SOIL EROSION SUSCEPTIBILITY EVALUATION BASED ON GIS TECHNOLOGY

Pinto, S.A.F.(1); Valerio Filho, M.(1)
Donzeli, P.L. (2)
(1) Instituto Nacional de Pesquisas Espaciais
12.201 - São José dos Campos, C.P. 515
São Paulo, Brasil

(2) Instituto Agronômico de Campinas
13.100 - Campinas, S.P., C.P. 28
Brasil

ABSTRACT:

This study was undertaken in an agricultural watershed (eastern Sao Paulo State, Brasil) and its purpose was to indicate soil erosion susceptibility areas and to provide information for rural planning. A geographic information system - GIS (SGI/INPE) was used to integrate physical parameters of the USLE model adjusted. Erosivity, erodibility, slope length and slope gradient parameters (R, K, L and S USLE factors, respectively) were associated with soil loss tolerance data to define tolerable cover-management and soil conservation practices (tolerable CP factors - USLE). Tolerable CP and actual CP data (determined from Landsat and field informations) were integrated in the GIS environment. A susceptibility soil erosion classe map (at 1:60.000 scale) was obtained and it will be used for soil conservation planning of the watershed.

KEY WORDS: Remote Sensing, GIS, Soil Erosion

1. INTRODUCTION

Development countries have an urgent need to improve their agricultural production. This process induces a lot of inadequate land use/cover for the rural environment. The intensification of agricultural activities may result in increasing erosion processes and accelerated soil losses, threatening natural resources integrity, mainly water quality, and the productivity of agricultural systems. In this context, the knowledge of potencial erosion of specific soil groups is very important to support agricultural and environmental planning.

GIS constitutes a technique designed to acquisition, storage, manipulation and analysis of large amount of geocoded data (Marble and Peuquet, 1983; Bocco and Valenzuela, 1 988; Ventura et al., 1988).

The objetive of this study is to evaluate the soil erosion susceptibility by using GIS technology in analytic integration of environmental data. The analysis was orientated by the Universal Soil Loss Equation model USLE (Wischmeier and Smith, 1978), depicting soil loss by rainfall erosion.

The selected study area is a small watershed at the eastern portion of Sao Paulo State - Brasil (Sao Joaquim river - 22^{o} 00'- 22^{o} 05' south lat. and 47^{o} 20' - 47^{o} 35' long west Green.), included in the National Watershed Management Program.

2. METHODOLOGICAL PROCEDURES

The analytical procedure was to digitally integrate the following USLE parameters: topographic factor (slope stepness and slope length - LS), erosivity (R), erodibility (K), land use and management (C) and conservationist practices (P). An adjusted USLE model was applied, considering non-availability of different environmental data in Brasil (Bertoni and Lombardi Neto, 1985).

Data were sampled from topographic maps (topographic factor), available tables (erosivity and erodibility) and thematic classification of TM and HRV imageries associated with field work (land use/management and conservationist pratices).

The Natural Erosion Potential (NEP) was derived from the ajusted USLE as folllow:

$$NEP = R * K * (0,00984 * L^{0,63} * S^{1,18})$$

The information concerning NEP was associated with the tolerable soil loss level (At) to assess and spatially detect the fator CP tolerable (CPt). This procedure is performed due to the following relation spatially:

$$CPt = At/NEP$$

Susceptibility erosion data (Se) was obtained through the evaluation of CP actual and CP tolerable

$$Se = CP\ actual - CP\ tolerable$$

Data analysis for the evaluation of NEP and characterization of soil loss susceptibility were made using raster format data, with the support of a GIS developed at INPE (SGI/INPE, Souza et al., 1990). An erosion susceptibility map at scale of 1:60.000 was obtained using a graphic plotter.

3. RESULTS

The observed C factor was derived from a land use map obtained through TM and HRV/SPOT imageries classification (Figure 1). The P factor was considered as a constant value for the whole watershed, representing contour cultivation (P = 0,5). These informations (observed CP) were introduced in a GIS. The different values attributed to the C factor are shown in table 1.

