SIAT - LAND EVALUATION SYSTEM - V. 2.0

Gilberto J. GARCIA

Regional Planning Department, IGCE-UNESP – Sao Paulo, Brazil

E-mail: gilberto@rc.unesp.br

Sergio Luis ANTONELLO

Mônica G.M. MAGALHÃES

CEAPLA – Center for Environmental Analysis and Planning, IGCE-UNESP Sao Paulo, Brazil

www.igce.unesp.br/igce/ceapla/

Homero FONSECA FILHO

Department of Natural Resources, UFLa/UFSCar Sao Paulo, Brazil

E-mail: fonseca@iname.com

ABSTRACT: The SIAT is a specialist system for Land Evaluation derived from the MicroLEIS - Land Evaluation Information System developed in Spain. In its first version the 12 variables were adapted and adjusted for tropical conditions as well as the program structure and data bank. The variables are: A - Relief Factor: 1) Slope; B - Soil Factor: 2) Effective Depth, 3) Texture, 4) Stoniness, 5) Drainage, 6) Acidity (pH); C - Erosion Factor: 7) Soil Erodibility, 8) Slope, 9) Vegetation Density, 10) Erosivity of rain; D - Bioclimatic Deficiency Factor: 11) Frost, 12) Available Water. In that time the test field showed that the best results were obtained when working with scales near 1:100.000. In this second version the ranges for each variable were refined and a communication interface with the Geographic Information System IDRISI was introduced that allowed the exchange of data among the two programs. After that, maps are digitazed by AutoCAD and IDRISI starting from satellite images, aerial photographs, soil maps, vegetation maps etc. Another import modification was the adoption of an equation to calculate the Erosivity of Rain in place of the original map as part of the User's Guide. Finally as part of the improvement of this version the format of the User's Guide was changed from analogic to digital becoming part of the package. The test field showed that the use of the SIAT is now much more friendly and showing a much better precision enabling the use of scales 1:50.000 or smallers. Another advantage of the SIAT is that there are no limits for its development which is possible changing the variables, the ranges of the variables and even the number of variables (layers).

INTRODUCTION

Brazil has continental dimensions and there are great differences in terms of environmental problems among regions. In the southeast region the main problem is the soil erosion and a computerized system which evaluates the land use suitability could be a helpfull tool in the agricultural planning. In the north (Amazon basin) the problem is the identification and evaluation of areas to be preserved or developed under a special sustainable management.

In the middle of the 40's (Jacks, 1946) was clear the necessity of a methodology to be applied in this field of study. Finally the USDA - United States Department of Agriculture proposed the USDA system (KLIMGEBIEL & MONTGOMERY, 1961). Since the very beginning is possible to detected the trials to process the data digitally mainly do to the large amount of available data. HOPKINS (1977), STEINER (1987) and WHRIGTH et al (1983) among others are experts which spent time in the search to improve the methodology. In Brazil this methodology was adapted by several authors as VIEIRA et al (1976), RAMALHO et al (1978), LEPCH (1983) e OLIVEIRA & BERG (1985).

The MICROLEIS - Land Evaluation Information System was developed for the ecological evaluation of lands in mediterranean regions (ROSA et al, 1992). The CERVATANA module is part of the system and is used to characterize the suitability of agricultural soils. This module was adapted by GARCIA et al (1995) for the conditions of the southern part of Brazil and renamed as SIAT - Land Evaluation System.

The objective of this project was the implementation of the SIAT to a modern version considered as SIAT V. 2.0, more precise and friendly.

MATERIAL AND METHODS

In this second version was choosen the Jacaré-Pepira watershed in the state of Sao Paulo. An integrated analysis was performed and the data were prepared to be used in the new system (GIOMETTI, 1993). The data related with Soil Factor (Effective Depth, Texture, Stoniness, Drainage and Acidity = pH), Relief Factor (Slope),

Erosion Factor (Soil Erodibility, Slope, Vegetation Density and Erosivity of Rain), Bioclimatic Deficiency Factor (Fost, Available Water) were storaged in a appropriate data base and all layers referenced to a common coordinate system.

Several changes were necessary related with the variables:

1. Soil Factor

- Effective Depth - Same

Range	Code
> 200 cm	1
200 - 80 cm	2
80 - 40 cm	3
< 40 cm	4

- Drainage - Same

Range	Code
Good	1
Moderate	2
Excessive or Deficient	3

- Texture - Same

Range	Code
Balanced	1
Clay	2
Sand	3

- Acidity-pH - Same

Range	Code
7.0 - 6.0	1
6.0 - 5.0	2
5.0 - 4.0	3
< 4.0	4

- Stoniness - Same

Range	Code
< 10%	1
10 - 20%	2
> 20%	3

2. Relief Factor

- Slope (Original Range)

Code
< 05%	1
05 - 10%	2
> 10 - 20%	3
> 20%	4

- - (New Range)

Code
≤ 06%	1
> 6 - 10%	2
> 10 - 15%	3
> 15%	4

3. Erosion Factor

- Soil Erodibility - Same

Range	Code
Light	1
Moderate	2
High	3

• Slope (Original Range)	Code	• - (New Range)	Code
< 10%	1	< 10%	1
10 - 20%	2	10 - 15%	2
> 20%	3	> 15%	3

- Vegetation Density

A better approach was obtained by using the C Factor criteria of the USLE - Universal Soil Loss Equation instead the percentage of vegetation coverage. (BUENO, 1994 and PINTO, 1995).

