COMPLEX ANALYSIS IN THE RIVER BASIN OF TOPLIŢA AND TECHNOLOGICAL SOLUTIONS FOR SLOPES STABILIZATION

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Abstract
Landslides distribution is differentiated function of various causal factors or conditions (litology, declivity, land use, precipitations). For each factor, it can be depicted some homogeneous areas, with numerical coefficients, in a incresing succession (1 – very high; ... 5 – very low), using the GIS. The complex arrangement involves the analysis and diagnosis of watershed planning, establishing its vulnerability to the action of natural and anthropogenic factors. New technologies for earth reinforcement with other engineering works to stabilize the slopes, are durable works because the chemical properties of high density polyethylene, which does not react with any other environmental component (ex. earth geogrid reinforcement). New technologies for earth reinforcement executed in complex with other engineering works to stabilize the slopes, are durable works because the chemical properties of high density polyethylene, which does not react with any other environmental component. Using special technology to stabilize determined substantial time and cost savings compared to traditional solutions. The landscape of slopes reinforced with geogrids, due to external quality topsoil is clearly superior to the classical solutions of stabilization.

Keywords: slope stability, analyze, technological solution, GIS

1. INTRODUCTION

In the geomorphological literature, when dealing with a process frequently invoked causes (development conditions, factors) that led to its emergence and development. Furthermore, we refer to a number of variables that can take, at a given time, different values and acting on the object of research may affect the value of optimization parameter. If you require computer processing, it is necessary that these factors be quantified.
The need to ranking the control factors issues from theirs weighting and manifestationt in a system depends on the scale and types of existing processes, and generally, on the cause-effect relationships, so the effect may become cause at a time.
The catchment analysis involves recording the most general factors, namely the field areas of influence: the geological factor, the climatic factor, the hydrological factor, vegetation, anthropogenic factor [1].

2. COMPLEX ANALYSIS

Topliţa basin, which were investigated, is included in the Argeş Hillocks. Topliţa is a right tributary creek of Vâlsan river. It presents a more elongated basin north-north-west - south-south-east, with absolute altitudes ranging from 726 m (Perşa Peak) and 480 m at the confluence. The total length of the main artery is 11.25 km, and the maximum width of the basin is 4.5 km, of which 1625 m on the right side of the valley and 2975 m on the left side, highlighting the asymmetric nature of the basin.
(a) ***geological factor***
Lithological composition. Topliţa basin is placed entirely in the piedmont area, consisting of monoclinal Pleistocene formations, represented by alternations of sands, gravels and clays with a predominance of lacustrine facies in the base, continued at the top with gravel, sands and blocks with torrential stratification. On the interfluves, the gravels complex is covered with yellowish loess.
Superficial deposits are represented mainly by deluviums thickness often exceeding 5 m. The high slope (above 20°), these thicknesses are 2 m average. The clay fraction presence in the deluviums influences the slopes stability prone to landslides. On the interfluves, there are eluviale deposits, commonly 1-2 m thick, sometimes even below 1 m. On the bottom of Topliţa and Vâlsan valleys, with floodplains,

terraces and dejection cones, there are aluvio-proluvial deposits, sometimes leveled layout.

(b) ***geomorphological factor***

Morphographical features highlight the geomorphological groove character, given the constraints of a watershed on both sides. From the far north (Dealul Mare, 760 m), the basin is bounded by Cirianului Peak (677 m) and Sterioiului Hill (632 m), oriented approximately north-south. Interfluve then becomes a NW-SE direction, gradually decreasing in altitude from 597 m (Băila Hill), in 577 m and down to 500 m where the character disappears, the slope is confusing with the Vâlsan slope. These ridges, one after the other, constitutes the watershed between the Topliţa and Sasu, Arges and Buneşti catchments. In the east, from the same north point, the valley is closed by the Malu Roşu peak (664 m) - Râpa Văinii (616 m), with a bow disposition. At an altitude of 550-500 m, in Ceauşului Hill, the peak character is lost crossing the Vâlsan slope. Peak is the interfluve between Topliţa and Șoptana catchments.

Connection between the interfluvial ridges and valley bottoms is done by Topliţa valley slopes, which have been heavily fragmented by tributaries, creating peaks and secondary interfluves, without relief pregnancy for the general area of the slope. Most important are the interfluves between Topliţa and Călugărului Valley and major tributaries located on the left side of Topliţa.

The bottom of the valley is generally narrow (300-500 m), with enlargement sectors (most important areas of confluence). At the bottom of the basin are Vâlsan floodplain and terraces, affected by the Topliţa dejection cone.