TABLE 1 - FACTOR C VALUES (SAO JOAQUIM WATERSHED)

crop/land cover		C factor
summer crops		
soybean	....	0,2086
corn	....	0,0860
rice	....	0,4862
cotton	....	0,4737
citrus	....	0,1350
sugar cane	....	0,1000
reforest	....	0,0001
pasture	....	0,0100
native veget.	....	0,00004

NEP data, deduced from the integration of the USLE physical parameters (R, K, L and S) were classified into three intervals: low, medium and high NEP. Figure 2 shows the spatial distribution of these classes over the watershed. High NEP class coincide spatially with points with high slope stepness.

Susceptibility data was derived through the integration of the values corresponding to the observed CP and the tolerable CP (CPt) into a GIS/INPE. These data were classified into four intervals: null, low, medium and high erosion susceptibility to soil losses. Figure 3 shows a map with this distribution over the whole area.

The analysis of the NEP and susceptibility data (Figure 2 and 3 respectively) shows that high NEP values are generally associated with high erosion susceptibility classes. Nevertheless, there are points where high NEP areas presents low susceptibility to soil erosion due to the vegetation cover protection (i.e., citrus or native vegetation - Figure 1).

4. CONCLUSION

The USLE model can be used to characterize the potential soil erosion (Natural Erosion Potential - NEP) and the soil erosion susceptibility. These data were integrated by a Geographic Information System, a powerfull technique for data manipulation and transformation. In this study was used INPE's GIS facilities. The possibilities of application of this technique for small agricultural watershed conservation planning was presented.

5. REFERENCE

BERTONI, J; LOMBARDI NETO, F. 1985 Conservacao do Solo. Piracicaba. Livroceres, 392 p.

BOCCO, G.; VALENZUELA, C.R. 1988 Integration of GIS and image processing in soil erosion studies using ILWIS. ITC Journal, 4: 309-319, 1988.

MARBLE, D.F.; PEUQUET, D.J. 1983 Geographic information system and remote sensing. In: Manual of Remote Sensing, 2nd edition, Falls Church, American Society of Photogrammetry, p. 923-958.

SOUZA, R.C.M.; ALVES, D.S.; CAMARA NETO, G. 1990 Development of Geographic Information and Image Processing Systems of INPE. Proccedings, Brazilian Symposium on Geoprocessing, Sao Paulo. INPE, Sao Jose dos Campos.

VENTURA, S.J.; CHRISMAN, N.R.; CONNORS, K.; GURDA, R.F.; MARTIN, R.W. 1988 A land information system for soil erosion control planning. Journal of Soil and Water Conservation, 43(3): 230-233.

WISCHMEIER, W.H.; SMITH, D.D. 1978 Predicting rainfall erosion losses - a guide to conservation planning. Agriculture Handbook, N 537, U.S. Departament of Agriculture, Washington, 58 p.

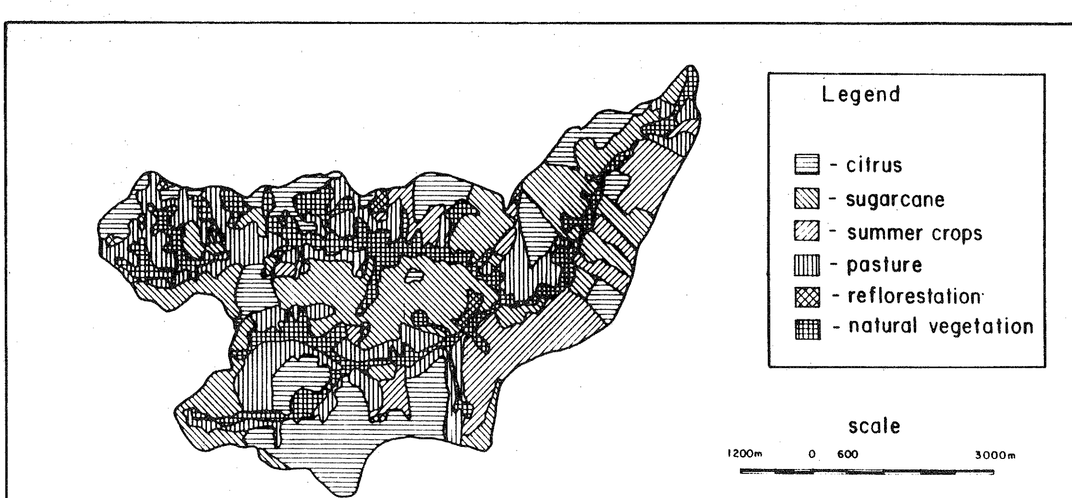

Figure 1 - Land use/land cover map.

