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Effect of landslides on the development of the districts of north Tehran City

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Abstract: Tehran City, located to the southern part of the Alborz Mountain, faces a number of geological hazards such as earthquake, flooding, and landslides. The city has a population of over 10 million citizens and is growing fast in both vertical and horizontal dimensions. The northern part of the city which has a better climate and environment is expanding towards the foothills and parts of the Alborz Mountain.

The geological setting of the region consists of alluvial deposits that include various sizes and shapes of aggregates. Local relief, the result of tectonic activity, has a great influence on the soil types. The boundary between the alluvial deposits of the foothills and the tuffaceous rock of Eocene age at the Alborz mountain front is the major North Tehran Thrust Fault. The fault is active and is surrounded by a weak zone of crushed rock units and alluvial deposits. Most of the regions landslide events are detected and recorded in this region.

In this research, using aerial photographs and satellite images, geophysical measurements, boreholes information, and site investigation, the main geological features of the region have been mapped. Consequently the exact location of faults, landslides and expansion of the alluvial fans have been identified. Accordingly a landslide hazard zonation map has been prepared using the GIS method.

The results show that two types of landslides, defined as static and dynamic landslides, can be identified in the region. The static landslides are triggered by many factors such as seasonal rainfall, construction activities, and topographic relief. On the other hand the dynamic landslide are mostly triggered by tectonic activities on the North Tehran Fault.

Résumé: La Ville de téhéran qui est localisée à la partie méridionale de la Montagne de Alborz fait face à plusieurs dangers géologiques tels que tremblement de terre, l'inondation, et le glissement de terrain. La ville peuple par-dessus 10 millions de citoyens et grandit rapidement dans les dimensions verticales et horizontales. La partie septentrionale de la ville qui a un meilleur climat et la meilleure vue augmente vers les contreforts et les parties de la Montagne de Alborz. Le cadre géologique de la région consiste en des dépôts alluviaux qui incluent de diverses tailles et les diverses formes de totaux. Le soulagement local qui sont les résultats d'activités tectoniques a la grande influence sur les types de sol. La frontière entre les dépôts alluviaux des contreforts et le rocher de tuffaceous d'âge éocène au devant de montagne de Alborz est un Défaut de Poussée de Téhéran du nord principal. Le défaut est actif et est entouré d'une zone faible d'unités de rocher écrasées et des dépôts alluviaux. La plupart des événements de glissements de terrain sont détectés et sont enregistrés dans cette région. Dans cette recherche, par les aides de photographies aériennes et d'images par satellite, les mesures géophysiques, l'information de boreholes, et l'investigation de site, les caractéristiques géologiques principales de la région sont faites la carte de. Par conséquent l'emplacement exact de défauts, les glissements de terrain, et l'expansion des ventilateurs alluviaux est identifié. En conséquence une carte écrasante de zonation de danger est préparée l'utilisation de la méthode de GIS. Les résultats montrent que deux types de glissements de terrain définissent comme le glissement de terrain statique et dynamique peut être identifié dans la région. Les glissements de terrain statiques sont déclenchés par beaucoup de facteurs hauteurs des précipitations tels que saisonniers, les activités de construction, et le soulagement topographique. Sur l'autre transmettre le glissement de terrain dynamique est surtout déclenché par les activités tectoniques du Défaut de Téhéran du nord.

Keywords: alluvium, engineering properties, geological hazards

INTRODUCTION

The Tehran region is located on the foothills of Alborz Mountain and is home to over 10 Million people. It has been the country's capital city for over 200 years. The City, a veritable boom town, undergoing intense development, continues to expand both in vertical and lateral directions. Figure 1 shows the location of Tehran City within the Alborz Mountain.

Iran is among the most earthquake-prone countries in the world; the likelihood of a major earthquake hitting Tehran is great (Berberian 1983). The city is located close to the North Tehran Fault, which is to the north, and several fault to the south, as well numerous faults criss-crossing the city. Tehran experienced its last major earthquake in 1830. The fault lines around Tehran have been slipping and gathering energy ever since. Due to the ignorance of these tectonic conditions most of the developed urban areas are facing a direct threat from the geological hazards such earthquake and landslide particularly in the foothills, which benefits from a better climate and, in which, most the high rise building are located. In recent years urban geology is increasingly recognized as a needed discipline for the city planners and engineers.

In this paper the potential of Tehran to geohazard was considered and according to various available data a hazard zonation map has been drawn.

