# Comparative study of trhee methods used to laboration of declivity charts

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## Abstract

The main purpose of this work was to compare three methods applied for the elaboration of the declivity charts of the Ribeirão Agua Fria- Bofete (SP) basin. The comparative analysis of data obtained from manual (Abacus) and digital (GIS-IDRISI and GIS-SPRING) methods revealed a discrepancy. The GIS method presented lower time of processing, with the possibility of to be even lower with the use of microcomputers of greater processing speed. The used of more refined grids, although it increases the time spent, it improves the precision of the results.

**Key words:** declivity charts; methods; SIG-SPRING; SID-IDRISI.

## Introduction

The development and use of land as to not only protect it from erosion, but also to develop its production capacity gradually, requires an initial and effective planning.

The misuse of land and without planning impoverishes it in an irreversible manner, causing low productivity of crops and bringing up, in certain regions, as a consequence, the low social, economic and technological rural population level.

The use of soil, when not taken into account their physical and chemical properties, nor the relief (slope factor), causes a sharp wear of it.

The bottom slope factor retains a high degree of importance in this process because it is a physic data that subsidizes a geoenvironmental survey of the area.

In this context, the technical-scientific knowledge of issues related to soil conservation in the basin of Ribeirao Agua Fria- city of Bofete (SP) is of critical importance to the protection of spring's waters.

Thus, this research had as its goal the comparative analysis of three methods used in the preparation of the declivity charts: manually (Abacus) and through the Geographic Information Systems IDRISI and SPRING from the basin, providing the basis for future agricultural, geoenvironmental projects and planning, As well as providing techno-scientific information to the rational and appropriate occupation of the basin with a correct management.

## Materials and methods

The basin of Ribeirao Agua Fria located in Bofete Count (SP), is situated geographically between coordinates: 48° 09 '30 "to 48° 18' 30" W longitude Gr, 22° 58'30" to 23° 04' 30 "S latitude and presents an area of 9.180,125 ha.

The border of the limit of the basin and the curves of equidistant level of 20 x 20 m in the area of the study were obtained from the planialtimeter map of Conchas, Anhembi, Botucatu and Pardinho in 1:50000 scale, edited by the Brazilian Institute of Geography and Statistics - IBGE in 1969, for the elaboration of the slope letters through the Geographic Information Systems - IDRISI and SPRING and though the manual process (Abacus), according to De Biasi (1970).

In the processing of the data obtained by digital process (GIS - IDRISI), a microcomputer Pentium, 500 MHz, 10 Gb HD, 128 MB of RAM, with output for the ink jet printer the HP DeskJet 692 C was used, and the entry of data held by Vivid Scanner Genius Pro II.

The slope letter of the basin obtained by the manual process was developed as the method advocated by De Biasi (1970), and the classes of slope used for soil conservation from 0 to 3%, 3 to 6%, 6 to 12%, 12 to 20%, 20% to 40% and over 40%, suggested by the Soil Survey Staff (1975).

The areas corresponding to the classes of slope from 0 to 3%, 3 to 6%, 6% to 12, 12 to 20%, 20 to 40% and more than 40% obtained by the manual process (Abacus) were evaluated with the use of the Software

SPLAN - planimetry scanned System, developed by the Section of Topography and Aerophotogrametry from FCA/UNESP/*Campus* of Botucatu, according to Silva et al. (1993).

In order to obtain the declivity charts by SGI - IDRISI a scanning of the basin's map was made, converting the analog information into digital. Then, it was made the import of the format. BMP generated in the scanning process into the .IMG format, by the module File / Import and then later the georeference of the digital image to the UTM system, using 4 points of control located in corners of the image, through the Reformat / Resample module.

The digitalization of the mask of the basin polygon was done by the module On Screen Digitizing and the digitalization of the curves of the level on the computer screen by the scanning module. Next, the curves of level were rasterized through the Reformat/Raster/vector conversion/ Lineras module and interpolated by the Data entry, Surface, Interpolation and Intercom module to obtain the classes of slope. Then, it was made the reclassification of the outcome of the interpolation, searching this way, the location of each slope interval of the basin area and the calculation of the area was obtained by the Analysis/Query Data Base/Area module.

For the development of the declivity charts by SGI - SPRING, initially, it was held the reading of the scanned topographic letter (through a scanner) in the *Impima* module, in order to convert the TIFF format of the letter into GRB. Then, it was made the record of the letter in the SPRING module and the edition of isolines that were inserted in a category MNL (Model Number of Land). This way, after editing all samples, a triangular grid was created in order to obtain the slope, in which was made a slice setting up the range of quota, in which was used the recommendation advocated by the Soil Survey Staff (1975).

## Results and discussion

The classes of slope obtained by abacus (Table 1) showed a higher prevalence of areas with 0 to 3% of slope, consisting 26.33% of the basin, ranked according to Donzeli and Chiarini (1973) as plane relief and by Lepsch et al. (1991) as land suitable for the cultivation of annual crops. The classes from 6 to 12%, represented by 25.06%, were classified by Chiarini and Donzeli (1973) as wavy relief and by Lepsch et al. (1991) as land suitable for the cultivation of permanent crops with extensive use of mechanization, being so, we can say that these two classes of slope dominated by more than 50% of the total area of the basin.

