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LANDSLIDE HAZARD IN BULGARIAN PART OF THE RHODOPEAN MOUNTAIN MASSIF

Rosen Iliev, Ilia Mitkov
South-West University „Neofit Rilski“ – Blagoevgrad, Natural – Mathematical Faculty, Department of Geography, Ecology and Environment protection.
e-mail: rosen_faust@abv.bg; iliamitkov@swu.bg

Резюме

Целта на настоящия доклад се явява анализът на предпоставките за развитието на свлачищната опасност в рамките на Родопския планински масив. За постигане целта на изследването са формулирани следните научни задачи:

- анализ на географското разпределение и генезиса на свлачищните процеси в Родопите;

- изграждане на обобщен модел на свлачищната опасност в рамките на Родопския планински масив (по литературни данни);

Ключови думи: *Родопи, свлачища, опасност.*

Introduction

The Rhodopean Mountain Massif is large mountain system in the eastern part of the Balkan Peninsula. It is prolonged in WNW – ESE direction at one longitude from 225 km by maximal width -130 km in South Bulgaria and North-East Greece. The total area of the Rhodope Mountains is about 18 000 km², of which on Bulgarian territory is 14,738 km², which represents 81.88% of its entire area.

The Rhodopean Mountain system includes a big number of different oriented mountain ridges. They are closed some relief depression areas. The altitude characteristic of the mountain massif gives good reason to divide it in general on two parts- the western one and eastern one. The border between them emerged in Kayaliyka River Valley (a tributary of the Maritsa River), Kitka Saddle (735 m), Borovitsa River Valley and southeastern slopes of the hill Zhalti dyal reaches the border Tri kamaka Saddle (550 m), located southeast of the town of Zlatograd.

The complex tectonic and geomorphological development of the Rhodope Mt. is a prerequisite for the emergence in his territory of different adverse risk processes. Key place among these processes occupy landslides. They form one of the main geological hazards in this part of the country.

Genesis and distribution of landslides in the Rhodopes

Landslides form a significant component of the natural disasters that affect most of the hilly regions around the country. Landslides are downward and outward movement of slope materials such as rock debris and earth, under the influence of gravity. Although the term landslide in the strict sense may be defined as a process involving the downward and outward movement of a part of the slope forming material due to the action of gravity, other forms of mass movements like falls, flows, topples and creeps are generally included in the term landslides.

The causes of landslides in any form are thus multitudinous. Geological or topographical factors condition the location of a potential landslide. If weathered or unweathered bedrock contains inherent lithological or structural weakness, then these areas will favor slide failure. Lithologically favorable material includes leached, hydrated, decomposed, chloristic, or micaceous rocks, shales, poorly cemented sediments, or unconsolidated material. (Bryant, 2005)

Landslides are widely, but unevenly developed in the territory of the Rhodope Mountain. Here you can find all major types of landslides- ancient and modern, active and extinct, big and small, fast and slow, detrusion and delapsion type etc. This colorful set of different mechanism, size and speed of manifestation landslides in greatest extent determined by the diverse geological and tectonic structure of the mountain, indented relief and underground hydrodynamics (Бручев, 1994). The main factors determining landslide activity in the region can be grouped into three main types: geological-tectonic, geomorphological and anthropogenic. (Table 1)

Table 1 Main landslide causes in Rhodope Mts.

Geological- tectonic	*Geomorphological*	*Anthropogenic*
Tectonic uplift; Earthquakes; Adversely oriented discontinuity (bedding, schistosity, faults, unconformity, contact, and so forth);	Weathering; Contrast in permeability of materials; Weathered materials; Sheared, jointed, or fissured materials; Fluvial erosion of slope toe or lateral margins; Subterranean erosion (solution, suffosion); Deposition loading slope or its crest; Vegetation removal (by fire, drought);	Deforestation; Excavation of slope or its toe; Mining; Artificial vibration;