(Original Range)	Code	- (New Range)	Code
> 80%	1	Factor C < 0,001 - Forest, High Savana	1
80 - 40%	2	0,001 ≤ Factor C < 0,045 - Forestry, Pasture,	
< 40%	3	Orchards	2
		Factor C ≥ 0,045 - Crops, Bare Soil	3

- Erosivity of Rain

This variable was originally obtained through a map and now replaced by the equation EI = 89,823 $(r^2/P)^{0,759}$ were:

r = Average of precipitation in a selected month; P = Total precipitation in a year

(Original Range)	Code	- (New Range)	Code
< 700	1	< 575	1
700 - 725	2	575 < 625	2
725 - 750	3	600 < 625	3
> 750	4	≥ 625	4

4. Bioclimatic Deficiency Factor

- Available Water (AW = P - ETP) (Original Range) Code

≥ 500 mm	1	- (New Range)	Code
500 – 350 mm	2	≥ 350 mm	1
350 – 200 mm	3	350 – 200 mm	2
< 200 mm	4	< 200 – 100 mm	3
		< 100 mm	4

- Frost (days/year) - Same

Range	Code
< 2	1
2 - 4	2
> 4	3

The Figure 1 is the flow diagram of the methodology. The SIAT is a weighting matrix were each layer is divided in cells all under de same reference system. The program starts in the cell 1-1 for the 12 layers and so on. The result is a map showing 4 classes of land suitability.

S1 - Excelent Capacity - None or only a few restrictions.

S2 - Good Capacity - Some edaphic, climatic or topographic restrictions.

S3 - Moderate Capacity - Important edaphic, climatic and topographic restrictions. Soil conservation management are needed.

N - Low Capacity - Adequate for pasture, forestry or to be protected areas.

The program is also able to show for each class the existing constraints, which is a good support for the planner.

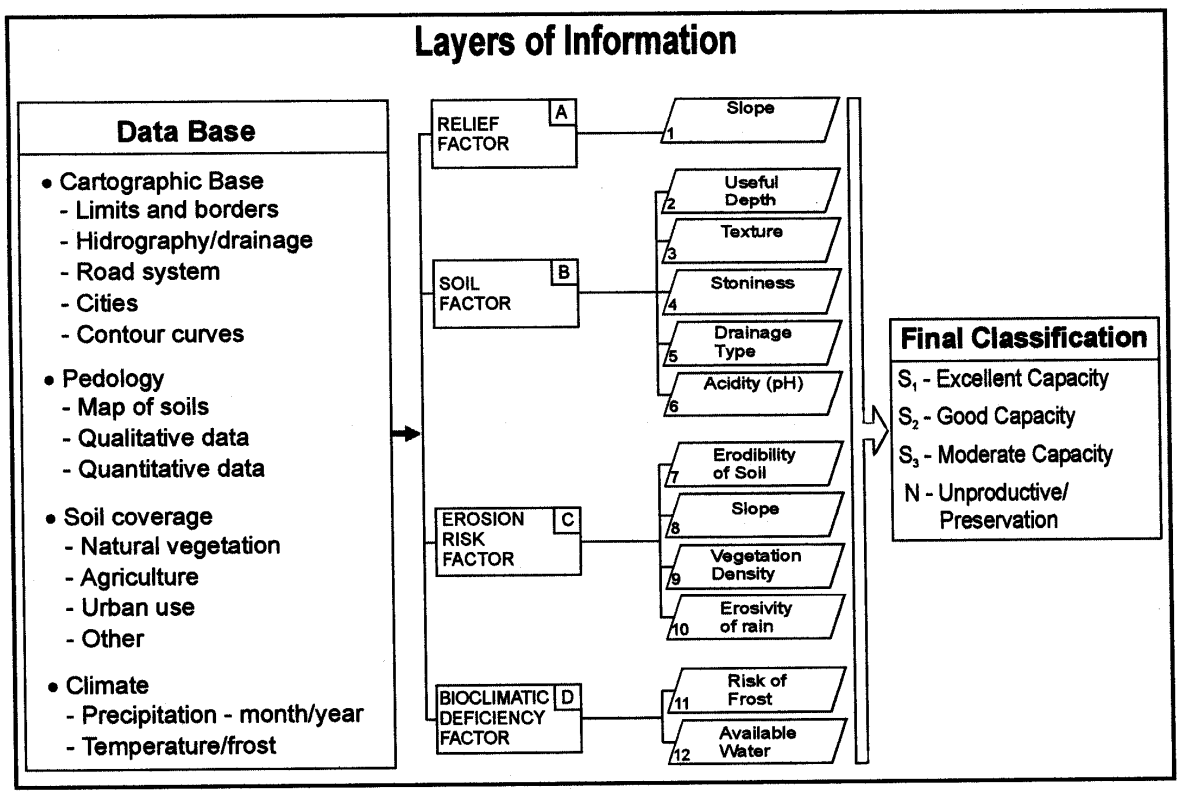

Fig. 1 – Flow diagram of data in the system.

