SEMIAUTOMATED MAP OF CLIMATE AND GEOMORPHOLOGIC ATTRIBUTES FROM SÃO JOÃO – MG RIVER BASIN, BRAZIL

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ABSTRACT:

This study proposes a survey of environmental information by applying techniques of modeling and image segmentation in the definition of landscape units. Landscape attributes such as climate and topography were selected to start the characterization of the São João – MG river basin, located in southeastern region Brazil. The semiautomated mapping was produced from data extracted, respectively, of the DEM Aster and Topodata, and grid Worldclim. This database was processed and scaled to 1:100,000 scale, generating a geomorphological classification, according to criteria of IPT (1981), two climatic classifications, the first by the methodology of Koppen (1928) and second by methodology Thornthwaite & Mather (1948) and a classification of land use. The thematic maps were associated in GIS with a geological base, soil vector, defining landscape units.

1. INTRODUCTION

The semiautomated method is an effective procedure as a subsidy to landscape planning maps. This method is efficiency by enabling the application of thresholds in the establishment of classes and the definition of landscape units. The classification in regions by means of instruments segmentation and object-oriented analysis is a procedure in better than the traditional pixel-by-pixel.

1.1 Landscape Units

Landscapes are complex natural systems, which occur very second interactions between natural and anthropogenic components (attributes) in the geographical area. They cover areas with specific characteristics (homogeneous), but heterogeneous with respect to the neighborhood (Turner et al. Al., 2001).

The climate through its elements contributes to the weathering process and modulations of land forms. Influences in the pedogenesis and interferes in the process of colonization of the vegetation. The knowledge of their types in the planning process helps to guide the use and occupation of land in different landscapes.

According Ayoade (2004) and Vianello & Alves (2000) it is possible to define areas where the climate is relatively uniform across diverse landscapes. This region is commonly known as climatic region. In this case, the classification of climatic types and their mapping procedures are required in the description and identification of landscapes contained in these regions.

The relief forms may be facilitative or restrictive processes of land occupation, the territorial arrangement of landscapes and production. Its characteristics are important for the definition of urban and rural infrastructure best suited to production systems in different landscape units (Ross, 2006). The relief, in its forms, reveals the endogenous and exogenous process, which definition of the different landscape units.

The classification of the landscape should reflect the level of state territory and simultaneously, the degree of spatial differentiation (Mateo Rodriguez, et al., 2004). The different arrangements attributes of the landscape for the formation of units with specific characteristics, in particular from the attributes climate and geomorphology.

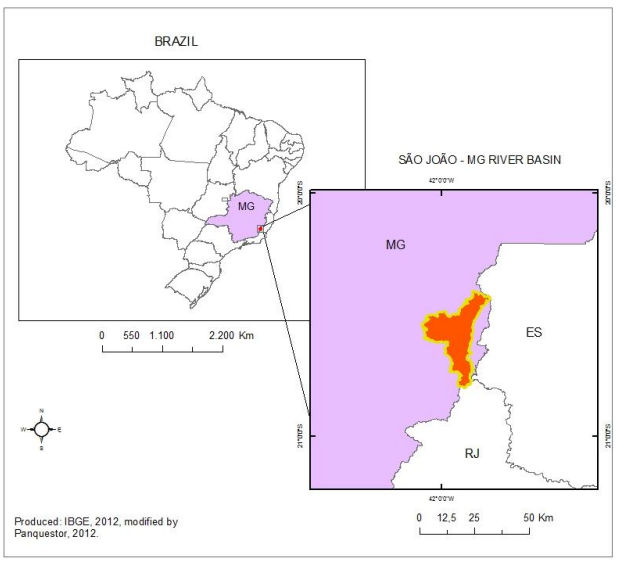

Figure1. São João River Basin – MG, Brazil.

The general objective of this study was to delineate landscape units in the river basin of the São João – MG (figure 1) by means of natural attributes. The specific objectives were: to classify the types of climate according to the methodologies proposed by Koppen (1928) and Thornthwaite & Mather (1948) and classify the types of relief in accordance with the proposal of IPT (1981).

