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MODELING OF NATURAL VULNERABILITY TO EROSION THROUGH THE GEOGRAPHIC INFORMATION SYSTEMS IN MORRO DO CHAPÉU-BA

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The environment is always in permanent change keeping its proper dynamics with its own rhythms.However, when the people move themselves occupying specific locations, some transformations can take place, constituting threats for the environment and for the man himself. These changes are related to the enviroment degradation, which has erosion as one of its most significant processes.

To understand this dynamic, it is necessary to model the environment in a way that is possible to identify areas with different degrees of natural vulnerability to erosion and thus provide actions that relieve these impacts.

The erosive processes are part of the lithosphere modeling system and have its intensity degree more stable or more intense according to the sum of several physical variables (lithology, leveling, landscape, rainfall and hydrography), biological variables (ecosystem- the type of the original and second growth vegetation) and anthropogenic variables (the type of human occupation and mining activities).

The impact of the rain on the soil has its effects reduced because of the vegetation and so the pedogenesis is benefited and the erosive processes minimized. On the other hand, if there is no vegetation or if this is insuficient, morphogenesis becomes more intense and the erosive processes enhanced.

The degrees of intensity of the erosive processes are enhanced in areas where there is more rainfall or where there is no vegetation, with greater difference in topography levels. On the other hand, they are relieved in opposing conditions. However, many more variables are associated to this process and at many times, it is impossible to measure the environment degeneration.

It is quite common to distinguish the geological slow erosion, which happens under the inexorable action of natural agents from the accelerated one, which is the direct result of human activity upon nature, which provokes the acceleration of the process (Souto, 1985; Braga, et al, 2003).

This work aims at defining a methodology for evaluating the vulnerability natural to erosion (the slow one and the accelerated one) in the county of Morro do Chapéu, Bahia, using a Geographical Information System .

