THE ROLE OF MASS WASTING IN GEOMORPHOLOGICAL EVOLUTION OF THE TERRITORY OF REPUBLIC OF ALBANIA

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Abstract: The problem of studying the mass wasting in Republic of Albania and their geomorphological activity is considered as a largely historical and difficult phenomenon. The morphological evolution of the sloping processes where they are formed requires detailed study of the sedimentological and chronostratigraphic data of the territory.The problems of hillside instability are among the most destructive natural hazards of territory of Albania, which represents one of the greatest threats to the life and material goods of the population. Landslides, landslides, flows and complex movements occur day by day around landscapes of Albania. Each year these disasters cause many victims, injured and injured, as well as large economic losses. The impact that this type of danger causes is of greater magnitude in low-income countries due to its high degree of vulnerability. To prevent future disasters associated with hillside instability, it is of the utmost importance that all members of the population know this phenomenon and remain attentive to the manifestations that prey on it and the factors that generate it. The study of these dangers related to hillside instability involves the participation of interdisciplinary groups of specialists, who analyze not only the process as such, but also the resulting socio-economic effects. The first step to reduce the harmful effects caused by these natural phenomena is to spread knowledge and foster culture among the inhabitants of a territory about them. Many of the slopes are in a potentially unstable condition, so that movements can start easily. This is due to different factors. On the one hand, the forming thermal materials may be poorly resistant or be characterized by the presence of weakness systems such as diaclases, fractures, failures. etc, which implies latent instability, or the slopes may be exposed to external factors, such as erosion, that play a very important role in their imbalance. The presence of excessive rains and intense tremors are the main detonating mechanisms of instability in the context of natural disasters. Do not cut trees or destroy the natural vegetation of the region and do not dig the hillsides in the form of cuts and terraces without authorization. Where the surface of the natural terrain is inclined, it is important to don't allow water from household drains to infiltrate the terrain. It must give immediate notice to the civil protection, so that they are responsible for expediting the repair work, so that the ground does not soften. It is very important that you are attentive to the indications of the civil protection authorities of your community, especially during the rainy season. If infractructure of settlements are located on the side of a hills, should constantly check the walls and ceilings for cracks or subsidence.
Keywords : geomorphology, mass wasting, physico-geographical factors, lithology

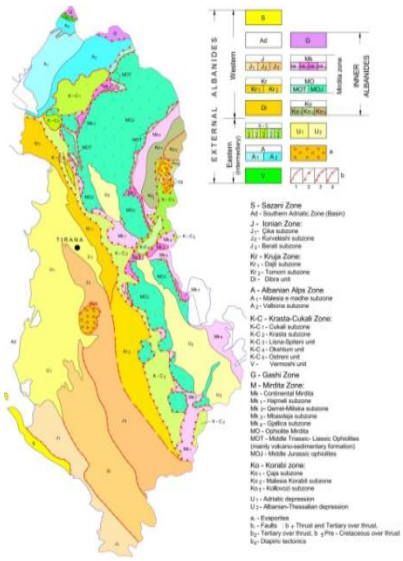
1. WORKING METHODS

The characteristics of rocks, as well as their influence in function of the modeling of relief have been utilized, thanks to geological information. The mass wasting are the reflection to the relief of diverse rocks and the geological structures that build the mountainous range. The activity of mass wasting is related to the denudation processes, active tectonics, especially during intense diagonal reverse faults. Special importance is given to the phenomenon of rockfalls, solifluction, landslides and torrential flows, which are closely related to the morphogenic role of climate, hydrography, soil and vegetation. This has enabled to draw important conclusions regarding the orientation of morphological evolution in the perspective of the relief. Through the analysis of slope processes, we can judge the extent of degradation and intensity of soil erosion. Based on the field surveys and the evaluation of values in relation to the parameters of the physico-geographical factors and the activity of human intervention on the geographical environment, the genetic causes and the most critical sectors of the natural environment of the territory of Albania have been determined.

2. IMPACT OF PHYSICO-GEOGRAPHICAL CONDITIONS ON MASS WASTING

In the territory of Albania, mass wasting are closely related to rock diversity, faulting tectonics, tectodynamic conditions and the Mediterranean climate. All these factors have contributed to the increase of the depth and density values of the relief and degradation of natural vegetation. The wide presence of the forest surface has been able to maintain partially the morphological equilibrium of the slope. The main factor is lithological content, where flysch and molasses appear more volatile in contact with precipitation and other climatic elements and depending on the physico-chemical composition of the soils. The widespread spread of ultrabasic and limestone rocks has created conditions for the development of rocky streams along the slopes. Slides and muddy streams occur more in the

flysch and molassic sectors, where alevrolite clays cause instability for sandstones. The lithological factor affects the surface flow, closely related to the ability of soils to infiltrate the latter. Rock permeability is particularly affected by the alternation of permeable rock layers with clays, alevrolites, sandstones and conglomerates. Typically these phenomena occur in molasses and the flysch are displayed. Complex relationships between landforms and the external environment were indicated. Geomorphic systems are often affected by episodic large events such as megafloods which lead to a disturbance of system adjustment, sometimes in a catastrophic way. Also, responses of geomorphic systems to external changes tend to be nonlinear, including lag time, relaxation time, and thresholds.[1]