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1.2 The semiautomated mapping

The application of procedures aimed at obtaining thematic maps from a structured database leads to a faster identification of landscape units according to the thresholds for the selected attributes.

However, using a larger amount of information and greater spatial resolution, confusing maps tend to be generated through the methods of classification pixel-by-pixel. So need to change about the procedures used. The general idea is to approach the object-orientation to a problem, applying the techniques of classification by division or grouping (Medeiros, 1999).

The procedure based on segmentation and delineation of regions in terms of average data (or variance, size, shape and texture) reflectance or radiance brings new possibilities and better mapping results (Kux & Blaschke, 2007).

On this basis it was decided to use the application eCognition® (Definiens, 2009), which enables the construction of thematic maps from procedures such as segmentation and object-oriented analysis. There are operators that contribute to the definition of classes and identification of landscape units.

From a data base and make it possible to extract their semantic analysis, which allows the establishment of relationships between different variables called objects. These objects are listed according to the supervised classification in which its attributes are automatically compared and correlated.

This comparison and correlation allow the establishment of classes within hierarchical networks, occurring interdependence between the involved objects according to attributes (keys) entered by the researcher (Camargo, 2008). There are conditions to be established classes and their redefinitions new classes hierarchically dependent.

So, these keys of interpretation contribute for both aspects to the geomorphological and climatic. Research data sources such as rankings of Koppen (1928) and Thornthwaite & Matter, and geomorphological mapping of the IPT (1981) allowed the definition of intervals or keys to the interpretation of the phenomena studied

In this study the classification algorithm allows the inclusion of multiple combinations made by logical operators, using the fuzzy membership functions for the thresholds (Definiens, 2009). Fuzzy logic is characterized as the ability to handle intermediate values between 0 and 1, defining for each object a set of degrees of membership.

1.3 The Development Study

The study was conducted in two well defined steps which were also divided in this article. Initially the classes were established according to the climatic classification of Köppen (1928) and Thornthwaite & Mather (1948).

Then there is the definition of geomorphological units in accordance with criteria established by IPT (1981). Associated with geomorphological mapping is the mapping climate seconds Thornthwaite & Mather (1948), considered more appropriate where the procedure is made between the hierarchy of objects.

2. METHODOLOGY AND RESULTS

Mapping climate has been drawn from the grid Worldclim, which represents data interpolated to 1km pixels worth of resolution (Hijmans, 2005). The data were scaled to obtain an approximate map scale of 1:100,000. The spline method was used in the application ArcGIS® (ESRI, 2008).

2.1 The Koppen Climate Classification (1928)

For the classification of Koppen (1928) interpolated data were processed using ArcGIS® (ESRI, 2008) raster calculator tool to extract the following information:
a) Temperature of the warmest month and the coldest month.
b) Average rainfall of the driest month and yearly total.

Depending on the rainfall below 2,500 mm per year and the temperature be between 18 ° and -3 ° C climate was classified as C (mesothermal - subtropical) (Vianello & Alves, 2000). Three classes were identified (table 1). Their descriptors and thresholds are as follows:

Typologies	**Thresholds**	
	Mean Temperature warmest month	Mean Rainfall driest month
Cwa	> 21 and 22	< 29.9 and 30
Cwb	< 21 and 22	< 29.9 and 30
Cfb	< 21 and 22	> 29.9 and 30

Table 1. Koppen Classification (1928)

The segmentation for interpolated climate data was performed with the scale parameter value 100 in the application eCognition® (Definiens, 2009). The same value was used for the next climatological classification.