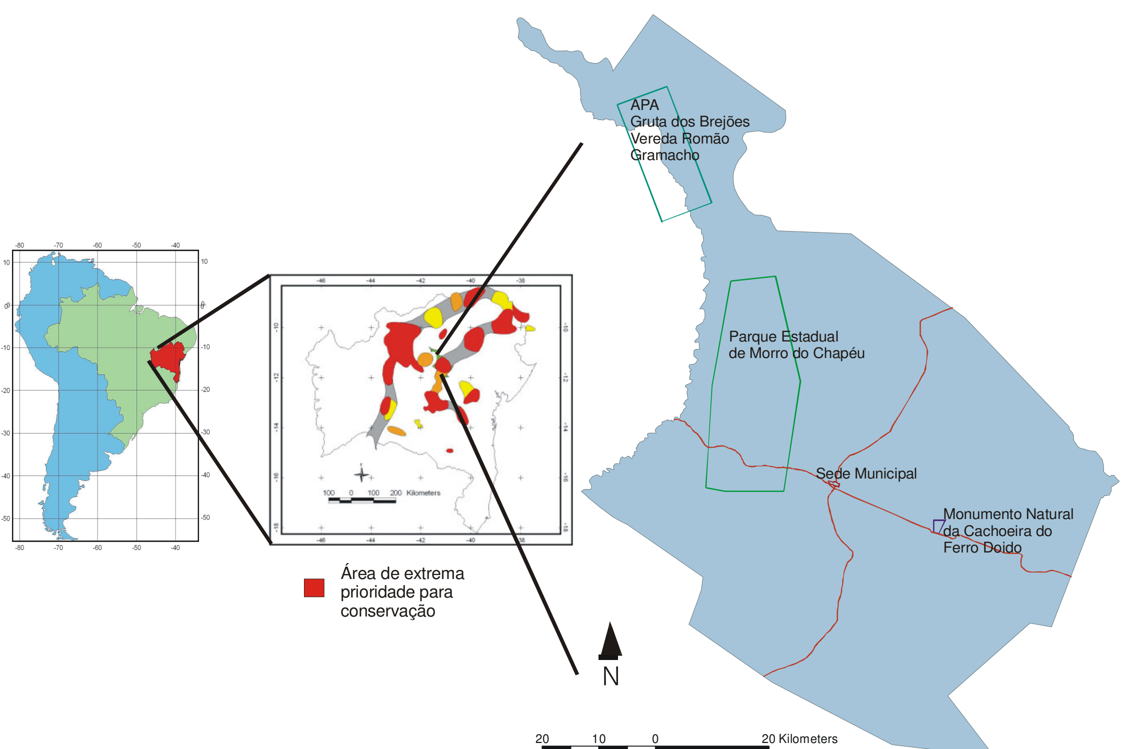
THE AREA OF STUDY

The region of Morro do Chapéu has topographic levels ranging from 480m to 1,293m which turns it into an orographic barrier and which provides a great variance in climate, soils, landscape and hydrography among other social and environmental aspects. This makes the comprehension of the environment difficult as well as its management.

The current population of Morro do Chapéu is 34,494 inhabitants (IBGE, 2000). It is situated on the North of Chapada Diamantina (a mountain range in Brazilian Northeast). The area of study is located between 10°46' 3.86" and 12° 0'44.93" latitude South and 41° 30' 46.69" and 40° 42' 15.56" longitude West (Picture 1).

Figure 1- Map of location of the area of study.

Picture 1- Map of location of the area of study.



MATERIAL AND METHODS

The material used for this work was what follows.

1- Topographic maps of these counties: *Camirim* SC.24-Y-A-IV; *Umburanas* SC.24-Y-A-V; *Mirangaba* SC.24-Y-A-VI; *Irecê* SC.24-Y-C; *Jacobina* SC.24-Y-C-III; *Canarana* SC.24-Y-C-IV; *Piritiba* SC.24-Y-C-V; *Morro do Chapéu* SC.24-Y-C-VI; analogous and digital, on the scale of 1:100.000.

2- Reports plus climatic, geological, vegetation and soil maps on the scale of 1:200.000 – CPRM, 1995.

3- SRTM/NASA Digital Topographic model, with spatial resolution of 90m.

For this work, we chose the building of a data base, which composed a Georeference Information System, with several topics edited and based on a data project called Projeto Mapas de Morro do Chapéu (CPRM, 1995). This included climate, vegetation, geology and soils (scale 1:200.000). And also included results from MDT (Ground Digital Model) (SRTM/NASA) such as differences in topography, aspect, convexity and shading.

This data was integrated in a GIS environment by using the combination of two techniquesWeighted Median Inference -WMI (Silva, 1999) and Analytic Hierarchy Process - AHP (SAAT, 1978).

For this research, the vulnerability natural to erosion was considered based on the balance morphogenesis-pedogenesis (TRICART 1976), where the weight for each attribute of a feature varied on a scale from 0 to 5; 1-2 meaning stable, 3 meaning intermediate and 4-5 meaning unstable.

At first, we did not consider human intervention on this process by using data of geology, geomorphology, soils, climate, vegetation and anthropogenic use. So that, on a second phase, we could evaluate the anthropogenic consequences on this environment, being able thus to distinguish between “slow” and “accelerated” erosion.

That way, modeling was built with the aim of distinguishing between these two erosive processes. At first, human interference was not taken into consideration on this process. With these results, we were able to evaluate the environmental picture of this county, identifying its fragilities and the different degrees of geological or “slow” erosion.

As a result of the model hereby created, on a second phase it was possible to add the areas of cattle raising and second growth, allowing for the identification of the different degree of the vulnerability to the “accelerated” erosion.

RESULTS AND DISCUSSION

The sum of the analysis data through the System of Geographical Data made it possible to construct two thematic maps, which represent the reality of this county in two different aspects.

In the first one, a hypothetic situation was created to show how the vulnerability natural to the erosion would be without human presence thus not taking into consideration any anthropogenic interference (Picture 2A).

