ATELIÊ GEOGRÁFICO ISSN: 1982-1956
http://www.revistas.ufg.br/index.php/atelie

Palm swamps of the Araripe Plateau: subspaces of exception in the semiarid of the state of Ceará, Brazil

Veredas da Chapada do Araripe: subespaços de exceção no semiárido do estado do Ceará, Brasil

Veredas du Plateau du Araripe: sous-espaces d'exception au semi-aride de l'état du Ceará, Brésil

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Abstract
In the region of Cariri Ceará, the natural singularities, especially in the areas of direct influence of Araripe Plateau, reaffirm their exception character within the semi-arid region of northeastern Brazil and define the palm swamps as exception subspaces. In this article, we seek to present the natural characteristics of the palm swamps of the Araripe Plateau, which are possess Pantotidalic Gleysol (WRB, 2014), acid, very weathered, with predominance of negative charges. These soils support Mauritia flexuosa, among other freatophytes, which are heritage of a complex paleoecologica and paleoclimate evolution, maintained today by the influences of the exudation zones. The palm swamps of the Araripe Plateau are classified from the geomorpholocial point of view, belonging to 4 (four) specific types: *Patamar*, Chapadão drepression, foothill and hillside, they form at these topographic positions due to the water table depth, having its evolutionary process related to the erosion and escarpment recoil. The palm swamps of the Araripe Plateau are currently refuges and strained by the semiarid climate.
Keywords: Plateau of the Araripe; exception subspaces; palm swamps; Cariri Ceará.

Resumo

Na região do Cariri cearense, as singularidades naturais, sobretudo nas áreas de influência direta da Chapada do Araripe, reafirmam seu caráter de exceção dentro do semiárido do Nordeste brasileiro e definem as Veredas como subespaços de exceção. Neste artigo, busca-se apresentar as particularidades naturais das Veredas da Chapada do Araripe, que são possuidoras de Gleissolos Melânicos Tb distróficos, ácidos, muito intemperizados, com predomínio de cargas negativas. Esses solos sustentam renques de buritis, entre outras freatófitas, que são heranças de uma complexa evolução paleoclimática e paleoecológica, mantidos atualmente pelas influências das zonas de exsudação. As Veredas da Chapada do Araripe são classificadas do ponto de vista geomorfológico, pertencentes a 4 (quatro) tipos específicos: de Patamar, de Depressão em Chapadão de Sopé e de Encosta, formam-se nessas posições topográficas em função da profundidade do lençol freático, tendo seu processo evolutivo relacionado com o sistema de erosão e recuo de escarpa. As Veredas da Chapada do Araripe, encontram-se atualmente refugiadas e tensionadas pelo clima semiárido.
Palavras-chave: Chapada do Araripe; Espaço de exceção; Veredas; Cariri cearense.

Résumé

Dans la région du Cariri au Ceara, des singularités naturelles, en particulier dans les zones d'influence directe de la Chapada du Araripe, réaffirment leur caractère d'exception au sein de l'état semi-aride du nord-est du Brésil et définissent les Veredas comme des sous-espaces d'exception. Dans cet article, nous cherchons à présenter les caractéristiques naturelles des Veredas de la Chapada do Araripe, qui sont des Hyperdystric Umbric Subaquatic Gleysols (WRB, 2014), acides, très altérés, avec une prédominance de charges negatives. Ces sols supportent des croûtes de buritis, parmi d'autres freatophytes, héritages d'une évolution paléoclimatique et paléoécologique complexe, maintenue aujourd'hui par l'influence des zones d'exsudation. Les Veredas de la Chapada du Araripe sont classés du point de vue géomorphologique, appartenant à 4 (quatre) types spécifiques: de Patamar, de la Dépression à Chapadão, de Sopé et d'Encosta, sont formés dans ces positions topographiques en fonction de la profondeur de la nappe phréatique, et leur processus évolutif est lié au système d'érosion et d'escarpement. Les Veredas de la Chapada du Araripe sont actuellement des réfugiés et soumis au climat semi-aride.
Mots-clés: Chapada du Araripe; Espace d'exception; Les Veredas; Cariri au Ceará.

Introduction

Cariri Ceará is an exceptional regional space into the semi-arid region in Brazilian northeast. The natural disparity of this area is not due to a climate distinction as it was already said by Nimer et al (1971) and reassured by Guerra (2019), but this happens due to the hydrogeological conditions, in special by the water supply that comes from the suspended aquifer of the stratigraphic layer in the Exu Formation which covers the whole Araripe Plateau.