RESULT AND DISCUSSION

One of the objectives was the modification of the input and output of data in the SIAT since in the first version the data entry was performed by digitazing the code values cell by cell for each layer. A routine of import/export data was developed to be compatible with the IDRISI. This improvement was essential due to the amount of data specially in the field of environmental planning.

In this project each layer presented 1430 rows and 2070 columms resulting in files about 8,67 Mb. In the first SIAT'S version was possible to process 140 rows and 140 columms each, which means a very important improvement.

Another objective was the study of the ranges for each variable. Analysing the results is possible to say that the limits have to be adjusted as changes the region, mainly in terms of soils. In another words, the limits used in this project probably are not the same for the Amazon region since it shows a very different

edaphic-climatic situation. However the tests are easy to be carried out and this adjustment cannot be considered a great problem.

The development of a routine to calculate the Erosivity of rain instead a map was an important improvement mainly due to the better precision obtained. Finally as part of the version 2.0 the User's Guide is now part of the system and can be used in the digital format.

CONCLUSIONS

- The new version of the SIAT system showed a much better precision compatively to the original version enabling working scales between 1:20.000 and 1:50.000.
- There are no limits in the development the SIAT, since is possible the change of variables, the ranges of the variables and even the number of variables (layers).

REFERENCES

BUENO, C.P.P. Zoneamento de susceptibilidade à erosão dos solos de bacia do rio Jacaré-Pepira - SP, com vistas ao Planejamento Ambiental. Rio Claro, 1994. 137 p. (Tese de Doutor em Geociências IGCE - UNESP).

GARCIA, G.J. & ESPINDOLA, C.R. SIAT - Land Evaluation System. In: Int'l Cart. Conference. Barcelona. Proceedings, p. 585-590. 1995.

GIOMETTI, A.B.R. Contribuição ao diagnóstico e macrozoneamento da bacia hidrográfica do rio Jacaré-Pepira - SP, Rio Claro, 1993. 188 p. (Dissertação de Mestrado em Geografia - IGCE/UNESP).

HOPKINS, L.D. 1977. Methods of generating land suitability maps: A comparative evaluation. J. American Inst. of Planners vol. 43, 386-400. 1977.

JACKS, G.V. Land classification for Land Use Planning . Imperial Bureau of Soil Science. Tech. Comunication nº 43. 1946, 48 p.

KLIMGEBIEL, A.A. & MONTGOMERY, P.H. Land Capability Classification. USDA, Soil Conservation Service, Agricultural Handbook 210, 1961, 260 p.

LEPCH, I.F. Manual para levantamento utilitário do meio físico e classificação de terras no sistema de capacidade de uso. Soc. Bras. Ciência do Solo. Campinas, 1983. 175 p.

OLIVEIRA, J.B. & BERG, M. 1985. Aptidão agrícola das terras do Estado de São Paulo, Quadrícula de Araras. IAC, Campinas, 1985. 60 p.

PINTO, S.A.F. Contribuição metodológica para análise de indicadores de erosão utilizando técnicas de sensoriamento remoto, geoprocessamento e modelo preditivo. Rio Claro, 1995. 136 p. (Tese Livre-Docência - IGCE -UNESP).

RAMALHO, A.; PEREIRA, E.G. & BEEK, K.J. Sistema de avaliação da aptidão agrícola das terras. Brasília, Embrapa, 1978. 70 p.

ROSA, D.; MORENO, J.A.; GARCIA, L.V. & ALMORZA, J. MicroLEIS: A microcomputer-based Mediterraneam land evaluation information system. Soil Use and Management. Vol. 8, pp. 89-96. 1992.

STEINER, F. Agricultural land evaluation and site assessment. An introduction. Environ. Management, vol. 11, pp. 375-377. 1987.

VIEIRA, L.S.; MARTINS, J.S. & SANTOS, S.P. Sistema quantitativo para avaliar as possibilidades de utilização ecológica da terra. Brasília, MME/PNPM/Projeto Radambrasil, 1976, 50 p.

WRIGHT, L.E.; ZITZMANN, W. & GOOGINS, R. LESA - Agricultural land evaluation and site assessment. J. Soil and Water Conservation, 38:82-86. 1983.