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# THE MECHANISM AND THE DETERMINING FACTORS OF PRODUCING THE INSTABILITY PHENOMENA IN THE ENVIRONMENTAL IMPACT ASSESSMENT

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***Abstract***
*Large-scale landslides come together with floods and earthquakes, in the category of natural disasters that cause serious damages, and life casualties as well, if they are not tamed and if not acting the rescue operations in due time.*
*Landslides can occur either through natural evolution of processes up to critical situation in which a stability loss of sloping soil occur, or by human intervention, with works that can influence the equilibrium state close to the limit.*
*Most landslides are triggered as a result of an intervention binding to several factors. In the landslides analysis process one must take into account the interdependence of factors that can trigger such events. Trying to simplify interpretation of landslides phenomena by considering only one or other of these factors may lead to a misunderstanding of the process and mechanism and thus to a partial or defective result of the problems facing the studied area.*
*The main factors of instability can be divided into two categories: permanent factors (gravity, water, mechanical action, chemical action, nature and soils mechanics characteristics, earth structure, morphology) and time-varying factors (precipitations, temperature, earthquakes, volcanoes, human action).*
*Being investigated in the frame of the natural relief shaping processes, landslides, and other ground movements are widely spread in our country being directly linked to lithologic substrate and to climatic regime as well.*
*Eventually, natural events caused by landslides, are large scale potential risk factors for Romania which can manifest both individually and especially complimentarily with earthquakes action as well, if occurring on a large action area.*

Keywords: landslide, earthquake, disaster, environment, instability

## 1. INTRODUCTION

Soils affected by instability phenomena are such a category of soils which require special measures to ensure their stability to prevent degradation of existing buildings or if the placement of new construction. Issues related to slopes stability located where human settlements are or on nearby roads slopes, have a supplementary importance compared to other stability problems.
Consequently, in case of the potentially instable slopes is preferable to take measures in order to achieve strength – and stabilization to limit the stability risk loss of the slip phenomena.
In order to establish some stabilization - consolidation solutions applicable to a certain slope is strictly necessary to take into account the following: layer stratification and physical-mechanical characteristics, groundwater level and movement regime, determining the factors that cause the instability phenomenon, etc.

A landslide (or landslip) is a geological phenomenon which includes a wide range of ground movement, such as rock falls, deep failure of slopes and shallow debris flows, which can occur in offshore, coastal and onshore environments [8].
Landslides pose a recurrent hazard to human life and livelihood in most parts of the world, especially in some regions that have experienced rapid population and economic growth. Hazards are mitigated mainly through precautionary means, for instance, by restricting or even removing populations from areas with a history of landslides, by restricting certain types of land use where slope stability is in question, and by installing early warning systems based on the monitoring of ground conditions such as strain in rocks and soils, slope displacement, and groundwater levels [1].

## 2. CURRENT STATE OF RESEARCH ON THE EFFECT OF INSTABILITY PHENOMENA ON CONSTRUCTIONS

The constructions placement on the ground is a problem of great technical and social responsibility.
Soil foundation and foundation system must be carefully and responsibly considered, because of their economic and social implications.
Technical measures applied before triggering of the phenomenon, have a preventive character. After sliding, the technical measures to be considered, concerns the causes which have encouraged the slide and should lead to stabilizing and strengthening of the affected massifs.
Globally there is intense concern in reducing the effects of the phenomena of instability on the building. Landslide phenomena have attracted attention of specialists from all around the world, reflected in advanced research methods, analysis and calculation of land stability, for the adoption of effective measures to prevent such phenomena [3]. Natural slopes stability problem has been furnished and are subject to one of the main sessions and special each International Conference.
In the U.S., where there have been losses of lives and considerable material were made in the studies of 50 states on the types of landslides and how to open them, establishing the primary data to control the phenomenon. The studies reflect the influence of topography, geology and climate on landslides potential [5].
A group of researchers from the Center for Geographical Studies at the University of Lisbon is currently exploring the general methodology of probabilistic risk assessment of landslide occurrence; taking into account the typology of its test area is located 20 km north of Lisbon, the most heterogeneous geological formations, in terms of lithology. To validate the prediction results, the set of information about the landslide was partitioned using different criteria: time, space and random.
Investigated the natural processes shaping the relief, subsidence and other ground movements were widely in our country is directly linked to lithological stratum and climatic regime.
The efforts to identify, research and monitoring of landslides is conducted under a program adopted by the Central Commission for Prevention and defense against the effects of earthquakes and landslides, with the ultimate goal of drawing risk maps to slip across the country, from areas that are or will be placed civil.
In order to assess the work to be done to prevent and / or stabilize landslides, is intended to monitor potential slide areas to determine the equilibrium conditions of the masses of earth, that their stability.
To detect landslides in its different phases and identify the factors that generate it, there are no studies which have proposed that the final result geological mapping. Thus, to follow the geological nature of the terrain, age formations, lithology, tectonic history, the presence of underground water level and sliding elements have been identified that can be directly observed (before the separation, sliding terrace, batteries, sliding, longitudinal cracks and cross slipping relief, edges and the slipping) [6].