Morphometric variables

Topliţa basin, with an area of 28 km², falls into the hilly relief, there can be frequently filled with some meteorological phenomena (great torrential rain, as in 2005), which would be passed in the large floods occurrence that increased solid transport. Maximum relief energy, given by the difference between the extreme altitudes, has a value of 280 m.

Distribution of relief altitudes show a gradual increase in the maximum percentage values of the landscape development located between 500 and 600 m (here is also situated the basin average altitude - 543 m), then there is a gradual decrease in rates. Hypsometric integral expressed a young relief with the passage to maturity, with a high denudation potential, but is influenced by other morphometric factors.

Circularity ratio (1.48) express a moderate degree of torrentiality.

The slopes (slope gradient) is one of relief items whose influence is decisive on the present-day modelling processes. Analyzing the percentage distribution of slopes, there is a domination of slopes class between 10 and 15°, which is 35.3%; nex tis the slopes group between 5 and 10°, representing 32.4% and group 15 to 20°, with percentage values lower, 16%. Other slopes categories occupy areas of less importance in the global quantum. Analyzing the significance of these slopes, we can say that the slopes with values of 5-15° (67.7%) are characteristic to the slopes shaped by landslides, according to the lithology of alternating sands, gravels and clays.

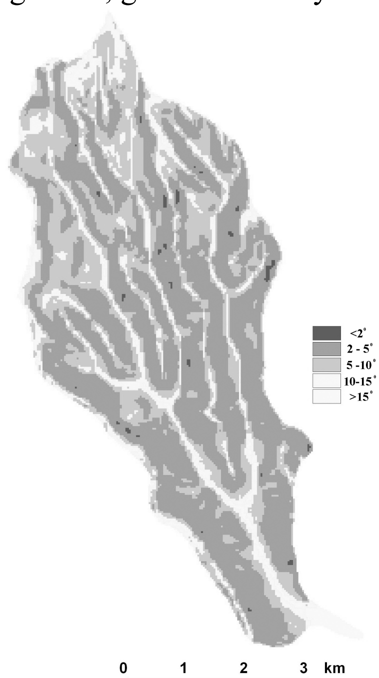


Figure 1 The slopes (slope inclination)

(c) ***climatic factor***

Rainfall is the most important factor in climate control hierarchy of geomorphological processes. They are important both in terms of quantity, but especially in the time distribution of rain number, duration and intensity.

Average annual precipitation amounts that fall within the area are between 700 and 900 mm, with a gradient of 63 mm/100 m. The maximum values recorded between May and July, with volumes of 80-100 mm/month. The highest monthly precipitation amounts can occur in any month of the year, but especially in the months of peak rainfall: Curtea de Argeş 290.1 mm/June 1940; Piteşti 267,8 mm/June 1975; Curtea de Argeş 266,6 mm/July 1975; Piteşti 181,7 mm/July 1979; Curtea de Argeş 256,5 mm and Piteşti 282.9 mm in October 1972. Annual minimum occurs in late winter, in February and March, when the average monthly amounts of 35-40 mm and in September (40-45 mm).

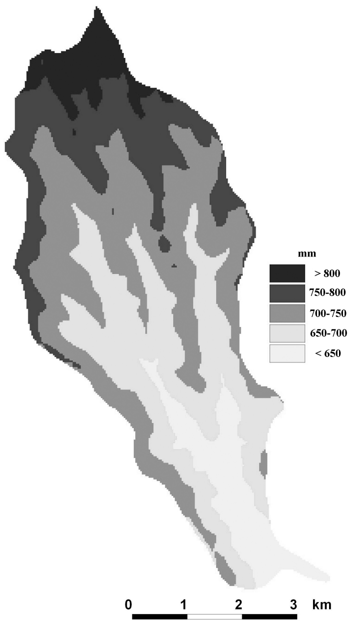


Figure 2 Distribution of average annual precipitation amounts

(d) ***vegetation factor***

Topliţa basin lies in the nemoral forest belt (oak with hornbeam, which frequently occur in mixt species: beech, silver linden, maple, English oak and birch). Valley bottom is occupied by the species of willow (*Salix alba, S. purpurea*), alder (*Alnus glutinosa*) and poplar (*Populus alba, P. nigra*). Forest area is 62.3% of the basin.

