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Delineation of the Matança River Basin by the TauDEM automatic demarcation tool

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***Abstract*— *The automatic delimitation of watersheds stands out as essential for the planning and management of water resources, and the delineation and layout of the hydrographic network influences conjunctures in this process. The use of natural resources such as water due to their use in agriculture, industry and urban supply was part of the growing scientific advance regarding the evolution in the scenario of cartographic representation currently dominated by digital cartography. In order to provide a data structure for further hydrological studies by morphometry, it is permissible to establish parameters that indicate the behavior of the river basin, such as flood potential. Therefore, this study had the objective to define the Hydrographic River Basin the Killing making use of TauDEM extension (Terrain Analysis Using Digital Elevation Models), appliance exclusive to hydrological analysis with membership of Digital Elevation Models (DEMs), which can be obtained from remote sensing products absorbed in a variety of free or commercial software such as ArcGIS and QGIS. Given the results obtained it can be attributed that the TauDEM tool is very efficient for automatic delimitation of river basins, mainly reducing the time spent in the process, giving incentives for the diagnosis and planning of watersheds. It is concluded in this study that the Matança River Basin has a flat and gently undulated relief, not susceptible to flooding.*

***Keywords*—hydrographic basin; morphometry; TauDEM.**

I. INTRODUCTION

The watershed is an area of natural rainwater catchment, resulting from the effect of precipitation that converges the flows to a single outlet point, called exutorio. The basin consists essentially of a set of strands surfaces and a drainage network of watercourses which channels lead to a bed in exutori the (Rachel Finkler, 2012).

According to Garcez, Alvarez (1988) Watershed is the set of areas with slope towards a given cross section of a watercourse, measured in the horizontal projection areas. Botelho (1999) understands that the concept of watershed is intuitively linked to that of watershed, differing only in the size of the drained area. A watershed may be either in a larger basin or may contain smaller ones. These smaller river basins are called sub-basins.

For birth; Villaça (2008) The river basin is an open system consisting of rivers that are interconnected hierarchically, with tributaries (springs) that develop and interconnect with other watersheds and progressively increasing their volume.

The middle Tocantins River has territorially larger basins, with low population density where most of the water bodies that flow into the reservoir are found. The main tributaries are: Ribeirão Santa Luzia, Ribeirão Água Fria, Ribeirão São Joao, where the city of Palmas is located., Taquaruçu Stream, Conceição Stream, Lajeado River, Matança River, Crixás River, Carmo River, Mangues River, Dirty Water River, Sao Joao Stream and Areias River making up the 13 sub-basins (Tundisi, 2006).

The main sources of pressure on biodiversity in these basins and on the quantity (formation) and quality of water resources are the increasing replacement of native Cerrado vegetation by agriculture, the evapotranspiration of extensive soybean, corn and sugarcane crops, catchments. without the right of use, pollution due to the application of agrochemicals, removal of vegetation cover from wetlands and destruction of the ecological smoothness of riparian zones. In these basins, there is also no information available about the quantity or quality of water resources (FAPTO, 2016).

The Tocantins and Araguaia Hydrographic Region is the largest in the area of drainage totally contained in Brazilian territory and scene of agile process of socioeconomic development that should intensify in the next decades due to the national and international demands for commodities. As a strategic means for the country, water, agricultural, mineral, navigation and power generation potentials will be increasingly demanded.

The Tocantins and Araguaia River Basin District was defined by Law 9,443 / 97. This decision ended with the elaboration of its Strategic Water Resources Plan, following the criteria of the Integrated Water Resources Management System, which brings PNRH implementation in an integrated, decentralized and participatory way in the main Brazilian basins and regions. The strategic character is conferred by the search to minimize and anticipate future conflicts, establishing rules for the articulation of water use with other sectoral policies to ensure its sustainable use.

In Brazil, public agencies such as the National Water Agency and the Brazilian Institute of Geography and Statistics offer data for watersheds, however, much information about small watersheds is not available. Because of this, in many cases it is necessary to delimit watersheds at specific scales of interest.

GIS basin delimitation methods usually do not use parameters such as the basin outlet or basin order to define the extent of the boundary. Without parameters, the programs demarcate watersheds of varying proportions, and hardly watersheds, especially those with rivers of small order and length.

