Geotechnical hazard evaluation of the Medvednica Nature Park

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Abstract: In making the article, several thematic maps with scale 1:25000 were used. They have been adopted as the factor maps and with their overlapping the map with new contents was made. The Preliminary qualitative map of sliding hazard, including the erosion, was made by heuristic approach.

Key words: landslide hazard zonation, causative factors, surface and ground water conditions

Introduction

The investigation area is represented by Medvednica mountain, with the surrounding area. The total surface of investigated area -Medvednica Nature Park[1], is around 225 km^2. The mountain belongs to the SW mountain cores of Pannonian basin. Geology and other nature based conditions predestined the individual terrain parts for the different types of instability. Their distribution is reflected on the space usability and the state of the inhibited areas[2]. Under the term "Geotechnical hazard" it is presumed here firstly the sliding hazard, including the erosion.

The analysis of the causative factors

Preparatory and triggering factors - The evolution of recent landslides is under the influence of ground conditions, geomorphological processes, physical processes of seasonal character - prolonged high precipitation and especially significant permanently present man made processes. They all are the preparatory factors. The extreme hydrological phenomena - torrent floods of the mountain streams of Medvednica Mt., as the triggering factors, can cause the mass occurrence of the landslide. Such phenomena could be initiated by intense precipitation of thousand-year return period like the strong mountain torrents occurred in summer of 1989 and they had all the characteristics of natural disaster[3]. Due to known epicenter region near Kašina, the strong earthquakes should be counted as the initiation causes.

The lithological map with outlined engineering geological units, the inclination map with four categories (0-5°, 5-12°, 12-32° and >32°) and the landslide map were made. On the latest map, the areas with increased erosion and generally unstable areas are shown. Structural-geomorphological map[4] shows the main characteristics of recent structures. Hydrogeological map was considered tightly with geomorphological map. In that way, the

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map with new contents was produced - surface and groundwater condition map. That enabled the evaluation of dominant triggering factor for activation the new landslides. The integration of facts from all the maps and engineering evaluation lead to new quality that was presented in the last - synthetic, qualitative map of prognostic meaning (Fig. 1).

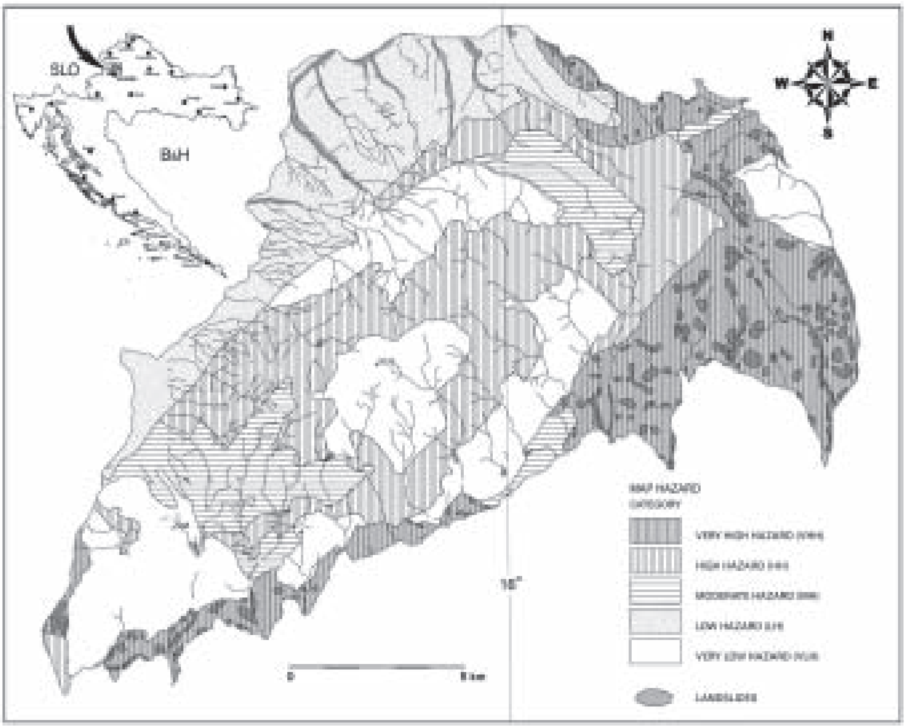

Figure 1. Preliminary qualitative map of sliding and erosion hazard

Hydrogeological properties of Medvednica Mt. and brim – They are differentiated according to two main morphohydrographic unities: mountain massif and low Neogene hills, enclosing the massif. The rocks are divided into two main categories: permeable and impermeable[5 & 6]. The permeable rocks are divided into the subclasses with good and poor permeability and the impermeable rocks are divided into the subclasses with low permeability and impermeable rocks.