The Rhodope Mt. are part of your own landslide region in the composition of the South Central landslide zone. In the course of extensional taphrogenesis and block disintegration a flat board fence shoulders of Hvoynenska and Jagodinska depressions, and the Mesta, Struma and Dospat graben valleys involves the development of active landslides. Much of landslides in the area are developed in fault zones and structures surrounding and intersecting Rhodope Mt. (Яранов, 1960). The landslide activity is mainly associated with the Chepino, Dospat, Devin and Ardino depression fault system and same smaller seismic faults, which mark the boundaries between uplifted local dome structures within the Rhodope Mt. The occurrence of earthquakes in steep landslide-prone areas greatly increases the likelihood that landslides will occur, due to ground shaking alone or shaking- caused dilation of soil materials, which allows rapid infiltration of water.

A significant part of landslides are concentrated within a deep gorge carved valleys and peripheral slopes of lava pall in the Eastern Rhodopes. The majority of landslides here are stabilized, but some, like those in the villages of Zhenda and Bezvodna (Chernoochene Municipality) village Nenkovo (Kardzhali Municipality) and villages Jamino and General Geshevo (Dzhebel Municipality) show periodic activation (География на България, 2002). Landslides in the region often have detrusion-

delapsion character, shaped by geological- stratigraphic structure and physic-mechanical properties of the geological substrate. Geological structure can be represented as a two-layer environment, built from top layer, most often brittle volcanic massif, continued in the more easily deformable plastic rocks of marl, tuff, etc. Such landslides are observed around Madzharovo, Nanovitsa, Stramnoridska caldera and in town of Dzhebel- so call 'Drunken forest". Considerably smaller by volume and surface landslides occur in the periphery of the Tertiary and Neogene hollow depression. An essential part of landslides are attached to deeply carved river valleys.

In the Western Rhodopes landslides are formed at the periphery of Bratsigovo-Dospat and Smolyan rhyolite shroud and the scope of normal fault structures with well-formed delluvial-prolluvial fan deposits. In the western part of the Rhodope Mt. typical landslide areas are outlined Smolyan, Hrabrino, Jagodina and Borino Tertiary depressions and deeply cut into their river-valley network. Most landslides here are relatively stabilized, but those in the region of Smolyan are activated periodically. The Smolyan detrusion landslide region is formed as a result of impaired balance border contact between thick rhyolite cover, characterized prismatic cracking and strech waterproof Paleogene sediments.

Landslide processes are particularly pronounced on the northern edge of the mountains, especially the area around the towns of Asenovgrad, Perushtitsa and Krichim.

Analysis of the landslide hazard in Rhodope Mountain Massif

Landslide hazard is anything associated with landslide that may affect the normal activities of human society. Landslide hazard is therefore “the probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomenon”. Guzzetti et al. (1999) preferred the definition to include the magnitude of the event, i.e. the area, volume and velocity or momentum of the expected landslide.

Landslide hazard (H) describes mathematical with the magnitude (M) and probability (P) for the occurrence of a landslide (Table 2), where

$$H=MxP$$

Table 2 Classification of the landslide hazard

Hazard	*Description*
≥ 30	Extremely high
≥20<30	Very high
≥10<20	High
≥7<10	Moderate
≥3<7	Low
≥ 2	Very low

Any landslide hazard or risk assessment must begin with the collection of information on where landslides are located. This is the goal of landslide mapping. A landslide inventory is the simplest form of landslide map. It records the location and, where known, the date of occurrence and types of landslides that have left discernable traces in an area (Hansen, 1984).

Maps are a useful and convenient tool for presenting information on landslide hazards. They can present many kinds and combinations of information at different levels of detail.

Hazard maps show the areal extent of threatening processes: where landslide processes have occurred in the past, recent occurrences, and most important, the

likelihood in various areas that a landslide will occur in the future. For a given area, hazard maps contain detailed information on the types of landslides, extent of slope subject to failure, and probable maximum extent of ground movement. These maps can be used to predict the relative degree of hazard in a landslide area. Areas may be ranked in a hierarchy such as low, moderate, and high hazard areas. (The Landslide Handbook- A Guide to Understanding Landslides, 2008).