Map 1. Tectonic Map of Republic of Albania.[2]

These rocks are incorporated by intense tectonization, with longitudinal and transverse tectonic movements, intensifying slope processes. The tectonic lines that cross the Elbasan district surface are quite and clearly delineated by line contours and earthquake configurations creating unstable areas over wide areas; instability that results from the uneven movement of different blocks of land in these NE-SW directions and consequently different landings occur. Although these movements are very slow, they can become very threatening in the event of earthquakes.[3] The relief factor appears to be among the most prominent and this is explained by changes in morphographic elements where in some of the segments the sloping processes occur at a very high intensity. Moderate to high values of the depth of relief of the relief especially in the upper sections of the valleys of Shkumbin, Devoll, Mat and Erzen have brought about considerable instability of the slope equilibrium. The slope of the slope is one of the main elements of the relief and in many cases it coincides with the decline of terrigenous and carbonate rock layers. Convex forms of slope are distinguished for high slope values during its lower part where waters flow faster and accumulate less humus than during concave slopes. Slope exposure is another factor where western and southern slopes are more easily subjected to denudative processes. Within the Mediterranean climate, precipitation directly affects the hydrographic network and at the same time the slope processes, where the highest values of the maximum during October-March have led to the dense development of quarries and mudflows that erode and transport large amounts of sediment materials to the Shkumbin and Ishëm valleys in the form of glacis-cones. Vegetation has had a significant impact on the density of its species, while plant roots have greatly influenced shrinkage processes. Deciduous vegetable debris supplies humus reserves and improves soil structure, while during the winter the plants absorb a large amount of rainwater, significantly reducing surface runoff. Summer pastures in mountainous ranges during the winter are covered with a thick layer of snow and it is often the case that the snowmelt period is short, resulting in a very large water flow in the segments, stripped of vegetation significantly reactivating slope processes.

[1] Oguchi. T. Butler. D. *The International Encyclopedia of Geography*. *Chapter: Geomorphic systems.* © John Wiley & Sons, Ltd. Published (2017)

[2] Collective authors. *Tectonic map of Republic of Albania*. Academy of Sciences of Albania. Scale 1:200.000, Tirana. (2002).

[3] Municipality of Elbasan. *Document of the final environmental strategic assesment report of the general territorial plan of the municipality of Elbasan*. (2016)

Current developments in rural agricultural areas have brought about changes in physico-geographical elements, accelerating slope processes, with the predominant part of the settlements rising above terraced levels. Most of the denudative forms are located near motorways and footpaths, where the latter often serve as temporary beds of 60-80cm depth for some torrential streams. Some of the reservoirs have led to a gradual increase in groundwater levels around the confined segments, leading to the activation of many subsidence and surface runoff. Active sloping processes endanger the socio-economic activity of the local population, motor and autopsy roads, rural dwelling houses and plenty of planted land.