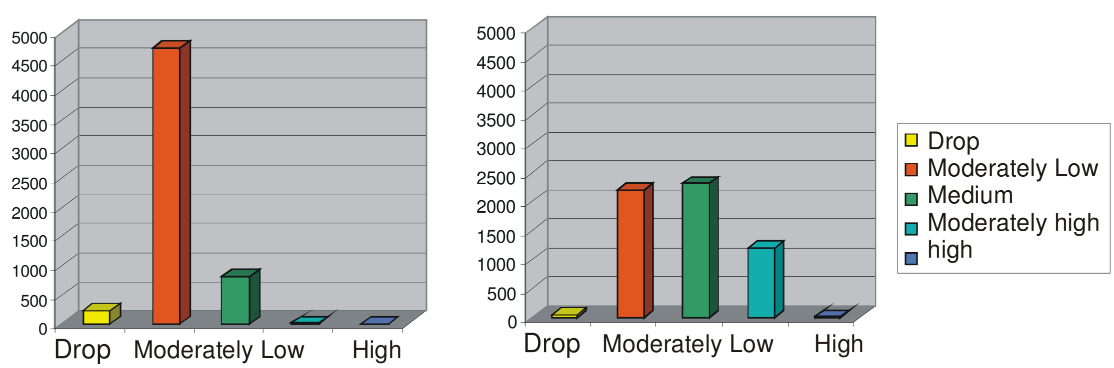
In the second map, the anthropogenic activities related to the use and occupation of the land were taken into consideration (Picture 2 B).

These results were quantified (Chart 2) and generated graphs, which demonstrate more clearly the situation of the county (Picture 3).

Chart No.2 – Comparison of the area and percentage of slow and accelerated erosion.

	Slow Erosion (Km^2)	%	Accelerated Erosion (Km^2)	%
Drop	220.38	3.8	41.40	0.72
Moderately Low	4723.68	82.1	2199.45	38.22
Medium	801.56	13.9	2316.27	40.25
Moderately high	9.76	0.2	1195.96	20.78
high	0.00	0.0	2.04	0.04

Picture 4 – Graphs of comparison between slow and accelerated erosion.



Through this simulation, it was possible to evaluate when and how much human presence accelerated the process of erosion in the county and also to identify the most fragile areas and those ones which were fragilized by anthropogenic interference.

In Picture 2A, one can observe that the area most susceptible to erosion was located in the central region of the county. This corresponds to an area with bush-timberlike graminaceous vegetation, known as *Campos Rupestres*[1], with alicus A litholic soils (weak and moderate) of the Arenaceous Rocky Phase, with rock emergings (ondulated and highly ondulated relief).

Although the area of the county has a great unevenness of topographic levels and despite it being located mainly on highlands, its climate helped generate a dense vegetation, which lead to the stability of the county. Even in areas of *Caatinga*[2], the local vegetation differs from other areas of the greater region called *Pediplano Sertanejo*[3], being confused at times with *Cerrado*[4] and more, at times getting really dense. These very specific features give the county area a certain stability on one side, but fragilities on another side. When the vegetation is taken off, the erosive process is accelerated, exposing the soil to the torrential rains that fall occasionally, but that are common in the region. In this environment, the topographic unevenness associated with the large areas of arenaceous soils make these areas very susceptible to the erosive processes, when great quantities of material are transported elsewhere.

The results of these processes can be observed in Picture 2B. The central part, at first considered intermediate or medium, being more susceptible to erosion, had little consequences of anthropogenic intervention. Whereas certain areas to the West, to the North and to the East, in spite of being better drained, were the ones which had the greatest consequences of anthropogenic interference and thus became more vulnerable to erosion.