For the needs of Ministry of Regional Development and Public Works of Bulgaria in 2006 it was updated map of landslide hazard, based on information and data from fund «Geoprotection» - LTD and «Engineering geological map of Bulgaria» in a scale 1: 500 000. Based on these sources by spatial density of landslides throughout the country and through the method of Kernel outlines areas with varying degrees of landslide hazard in the country. (Fig. 1)

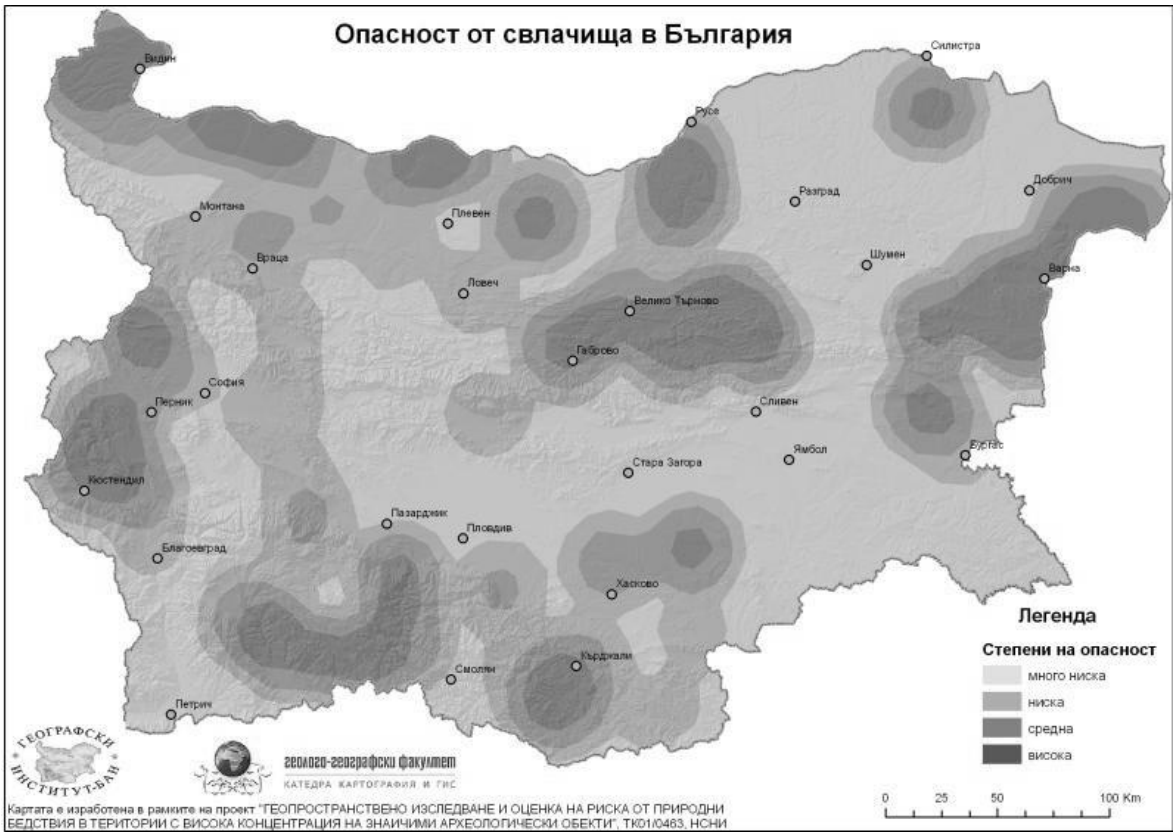

Fig.1 Landslide hazard map of the Republic of Bulgaria. (B.A.S.)