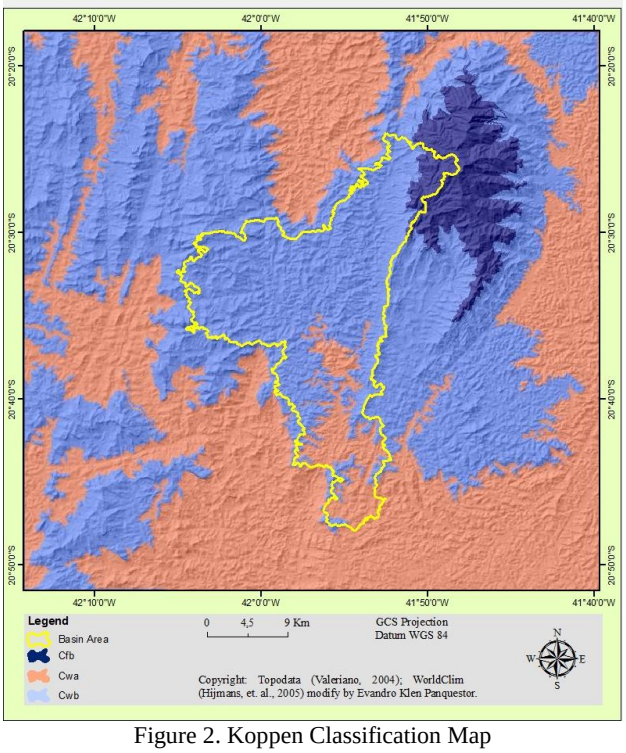

Figure 2. Koppen Classification Map

The previous map (Figure 2) shows the predominance of Cwb class (medium humidity) in relief of hills and Cwa (intermediate and higher temperature) in relief of lower altitude. The Cfb

climate is limited to medium-sized mountains are characterized by concentration of rain.

2.2 Classification of Climate Thornthwaite & Mather (1948)

In order to establish the type of classification was necessary to make the water balance of the study area. The data obtained were interpolated to the grid Worldclim new scale (1:100.000). The raster calculator tool was used along with map algebra in order to obtain the following data: potential and actual evapotranspiration; accumulated negative; and rate of storage.

Typologies	Thresholds	
	Mean (TEI)	Mean (EHI)
Subtropical Superhumid B'1 A' (mesothermal)	> 550 and 551	> 100 and 101
Subtropical Humid B'1 B'3 (mesothermal)	> 550 and 551	< 79 and 81
Subtropical humid B'1 B'4 (mesothermal)	> 550 and 551	Over the area 80 and 101

Table 2. Thornthwaite & Mather Classification (1948).

From these data have been established the Thermal Efficiency Index (TEI) and Effective Humidity Index (EHI). The classes identified above (table 2).

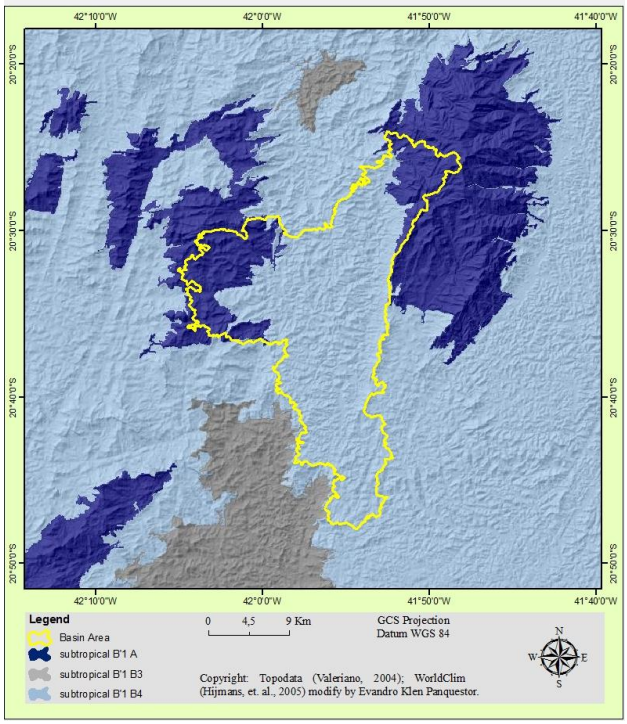

Figure 3. Thorntwaite & Mather Classification Map

The previous map (Figure 3) shows the predominance of subtropical B'1 B3 class (medium humidity) in relief of hills and subtropical B'1 B4 (intermediate and higher temperature) in relief of lower altitude. The subtropical B'1 is a class climate limited to medium-sized mountains. This class is characterized by concentration of rain and low temperature.