Pastures and grasslands, occupying 15%, are secondary and cleared forests occurring. They are average productivity and the most typical association is *Agrostis tenuis* with various accompanying mesophilic. It is an association rich in species; with *Agrostis tenuis*, unprecedented abundant *Festuca pratensis, F. valesiaca, Dactylis glomerata, Phleum pratense, Briza media, Cynosurus cristatus*, the less evolved soils *Agropyron repens* and *Brachypodium pinnatum*. Add the various mezoxerophyte or xerophyte species as *Festuca rupicola*, *Botriochloa ischaemum, asperula cynanchica, Dorycnium herbaceum*.

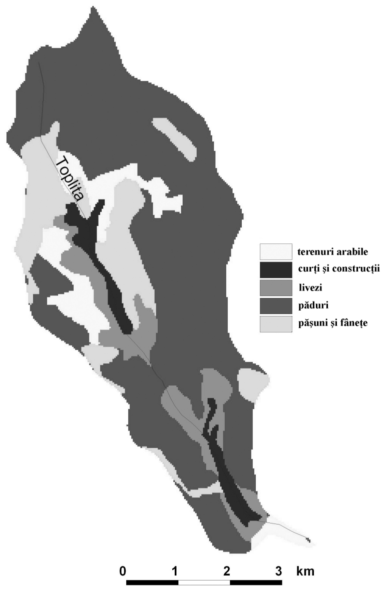


Figure 3 Land use

(e) ***anthropogenic factor***

Human influence has been felt ever more strongly in relief changes, both indirectly (deforestation) and directly.

Deforestation, particularly unfair cuts in the last decades, is the main cause of natural landscape degradation and change the balance of different ecosystems. The action was more intense along the bottom of valleys and slopes, as a result of road expansion and building settlements fireplaces. Satmary map (1857), compared with the current maps, reveal a marked tightening of the area occupied by forest. The consequences of deforestation are to increase the torrential flow regime, the increase in solid flow of rivers in extensive land

degradation (landslides, gullying). But in fact in most cases, land degradation has not occurred because of both logging and especially because of the use after deforestation, grassland or agricultural crops, so land the best natural potential, but used improperly, have reached a more advanced state of degradation than some very poor areas with potential but the anthropogenic pressure is not manifested so intensely.
The actions that man has exercised directly on the environment include: development of forest roads, plantation, slope stabilization work (fences, etc.) and expanding settlements.

3. RESULTS

Depending on the morphodynamic nature, contribution and effectiveness, each factor has an active function (direct influence) or play a passive role (indirect influence) to maintain balance slopes. In reality, the two sets of factors are closely inter-modelers.
Have been proposed various techniques for assessing susceptibility (vulnerability) to landslides [2], [3], [4], [5].
Statistical evaluation of physical factors influencing slope stability was achieved by cell-grid (30x30 m square). The final result is a numerical ratio for each cell, which is facilitated by the use of GIS.
By overlaying different maps for each considered factor, two by two on informatic levels, resulting landslide susceptibility map.
(1) very high susceptibility (33%) - areas already affected by deep landslides and even collapse, on large areas, and active torrents;
(2) high susceptibility (34%) - areas with high-excessive erosion, associated with gullying and landslides triggered amid large areas of old-slide processes, stabilized;
(3) average susceptibility (20%) - areas of predominantly moderate sheet erosion and shallow landslides, mud flows sometimes; there is risk of activation in rainy years, changing land use (clearing, grubbing) or works to slopes destabilize;
(4) low susceptibility (9%) - areas without landslides, but the instability potential, currently affected by sheet erosion processes;
(5) very low susceptibility (4%) - areas with very weak denudational processes, erosion generally unappreciated.