From the attached map it is clear that high levels of landslide hazard in Rhodope Mountain are characterized the regions of Chepelare-Smolyan to the west and Kardzhali-Ardino-Dzhebel to the east. Regions with medium degree of landslide hazard are the peripheral parts of the Mesta River Valley, parts of the Central and East Rhodope Mt., as well as the area Asenovgrad-Krichim to the north. The remaining parts of the mountain are characterized by low and extreme southeastern parts even with very low landslide hazard.

Some conclusions

Landslides in the Rhodope Mountain are the product of the complex interaction of endogenous and exogenous ground forces. Fault tectonics, complex lithological substrate, consists of rock types with Cretaceous, Paleogenic, Neogenic age, steep gradients, all notes of the deep river-valley network and proximity to some dangerous seismic foci determine landslide hazard in the western and central part of the

Rhodopean Mountain Massif. In the eastern part of the massif no less dominant role in the formation of landslide hazard plays deforestation and frequent wild fires in the summer, which in turn strengthens wind and water erosion, and hence landslides. Unfortunately no small part in creating conditions for the occurrence of landslides play and unfavorable anthropogenic activity through inappropriate exploitation of mineral deposits in the area.

References

Бручев, Ил., Геоложката опасност в България. Обяснителен текст към карта в М 1:500000, изд. БАН, С., 117 с., 1994

Мазур, И.И., О.П. Иванов, Опасные природные процессы, Москва, „Экономика”, 365 с., 2004

Николов, В., М. Йорданова, Ив. Ботева, Планините в България, Акад. изд. „Марин Дринов”, Трето преработено и допълнено издание, София, 2013

Яранов, Д., Тектоника на България. – Техника, София, 1960

Bryant, E., Natural hazards, Cambridge University Press, Second Edition, 312 p., 2005

Bruchev, I., Dobrev, N., Frangov, G., Ivanov, Pl., Varbanov, R., Berov, B., Nankin, R., Krastanov,
M., The landslides in Bulgaria — factors and distribution. — Geologica Balc. 2007

Guzzetti,F., Carrara A., Cardinali M. & Reichenbach P., Landslide hazard evaluation: an aid to a sustainable development. Geomorphology, 31, 1999

Hansen, A., Landslide hazard analysis. In: Brunsden D. & Prior D.B. (eds.), Slope Instability, John Wiley and Sons, New York, 1984

Protopopova, V., E. Botev, I. Georgiev, D. Dimitrov, Focal mechanisms of some earthquakes in Rhodope seismic zone, Seventh BgGs National Conference with International Participation „GEOPHYSICS”, 2015

Tzankov, Tz., R. Iliev, MORPHOTECTONICS OF THE RHODOPEAN MOUNTAIN MASSIF, FOUR INTERNATIONAL CONFERENCE „Geographical Sciences and Education”, Shumen, 30-31 October , 2015

Tzankov, Tz., R. Iliev, MORPHOSTRUCTURE OF THE RHODOPEAN MOUNTAIN MASSIF, Publishing House “Grafika 19”, Sofia, 2015

Varnes, D.J. Slope movements, type and processes. In: Schuster R.L. & Krizek R.J. (eds.), Landslide analysis and control. Washington Transportation Research Board, Special Report 176, NAS, Washington, 1978

Varnes, D.J., and IAEG Commission on Landslides and other Mass–Movements, Landslide hazard zonation: a review of principles and practice. UNESCO Press, Paris, 1984

*** Анализ и оценка на риска от уязвимостта на секторите в българската икономика от климатичните промени, Европейски фонд за регионално развитие на ЕС чрез оперативна програма „Околна среда 2007-2013 г.“

*** Методика за оценка на геоложкия риск, Българска академия на науките, Геологически институт „Страшимир Димитров”, Министерство на регионалното развитие и благоустройството, София, 2014

***Физическа и социално-икономическа география на България, Географски инст. БАН, Изд. “Форком”, София, 2002

******* The Landslide Handbook- A Guide to Understanding Landslides, U.S. Geological Survey, Reston, Virginia, 2008