The classifications of Köppen (1928) and Thornthwaite (1948) are considered by the empirical use of descriptive numerical data. The criticism is that the first classification concerns the manner of obtaining such data. The numerical grid Worldclim expanded access to these data (precipitation, temperature and bioclimatic) for greater accuracy.

Köppen developed a simple and practical methodology to be applied. In the case of Thornthwaite & Mather (1948) the search for greater precision and based on water balance requires greater accuracy. In practical terms, demands more operations, but contributes to ecological and agricultural studies (including the territorial) given to consideration of evapotranspiration and moisture data.

The first classification also showed greater accuracy in relation to topography and its forms. The differences in topography, especially the tops, were well delineated. In the second method there was no strong correction, though still present.

The object-oriented analysis (OOA) allowed the digital numerical bases used could be processed in fuzzy logic with interpretive keys (key words specific to each classification).

By allowing a small degree of variation in the determination of classes, the fuzzy logic approach contributes to the natural phenomena. The climatic classification of Thornthwaite & Mather (1948) could better express the relationship between altimetry and thermal variation. Thus, the hierarchy was established between the three climatic types and identified six types of relief.

2.3 Geomorphologic Classification

The geomorphologic classification was made from data extracted from Aster DEM subsequently corrected with the DEM Topodata scale of 1:100,000 (Valeriano, 2004). The data used were slope, hillshade and topography, which were combined to the software eCognition.

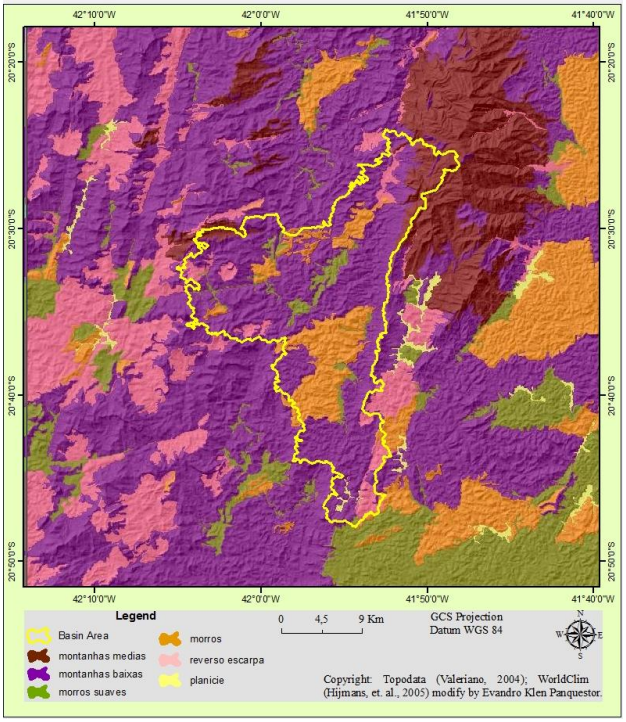

Figure 4. Geomorphologic Classification Map

We generated maps of slope and shading, which were used together in applications. The thresholds were set according to the definition of IPT (1981). Thus, from two cleavages 100 and 200, classes were defined in table 3.

Typologies	Thresholds	
	Amplitude (Dem Max – Dem Min)	Mean Slope (%)
Montanhas Médias	> 800 and 801	> 14.9 and 15
Montanhas Baixas	Over de area 280 and 900	> 14 and 15
Morros com Vertentes Suavizadas	Over de area 98 and 305	<14.9 and 15
Morros	Over de area 100 and 300	> 15 and 15.1
Reverso de Escarpas	> 310 and 311	< 13.9 and 14
Planícies	< 109 and 110	< 5.9 and 6

Table 3. Geomorphologic Classification

The previus map (Figure 4) shows the predominance of "montanhas baixas" (low mountain) class in a north direction of basin. The class "montanhas médias"(medium mountains) is a small region to the northeast and northwest of the basin, representing two sources of rivers that are part of the basin of the São João river.