3. THE MAIN TYPES OF PROCESSES THAT OCCUR DURING MASS WASTING

Human activity on the river basin environment has been intense. The river basins have been inhabited for a long period of time by a dense population, while the territory has been crossed by a dense network of roads, even of an international character, such as the "Egnatia Road" with its associated branches. Even in the mountainous sectors, the local population has intensified the environment r, resulting in the disruption of the very fragile natural balance. As a consequence, the sloping processes intensified, resulting in large-scale degradation of the territory.[4] The erosion process in Albania is distinguished for its high values due to the very favorable physico-geographical conditions. One of the important factors for the intensification of erosive processes is the artificial irrigation of agricultural lands in slopes with high slope values. Within a short period of time, a layer of soil is disintegrated, which in ordinary natural conditions would be destroyed for a period of several decades. Necessary rules are not applied during irrigation of agricultural lands, as the waters are discharged under high pressure, in the top-down direction, thus carrying and transporting the soil layer. The water would be required to be discharged through the horizontal channel irrigation canal system, parallel to the isohip lines and always under the control of the relevant personnel. Consequently, in many sectors such as the Tirana river Basin, Kerrabe, Mallakastra and the upper sector of the Shkumbini and Erzeni river basins, large erosion hot spots have developed.[5] Territorial degradation is closely related to natural factors, which determine the nature and intensity of the action of external relief modeling processes. Human activity may accelerate the intensity and pace of external processes or may at a minimum slow this pace and intensity. Current studies on relief degradation are carried out by specialists in various fields, such as geomorphology, agronomy, biology, ecology and forestry, etc. Geomorphology manages to determine the laws of the development of relief morphodynamics, providing great assistance to researchers in other fields of science, to determine on a scientific basis, safeguards against continuous degradation of the relief, to protect and enrich the environment geographical. Large spreads, especially in sections consisting of flysch and molasses rocks, have torrential processes of very irregular surface flows, which are closely related to climatic, topographic, lithological and vegetation conditions. They have depths and widths of several tens of centimeters, which have formed new and local erosion bases, resulting in erosion hot spots called badlands, especially in hilly terrain, such as in Kerrabe, Burimas, Vilëz, Preza, etc.[6] The landslides represent displacements of the rocks that form the slopes of mountains, hills, hydro-amelioration works or other man-made ramps. Rock movements can occur along the slope or laterally, as a result of natural phenomena or even as a result of human activities. The landslides do not cause losses and damage as great as other disasters, but they are dangerous and can lead to the destruction of buildings by displacing the rock layer or by covering it. Also, the landslides can obstruct the flow of some running water, creating temporary or permanent accumulation lakes, they can even cause the dams to be destroyed by forming a strong wave, upon entering the lake, suddenly, a large volume of rock. In our country, the landslides are quite widespread. Weathering on hillslopes, as elsewhere, includes the in situ conversion of bedrock into regolith and the subsequent chemical and mechanical transformation of regolith. Several hillslope processes serve to transport regolith and other weathering products. They range from slow and continual processes to rapid and intermittent processes. Splash processes into three categories: leaching, soil creep, and rainsplash and sheet wash. Rocks are subject to stress and gravitation.[7]

[4] Qiriazi. P. Sala.S. Erosion-denudative forms and some estimates of erosion intensity in the Shkumbini watershed. *Geographical Studies. No. 6*. (1995)

[5] Krutaj. F. Qiriazi. P. Current external processes that modeling our country's landscape. *Geographical Studies. No.2*. (1987)

[6] Qiriazi. P. Geomorphological problems of degraded terrain of Tirana District. *Geographical studies. No. 4*. (1990)

[7] Hugget. R. *Foundamentals of Geomorphology*. U.S.A. (2017)

Photo. 1. Landslide in Gjinar

The causes of landslides are changing the groundwater level, torrential rains, slope and other vertical loads, leading to collapse etc. Seismic motion generates besides the phenomenon described above and another phenomenon called liquefaction of saturated sands. This phenomenon has the peculiarity of producing landslides even in horizontal lands, when layers of earth with some cohesion are laid on soft rocks that lose much of their resistance during the earthquake, due to liquefaction. The style of landslide activity, or the way in which different movements contribue to the landslide, can be defined by terms originally established by Varnes.[8] Solifluction occurs when fine clays begin to be saturated with water, then they reach the degree of plasticity, that is, the threshold or limit of plasticity, meaning the content expressed in percentage (%) of the amount of water relative to the volume of material relocating solids until the clay mass becomes plastic. When the clay layers reach the plasticity boundary conditions, then the solid material displacement develops slowly, in the form of lenses, but without causing the surface of the relief to be broken or broken. So the limit of the development of fluidity or fluidity is conditioned by the value of the percentage of water within the mass of clay formations, causing the phenomenon of solifluction or mudflows.[9] As in the highest mountainous sectors, which lie at an absolute altitude above 1800-2000m, in Albania, at these same reliefs, the phenomenon of solifluction develops, closely related to periglacial phenomena, depending on the conditions of the alpine climate, with cool, harsh winter summers, where there is a pronounced impact of snow cover and freeze-thawing of the relief surface.[10] In conditions where the watercourses that erode the relief surface have equal values, then the glaciers have the same morphometric elements, while the joining of these glaciers towards a single or shared glacier during the lower subsurface is more rapidly realized. These topographic conditions of these glaciers are created in situations where the slopes have longitudinal or almost longitudinal profile.[11]

Photo 2. Denudation processes in central part of Albania.

Slow movements are processes that capture the decay crust on the slope, especially on the western slope of the Shkumbin valley. These create unstable slope situations, and do not look directly at the ground, but indirectly, observing the deformations that have different slopes, trees or objects. The most endangered slopes are those with clay, alevrolite, mergers, because they are more rapidly saturated with moisture. Here many bushes receive different