Low metamorphic rocks of Paleozoic age and the clastic rocks of lower Triassic age are mainly impermeable. These are various sandstones, siltstones, marls, conglomerates and various schists and marbled schistic limestones. The shallow groundwater circulation takes place in marbled deposits. Effusive rocks also build the impermeable complex. The outflow takes place along the concentrated surface flows and the infiltration goes through weathering zone and along the discontinuities of limited persistence. The SW part of Medvednica Mt. is built mainly of Triassic dolomites and litotamnium limestones with morphological features and shapes typical for karst regions. The concentrated outflow is dominant. Neogene hills include the brim of Paleozoic Medvednica massif. The SE foothill is partially built of Miocene carbonate deposits. They are outlined as specific, because the water sinks in them and the groundflows are dominant. The characteristic of Miocene deposits is frequent exchange of low permeable and impermeable units. The limited aquifers are connected to intrusions and lenses of sandstones, breccias, conglomerates, sands and limestones. The deposits of upper Pontian age include significant sand interbeds. Due to variable granulometric composition, from coarse over fine-grained sands to silt and clay, the value of hydraulic conductivity is very small. Rhomboidea-deposits towards the east change into deposits of lower Pontian, built of marls, clays and sands. The occurrence of permanent springs is rare, and periodic springs are very frequent. The noncohesive and low cohesive deposits of upper Pliocene and Plio-Quaternary age are of intergranular porosity and have low permeability. They spread along the NW foothill of Medvednica Mt., and consist of clay-sand-gravel mixture. The gravely-sand deposits along the torrent flows in the areas with smaller inclination have significant permeability.

Surface and ground water condition - The region of Nature park Medvednica is divided into six terrain types according to following criteria: lithology, spring types, outflow types (surface and underground), water condition and erosion, category of slope inclination and drainage possibility, including tectonic disturbance of rock masses and taking into account the secondary products (weathering products and slope deposits). The first terrain category is represented with carbonate deposits of Mesozoic and upper Tortonian age. The concentrated groundflow and very good drainage is dominant. The second category includes green schists with several lithotypes, effusive rocks and marbles, where surface concentrated flow and shallow groundflow take place. The third category is made of terrains with variable lithology, which causes the water to retain in the catchment area for longer time. It was taken into account if the pelite or carbonate component is prevailing in the Cretaceous flysch. Plio-quaternary deposits of north-west slopes of Medvednica Mt. represent the fourth terrain category distinguished by spread spring zones. The outflow takes place within the thick drainage net. Because the sand component prevails, the infiltration is quick and the drainage is good. In the low metamorphic rocks of Paleozoic age and clastic rocks of Triassic age the water outflow is slow. The water retains in the deposits with predominantly clayey composition and in the weathering zone which drainages slowly. The terrains with these deposits are low drained. In the last category with mixed clastic composition and with thick weathering zone, the slow surface outflow takes place with the emergence of flat erosion. The terrains are low drained. The water is saturating the weathering zone and the clay deposits almost during the whole year, creating numerous unstable slopes and landslides. The land sliding intensity is increased by numerous periodical springs and diffuse outflow of groundwater, if the waters saturate unconsolidated deposit and degraded part of parent rock. The mountain torrent streams, after the long lasting precipitation, erode the side parts of the riverbeds and cause the creation of new landslides.

CONCLUSIONS - PRELIMINARY QUALITATIVE MAP OF SLIDING AND EROSION HAZARD

The heuristic approach was used for the design of synthetic map[7] that was elaborated in the book[8]. But, it has been applied in the simplest version, without the division of the surface into elementary terrain-units. Such map should be used as the initial information about the terrain quality. In the future the process should continue with sophisticated GIS technology[9]. The display with map of landslide and erosion hazard zoning in this case represents the engineering expectations. The zoning according to landslide hazard, including erosion, mostly inherits the present morphostructural fabric of Medvednica Mt. and its brim.

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