# GEOMORFOLOGICAL ASSESSMENT ON THE ENVIRONMENTAL ANALYSIS OF THE SERRA DAS CONFUSÕES NATIONAL PARK – PIAUÍ STATE – BRAZIL

Mr. André Magalhães Rocha
MSc student at the Posgraduate Program in Geography – Federal University of Rio de Janeiro
Dr. Mônica dos Santos Marçal
Lecturer at Geography Department – Federal University of Rio de Janeiro
Dr. Antonio José Teixeira Guerra
Lecturer at Geography Department – Federal University of Rio de Janeiro

## ABSTRACT

The Serra das Confusões National Park is the largest park in northeastern Brazil, with a total area of 502902ha, including 9 municipalities, all in Piauí State, with the headquarters located in Caracol City.

The Park is situated on the top of a plateau, latitude 8°30'S; 9°30'S, longitude 43°W; 44°W, drained by channels which flow northwards to Parnaíba river, the main river of Piauí State.

Serra das Confusões National Park area is in on morphoestructural and morphoclimatical units inside the Piauí-Maranhão sedimentary basin plateau of the interplateau depression with a semiarid domain, covered by *caatinga* vegetation (RADAMBRASIL, 1973). The transition zone between *Caatinga* and *Cerrado* on the plateau, depressions and complex areas has a vegetation named *Carrasco*.

This paper aims to show a preliminary version regarding geology, geomorphology, pedology and hydrological dynamics on the environmental characterization of the Park and therefore to identify risk areas, to create a use planning and management for the area to improve a better use for these potentials.

The Parks geomorphological analysis can be justified by the high importance to understand the natural and social reality of the National Park, showing restrictions on use, always aiming the sustainability of the ecosystem delicate equilibrium, the physical environment, together with the visitor's safety.

## INTRODUCTION

The study area regards *Serra das Confusões* National Park. The park is the largest in northeastern Brazil, raging 502,902 ha of area, including *Guaribas*, *Caracol*, *Santa Luz*, *Cristino Castro, Jurema, Alvorada do Gurguéia, Elizeu Martins*, *Canto do Buriti* and

*Tamboril do Piauí* municipalities, situated on the top of a plateau, latitude 8°30'S; 9°30'S, longitude 43°W; 44°W (Figure 1).

The Park's administrative headquarters is located in *Caracol* city, with 12,000 habitants, which is the point of support to get into the Park. *Caracol* city is situated on the boundary between *Piauí* and *Bahia* States, being a city with few economical resources, which is reflected in the urban infrastructure. Most of the area of the *Serra das Confusões* National Park is located in the neighboring city of *Guaribas*, which has a population of 4,470 habitants.

The Park is situated on the top of a plateau, drained by channels which flow northwards to *Parnaíba*, the main river of *Piauí* State.

This work presents a preliminary study of the geomorphological aspects of *Serra das Confusões* National Park (*SCNP*), situated in *Piauí* State - Brazil, for environmental management, in the context of fragility areas and environmental preservation. This work shows an initial characterization on, geology, geomorphology, pedology and hydrological dynamics of this area, aiming to know the environment of the park, the physical environment and preliminary informations about relief forms for the region.