II. HEADINGS

In the procedures employed in the delimitation of the Matança River BH performed through the Terrain Analysis Using Digital Elevation Models (TauDEM), version 5.3, which was installed in the QGIS® program, the Digital Elevation Model (MDE) was used. of a digital representation of land surface relief, obtained from the Embrapa database, a free and open system, under the responsibility of the Ministry of Agriculture, Livestock and Supply. The relief MDE data map derived from the Brazil Radar Shuttle Topographic Mission used in this work was from Region SC-22-ZB (Mendes, 2018).

TauDEM is a toolkit for the extraction and analysis of hydrological information from topography as represented by a free, intuitive digital elevation model, which has Portuguese versions, developed by the Hydrology Research Group of Utah State University in the United States, available for free at http://hydrology.usu.edu/dtarb/. TauDEM is available for ArcGIS, QGIS and Mapwindow.

It works with vector and polygonal data, thus being able to integrate ground analysis into matrix bases for drainage network extraction and the assigned final basins of their geometric characteristics (Mendes, 2018).

The first step was to display the MDE for the Flat Coordinate System. The coordinates applied in this work were UTM / Sirgas 2000 Zona 22 Sul. With the MDE in the desired projection, the automatic basin delimitation processes were started, as shown in Fig 1. The first measure was the application of the remove depression function, from the Tools tab. Basic grid analysis, this tool removes the spurious depressions found in MDE. The next step was to generate the raster that indicates the water flow path using the Flow Directions function D8.

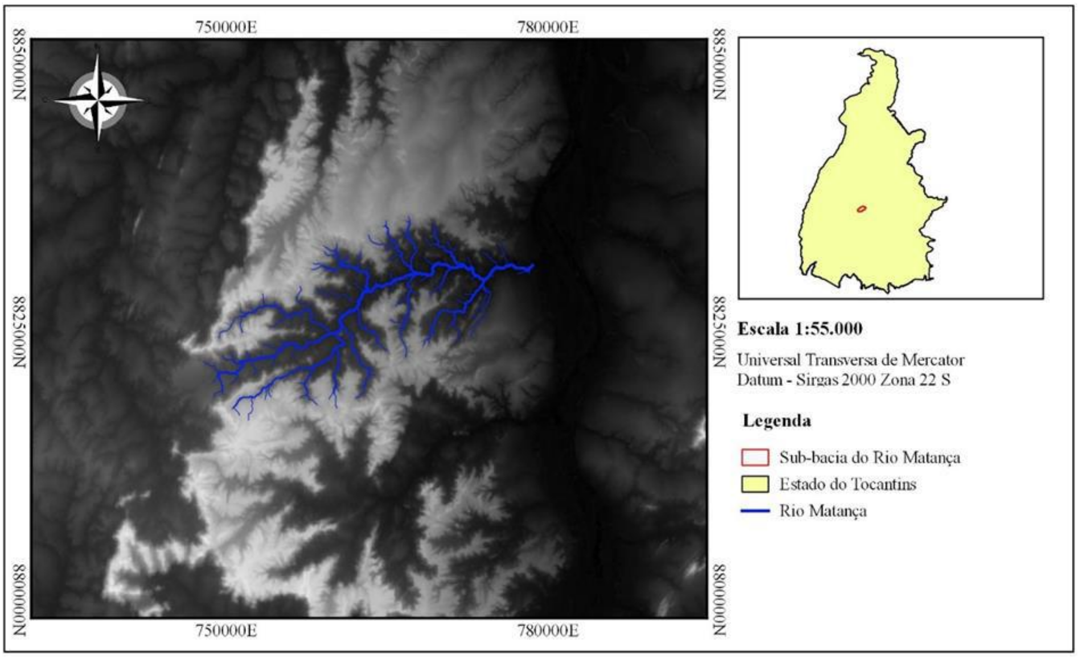

Fig.1: MDE da região da bacia do Rio Matança.

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The algorithm generates two raster files: D8 Flow Direction Grid, which shows flow direction, and D8 Slope Grid, which reproduces slope. The next algorithm used was Contribution Area D8 to demarcate basin boundaries by flow directions. This procedure was performed twice, the first time generating a raster representing the overall contribution areas of the MDE, through which it is possible to view the sub-basins. After generating the raster D8 Contributing Direction Grid, which depicts the directions of the contribution flowing into the basin, it is necessary to define the exutory point by means of a shapefile file, later indicated with Outlets. In the second execution of the algorithm was clarified positioning of the exutory and then generated a raster that indicates the Matança River basin.