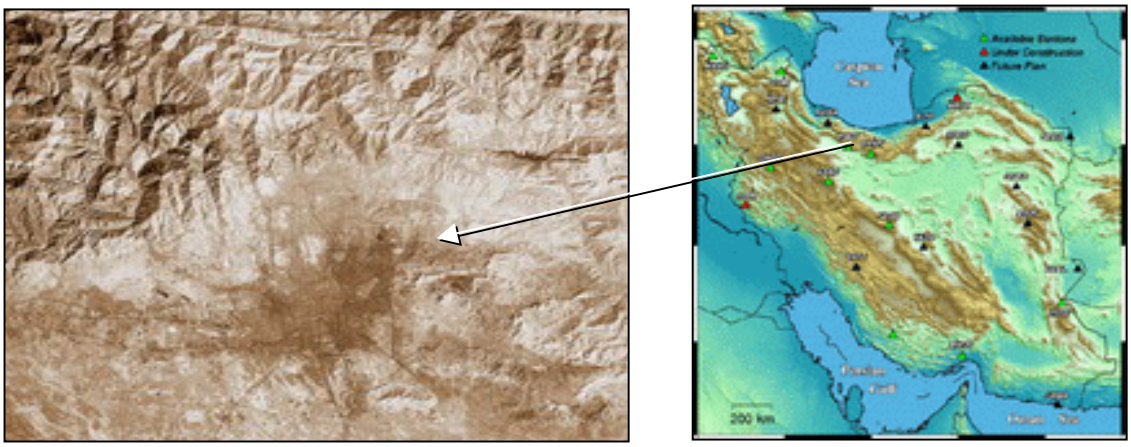

Figure 1. Location of Tehran City within the Alborz Mountain

GEOLOGICAL SETTING

The geological setting of Tehran can be discussed with respect to lithological units and structural elements.
Lithological units: There are mainly two types of lithological units in the studied area that are identified as Karaj Formation and Hezar-darreh Formation. The Karaj Formation is typically volcanoclastic material, which accumulated in a marine environment. The unit, which is of Eocene age, is highly fractured and weathered along fault locations and contains many intrusive rocks. An overview of tuffaceous rock units of Karaj Formation is illustrated in figure 2. The Hezar-darreh Formation largely consists of alluvial deposits with grain size ranges from clay and silt to cobbles and even boulders. The thickness of these deposits, which cover major parts of the city, varies between 150 to 1200 meters (Berberian 1983). The formation is of Plio-Pleistocene to Recent Age and according to their liothological composition, reletive age and engineering geological characteristics, the Formation was grouped into five units (Reben 1955). The older units are more homogeneous and have higher geotechnical properties such as SPT number over 50, internal friction angle in the range of 42 degrees, and the cohesion is 15 kN/m^2. The cohesion referrs to the properties of the cement within the coarse materials. In contrast, the younger units are more heterogeneous and have generally very low geotechnical characteristics.

Figure 2. Lithological units of Tehran area (a. Hezar-darreh Formation, b. Karaj Formation)

Structural elements: The structural elements of Tehran area mainly consists of a number of revears and thrust faults. The two main faults that can be distinguished are defiend as follows:
North Tehran Fault: The fault is almost 90 km long and the overall alignment is in the east-west direction. The dip angle is 10 to 80 degrees to the north. The fault is of thrust type that has forced the Karaj formation over the younger Hezar-darreh formation. Due to the expansion of the Tehran City, large areas of housing and other engineering projects are constructed along this fault. The high relief of the Tehran topography is believed to be caused by the action of this fault.
Ray Fault
Mosha-Fasham Fault: The fault is about 400 km long and has a trend in the nortwest-southeast direction. It lies about 30 km north of Tehran. The fault has forced the Paleozoic rock units over the Eocene rock units of Karaj formation. The fault is very active and most of Tehran's seismic activity originates along this fault.