## 3. MECHANISM AND THE DETERMINING FACTORS OF PRODUCING INSTABILITY PHENOMENA

Most sliding is triggered as a result of intervention coupled to several factors. Some factors influence acts for long periods, such as natural geological processes, others have a regular action, such as climate processes, and some random action, but high intensity, such as earthquakes.
The slip in the analysis processes to take account of the interdependence of factors that can trigger such events. Trying to simplify interpretation of slip phenomena by taking into account only one or other of these factors may lead to a misunderstanding of the process and mechanism and default to a partial or poor resolution assemble problems facing the area
The main factors of instability can be divided into two categories: permanent or highly variable factors, meaning a place predisposition factors to instability and time-varying factors the scale of a few months maximum, can act as triggers, must remember that man is often due to acceleration or drop instability.

### 3.1. Factors permanent

Gravity

The principal driving force for any landslide is the gravitational force and the tendency to move of this mass will be proportional to the hill slope angle. The resisting forces preventing the mass from sliding down the slope are inversely proportional to the same hill slope angle and proportional to the friction angle of the material.

Water

Slope saturation by water is a primary cause of landslides. This effect can occur in the form of intense rainfall, snowmelt, changes in ground-water levels, and water-level changes along coastlines, earth dams, and the banks of lakes, reservoirs, canals, and rivers.

Land sliding and flooding are closely allied because both are related to precipitation and the saturation of ground by water. In addition, debris flows and mudflows usually occur in small, steep stream channels and often are mistaken for floods; in fact, these two events often occur simultaneously in the same area.

Rapid changes in the groundwater level along a slope can also trigger landslides. This is often the case where a slope is adjacent to a water body or a river. When the water level adjacent to the slope falls rapidly the groundwater level frequently cannot dissipate quickly enough, leaving an artificially high water table.

Mechanical Action

Slight flows of water on the slopes trail soil particles and create ravines that can be more or less important after violent rains, vegetal density layer, the degree of slope inclination, soil nature, etc.

Underground water courses have the effect of trailing the particles and can cause on the surface land subsidence or small collapses. Together, these damages may favor the appearance of motion on the slopes. Increased interstitial pressures is an unfavorable element for establishing of a slope and the presence of a visible level and quasi-permanently indicate a greater predisposition to slip.

Erosion of riverbanks can lead in time to instability of the masses. Wave action that acts at the base of coastal cliffs contributes to regression of the banks by successive landslide caused by the gradual collapse and therefore progressive formation of ledges which are dislocated and discharged into the sea.

Chemical action

Weathering is an important factor in landslides; heavily weathered landscapes are much more likely to be eroded.

Chemical weathering refers to the breakdown of an object into particles with a different mineral composition than the original object. Water is perhaps the most powerful agent of chemical weathering: Over time, it can dissolve many kinds of rocks into a solution that has a different chemical makeup than the original substance. Other types of chemical weathering involve more complicated chemical reactions with oxygen, carbon dioxide, water or other compounds. The dissolution of rocks under evaporation (gypsum, rock salt, etc.) formed drilling cavities in the basement.

These dissolutions are favored by the circulation of groundwater, which are continuously aggressive waters: major cavities can form in decades. The dissolution of carbonated rocks, much slower, is the origin of karsts, can give rise to collapse.

