



Generation of a database for the factors affecting the landslide susceptibility by the use of GIS

AmirShahram Shahabi¹ and Esmaeil Najafi^{2}*

1. Electronic Branch, Islamic Azad University, Tehran, Iran

2. Science and Research Branch, Islamic Azad University, Tehran, Iran

**Corresponding Author*

ABSTRACT

Unregulated or unprofessional land development and land use management in mountainous regions with steep slopes has led to increased instances of landslides causing human losses and damage to urban facilities. This phenomenon also has numerous indirect environmental impacts such as the destruction of rangelands and forests, and creation and transportation of sediments that might fill or contaminate the artificial and natural reservoirs. It is obvious that any of these events can have grave consequences for urban macromanagement system and can be considered a managerial crisis. Therefore, the identification of areas susceptible to landslides and creation of a comprehensive, efficient and updatable database to prevent or properly manage this natural disaster is essential for an adequate natural resource management and effective construction and development planning. Landslide susceptibility mapping is one of the most important strategies for reducing the damage caused by landslides. There are several approaches to this strategy, but all these approaches require creating a comprehensive database composed of data concerning the factors contributing to the magnitude or probability of landslide. This paper introduces and discusses the effective methods for collecting the GIS data describing the landslide susceptibility factors.

Original Article:

Received 11 June, 2015

Accepted 22 Aug, 2015

Published 30 Sep, 2015

Keywords:

Landslides, mapping, GIS

Introduction

The threat posed by landslides has always attracted the researchers' attentions toward the possibility of predicting this type of natural disasters. Landslide is the gravity-triggered rapid or slow downward movement of rock materials, soil materials or a combination of both along an inclined plane. In a landslide all materials from top to bottom move with the same speed. To identify the areas most prone to landslide, researchers must prepare landslide susceptibility maps which divide the study area into several zones in terms of sensitivity and susceptibility to landslide. This requires careful assessment of several factors that might affect the possibility and severity of landslides. After the identification of these factors, all data regarding these factors must be gathered and imported into a in an updatable database. In this paper, ArcGIS software is used to collect and process such factors including geology, distance from lineaments, slope, aspect, precipitation, and elevation in the study area.

Materials

GIS

Geographic information system (GIS) is a collection of computer software and hardware designed to capture, store, process, and present all types of geographical data. This system can store, manipulate and analyze spatial data for research purposes.

As mentioned earlier, several factors including geology, distance from lineaments, slope, aspect, precipitation, and elevation is investigated. A brief introduction to each factor is presented in the following.

1-Slope

The slopes have always been considered as one of the main factors affecting the possibility of landslides. The most important factor in downward motion of a particle along an inclined plane is the gravitational force, and angle of incline plays a major role in the size of gravitational force exerted on particle.

2-Aspect

Aspect of slopes is an essential factors that indirectly affects the impact of other factors such as thickness of soil, vegetation, humidity, exposure to sunlight, and hot and dry winds and rainfall along different directions. The most importance factor related to aspect is the extent and effect of (exposure to) sunlight.

3-Elevation

Altitude can have a significant role in the probability of landslides because changes in altitude are correlated with changes in other factors such as humidity, precipitation, vegetation type etc.

4-Land use

Land use information is one the most important raw data researchers use for landslide susceptibility mapping. Land use is defined as the purpose for which a piece of land is currently exploited and also the manner of this exploitation. Depending on the study area, types of land use can include rangelands, forests, agricultural, horticultural, residential, and industrial lands, wastelands, lakes etc.

5- Distance from lineaments

Lineaments that can affect the landslide probability include faults, roads and waterways.

5-1- Distance from faults

Geological structure is one of the essential factors affecting the probability and magnitude of landslides in an area. The geological structures associated with the subject of this paper are discontinuities such as surface of strata, folds, fractures and most importantly faults.

5-2- Distance from channels

Flowing waters are also considered as one of the factors that increase the susceptibility of slopes to instability. Channels and other linear features weaken the slopes resistance and therefore reduce the safety factor of natural slopes thus causing an increased landslides probability.

5-3- Distance from roads

Linear features such as roads increase the risk of landslides by exerting additional loads and weakening the slopes resistance.

6- Geology

The type of materials involved in motion is an essential factor playing an important role in the landslide. Type of materials and their lithological resistance against erosion and weathering are the most important factors in this regard. Susceptible geological structures are among the main causes of slope instability.

Research Methodology

The widespread and effective use of computers has led to rapid development of geology and management science along with other sciences. Computers allow enable researchers to use numerous softwares to capture, collect, analyze and utilize the raw data through easier and more reliable procedures. ARCGIS is one of such softwares which is under constant development and expansion and is considered as the most important software associated with geographic information system technology. Several applications embedded in this software enable the researcher to capture, derive, handle, and digitalize the data required for landslide susceptibility mapping.

The process of landslide susceptibility mapping requires the researcher to use that software to prepare and digitalize several maps describing the status of slopes and their aspects, elevations, land use, distance from fault, distance from channels, distance from roads and geology of the studied area. Researcher then can store the data regarding each factor and each feature in an attribute table and edit and modify them as needed.

Results

GIS software can be used to analyze and then convert the raw data to the maps required for the research or to digitalize the existing maps in the software environment. This software enables the researcher to update the preciously stored data and merge the new and old information to prepare data for landslide susceptibility studies. Therefore, ArcGIS can be considered as one of the most useful and efficient tools for storing the landslide zoning data, because a onetime import of essential data into this software can serve as a basis for gaining continuous output, which only requires the researcher to just update the database and modify the parts in which data have changed over time. This feature enables the researchers and authorities to have access to updated landslide susceptibility maps.

References

1. Shahidi.F (2014). Investigation on the engineering geology and hydrological conditions affecting the mechanism of Saein Strait Landslide (Ardebil-Sarab Road). M.Sc. Dissertation, Tarbiat Modares University
2. Malekpoor.H (2009). Assessment of factors affecting landslide and it's zonation method (A case study, Taleghan Watershed). M.Sc. Dissertation, Tarbiat Modares University
3. Sepahvand.A (2010). Zoning Landslide Susceptibility using Artificial Neural Network in a Part of Haraz Watershed. M.Sc. Dissertation, Tarbiat Modares University
4. Rakei.B (2003). Landslide Hazard Zonation using neural network (Sefedar Gholeh area in Semnan Province). M.Sc. Dissertation, Tarbiat Modares University
5. Hansen.A (1984). Landslide hazard analysis. In: Brunsten D. & Prior D.B. (eds.), Slope Instability, John Wiley and Sons, NewYork, 523–602
6. Giovanni.B, John.J (2009). Dating, triggering, modelling, and hazard assessment of large landslide. *Geomorphology*.103
7. Lee.S, Min.K (2001). Statistical analysis of landslide susceptibility at Yongin, Korea, *Environmental Geology*. Vol. 40: 1095-1113
8. Soori.s (2011). Landslide hazard zonation using artificial neural networks A case study: Keshvari watershed (Nozhiyan).Vol 5 . No 2
9. MahdaviFar.M.R (1997). Landslide Hazard Zonation of Khorshrostan Area (Southwest of Khalkhal Town) . M.Sc. Dissertation, Tarbiat Modares University
10. Haghshenas.E (1995). Landslide Hazard Zonation and relationship with sediment production in talghan watershed.) . M.Sc. Dissertation, Tarbiat Modares University
11. Mir Sanei.R, Mhdvyfr.M.R. (2006). Project: optimization methods and criteria for mapping landslide zoning. Institute of natural disasters