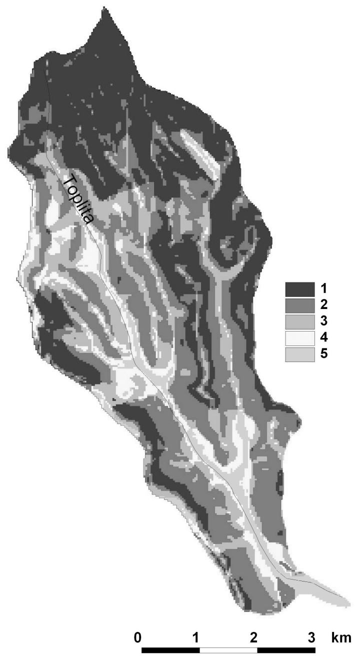


Figure 4 Land susceptibility to landslides

Thus, there is a real correlation between the areas with high susceptibility to landslides (fig. 4) and field research of the present-day geomorphological processes (fig. 5).
Left valley slope faces west and west-south-west, not exceeding 180-200 m high and 500-600 m in length, being drained by the longest tributaries of Topliţa: Călugărului Valley and Boului Valley. In general, because it is forested, predominantly appears stable. Right side, facing east and east-north-east, is subjected to the mass movement processes (landslides, falls, mud flows) and those of gullying.
Research has shown the differentiation of three sectors (in the longitudinal profile of the valley), the processes of erosion, transport and accumulation were different weight [5], [6]:
- in the upper basin is a large valley sector, advanced, suspended, largely fixed by tree vegetation. Scarps are mostly suspended and fixed by vegetation, extremely small portions

being active, but without a significant share in supplying beds with silt. This corresponds to a relatively stable sector earlier stage of modeling of the valley, where there were conditions for prolonged stability of the local base.

Sector I: 3000 m;

Lithology: blocks and gravel, alternating with coarse sands;

Slope processes: slopes predominantly fixed, forested, except right slope of Topliţa bordered by two successive steeps and ancient landslides, which is fixed and the origin where there is an active landslide.

- follow a transitional area, the predominant erosion portions alternating with the accumulation of silt. Sector begins with a steep descent of variable size (2-15 m) and continues with a deep narrow valley. The slope (5-20°) is marked by the emergence of numerous bed sill heights can exceed 2-3 m, and the banks are fixed at a rate of 40-50%. Is often temporarily flooded riverbed by deposits coming from the slopes. Slopes include stable landslides and tributary valley on the right side is active spring ravines and dripping hillsides with extensive processes and landslides, resulting in significant amounts of silt.

Sector II: 5600 m;

Lithology: gravels, coarse sands, clays;

Slope processes: slopes predominantly fixed, rather forested; slide waves on both sides of Topliţa, fixed and active landslides, torrents with high activity in the Topliţa village, on the right of Călugărului Valley.

- in the third sector, the predominant process becomes temporary silt deposition, the slope is 1-6°, thresholds are very rare and low shores are mostly fixed. The sector ends in dejection cone from the confluence of Topliţa with Vâlsan, which is still small compared with the basin extension, because a large proportion of transported alluvia are made even in the Topliţa floodplain.

Sector III: 3400 m;

Lithology: clays, sands and small gravel lenses;

Slope processes: both stabilized slopes with low declivity.

In conclusion, there is a concentration of modeling processes in the middle of the Topliţa basin, on the right side and on the only larger secondary valley on the right.