The consequence of the execution of the algorithm was the creation of a raster containing the MDE drainage networks. The newstage was the delimitation of the basin. In this procedure we used the function Reach and flow of Watersheds as shown in Fig.2 originating the raster that represents the Watershed. After performing these steps, the polygonized river basin vectorized raster remained in polygons.

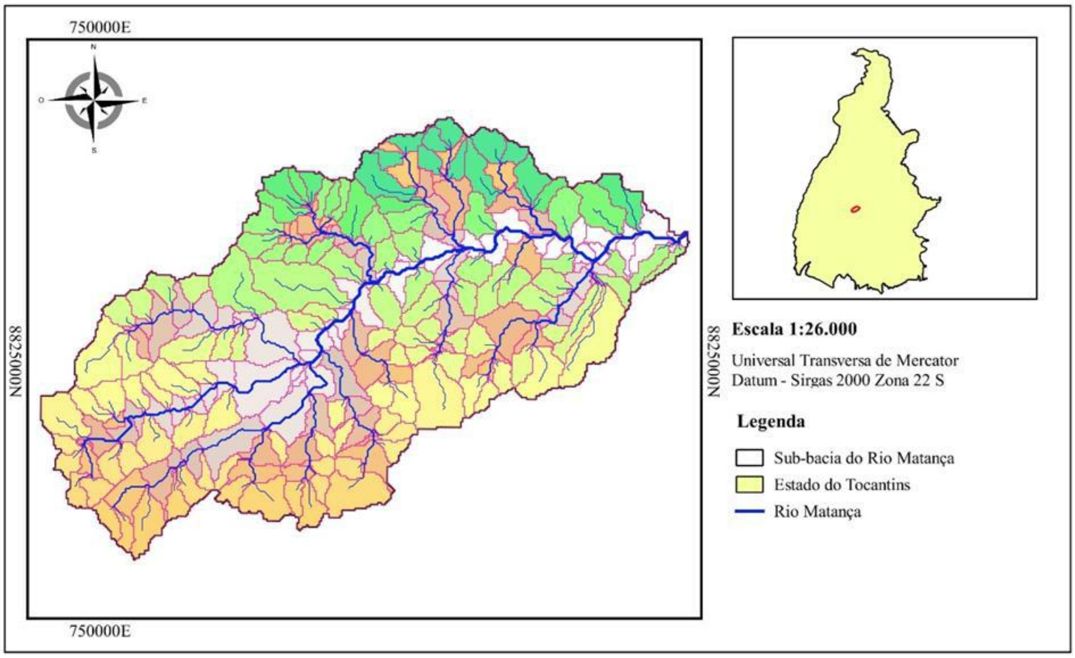

Figure 2: Bacia Hidrografica do Rio Matança.

III. RESULTS AND E DISCUSSION

Relief Morphometric Characteristics

The features associated with the relief are of great note as the relief is closely linked to the drainage and runoff characteristics. According to Carvalho e Silva (2006), the study of surface runoff may be for the engineer the most relevant of the phases of the hydrological cycle, precisely because it deals with the phenomenon of water transport on the terrestrial surface, given that most hydrological studies are involved in the use of surface water and protection as the actions generated by the displacement of water.

Fig.3 shows the slopes of the Matança River Basin. Through this map the slope classes generated in six distinct intervals suggested by Embrapa are presented, it is clear that a good part of the basin is flat with slopes ranging from 0 to 3%. And that in the most steep areas it is expressed in red (strong mountainous), highlighting the high relief at the runoff points, thus drawing the course of the river basin on the flat terrain.