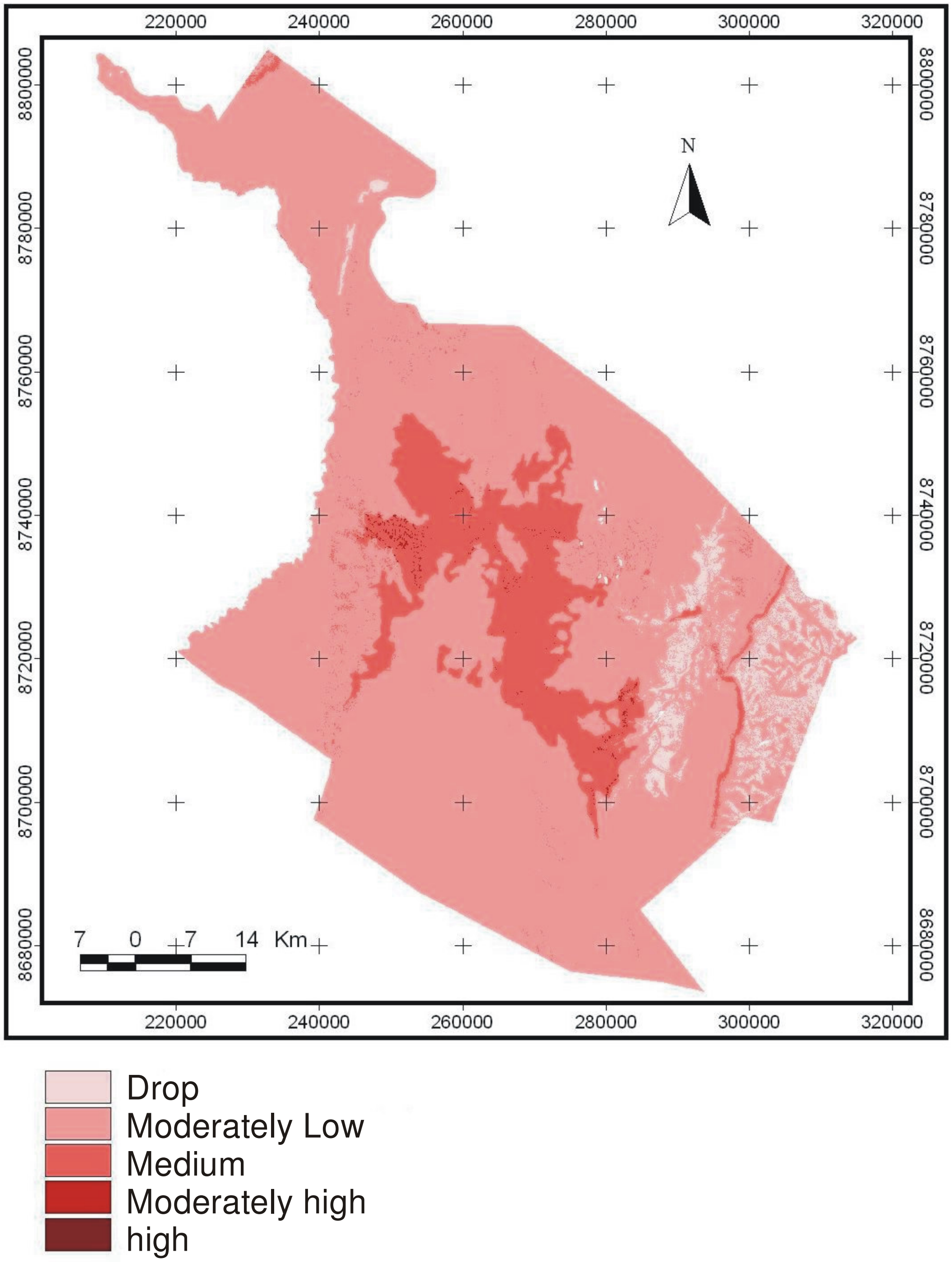
1 This kind of vegetation is typical of high altitudes in the dry lands of Brazilian Northeast.