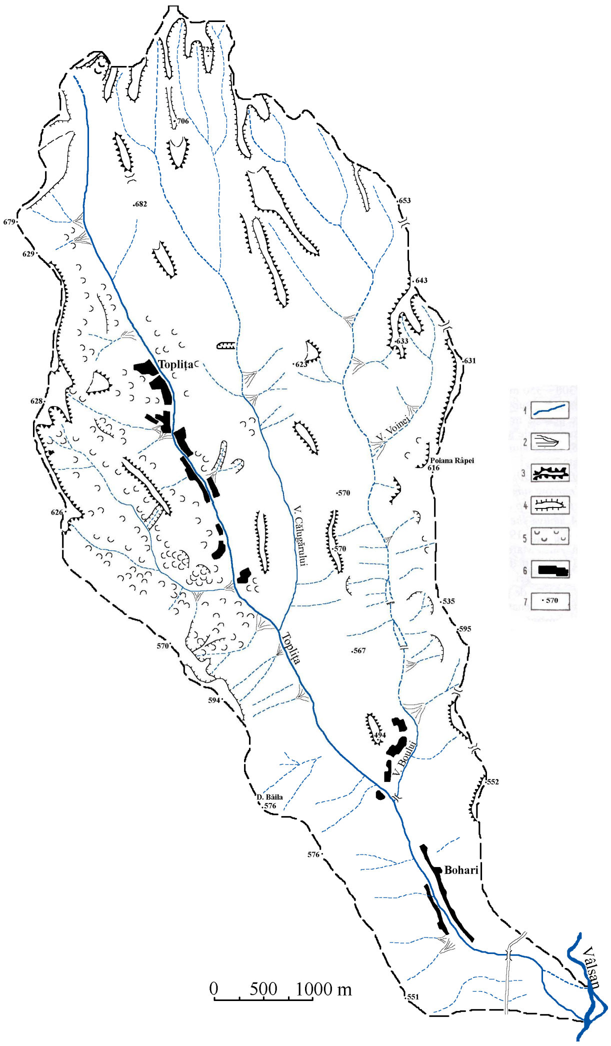


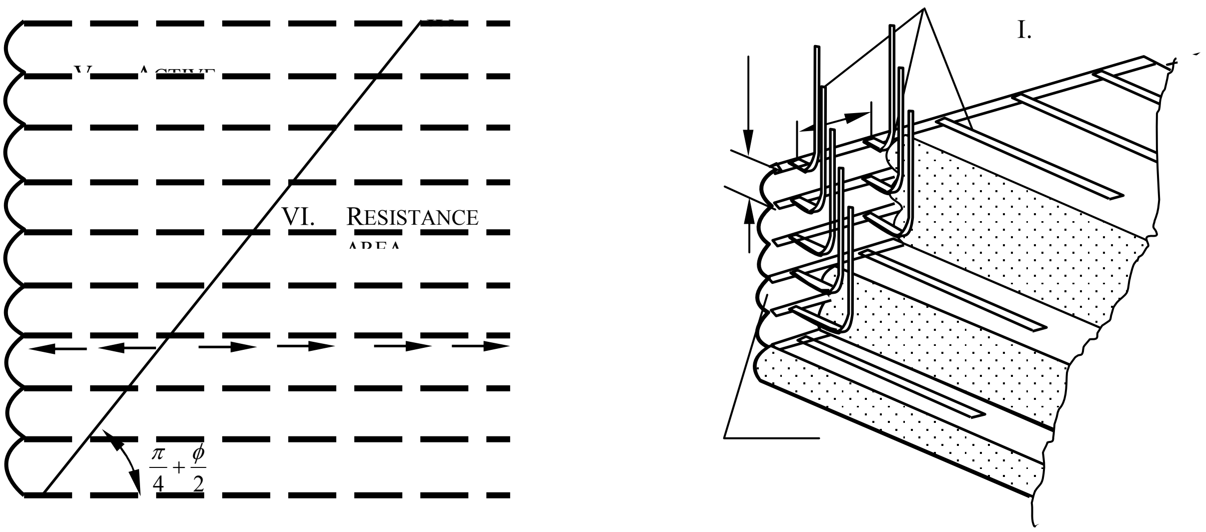
Figure 5 Topliţa basin
1. watercourse; 2. dejection con; 3. scarp over 5 m; 4. scarp below 5 m; 5. slide; 6. locality; 7. share

4. TECHNOLOGICAL SOLUTIONS

Choosing the best ways to prevent instability processes in a given area is an engineering problem, the solution which must take into account various factors in order to obtain the most effective results with less effort and expense possible.

It is generally assumed that the establishment of precautionary measures is more difficult because it requires anticipation of situations that can not be determined with precision:

phenomena scale, slide area shape, conditions for the process, etc.
To avoid worsening the balance after the execution of various works slopes or development of unfavorable natural factors should be considered a set of principles-measures:
- prohibition of felling trees, bushes or vegetation layer removal;
- restrictions on the work of earth excavation in the passive ban (which the opposing tendencies weight bearing), stop charging by executing the core deposits, various fillings, etc., slope gradients existing ban on the rise, stop digging the discovery by unstable layers of earth (clays with low consistency, etc.).
- imposing certain conditions on water regime in the area: land leveling to ensure surface water drainage to avoid stagnation in different depressions;
- the restriction on the dynamic stresses ban or limit the movement of heavy machinery, etc.
- complex work to slopes stabilize, using special technologies to land with geogrid reinforcement, fig.6.a, fig.6.b.
- benefit of geogrid reinforcement is that the slope may remain high (even vertical), fig.7, fig.8, fig.9, fig.10 and fig.11.



a) b)

Figure 6 (a, b) Schematic section through a reinforced earth with representation of the voltage distribution efforts reinforcement (geogrid)