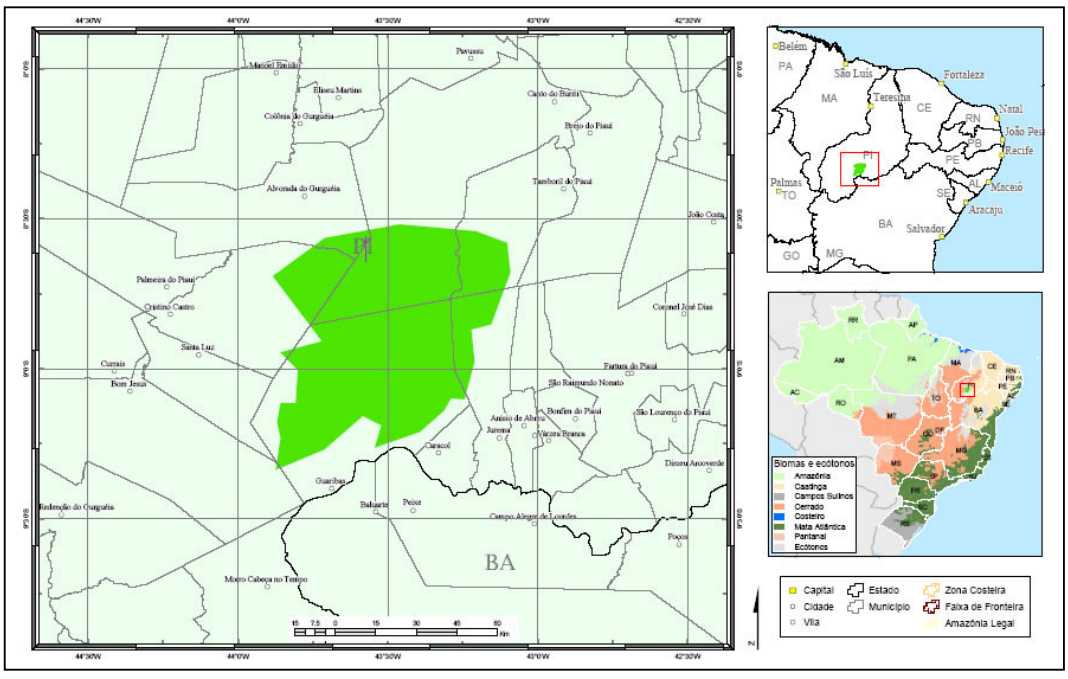


Figure 1: Map of localization

**Importance of the Geomorphological Study for the Administration and Management of the Environmental Preservation Areas**

Geomorphology analyses the relief forms focusing its morphologic characteristics, material components, operating processes and controlling factors, as well as the evolutional dynamics. It involves the studies directed toward the morphological aspects and the functional responsible dynamics and the landscapes topographical sculpture. In this way, it gains relevance for assisting the comprehension of terrestrial shape that appears as an element for human activities and spatial organizations (Christofoletti, 1998).

Geomorphology can possess an integration character, on the space-time evolution of the landform processes understanding those processes performance scale, before and after human intervention on a specific environment (Cunha & Guerra, 1996).

The geomorphological knowledge appears as an instrument used and inserted in execution of diverse sectorial categories of planning (Christofoletti, 1998). The aptitude of the land, for any considered development, will be determined by a variety of characteristics of the ground and the relief (Douglas, 1986).

In almost all the countries, the areas not protected are being quickly converted by human use. In many countries National Parks are the only reminders of the natural habitats (Schaik & Rijksen, 2002). According to those authors, the focus on biodiversity implies that let us abandon the agricultural poverty. It is true that the people who live inside or around the parks are long time resident or just-arrivals, frequently poor and neglected by corrupt or inept governments.

The objective of the parks is to preserve the biodiversity that they contain. In the long term it is difficult to reach those objectives, when the people are in activity inside them (Schaik & Rijksen, 2002). Nowadays, the not sustainable use is one of the most confused problem in the tropical conservation. The uncontrolled exploration has left many forests empty in many parts of the tropics.

In the case of the *SCNP*, the geomorphological analysis is not only because, as previously said, it's the largest Park in northeastern Brazil, but also it has great importance to understand the Park's reality, showing restrictions about the use, aiming the maintenance of the ecosystem and environment fragile balance and, at the same time, keeps the visitors safety.

The human element is the key for the success or failure, but the many integrated conservation and development projects (ICDPs), or other attempts to support the parks, are not conceived to make an integral use of this human element (Terborgh, 2002). According to

this author, the ecotourism can help to oppose some threats, for directing the attention to a park and supplying the local traders a base for its continuous welfare. The ecotourism is also necessary to construct loyal local, national and international support groups. The security and the stability of any park, in the long term, depends on the support of those groups.