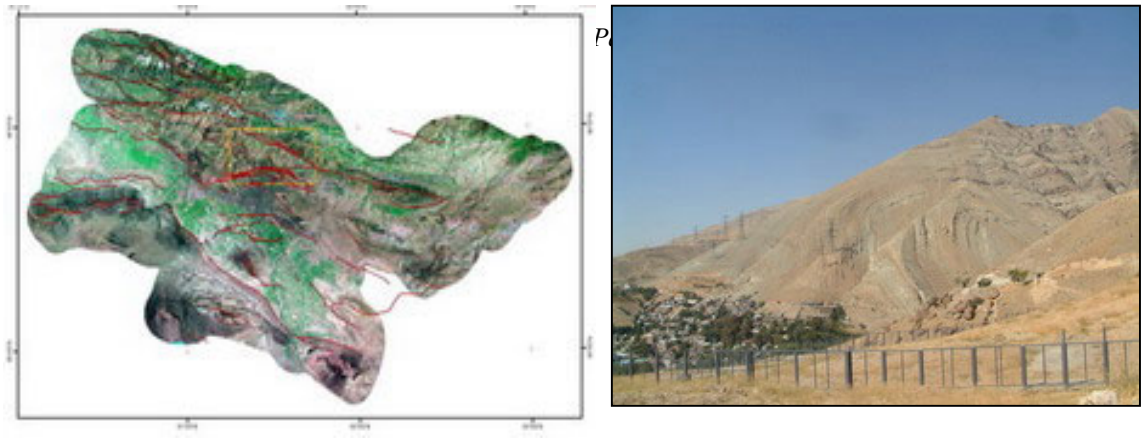

Figure 3. a. Location of the main faults in Tehran region, b. The North Tehran fault bounds the expansion of the City

Figure 4. Construction of new apartments blocks along the trend of Tehran's main faults.

DISCUSSION

To evaluate the rate of vulnerability of Tehran region to geohazard the occurrence of a number of factors were considered. The factors include geotechnical properties, type of lithology, neotectonic features and topographic relief. The GIS method was used to draw individual index maps such as relief map, static factor of safety map, seismic acceleration map and hazard potential map. By compiling the individual maps, a geohazard map of Tehran region was drawn; this is shown in figure 5.

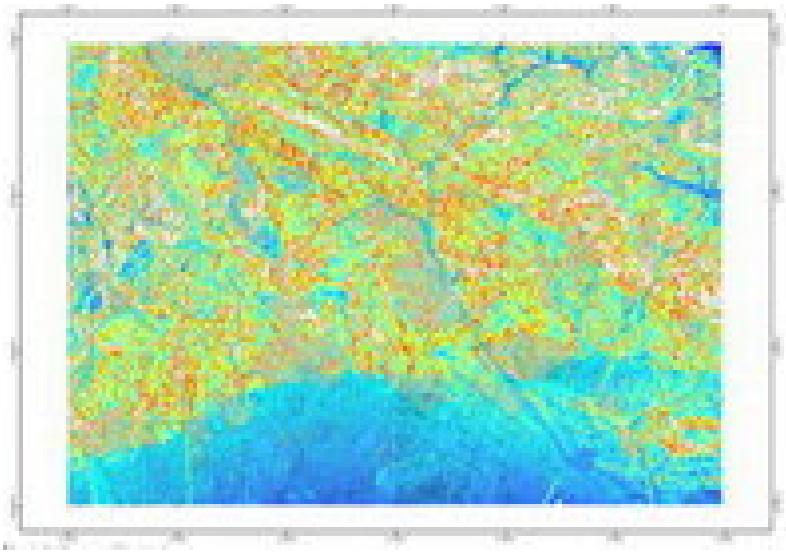

Figure 5. Geohazard zonation of the north Tehran region.

CONCLUSSIONS

The main geological features of Tehran region have been highlighted with particular reference to the type of lithology and structural geology elements. Since Tehran is located in a very active tectonic region where there is a high risk of seismic events and due to the large number of construction activities and the expansion of the City towards the north where the active faults are located, it is necessary to integrate geological and geotechnical data for any type of land-use planning and construction design in the region.

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REFERENCES

BERBERIAN M., QORAISHI M, ARJANG R., MOHAHER A., 1983, Investigation of Neotectonic, seismotectonic and fault-earthquake hazard in Tehran region and the surrounding area, Geological Survey of Iran, report no.56, 316 p. (in Persia).

JAFARI M. K., 2000, Seismic micro zonation of North Tehran with respect to site effect, Report no. 5018, International Institute of Earthquake Engineering and Seismology, IIEES, 84p. (in Persia).

NASSIRI S., 2004, Seismic landslide hazard zonation for Northern Tehran, MSc Dissertation, Supervised by Uromeihy A., Tarbiat Modares University (in Persia)

REBEN, E. H., 1955, The geology of Tehran plain. Am. J. Sci. 253, 617-639