The data showed that more than 38% of the area of the basin is made by the classes of slope from 0 to 3% and from 3 to 6%, it means, areas classified by Chiarini and Donzeli (1973) as plane relief and by Lepsch et al. (1991) as land suitable for the cultivation of annual crops

The strong wavy relief (12 to 20%), indicated for permanent crops, which require less soil mobilization, providing lower risk of erosion like coffee crops, sugar cane, pasture, etc.., was predominated in 17.03% of the area. The rugged topography dominated in 12.74%, it means, from 20 to 40% of slope, and can be used for the development of livestock and forestry, or yet, for environmental preservation, avoiding this way soil erosion. Only 7.0% of the basin has hilly topography (CHIARINI; DONZELI, 1973) and is rugged land, with slope of more than 40%, providing only for forestry and pasture with limitations, as Lepsch et al. (1991).

The classes of slope from 0 to 3% and > 40% obtained by SGI - IDRISI were smaller in relation to Abacus, that is, respectively, fell from 2.417,565 ha to 1.650,760 ha and from 642230 ha to 181920 ha, reducing at 31.72% and 71.67%.

The classes of slope from 3 to 6%, 6% to 12, 12 to 20% and 20% to 40, suffered a magnification, respectively, of 12.54%, 10.93%, 42.62% and 14,80%, that is, those areas have increased from 1,086.530 ha to 1,222.750 ha, from 2,300.470 ha to 2,551.890 ha, from 1,563.430 ha to 2,229.775 ha and from 1,169.900 ha to 1,343.030 ha.

The results allowed seeing that the biggest difference occurred for the classes of slope over 40% (71.67%) and the smallest difference to the slope of 6 to 12% (10.93%) were the less and more coherent data with the ground truth, respectively.

The classes of slope from 3 to 6%, 6 to 12% and > 40% obtained by SGI - SPRING were lower in relation to the true land (Abacus), that is, respectively, fell from 1086.530 ha to 359.93 ha, 2300.470 ha to 1766.04 ha and from 642.230 ha to 265.000 ha, reducing by 66.87%, 23.23% and 58.74%.

The classes of slope from 0 to 3%, 12 to 20% and 20 to 40%, suffered a magnification, respectively, of 37.38%, 23.41% and 27.07%, that is, those areas have increased from 2417.565 ha to 3321.15 ha, from 1563.43 to 1929.48 ha and from 1.169,900 ha to 1.486,56 ha.

The manual method demands a longer time in the drawing up of the map of slope, although the time was not timed, we can state that it demands around 60% more than the digital method. This time in the conditions in which the work was done could be even lower with the use of a microcomputer with greater speed of processing. On the other hand, a grid generated with greater refinement may decrease as the stage of entry of data varies with the refinement of grade, for example, a grid of 30 x 30m has nine times more data than a 100 x 100m one, as stressed Pereira Neto and Valério Filho (1993).

Regarding the accuracy of the data, although it requests more computing time, a lower grade would probably improve the classification of areas of the declivity chart generated by the digital process, that is, by the Geographic Information Systems, IDRISI and SPRING. This increase in computing time of the data can be compensated with more modern and faster equipment to process them.

As the declivity chart obtained by the manual process (Abacus) is the truth in this land and we adopted a minimum area able to map in rounding fields of classes of slope, perhaps a minimum area usage in digital process would be advisable, probably, the letter of slope by that method is closer to the manual method.

In this work, it was not applied any type of filtering data. In future work can be seen the use of different types of filters, because they interfere on the set of data, changing them in different ways and may contribute to the approximation of the values of the areas to the real figures (obtained by abacus).

## Conclusions

The results allowed us to conclude that the classes of slope from 0 to 12% represent over 50% of the total area of the basin. The comparative analysis of the data collected by the three cases showed a discrepancy, once the manual method (abacus) demanded 60% more time higher in the elaboration of the declivity chart than the digital processes. The time spent in the digital process may be even lower with the use of computers of greater processing speed. The use of grids with greater refinement may increase the time spent in preparing classes of slope obtained by the digital process, however, it will improve the accuracy of results.

**Table 1.** Comparison of the classes of slope obtained by the manual and digital method (GIS-and IDRISI GIS-SPRING) in the basin of Ribeirao Agua Fria - Bofete (SP).

| Slope classes | Abacus | | IDRISI | | SPRING | |
|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % |
| 0 a 3 | 2,417.565 | 26.33 | 1,650.760 | 17.98 | 3,321.15 | 36.38 |
| 3 a 6 | 1,086.530 | 11.84 | 1,222.750 | 13.32 | 359.93 | 3.94 |
| 6 a 12 | 2,300.470 | 25.06 | 2,551.890 | 27.80 | 1,766.04 | 19.35 |
| 12 a 20 | 1,563.430 | 17.03 | 2,229.775 | 24.29 | 1,929.48 | 21.14 |
| 20 a 40 | 1,169.900 | 12.74 | 1,343.030 | 14.63 | 1,486.56 | 16.29 |
| > 40 | 642.230 | 7.00 | 181.920 | 1.98 | 265.00 | 2.90 |
| Total | 9,180.125 | 100.00 | 9,180.125 | 100.00 | 9,128.17 | 100.00 |

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