**Regional Context of *Serra das Confusões* National Park (*SCNP)***

In this part of the work an environmental characterization for the Park's area will be carried out, such as social-economic and morphoclimatic contexts.

**Social-economics characteristics:**

*Serra das Confusões* composes one of the most beautiful areas of Brazil, sheltering great environmental, scientific and cultural potential, because its extraordinary biodiversity and magnificent geomorphologic formations that presents cave formations and dissection constructed scene on sandstone and shale, and archaeological sites (IBAMA-PI, 1997).

However, despite this rare beauty and great natural potential, the social-economic conditions of the population are extremely precarious, characterizing itself in one total lack of infrastructure, as much in the municipalities located in the area around the park, as in the park itself.

According to that it could be observed in the field, the population organizes itself on small counties located around the park, configuring the pressure zone. They are small agricultural communities that live on subsistence agriculture, not knowing the presence of the park. Those communities, in their majority, do not possess electric energy, water, basic sanitation, or any other kind of infrastructure, being totally dependent on *Caracol* city, that is the headquarters of the SCNP. However, the communication with the city is very difficult, therefore the only roads of linking are those that cut the park and are in bad conditions. The municipalities city halls of these communities rarely give some type of assistance, which finishes being up to IBAMA's care.

**Geologic characteristics:**

The SCNP presents four distinct geological formations:

- *Sambaíba* Formation, referring to the Triassic period - predominance of pink and reddish sandstones, also existing white or yellow with fine texture the average, little argillaceous sandstones, with fine intercalations of silex and intense presence of crossed stratifications;

- *Longá* Formation – it characterizes of shale and dark grey to black loam stone, in general carbonic, with intercalations of fine yellow-white plated sandstone;
- *Cabeças* Formation- prevailing grey-yellowish white sandstone, fine to medium, little micaceous, with abundance of heavy minerals;
- *Pimenteiras* Formation, referring to the Devonian period - it is initiated with shale of various colors, prevailing red and dark grey, micaceous, enclosing pyritiferous oolite nodus and stream beds, fine sandstone and loam stone intercalations varying from white to light grey are common on top of the Formation.

The *Sambaíba* and *Longá* Formations prevail in the north, while the *Cabeças* and *Pimenteiras* Formations prevail in the south part of the Park (RADAMBRASIL, 1973).

**Geomorphological characteristics:**

The region of the SCNP is inserted in the Morpho-Estructural and Morpho-Climatical Units, enclosed in *Piauí-Maranhão* Sedimentary Basin Plateau of semi-arid interplateau and peripheral depression domain, covered by *caatinga* and *cerrado* vegetation (RADAMBRASIL, 1973). The transition zone between *caatinga* and *cerrado* occurs on the plateaus, depressions and complex areas, being known as *carrasco* vegetation.

The largest relief mass is represented by the Piauí-Maranhão basin structural surfaces, submitted to pedimentation erosion processes (RADAMBRASIL, 1973). According to the Geomorphological Map of RADAMBRASIL PROJECT, on the scale of 1:1.000.000, Volume 1 - SC23 - *São Francisco* and SC24 - *Aracajú*, the area presents these structural forms:

- Structural Tabular Surfaces under pedimentation processes. Board Plateaus generally composed by sandstones, cuesta shaped or not limited by tracery work rims, locally dissimulated by pediments.
- Concerning the erosive forms pedimented valleys occurs, interplateaus valleys with well conserved pediments, generally converging without declivity rupture to river channels, eventually a retaken of the erosion process can occur. Incased rills and valleys appear as a type of dissection.

