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ORIGINAL ARTICLE

Assessment of rockfall potential in the Kula (Manisa, Turkey) Geopark Region

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Abstract The term Geopark is an interrelated phenomenon of geology, landscape, civilisation and society. One of the first Geopark areas in Turkey will be founded in the Kula district of Manisa. This region is an impressive area with its archaeological, historical and tourism-related features and its geological characteristics, such as cinders and maars, tectonic structures and earth pillars. Moreover, the earth pillars in the region present high-rockfall potential due to their geometric and lithologic peculiarities, formed by erosional processes. The present study aims in investigating the rockfall potential in this area by means of experimental investigation and numerical analyses. Extensive field studies including determination of earth pillar locations with rockfall potential, geological description of the earth pillars, scan-line surveys on discontinuities, identification of slope profiles, measurement of actual fallen block dimensions and sampling procedures were carried out. The eight earth pillar profiles were analysed to determine the run-out distances of basalt blocks and seven blocks were found to be capable of reaching the transportation line. For future protection purposes, barrier designs were suggested by computer analyses. Additional analyses were performed to determine rockfall-prone areas, taking into consideration the mapped rockfall source areas. Based on these analyses, the transportation line is threatened by potential rockfall. These results are in accordance with conclusions of the runout distance analyses. As a consequence, environmental aspects and rockfall phenomenon of the Kula Geopark Region must be taken into consideration during the planning process. It should also be pointed out that we have to own the values of geological heritages and to protect them based on the scientific and rational approaches.

Keywords Earth pillar · Geopark · Kula · Rockfall · Rockfall proneness

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Introduction

A rockfall event involves the displacement of single block or several rock boulders detaching from their original locations by falling and subsequent bouncing, rolling, sliding and deposition (Varnes 1978; Hutchinson 1988; Evans and Hungr 1993). It is one of the most hazardous natural processes, and has a great potential of threatening lives, roads, settlements and other facilities due to its rapid movement and high-energy bearing features. In general, rockfall hazard results from two processes: (1) detachment of a rock volume from the upper part of the slope (local failure of slope) and (2) propagation of this volume along the slope (Hantz et al. 2003). Different geological, geomorphological, climatologic and human effects may contribute to the occurrence of these processes, such as earthquakes, weathering, discontinuities, freeze and thaw cycles, rainfall, road cuts and so on.

To evaluate the potential hazard related to an unstable rock slope, it is essential to understand the processes and mechanism driving the instability (Eberhardt et al. 2002). However, in general, assessment of rockfall mechanism is a challenging work due to its complex nature. As in many landslide cases, analysis of a cause and effect relationship is not always simple, as a landslide is seldom linked to a single cause (Aleotti and Chowdhury 1999). For rockfalls, main difficulties arise from the determination of exact

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4. Owing to the fact that geology is the staple point of the Geopark concept, various disciplines of geosciences, such as engineering geology, palaeontology, volcanology, geomorphology and sedimentology should interactively considered when establishing a Geopark. In addition to legislative issues related to governmental and local administrations, success can only be achieved by taking into consideration different interdisciplinary works related to protection.

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