[8] Varnes. D.J. Slope movement Types and Processes. *In Special Report 176: Landslides: Analysis and Control. National Research Council, Washington.D.C*. (1978)
[9] Derrau. M. *Precis de Geomorphologie*. Text Paris. (1966)
[10] Coque. R. *Geomorphologie.* Text Universitaire Paris. (1998)
[11] Dumas. R. *Levant Espagnol*. Text - Paris. (1987)

translocations as a result of slow movements. They develop on rocky slopes in a repressive form, especially along slopes in tectonic rifts, which are distinguished for rapid morphological evolution. They are favored by cracks, cracks, plans, and coatings. Rocks of rock, from populations up to 10-15 cm in size, are present along the slopes of mountain ridges and have a length ranging from 45 to 150 meters. Climatic conditions with elements of solar radiation frosts, snow and heavy rainfall affect the high thickness of the radiated materials. Negative destructive forms extend along the slope, while depositional forms extend in their range. Negative forms have grooves and are exploited by quarrying. Geotechnical engineers have been concerned primarily with sliding movements and have not developed a complete set of landslide names, concentrating instead on the classification of materials. A similar approach can be used for highly weathered or mechanically disturbed rock masses. Rock falls may occur singly or in clusters, but there is little dynamic interaction between the most mobile moving fragments, which interact mainly with the substrate. Movement may begin slowly, but the last stage of failure can be extremely rapid. Rock rotational slide is a mass of weak rock on a cylindrical or other rotational rupture surface which is not structurally controlled. The morphology is characterized by a prominent main scarp, a characteristic back-tilted bench at the head and limited internal deformation. Rotational slides can occur only in very weak rock masses, often under the surcharge of a stronger cap rock. Most rotational slides in rock tend to move at slow or moderate velocities, partly because the rotational mechanism is self-stabilizing as the gravitational driving forces diminish with increasing displacement.

In the present study, a non-penalizing simplification was chosen, which also conforms to choices widely made in the matter, for example, from the Rodon-Vora and Mallakastra hills, dividing the landslides into active and inactive, introducing the concept of paleofrana to indicate large rock landslides, which occurred in tectonic, morphological and climatic contexts other than the current one, which are currently inactive, except for small areas that may present local shots. The mass movement types, distribution and shapes are strongly controlled by both the lithological characteristics and the multi structural setting. Active slow-moving landslides, commonly characterized by multiple and superimposed landslide bodies, confirming that the spatial distribution of the recent landslides is frequently influenced by the presence of older landslides. New mass movement of the river catchment represents a useful tool for territorial planning, and engineering-geological and environmental purposes in the study area. It is, also, the starting point for both quantitative landslide risk analyses and the design of the most appropriate risk mitigation measures.[12] Landslides were considered active in which indications of movements still in progress are detected, also with seasonal frequency; landslides in which, although no evidence of movement is detectable, morphological and climatic conditions are still present such as to be able to reactivate the phenomenon. The zoning of landslide hazard represents the most useful summary for spatial planning purposes, as, in addition to containing information about the current state of instability of an area, it represents, in a probabilistic sense, the vocation of a territory to failure.

Slumps are types of slides where in downward rotation of rock or regolith occurs along a concave-upward curved surface rotational slides. The upper surface of each slump block remains relatively undisturbed, as do the individual blocks. Slumps leave arcuate scars or depressions on the hill slope. Slumps can be isolated or may occur in large complexes covering thousands of square meters. They often form as a result of human activities, and thus are common along roads where slopes have been oversteepened during construction. They are also common along river banks and sea coasts, where erosion has under-cut the slopes. Heavy rains and earthquakes can also trigger slumps.[13]

4. PROTECTION AND INTERVENTION MEASURES IN THE EVENT OF MASS WASTING

The planned measures for prevention, protection and intervention in case of landslides are similar to those applied in case of earthquake. A peculiarity is the fact that the event does not take place by surprise. It may be assumed that the displacement of some layers of rock in the risk areas, thus creating the possibility of carrying out protective measures. Thus, a significant role is given to the actions of observing the conditions for favoring the landslides and the alarming of the population in a timely manner to achieve the protection. Making the necessary interventions in advance to establish the conditions for their emergence and development and applying the appropriate procedures for keeping them under control. Providing a water drainage system from the slope massif through a drainage system, afforestation and grassland of slopes and avoiding the placement of industrial or other construction objectives in

[12] Borrelli. L. Muto.F. Geology and mass movements of the Licetto River catchment (Calabrian Coastal Range, Southern Italy) *Journal of Maps. Volume 13, - Issue 2*. (2016)

[13] Nelson. S. *Mass Movements and Mass Movement Processes*. Lectures. Tulane University. (2018).

areas where the stability of the layer can no longer be achieved or is very expensive. In the intervention actions outside the particular cases, the recovery of the material goods and the recovery of the damages will be pursued.

5. RECOMMENDATIONS

- Setting up a commission against disaster and training on this line the own personnel,
- Establishing and ensuring the functioning of the information system at local level for disaster alarm
- Execution of afforestation and weeding in potential risk areas or other works of this type.
- Organizing and conducting the evacuation of the population and the material goods affected from the disaster area
- Inventorying and evaluating the effects and damages caused
- Planning and coordinating and coordinating the actions to restore the affected economic and social infrastructure

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