**Pedological characteristics:**

The types of soils mapped by RADAMBRASIL PROJECT (1973) appear normally under the form of soil associations, which hinders to realize a detailed analysis of the soil that effectively occurs in the Park. Still, such information is fundamental to identify the general

characteristics of the weathered materials that re-cover the geology of the area. According to RADAMBRASIL (1973), there are the following identified mapping units in the region of the SCNP:

Red-Yellow Latossol with average texture; Association of Red-Yellow Latossol average texture with Concrecional Lateritic soil and Quartzite Sands; Quartzite Sand association and Red-Yellow Latossol average texture; Quartzite Sand association with Red-Yellow Latossol average texture and Eutrophic Red-Yellow Podzolic Equivalent; Association of Litolic soil with Red-Yellow Latossol average texture and Quartzite Sands; Association Quartzite Litholic soil and Sands.

**Characteristics of the vegetation**:

The vegetation of the Park, typical of the Northeast Region, presents in its dense majority tree-bush *caatinga*, dense in some parts, the areas where it has cave presence, the raised infiltration of the water allows the exuberance of the vegetation in the areas where it has penetration of the light in the cave. Species of the arboreal *caatinga* are observed on the road side that cuts the Park, in the stretch driest of the valley. Bush species follow the valleys in the dry areas and present arboreal stratum (similar to a forest) down slope, where frequent springs occur. Many of them remain shedding water the entire year, supplying the local population and also shelter the local fauna. It has focus of bush *caatinga*, with the presence of cactus in ground of sandstone and conglomeratic outcrops, in the structural terrace that forms the edge of the rift valley, and arboreal *caatinga*, with lianas, and rare presence of cactus, resembling as a forest (IBAMA-PI, 1997).

**Serra das Confusões National Park Preliminary Geomorphological Studies:**

Field work has made it possible to know the reality of the Park, in situ, leading to a preliminary interpretation of geology, pedology and geomorphology of the area. The park presents several environmental fragility areas, such as deforestation by illegal wood extraction.

Based on relief classification associated with the concepts of morphostructure and morphosculpture presented by Gerasimov (1946 and 1968), which has inspired taxonomical purposes presented by Ross (1992).

According to Ross (1992), mapping geomorphology can be executed on six taxonomic levels, based on analysis of regional and local aspects: geologic structure, soils, hypsometry, slope steepness and relief forms.

According to this author, the first taxonomic level corresponds to the morphoestructural units, which for SCNP, corresponds to Middle North Sedimentary Basin. The second taxonomical level corresponds to morphoesculptural units corresponding to plateaus and mountain ranges of structural tabular surfaces under pedimentation processes. Board plateaus, generally composed by sandstones, cuesta shaped or not limited by tracery work rims local dissimulated by pepediments and depression, for erosive forms it has pedimentaded valleys, interplateaus valleys with well conserved pediments, generally converging without declivity rupture to the fluvial channels, eventually retaken erosion process. As dissection types presents incased rills and valleys.

The third taxonomical level is about the similar relief form, which for the SCNP area, corresponds to Plateaus with flat tops, Mountain Range with round tops and Interplateau depressions and Attached Valleys, molded by the acting processes.

The following taxonomical levels (4, 5 e 6), respectively correspond to individual relief forms to slope sectors and smaller forms, produced by erosive processes or recent deposits.

To the SCNP, the geomorphological mapping, until now, ranges itself to the presentation on the third taxonomical level, regarding the absence of topographical sheets on a higher scale than 1:100.000.

During this first field work, it could be noticed that the highest areas present forms which change according to the dissection intensity, so it could be identified the following units:

**1ª - Plateaus with flat tops (Figure 2),** located on the plateau central part, where the dissection processes is less intense, covered by bush *caatinga* vegetation and a sandy soil;

**2ª - Mountain Range with round tops (Figures 3 and 4),** located on the edges of the plateaus, where the dissection process is very intense, almost without vegetation and with relatively low soil thickness, because of the high declivity and hydrological dynamics; where the vegetations occurs it corresponds to bush/arboreal caatinga, presenting springs and river channels;

**3ª - Interplateau depressions and Attached Valleys (Figure 5),** located on the interplateau depressions, where the vegetation is formed by a denser arboreal stratum, resembling a small forest, characterizing the *carrasco* vegetation, on the top of a less sandy and more clay soils,

with a larger amount of litter and organic matter, occurring eventually artesian shaft and springs, supplying water to the local population.