2 This is a typical vegetation of a large dry region of Brazilian Northeast, known as Semi-árido.

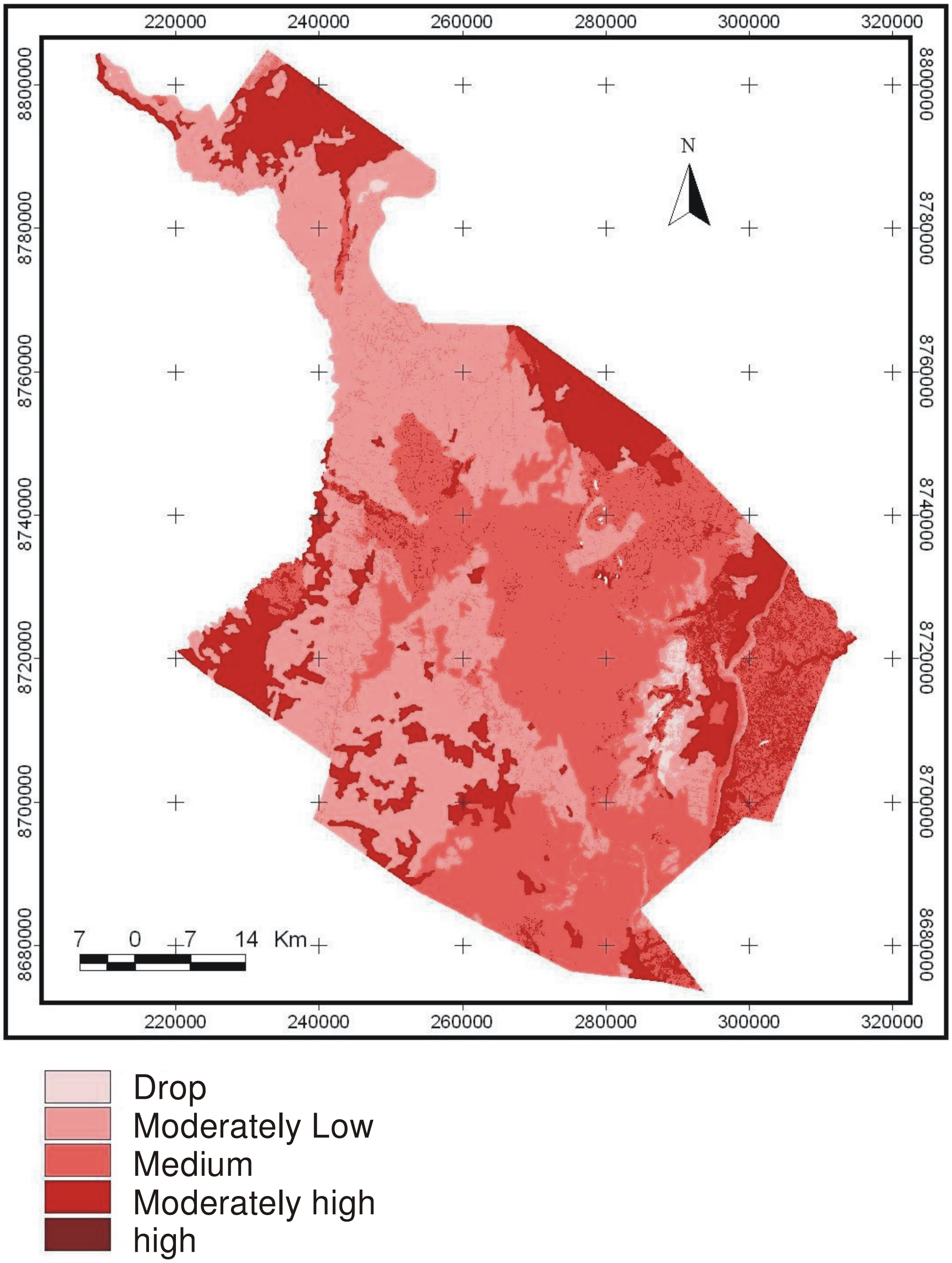
3 This is a greater geographical region in which the area of study is situated.

4 This is a geographical region situated in parts of central and southeastern Brazil with a typical vegetation of bush-like plants

Picture 2 – Simulation of erosion before anthropogenic interference – Morro do Chapéu, Bahia



Picture 2 – Simulation of erosion after anthropogenic interference – Morro do Chapéu, Bahia



CONCLUSION

Analysis made through Geographic Information Systems are an excellent tool for environmental applications. And it proved its efficiency in this work.

On an environmental approach, man has to be taken into consideration. In the picture of erosion, when we did not take the anthropogenic action into consideration, we idealized a hypothetical situation in order to verify how much the erosive process was accelerated through the use and occupation of the land.

This procedure allowed demonstrate that the vulnerability to erosion has increased significantly, creating unstable areas with high vulnerability, increasing the number of the intermediate areas (with intermediate vulnerability) and diminishing the areas with low vulnerability (the stable ones).

The method used allowed the comparison of the environmental picture with and without anthropogenic interference. Therefore, it was possible to evaluate how much, where and how the anthropogenic actions accelerated the process of environmental decline in the county.

In this study, we could identify the areas with the greatest risk to erosion and from that, create new propositions for managing the area, this way avoiding greater risks or creating less degenerative alternatives for fragile areas.

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