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 Agronomico de Campinas
13.100 - Campinas, S.P., C.P. 28
Brasil

ABSTRACT:
This study was undertaken in an agricultural watershed (eastern São 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/covers 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 potential 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 objective 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 São Paulo State (Sao Joaquin river - 22° 00' - 25° 05' south lat. and 47° 20' - 47° 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 practises).

The Natural Erosion Potential (NEP) was derived from the adjusted USLE as follow:

\[ \text{NEP} = R \times K \times \left( 0.00984 \times L^{0.63} \times S^{1.18} \right) \]

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

\[ \text{CPT} = \text{At/NEP} \]

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

\[ \text{Se} = \text{CP actual} - \text{CP tolerable} \]

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)**

<table>
<thead>
<tr>
<th>Crop/Land Cover</th>
<th>C Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>0.0286</td>
</tr>
<tr>
<td>Corn</td>
<td>0.0860</td>
</tr>
<tr>
<td>Rice</td>
<td>0.4862</td>
</tr>
<tr>
<td>Cotton</td>
<td>0.4737</td>
</tr>
<tr>
<td>Citrus</td>
<td>0.1350</td>
</tr>
<tr>
<td>Sugar Cane</td>
<td>0.1000</td>
</tr>
<tr>
<td>Reforestation</td>
<td>0.0001</td>
</tr>
<tr>
<td>Pasture</td>
<td>0.0100</td>
</tr>
<tr>
<td>Native Veget.</td>
<td>0.00004</td>
</tr>
</tbody>
</table>

NEP data, deduced from the integration of the USLE physical parameters \((R, K, L, S)\) 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 steepness.

Susceptibility data was derived through the integration of the values corresponding to the observed CP and the tolerable CP \((CP_t)\) 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 powerful 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


![Figure 1 - Land use/land cover map.](image-url)
Figure 2 - Natural erosion potential map.

Figure 3 - Susceptibility soil erosion map.