Soil type and mechanical characteristics

Lithological nature of geological formations allows predicting in general terms or mechanical behavior. All recent superficial formations, generally unconsolidated, are vulnerable and unstable when they cover the slopes. Lithology includes the composition, fabric, texture or other attributes that influence the physical or chemical behavior of rocks and engineering soils. These attributes are very important in determining the shear strength, permeability, susceptibility to chemical and physical weathering, which in turn affect slope stability.

Among the important characteristics of the solid constituents of sedimentary rocks are the size, size distribution, shape, area, surface characteristics and mineralogy of the rock or mineral particles, the mechanical strength of the particles. In fine-grained sedimentary deposits, the relative abundance of clay minerals and chemistry of water are dominant compositional factors influencing slope stability. With increasing water content, clayey materials lose shear strength, but the decrease in shear strength remain plastic or susceptible to ductile behavior rather than becoming liquid are strongly dependent upon the particular type of clay mineral present [7].

Morphology
The slope is better understood as an essential factor in the equilibrium slope. In clay formations, for example, observe a positive optimal sliding: a weaker slope is stable and strong slopes. Morphological context of a portion of the slope is also taken into account, particularly if the concentration of surface water or groundwater. In some regions there is a difference in terms of frequency of events between the slopes exposed to south and north, due to daily temperature jumps more marked in the first case.

Vegetation
Deforestation and vegetation loss may reduce up to 90% the stability of some slopes. Inefficient irrigation or sewage effluent disposal practices may result in increased ground-water pressures, which in turn can reduce the stability of rock and sediment.
The effect of vegetation on slope stability appears to be complex in that, depending on local conditions of soil depth, slope, and type of vegetation, a vegetation cover in some ways definitely promotes stability. The foresting on the rock wall may be a protection against falling stones and blocks, but should not be overestimated his ability, power off the blocks is quite limited. Compared with the phenomenon due to drainage, trees accelerate the process of improving a range of several meters.

**3.2. Time-varying factors**

Variable factors are those that trigger instability or which because a marked acceleration of movement that leads to rupture.
Precipitation and Temperature
Intense or prolonged rainfall rapid snowmelt or sharp fluctuations in ground-water levels can all trigger a landslide. In case of clayey soils, prolonged rainfall will be the main triggering factor. This is because clayey soils often need days of rainfall to cause their saturation. Intense rainfall over a short period of time will, however, not be sufficient to cause its saturation and trigger a landslide. In the case of residual and granular soils, this is not the case. These soils' structure allows for relatively rapid drainage and prolonged rainfall cannot saturate them. It is intense rainfall that will cause their saturation and the consequent reduction of frictional forces in the material (due to the increase in pore pressure), resulting in a potential landslide. The two principal reasons why landslides are triggered by these conditions are a rise of pore pressure and an increase of the slope weight. During intense or prolonged rainfall soils tend to saturate resulting in an increase of the pore pressure. Any increase in pore pressure will result in an equal diminution of the effective stress in the soil, which in turn results in a reduction in the frictional forces.
Temperature variations are a triggering factor of falling stones and blocks, due to differential dilatations that occur. The frost can cause a local increase of hydraulic pressure, if it covers endings of the fracture surface. The defrost is accompanied by the release of large amounts of water and lead to generate flowing type sliding (especially in the cold regions, where in the spring an unfrosted surface layer sits on an impermeable layer which don't freeze) or the fall of blocks.
Earthquakes and volcanoes
Landslides occur during earthquakes as a result of two separate but interconnected processes: seismic shaking and pore water pressure generation.