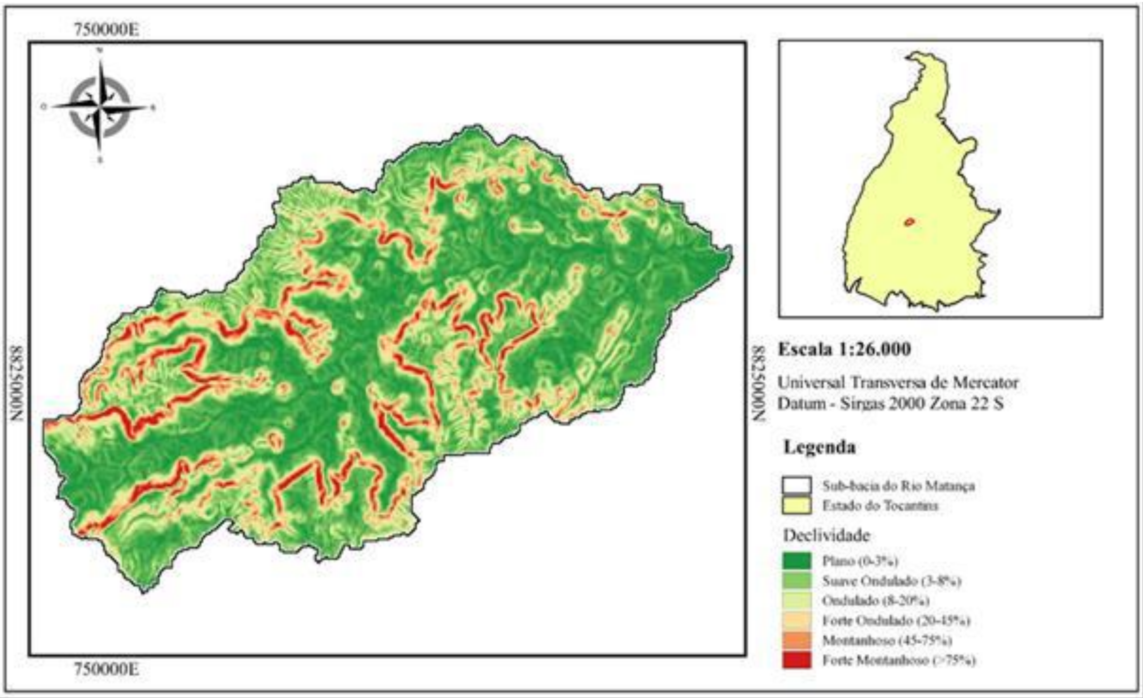

Fig.3: Declividades Bacia do Rio Matança.

Tabela 1: Relief Characteristic

Maximum altitude (m)	526
Minimum altitude (m)	228
Declivity	0 to 75%
Altimetric Amplitude	298
Relief Ratio	0,0092

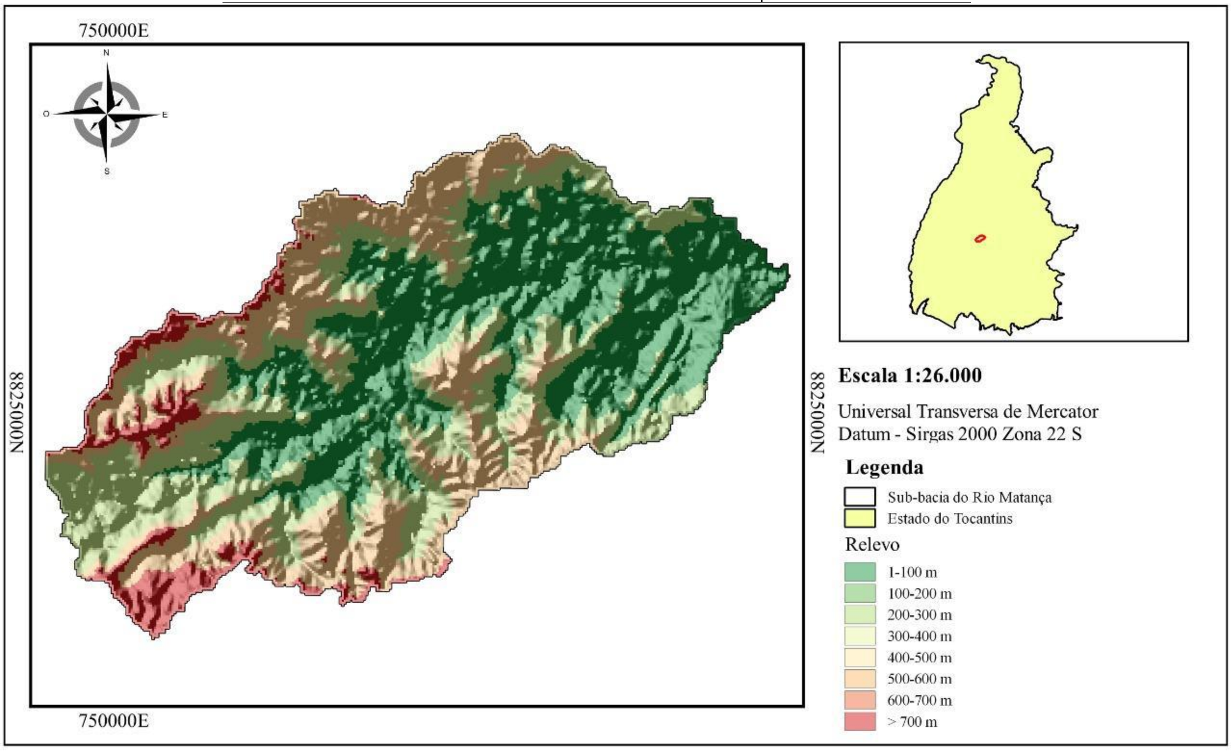

Fig.4: Mapa Hipsométrico da Bacia do Rio Matança.