Figure 2: Panoramic view of SCNP (Plateau)

Figure 3: Side view of mountain range top


Figure 4: Highly dissected mountain range top, characterizing the round tops.

Figure 5:Sucumbido river bed, characterizing the interplateau depressions and attached Valleys on the parks southeastern.

**FINAL REMARKS:**

This work represents a preliminary study of the geomorphological and social-environmental characteristics of the SCNP and is inserted in a larger project which aims to carry out, through a geomorphological analysis of detail for the Park's area, since the only available information is on a scale of 1:1.000.000, in the report presented by RADAMBRASIL published in 1973.

Therefore, this work aimed to give a general overview of the SCNP and, at the same time, through local information, raised in the field, it presents details of the Park's environment. The diagnosis of the SCNP environment, to be elaborated, through the agreement between the IBAMA-PI, UFRJ and UFPI will generate important subsidies with two main objectives:

1 – To provide the visitor, scientific information about the Park;

2 – To provide the IBAMA's officers, subsidies based on scientific criteria about the Park and its surrounding area, aiming the balance maintenance between the visitation and conservation of the Park's biodiversity.

In time, this paper authors like to thank for IBAMA – PI and Federal University of Piauí, for the help and patience during the field work time and the transferred material.

**LIST OF REFERENCES:**

ALMEIDA, F. G. (1996). A Estrutura Fundiária como mais uma Variável a ser considerada no Processo de Erosão dos Solos – Sorriso – MT. Tese de Doutorado. UFRJ/PPGG, 218p.

ALMEIDA, F.G. e GUERRA, A.J.T. (2001). Erosão dos Solos e Impactos Ambientais na Cidade de Sorriso (Mato Grosso). *In*: Impactos Ambientais Urbanos no Brasil. Orgs. A.J.T.Guerra e S.B. Cunha. Bertrand Brasil, Rio de Janeiro, 253-274.

ABRAHAMS, A.D. (1986). Hillsope Processes. Allen and Unwin, Londres, Inglaterra, 416p.

BACCARO, C.A.D. (1999). Processos Erosivos no Domínio do Cerrado. *In*: Erosão e Conservação dos Solos - Conceitos, Temas e Aplicações. Orgs. A.J.T. Guerra, A.S. Silva e R.G.M. Botelho. Editora Bertrand Brasil, Rio de Janeiro, 195-227.

BLUM, W.E.H. (2002). The Role of Soils in Sustaining Society and the Environment: Realities and challenges for the 21st Century. Keynote Lectures. XVII World Congress of Soil Science, Bangkok, Tailândia, 67-86.

BOTELHO, R.G.M. (1999). Planejamento Ambiental em Micro-bacia Hidrográfica. *In*: Erosão e Conservação dos Solos - Conceitos, Temas e Aplicações. Orgs. A.J.T. Guerra, A.S. Silva e R.G.M. Botelho. Editora Bertrand Brasil, Rio de Janeiro, 269-300.

BROCKELMAN, W.Y. *ET ALLI* (2002) – Mecanismos de Fortalecimento. In: Tornando os Parques Eficientes: Estratégias para a conservação da natureza nos trópicos. Orgs. J. Terborgh; C.V. Schaik; L. Davenport & M. Rao, Curitiba, Ed. da UFPR, 290- -304pp.

BROOK, D. e MARKER, B. (1988). Geomorphological Information Needed for Environmental Policy Formulation. *In*: Geomorphology in Environmental Planning. Org. J.M. Hooke. John Wiley and Sons Ltd., Plymouth, Inglaterra, 247-260.

