Geophysical Research Abstracts,
Vol. 11, EGU2009-8399, 2009
EGU General Assembly 2009


# A comparison between univariate probabilistic and multivariate (logistic regression) methods for landslide susceptibility analysis: the example of the Febbraro valley (Northern Alps, Italy)

M. Rossi, T. Apuani, and F. Felletti

Earth science department "A. Desio", University of Milan, Via Magiagalli, 34 – 20133 Milan (Italy), marcello.rossi@unimi.it

The aim of this paper is to compare the results of two statistical methods for landslide susceptibility analysis: 1) univariate probabilistic method based on landslide susceptibility index, 2) multivariate method (logistic regression). The study area is the Febbraro valley, located in the central Italian Alps, where different types of metamorphic rocks croup out. On the eastern part of the studied basin a quaternary cover represented by colluvial and secondarily, by glacial deposits, is dominant. In this study 110 earth flows, mainly located toward NE portion of the catchment, were analyzed. They involve only the colluvial deposits and their extension mainly ranges from 36 to 3173 m2.

Both statistical methods require to establish a spatial database, in which each landslide is described by several parameters that can be assigned using a main scarp central point of landslide. The spatial database is constructed using a Geographical Information System (GIS). Each landslide is described by several parameters corresponding to the value of main scarp central point of the landslide. Based on bibliographic review a total of 15 predisposing factors were utilized. The width of the intervals, in which the maps of the predisposing factors have to be reclassified, has been defined assuming constant intervals to: elevation (100 m), slope (5 °), solar radiation (0.1 MJ/cm2/year), profile curvature (1.2 1/m), tangential curvature (2.2 1/m), drainage density (0.5), lineament density (0.00126). For the other parameters have been used the results of the probability-probability plots analysis and the statistical indexes of landslides site. In particular slope length (0 ÷ 2, 2 ÷ 5, 5 ÷ 10, 10 ÷ 20, 20 ÷ 35, 35 ÷ 260), accumulation flow (0 ÷ 1, 1 ÷ 2, 2 ÷ 5, 5 ÷ 12, 12 ÷ 60, 60 ÷27265),
Topographic Wetness Index 0 ÷ 0.74, 0.74 ÷ 1.94, 1.94 ÷ 2.62, 2.62 ÷ 3.48, 3.48 ÷ 6,00, 6.00 ÷ 9.44),
Stream Power Index (0 ÷ 0.64, 0.64 ÷ 1.28, 1.28 ÷ 1.81, 1.81 ÷ 4.20, 4.20 ÷ 9.40). Geological map and land use map were also used, considering geological and land use properties as categorical variables.

Appling the univariate probabilistic method the Landslide Susceptibility Index (LSI) is defined as the sum of the ratio Ra/Rb calculated for each predisposing factor, where Ra is the ratio between number of pixel of class and the total number of pixel of the study area, and Rb is the ratio between number of landslides respect to the pixel number of the interval area. From the analysis of the Ra/Rb ratio the relationship between landslide occurrence and predisposing factors were defined. Then the equation of LSI was used in GIS to trace the landslide susceptibility maps.

The multivariate method for landslide susceptibility analysis, based on logistic regression, was performed starting from the density maps of the predisposing factors, calculated with the intervals defined above using the equation Rb/Rbtot, where Rbtot is a sum of all Rb values. Using stepwise forward algorithms the logistic regression was performed in two successive steps: first a univariate logistic regression is used to choose the most significant predisposing factors, then the multivariate logistic regression can be performed. The univariate regression highlighted the importance of the following factors: elevation, accumulation flow, drainage density, lineament density, geology and land use. When the multivariate regression was applied the number of controlling factors was reduced neglecting the geological properties. The resulting final susceptibility equation is:

P = 1 / (1 + exp-(6.46–22.34*elevation-5.33*accumulation flow-7.99* drainage density-4.47*lineament density-17.31*land use))

and using this equation the susceptibility maps were obtained.

To easy compare the results of the two methodologies, the susceptibility maps were reclassified in five susceptibility intervals (very high, high, moderate, low and very low) using natural breaks. Then the maps were validated using two cumulative distribution curves, one related to the landslides (number of landslides in each susceptibility class) and one to the basin (number of pixel covering each class). Comparing the curves for each method, it results that the two approaches (univariate and multivariate) are appropriate, providing acceptable results.
In both maps the distribution of high susceptibility condition is mainly localized on the left slope of the catchment in agreement with the field evidences.
The comparison between the methods was obtained by subtraction of the two maps. This operation shows that about 40% of the basin is classified by the same class of susceptibility. In general the univariate probabilistic method tends to overestimate the areal extension of the high susceptibility class with respect to the maps obtained by the logistic regression method.