Relief Ratio is a specification that involves the altimetric amplitude and the length of the main channel, and indicates the relationship between the maximum and minimum altitude difference in the basin and the total length of the main channel (Lana; Alves; Castro, 2001).

The Matança River basin demonstrated a relief ratio of 0.0092 (Table 1). The low value of the relief ratio is a result of the low altimetric amplitude and consequently a low average slope characterizing the relief as smooth wavy.

The values presented indicate that the Matança River Basin has a medium capacity to generate new watercourses, a fairly low and a small surface runoff, but some mountainous areas justify the existence of 237 river channels and approximately 262 km in length. the channels.

Tabela 2: Quantity of River Matança River Channels.

Order	# Of Channels
1st	119
2nd	65
3rd	27
4th	26

Table 2 presents the data resulting from the DEM in the TauDEM tool. In turn, it was possible to analyze that 50.21% of the fluvial channels are first order; 27.43% of the second order; 11.39% third order; 10.97% of the fourth order.

The study showed that the Matança river basin is largely formed by low altitudes and therefore a median altimetric amplitude. A relevant consideration for river channels is their longevity. According to Marcuzzo and Goularte (2013) in Tocantins the hydrological year presents a well-defined personality characterized by two periods: dry and rainy. Where the humid lasts longer,from seven months, from October to April. And the five-month extending from May to September. In addition, during the rainy season in the state precipitates approximately 90% of the entire volume of the Tocantins hydrological year.

The morphometric analysis represents a methodology for water functioning estimates in the absence of monitoring of climatic variables. For the morphometric characterization of this basin, it was necessary the hypsometric delimitations of maps with basic properties, to consider area, perimeter, axial length of the basin. From these properties the shape indexes of the basins were calculated, translated into the values of compactness coefficient (Kc), form factor (Kf) and circularity index (Ic).

The compactness coefficient (Kc), which is the relationship between the perimeter of the basin and the circumference of a circle of equal area to the basin, was calculated from the equation:

$$Kc = 0{,}28\frac{P}{\sqrt{A}} \qquad (1)$$

Where, P is the perimeter in km and A is the basin area in km². This coefficient is a dimensionless number that varies with the shape of the basin regardless of its size, so the more irregular it is, the greater the compactness coefficient, is the closer to the unit, the more circular the basin will be and the more subject it will be flooding (Villela & Mattos, 1975).

The form factor (Kf) is the ratio between the average width and the axial length of the pelvis. It was calculated from the equation:

$$Kf = \frac{A}{Lx^2} \qquad (2)$$

Where Kf is the form factor, A is the basin area in km² and Lx is the axial length of the basin in km. A basin with a low form factor indicates that it is less subject to flooding than another of the same size but larger in form factor (Villela & Mattos, 1975).

IV. CONCLUSION

With regard to the TauDEM tool, it can be concluded that it has shown to be an adjusted basis for the automatic delimitation of watersheds, thus being able to contribute to morphometric, hydrological and conservationist studies of these areas. Automatic delimitation of watersheds is a procedure chosen because it ensures less subjectivity and faster process, facilitating decision making regarding water resources planning.

It was also noted that in the Matança River the relief distribution varies in an amplitude of 298 m, with a maximum elevation of 526 m and a minimum of 228 m.

Based on the morphometric characteristic of the Matança River, it was possible to conclude the analysis that the basin with respect to the compactness (Kc) and shape (Kf) coefficients was 5.78 and 0.035 respectively, and according to Villela and Mattos. (1975), that the more irregular the basin, the higher the compactness coefficient, ie not subject to major flooding. For coefficients above one, the basin will show low susceptibility to flooding; In turn, the lower the value of this coefficient near zero, the greater the propensity to flood, the more rounded the basin and the more subject to flood it will be. For the form coefficient Villela and

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Mattos (1975) report that a basin with a low form factor is less susceptible to flooding. These coefficients are of a dimensionless value that varies with the shape of the basin without its size.

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