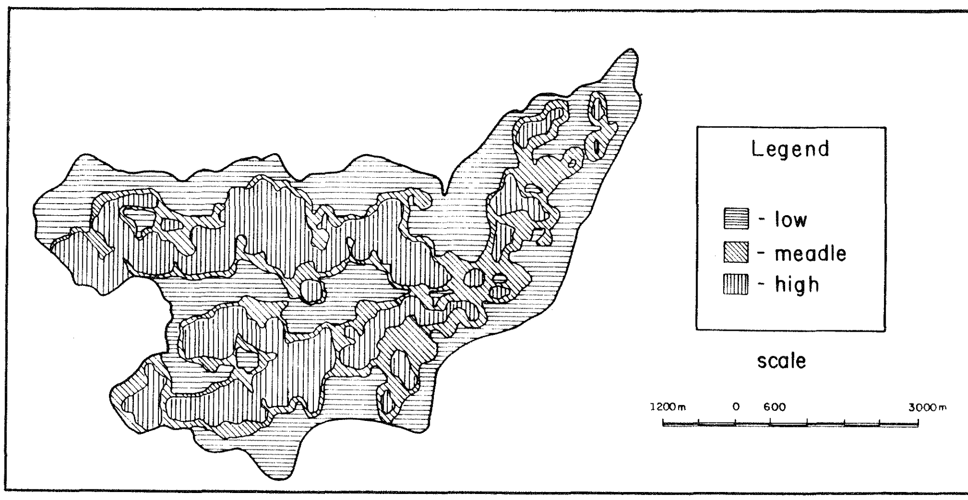

Figure 2 - Natural erosion potencial map.

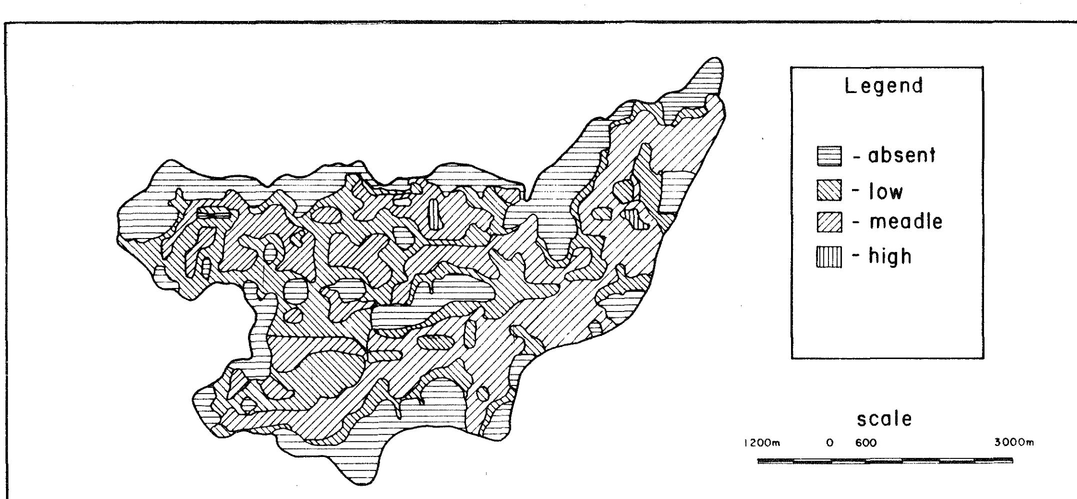

Figure 3 - Susceptibility soil erosion map.