

Assessment of rockfall hazard at Al-Noor Mountain, Makkah city (Saudi Arabia) using spatio-temporal remote sensing data and field investigation

ABSTRACT

Rockfall is one of the major concerns along different urban areas and highways all over the world. Al-Noor Mountain is one of the areas that threaten rockfalls to the Al-Noor escarpment track road and the surrounding urban areas. Thousands of visitors and tourists use the escarpment track road to visit Hira cave which is located at the top of Al-Noor Mountain. In addition, the surrounding urban areas of Al-Noor Mountain are continuously spreading over the recent years. The escarpment track road and the surrounding urban areas are highly vulnerable and suffers from recurrent rockfall mostly in the rainy season. The steep and highly jointed slope along the different faces of the mountain makes these zones prone to failure due to different actions such as weathering, erosion and anthropogenic effect. Therefore, an attempt has been made in this study to determine the Al-Noor cliff stability, by identifying the unstable areas, and to apply the rockfall simulations. A combination of remote sensing, field study and 2D computer simulation rockfall program were performed to assess surface characteristics of the cliff faces. Bounce height, total and translational kinetic energy, translational velocity, and number of blocks have been estimated. Different unstable zones along the Al-Noor Mountain and escarpment track road were determined using field investigation and remote sensing based image analysis. In addition the rockfall simulation analysis indicated that rockfall in zone 1 and zone 2 of the Al-Noor Mountain may reach the urban areas, whereas rockfall in zone 3 will not reach the urban areas, and rockfalls along the Al-Noor escarpment track road will have highly impact on the tourists. Proper preventive measures are also suggested to arrest the movement of falling rocks before reaching the urban areas and the Al-Noor escarpment track road. If proper care is taken, then further uncertain rockfall hazards can be prevented.

Keyword: Rockfall; Hazard; Remote sensing; GIS; Makkah; Saudi Arabia