It must be stressed that the precipitations admit higher annual averages in comparison to typical sertaneja areas, holding averages above 1.000mm/year in Crato and Barbalha townships. However, the bad distribution of the precipitations in time and space as well as the large year-on-year variability follow the rythm of the semi-arid climate, with a long drought season up to a eight-month-period of lack of rain, and a negative hydric balance during the most part of the year. However, what ensures the perennial hydraulic flow in the zone of exudation of the Araripe Plateau is the residence time of the water in

the suspended aquifer that, according to Mendonça (2001), lasts 180 years and in a slowly way it garantees the frequency of the defluvium.

The morphostructural complexity of the Araripe Plateau, favored by the depositional history and by the stratigraphic architecture of Araripe Basin, provides high seepage and large accumulation of groundwaters, highlighting the level of the suspended aquifers. In addition the modeling of the regional landforms and the singular nature of the pedological mantle, they make, this way, the support to house the exception conditions. These are the conditions that provide the conservation of the Palm swamps refugues.

Nature in its trajectory, safeguarded in Cariri Ceará, heritages replete of spatial singularities. Among them, the encraves of Cerrado and Rainforest (in portuguese: Floresta Subperenifólia Tropical Plúvio-Nebular – Mata Úmida), with refuges of the Palm swamps in isolated sites of the hillside north-eastern and foothill of the Araripe Plateau.

The exception factors come from the combiantion of the local and/or subregional factors, as Ab'Saber (1970) stands out:

> The exotic vegetation "islands" found inside he core areas of the different morphoclimatic domains and geobotanic can only be explained by local existence of exception factors, of lithological, microclimate, hydrological, topographical and paleobotany order. Under influence of two or more of these factors of physical and ecological order – through subtle local and subregional combinations – it can grow up small categoris of exotic landscapes, under the form of true encraves inside the morphoclimatic and climate-botanic domains, very distant from each other. (AB'SÁBER, 1970, p. 21).

In general, the exception areas ot the semiarid correspond to portions that present topographic orientation that favours the best humidity contribution, due to the altitude or to the water availability and/or to the capacity of groundwater storage. As a rule, the semiarid *core* is represented by wide erosion surfaces, with unexpressive altitudes wihich can vary from 100 to 400m, modelling on crystalline rocks, with low infiltration capacity, under semiarid climate, prevails, with precipitations between 600 and 800mm/year. Generate, shallow soil whith stony tendency, covered by the Caatinga xeric vegetation (SOUZA, 2000; SOUZA; OLIVEIRA, 2006; FERNANDES, 2006).

Nevertheless, the role of the climate oscillations throughout the Quartenary Period favored the process of expansion and retraction of determined types of vegetations, and it reguarded the enclaves/encraves, refuges and/or relicts inside of different complexes of vegetation, like the enclaves of the rainforest and Cerrado inside the Caatinga Domain (AB'SÁBER, 2003).

In relation to Palm swamps, it can be ensured that they are typical subsystems of the Cerrado Domain and they are represented by compartments located in the headwaters of the river systems, conditioned by hydrogeomorphological factors, which favor the formation of swamp areas due to the bad drainage, developing hydromorphofic soils and

Mauritia flexuosa, among others typical phytofloristic associations (BOAVENTURA, 2007; MELO, 2008; FERREIRA, 2008).

In the region Northeast semi-arid, the existence of the Palm swamps environment is rare. It has been identified in the paleodunes of São Francisco river by Barreto (1996) and in sectors of Cariri Ceará, under direct influence of Araripe Plateau by Guerra (2019). On the second case, the Palm swamps if are presented retracted, fragmented and isolated in refuges form, located near to the exudation zones of Araripe Plateau, in altimetric quotas from 600 and 800 m, involving the townships of Crato, Missão Velha and Santana do Cariri, in the State of Ceará (Figure 01).