The passage of the earthquake waves through the rock and soil produces a complex set of accelerations that effectively act to change the gravitational load on the slope. These processes can be much more serious in mountainous areas in which the seismic waves interact with the terrain to produce increases in the magnitude of the ground accelerations. This process is termed topographic amplification. For the main part seismically generated landslides usually do not differ in their morphology and internal processes from those generated under non-seismic conditions. However, they tend to be more widespread and sudden. The most abundant types of earthquake-induced landslides are rock falls and slides of rock fragments that form on steep slopes [4]. However, almost every other type of landslide is possible, including highly disaggregated and fast-moving falls; more coherent and slower-moving slumps, block slides, and earth slides; and lateral spreads and flows that involve partly to completely liquefied material (Keefer, 1999). Rock falls, disrupted rock slides, and disrupted slides of earth and debris are the most abundant types of earthquake-induced landslides, whereas earth flows, debris flows, and avalanches of rock, earth, or debris typically transport material the farthest. There is one type of landslide that is essential uniquely limited to earthquakes - liquefaction failure, which can cause fissuring or subsidence of the ground. Liquefaction involves the temporary loss of strength of sands and silts which behave as viscous fluids rather than as soils. This can have devastating effects during large earthquakes.
Some of the largest and most destructive landslides known have been associated with volcanoes. These can occur either in association with the eruption of the volcano itself, or as a result of mobilization of the very weak deposits that are formed as a consequence of volcanic activity. Essentially, there are two main types of volcanic landslide: lahars and debris avalanches, the largest of which are sometimes termed flank collapses.

Liquefaction process

The passage of the earthquake waves through a granular material such as a soil can induce a process termed liquefaction, in which the shaking causes a reduction in the pore space of the material. This densification drives up the pore pressure in the material. In some cases this can change a granular material into what is effectively a liquid, generating 'flow slides' that can be rapid and thus very damaging. Alternatively, the increase in pore pressure can reduce the normal stress in the slope, allowing the activation of translational and rotational failures.

Human causes include:
- removal of vegetation;
- interference with, or changes to, natural drainage;
- leaking pipes such as water and sewer reticulation;
- modification of slopes by construction of roads, railways, buildings, etc;
- overloading slopes;
- mining and quarrying activities;
- vibrations from heavy traffic, blasting, etc; and
- excavation or displacement of rocks.

Disturbances often precarious balance of the natural environment, made by man can directly trigger movements, in particular:
- changes the natural balance of the slopes: digging at the foot of the slope, embankments at the end of the slope;
- hydro-geological conditions of the environment changes: removing water from a slope (sewer hole, for example), excessive pumping of water favors dissolving soluble rock, etc.;
- vibrations caused by explosions, which are likely to trigger the fall of stones and blocks, or vibration due to road traffic.

## 4. CONCLUSIONS

It is obvious that landslides have become a very serious problem all around the world. Although landslides can occur as a result of natural processes, many of these landslides can be avoided with proper planning and the

implementation of different timber harvest techniques. Many communities that have come to depend upon timber harvesting as their primary economic function have begun to lobby for alternative methods in which the harvesting is carried out to not only insure future yields, but also to prevent more occurrences of environmental hazards in their areas [2].
Engineering works to ensure the stability calculation of slopes and very diversified in recent years by adopting economic and reliable construction solutions.
With reference to the morphological configuration of adjacent slopes and platforms, we can say that the loss of steady state comes from the change in mass distribution and loading, through the separation, subsidence, erosion, etc. To return to stable situation, is recommended to improve compliance of relief, with slopes regular, monotonous, with a rake that will ensure stability.
Prevention and control by building support sliding require careful scrutiny because this type of work requires special materials and equipment generally large funds. Therefore the use of such measures will be decided by a technical-economic analysis pertinent, in which to take into account the importance and cost work protected the degree of risk, the damage that would occur through disposal slope.
Vulnerability to landslide hazards is a function of location, type of human activity, use, and frequency of landslide events. The effects of landslides on people and structures can be lessened by total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. Local governments can reduce landslide effects through land-use policies and regulations. Individuals can reduce their exposure to hazards by educating themselves on the past hazard history of a site and by making inquiries to planning and engineering departments of local governments. They can also obtain the professional services of an engineering geologist, a geotechnical engineer, or a civil engineer, who can properly evaluate the hazard potential of a site.
There are various direct methods of preventing landslides; these include modifying slope geometry, using chemical agents to reinforce slope material, installing structures such as piles and retaining walls, grouting rock joints and fissures, diverting debris pathways, and rerouting surface and underwater drainage. Such direct methods are constrained by cost, landslide magnitude and frequency, and the size of human settlements at risk [9].

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