of any controlling measures, there is a possibility of new landslides in the future. This is precisely one of the reasons why, at the level of al administrative territorial units, the areas affected by landslides and other geomorphological processes must be known for each category of land use.

In terms of land distribution, most landslides are to be found on the slopes of the Someşului Mic River tributary valleys: Buneşti Valley, Nima Valley, Salatiului Valley, Țopului Valley și Mintiului Valley (fig. 2).



Fig. 2. Landslide distribution at Mintiu Gherlii

As to landslides, these are superficial and medium landslides (Varnes, 1998). Their frequency is related to the geological sublayer and land use. These are Miocene age formations that belong to Sarmatian and Holocene eras (this applies only to Someşului Mic flood plain and terraces). At Mintiu Gherlii, the following rocks are specific to the Sarmatian: clay, marls, marly clays, sands, and tuffs. The clays contain minerals such as montmorillonite, illite and beidellite which retain water.

Being a territory dominated by sloping surfaces like hillsides, and considering the presence of the mentioned rocks, the susceptibility to landslides

GHEORGHE ROȘIAN, HORVATH CSABA, LIVIU MUNTEAN, VLAD MĂCICĂȘAN, ROZALIA BENEDEK

according to models made for the Transylvanian Depression (Bălteanu et al., 2010; Petrea et. al., 2014; Roșian et al., 2016) or for other areas (Chung et al., 1995; Sarkar și Kanungo, 2004; Armaș, 2011; Bălteanu and Micu, 2009) remains high.

As to land use categories and sub-categories, according to the structure of land ownership in Romania, there are agricultural lands (arable, orchards, pastures) and non-agricultural lands (forests, bushes, waters, yards and buildings, road networks) (table 1).

The territorial distribution of these categories is very inconsistent, and it is very influenced by the relief. For example, forests occupy the upper part of the slopes and interfluves, arable lands the lower part of the slopes and floodplains, pastures the middle part of the slopes, while settlements are located both in the floodplains of the Someşul Mic and some basins of the tributary's valleys (fig. 3).



Fig. 3. Land use map of Mintiu Gherlii commune

It can be noticed in Table 1 that the largest land surface areas and highest percentage belong to the following land use categories: forests, pastures, and arable land. On the opposite side, there are land areas in which are bushes, yards and buildings, roads, waters, and orchards.

Unit	Land use category	Area (ha)	Weight (%)	Landslides (ha)	Weight from category (%)	Weight from total (%)	No. of landslides
Mintiu Gherlii	Arable land	2982	39	31	1.1	0,4	19
	Orchard	37	1	0	0	0	0
	Pasture	1766	22	197	11.1	2,6	62
	Forests	1932	24	5	0.2	0,1	11
	Shrubs	483	6	6	1.2	0,1	16
	River	72	1	0	0	0	0
	Built-up area	436	5	0	0	0	0
	Roads	137	2	0	0	0	0
Total		7485	100%	239		3,2	108

The Correlations Between Land Use and Landslides \ldots

Table 1. The weight and number of landslides at Mintiu Gherlii

The most affected land use areas by landslides are: pastures, arable land, bushes and forests (table 1). If for the first three areas there is a reasonable explanation given the existing influences between land use and their susceptibility to these geomorphological processes, in the case of landslide taking place in the forests, things are different. Even if the land stabilising role of the forest is well-known, the 11 landslides in the forest areas are related to deforestation which is taking place on the left slope of the Nima Valley. Despite the absence of the forest in this land area, the official land use category is still the same, statistically explaining the presence of landslides in the forest areas.

The high values of the areas affected by landslides on pastures can also be explained by the way they are used, referring here to overgrazing and all its consequences on the stability of the land, as well as the fact that once affected by landslides, in the absence of any action to combat them, other land categories have not been properly used and have started to be used as pastures.

Given that 3.2% of the commune's surface area is affected by landslides, and among the various categories of land use, pastures are affected to a proportion of 11%, measures must be taken to combat them: draining surface and underground water, shaping-leveling the terrain, building terraces, stabilizing the land with herbaceous, shrub and forest vegetation, building retaining walls, etc. At the same time, measures are necessary to prevent landslides: changing the agricultural practices used, preventing water from accessing susceptible land, prohibiting excavations for road construction, banning deforestation, restricting human and animal access, improving natural land drainage, afforestation, capturing springs and ensuring directed water evacuation; al this to avoid new landslides.

GHEORGHE ROȘIAN, HORVATH CSABA, LIVIU MUNTEAN, VLAD MĂCICĂȘAN, ROZALIA BENEDEK

4. CONCLUSIONS

The analysis carried out in the Mintiu Gherlii commune to establish the correlations between land use and landslides highlights that the largest affected areas by these geomorphological processes belong to agricultural lands used as pastures and arable lands. This means that the land use, especially concerning the pastures located on slopes with a gradient greater than 7°, needed to be improved.

For this reason, measures are necessary to prevent and combat landslides, reduce the affected areas, and introduce them into the economic circuit as much as possible. In the situation where geology and relief are relatively uniform on both sides of the Someşul Mic Corridor, in the hydrographic basins of the river's tributaries, the variable that introduced differentiations is represented by land use.

It is important to consider that in conditions where the lands affected by landslides are mainly agricultural (pastures and arable lands), and the primary source of income for many households is agriculture, the standard of living can be affected.

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THE CORRELATIONS BETWEEN LAND USE AND LANDSLIDES ...

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