The hills ("morros") are found at the center of the basin, in which there is a large movement of relief. Other forms of relief, such as soft hills, hills and "planícies" (low altitude relief) are outside of the basin area, influencing it indirectly.

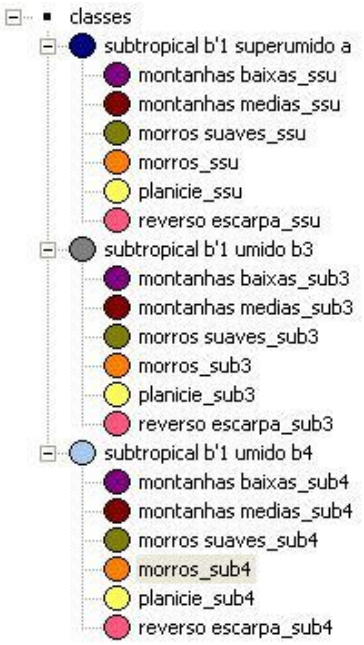

Figure 5. Hierarchical Climate and Geomorphologic Classes

Figure 5 depicts the process used in the hierarchy of classes and subclasses. Started from the weather as large classes in which the data were related to relief from the second annotated bibliography described previously entered.

This hierarchical process was used for classification of landscape units and better definition for studies of land use. The next map shows this hierarchy.

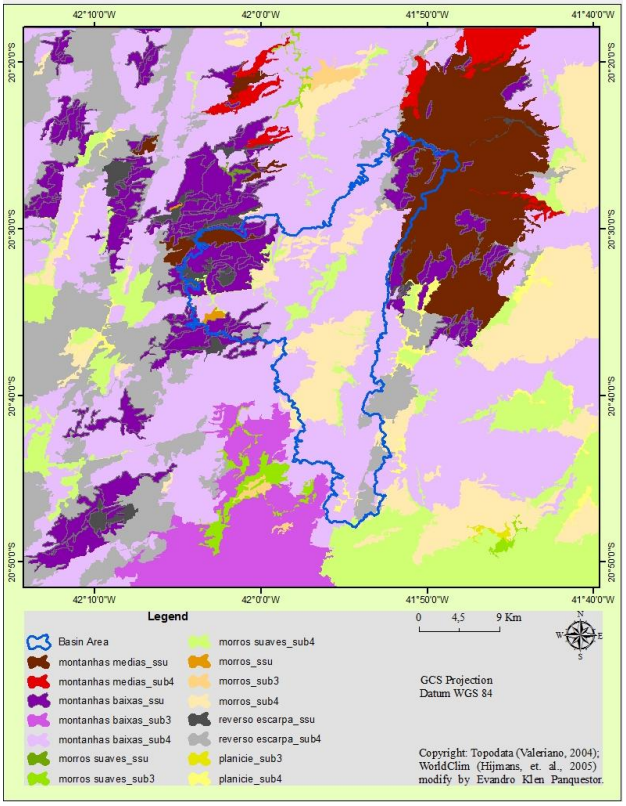

Figure 6. Landscape Units (Climate and Geomorfologic Map)

In Figure 6 there is a distribution of fifteen landscape units identified from the relationship between climate and topography in the São João River. This study did not require further action other than those mentioned descriptors due to reasonable identification of classes.

3. CONCLUSION

From this procedure were defined combinations of fifteen types of terrain and climate types. These units constitute the basis for the future integration of geological, soil and land use configuration in order for the territorial units.

Furthermore, the utilization of fuzzy logical and the Definiens eCognition bring new possibilities to the segmentation and multiresolution detection regions for subsequent classification. The final products (thematic maps) were produced and given more to this technology than the classification pixel-by-pixel.

The landscape units found may be divided using a larger number of descriptors or through manual intervention compared with the actually achieved in visits to these units. In any case, the procedure was especially effective because it allows the production of maps current scale does not exist for the basin of the São João River.

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