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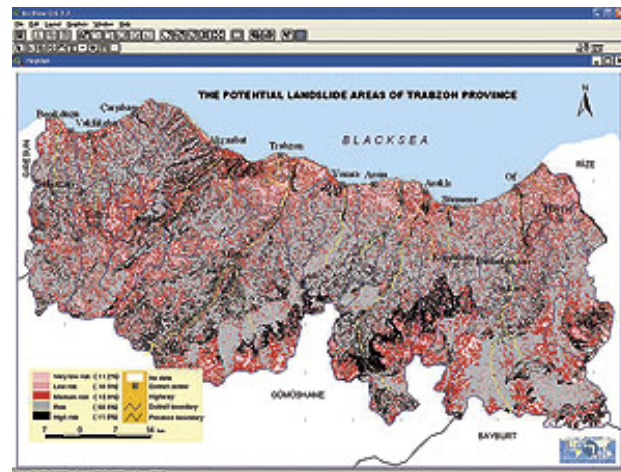
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In Trabzon Province, Turkey, Potential Landslide Areas Are Detected with GIS

By Selcuk Reis, Ph.D., Nigde University, and Tahsin Yomralioglu, Ph.D., Karadeniz Technical University

Many natural hazards in Turkey are the result of its tectonic formation, geological structure, topography, and meteorological features. Ninety-five percent of the population and 92 percent of the country's total area run that risk. The most common such hazards are earthquake, flood, landslide, and avalanche and rockfalls. Excluding earthquakes, since the beginning of the 20th century, approximately 3,600 people have died and approximately 155,000 houses have been destroyed because of these disasters. Landslides are the most widespread and damaging hazards and are responsible for 1,300 of those lives and almost 63,000 houses lost.



Potential landslide areas map of Trabzon, Turkey.

According to records kept since 1950, the province of Trabzon, which is located in the northeast region near the Black Sea, is one of the areas where landslides most commonly occur. Between 1950 and the present, there have been more than 270 landslides in Trabzon. The factors affecting the occurrence of landslides are the morphology of the region, geological structure, weathering of rocks, meteorological characteristics, settlement types, and various types of excavation work. Heavy precipitation, sloping topography, and the removal of forests for agricultural purposes increase the landslide risk.

Factors	Scores	Weights
Slope (%)		100
0–20	100	
21–30	70	
31–40	40	
41–50	20	
> 51	10	
Lithology		60
A1, P1	30	
Krū2, Krū1	60	
Ev, Jk, Jl	70	
Krū2, Krū1	80	

Factors	Scores	Weights
Land cover		40
Rocky	100	
Forest	80	
Settlement	50	
Agriculture, pasture	40	
Stream and Road		20
Stream	10	
Road	10	
Other areas	100	

Factor scores and weights used to determine potential landslide areas.

A GIS analysis has been conducted in Trabzon province to determine potential landslide areas. Since the province covers a large area (4,660 square kilometers), the study is largely dependent on spatial data. Many parameters and methods of assessment exist, but there is little agreement in the literature as to which factors should be included in the determination of risky landslide areas. However, in detailed studies, the number of factors can be increased depending on the study area characteristics. For the purposes of this study, topography, lithology, land use, and stream and road networks were considered, and the Weighted Linear Method was applied to determine hazardous landslide areas.

ArcInfo and ArcView were used because of easy access and viewing of data, high storage capacity, and quick analysis. The data layers belonging to selected factors were obtained from different public organizations as paper maps and were digitized within the ArcInfo environment. Following digitization, these layers were converted into 100-meter grid formats using ArcInfo commands.

Scoring Potential

Factor scores were determined based on a 0–100 scale range. On this scale, high scores represented low landslide risk while low scores represented high landslide risk. Factor weights

were determined in a similar approach, and each factor was scored relative to the other factors on a 0–100 scale. The accompanying table presents the factor scores and weights used. The slope was accepted as the most important factor because of its impact on the landslide. Therefore, the slope factor was given the highest weight.

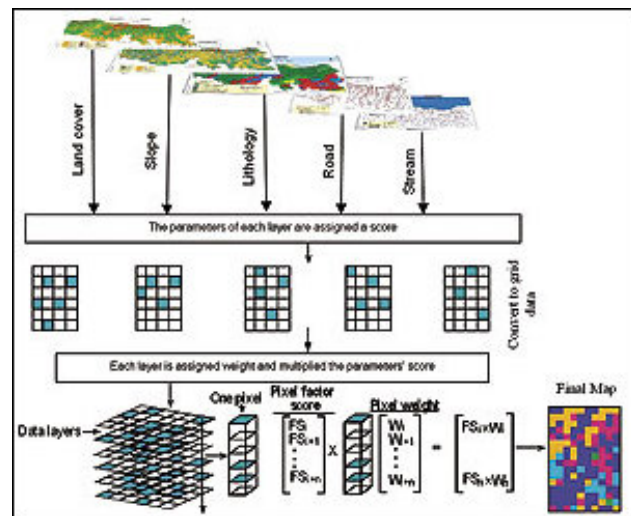
After determining the factor scores and weights, they were multiplied by each other using ArcView software's map calculator

submenu under the Analysis menu to obtain pixel scores. Then these pixel scores were added to each other, and finally, the pixel scores were evaluated and a potential landslide map was produced in five classes: very low risk, low risk, medium risk, high risk, and very high risk. Analysis shows that high-risk areas, covering 62.4 percent of the province, are dominant. Only 21.7 percent of the province—typically close to the coastline where a flat topography is frequently the norm—is without landslide risk.

To examine landslide risk in villages, maps of both landslide potential and settlement areas are overlaid. This study shows the number of settlements with respect to the potential landslide classes. According to these results, 56 possible settlement areas are considered very high risk while 227 are high risk. In other words, 51 percent of the villages in Trabzon are under landslide risk.

This work was done at the GIS Research Lab (GISLab), which has provided GIS services at Karadeniz Technical University since 1995. The ArcGIS framework has enabled setup of spatial analysis functionality for complex environmental solutions tasks.

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Procedure for determining potential landslide areas.

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