BRASIL (1982) – Projeto Radambrasil, Rio de Janeiro.

CASSETI, V. (2001) – Elementos de Geomorfologia, Editora da UFG, Goiânia, 137p.

CHRISTOFOLETTI, A. (1980) – Geomorfologia, 2ª edição, São Paulo, Ed. Edgard Blücher Ltda., 187p.

CHRISTOFOLETTI, A. (1998) – Aplicabilidade do Conhecimento Geomorfológico nos Projetos de Planejamento, *in "GUERRA, A.J.T. & CUNHA, S. B. (ORG) - Geomorfologia: Uma Atualização de Bases e Conceitos",* 3ª edição, Rio de Janeiro, Ed. Bertrand Brasil, pp. 415 – 440.

COOKE, R. V. & DOORNKAMP, J. C. (1974) – Geomorphology in Environmental Management, Ed. Oxford, 413p.

CUNHA, S.B. & GUERRA, A.J.T. (1996) – Degradação Ambiental, *in "GUERRA, A.J.T. & CUNHA, S. B. (1996) – Geomorfologia e Meio Ambiente",* Rio de Janeiro, Ed. Bertrand Brasil, pp. 337 – 379.

CUNHA, S.B. & GUERRA, A.J.T. (2003) – A Questão Ambiental: Diferentes Abordagens, Rio de Janeiro, Ed. Bertrand Brasil, 248p.

DEMEK, J. (1967) – Generalization of Gomorphological Maps, *in "Progress Made in Gomorphological Mapping",* Brno.

DOUGLAS, I. (1986) – Urban Geomorphology, *in: " A Handbook of Engineering geomorphology"*, Glasgow – Wales, Ed. Blakie & Son Ltda., pp 337 – 379.

GERASIMOV, I. (1980) – Problemas Metodológicos de la Ecologizacion de la Ciência Conteporânea, *in "La Sociedad y el Médio Natural",* editorial Progresso, Moscou.

GUERRA, A. J. T. & GUERRA, A. T. (1997) – Novo Dicionário Geológico – Geomorfológico, Ed. Bertrand Brasil, 648p.

GOUDIE, A. (1985) – The Nature of the Environment, Ed. Basil Blackwell, 370p.

KARANTH, K. U. & MADHUSUDAN (2002) – Mitigando Conflitos entre Pessoas e a Vida Selvagem no Sul da Ásia. In: Tornando os Parques Eficientes: Estratégias para a conservação da natureza nos trópicos. Orgs. J. Terborgh; C.V. Schaik; L. Davenport & M. Rao, Curitiba, Ed. da UFPR, 274 – 289pp.

LITTLE, P.E. (2003) – Plolíticas Ambientais no Brasil: Análises, Instrumentos e Experiências, São Paulo, Ed. Petrópolis, 463p.

MESCERJAKOV, J.P. (1968) – Les Concepts de Morphostruture et de Morphoesculture: Um Nouvel Instrument de L'analyse Geomorphologique, *in Annales de Geographie*, 77e. années, n° 423, Paris.

ROSS, J.L.S. (2000) – Geomorfologia: Ambiente e Planejamento, 5ª edição, São Paulo, Ed. Contexto, 85p.

SCHAIK, C.V. & RIJKSEN, H. D. (2002) – Projetos de Conservação e Desenvolvimento: Problemas e Potenciais. In: Tornando os Parques Eficientes: Estratégias para a conservação da natureza nos trópicos. Orgs. J. Terborgh; C.V. Schaik; L. Davenport & M. Rao, Curitiba, Ed. da UFPR, 37 – 51pp.

TERBORGH, J. (2002) – Superando os Impedimentos para a Conservação. In: Tornando os Parques Eficientes: Estratégias para a conservação da natureza nos trópicos. Orgs. J. Terborgh; C.V. Schaik; L. Davenport & M. Rao, Curitiba, Ed. da UFPR, 267 – 273pp.