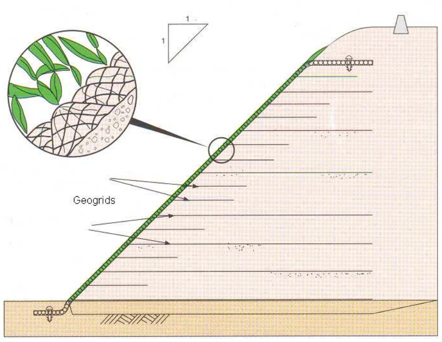


Figure 7 TENSAR geogrid stabilization for slopes greater than 45°

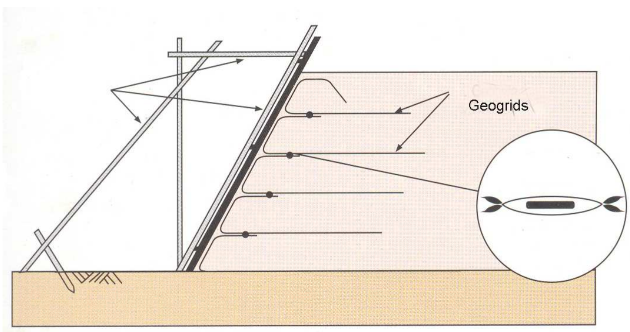


Figure 8 Reinforcement and prestressing methods of lands

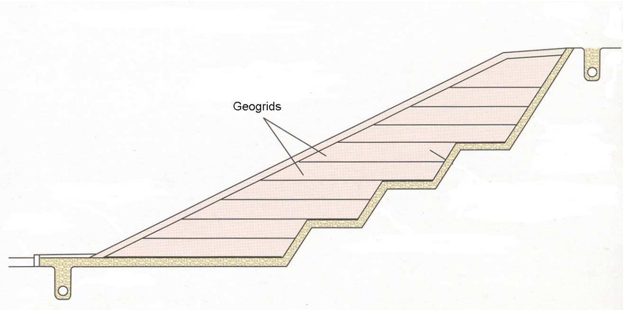


Figure 9 TENSAR uniaxial geogrid reinforcement

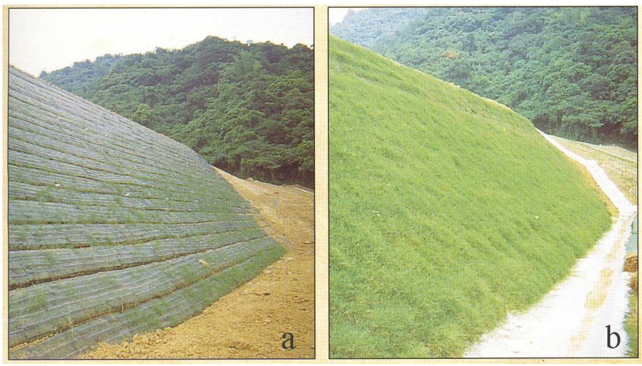


Figure 10 Examples of massive fixed (a, b) land with geogrid reinforcement

Figure 11 Examples of solid stabilized uniaxial geogrid

5. CONCLUSIONS

Mitigating the negative effects of landslides are carried out development work of the slopes, and other methods to ensure the protection of people and goods: exposed lands zonation; discourage development in exposed areas; forecast and increase their anticipating time; operative actions.

The complex arrangement involves the analysis and diagnosis of watershed planning, establishing its vulnerability to the action of natural and anthropogenic factors. Landslides are complex phenomena that cause major ecological impacts on the environment, the cost of slope stabilization work being very high.

New technologies for earth reinforcement executed in complex with other engineering works to stabilize the slopes, are durable works because the chemical properties of high density polyethylene, which does not react with any other environmental component.

Technology for earth geogrid reinforcement, allows a wide range of earth, including cohesive and aggressive earth.

Using special technology to stabilize determined substantial time and cost savings compared to traditional solutions.

The landscape of slopes reinforced with geogrids, due to external quality topsoil is clearly superior to the classical solutions of stabilization.

6. REFERENCES

[1] Rădoane N. Geomorfologia bazinelor hidrografice mici. Suceava: Edit. Universităţii, 2002.

[2] Galli M., Guzzetti F. Landslide vulnerability criteria: a case study from Umbria, Central Italy. Environmental Management 2007; 40: 649-664.

[3] Guzzetti F., Reichenbach P., Ardizzone F., Cardinali M., Galli M. Landslide hazard assessment, vulnerability estimation and risk evaluation: an example from the Collazzone area (Central Umbria, Italy). Geogr. Fis. Dinam. Quat. 2009; 32: 183-192.

[4] Petrescu N., Măgdălina I. Amenajarea, organizarea şi sitematizarea teritoriului. Târgovişte: Edit. Bibliotheca, 2009.

[5] Tanislav D. Studiul geographic al hazardelor naturale din Podişul Getic – sectorul Olt-Dâmboviţa. Târgovişte: Valahia University Press, 2009.

[6] Teodorescu V. Morfodinamica versanţilor din bazinele hidrografice mici. Bucureşti: Edit. Fundaţiei *România de Mâine*, 2001.