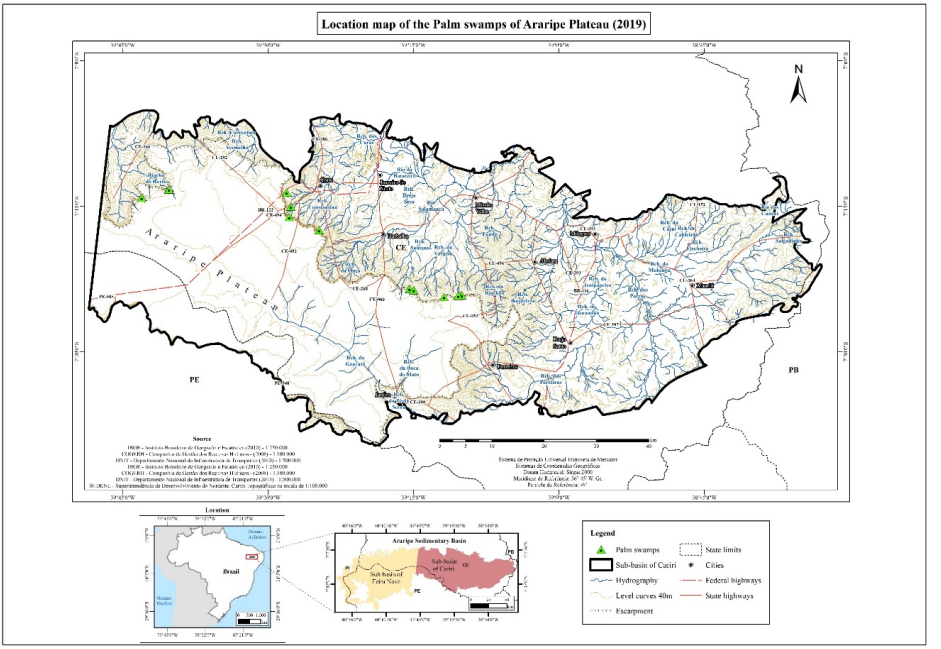

Figure 01: Map of the localization of Palm Swaps of Araripe Plateau.
Source: Guerra (2019).

The Palm swamps of the Araripe Plateau are found on selectives points on hillside and foothill the Araripe Plateau, and they are in topographical positions according to an influence of the exudation zones, in association to hydrogeomorphological, pedological and phytoecological factors.

Palm swamps of Araripe Plateau: hydrological and edapho-botanic relations

Palm swamps are environmental subcompartments typical of areas of plateaus covered by Cerrado and they are, in special, the expression of the high soil moisture,

derived from the abundance of groundwater. The Palm swamps of Araripe Plateau are found on eastern hillside and on the western boundary of the east section of the Araripe sedimentary basin, where the waters of the upper aquifer of the Araripe Plateau sprout out, which run to the peripheral depression of Cariri.

Considering the conditioning factors to Palm swamps formation defined by Boaventura (2007) to the central Brazil, in relation to the Palm swamps of Araripe Plateau, there is logic in the aspects connected to geological and hydrogeological contexts - as far as to the aspects related to regional and local reliefs – as well as the hydrogeological, pedological and phytogeographic contexts (GUERRA, 2019).

Regionally, preponderate the presence of cretaceo sedimentary plateau about sedimentary lithology permoporous (Exu Formation), with deep soils and permeable (Oxissols), overlapped by a impermeable stratigrafic layer (Santana Formation) in addition to local base level, originet from erosion work and drainage readjustment, including the modelling of shallow amphitheaters with flat bottom and with low slope which favors the slow fluvial flow. Finally, the tropical climate with two well-contrasted seasons (GUERRA, 2019).

This situation is identified on hillsides and foothill of Araripe Plateau, where the Palm swamps we are studying are found. Next, we have a flowchart that explains the conditions that favors the occurence of the Palm swamps of Araripe Plateau:

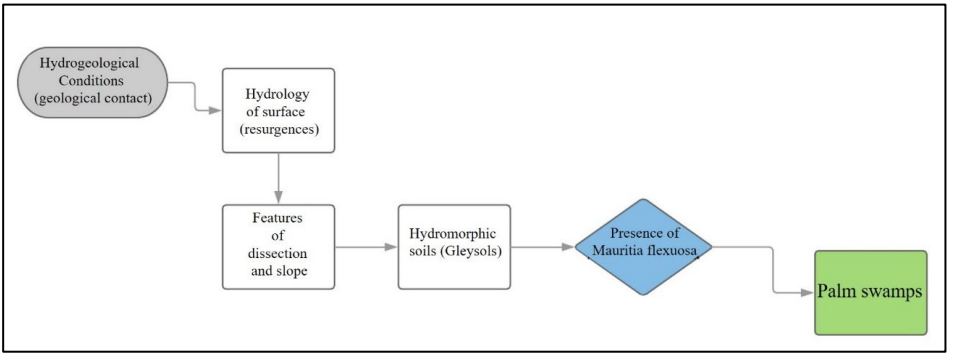

Figure 02: Flowchart representing the conditions that favors the occurrence of Palm swamps of Araripe Plateau
Source: Guerra (2019).

Through the presented flowchart we can notice that hydrogeology is a condition *sine qua non* to the occurrence of the Palm swamps in Araripe Plateau. The geological contact of the Exu Formation (aquifer) with the Santana Formation (aquitard) result in water accumulation in the suspended aquifer and origine the resurgences, which follow the direction of the plunge of the lithostratigraphic layers, due to the blocks tilting of Araripe Plateau to NE and W. The water supply of the upper aquifer feeds the surface hidrology, forms exudation zones on these steep slopes and models shallow amphitheaters arranged altitudes between 600 and 800 meters long (GUERRA, 2019).

The existence of perennial springs that drain to the peripherical depression of Cariri, associated to few dissection features, with low energy of the relief and low local slope contributed by the condition to the formation of acid and gley soils, and it has the Mauritia flexuosa is the main floristic composition. They are, drain headboards that house Palm swamps (GUERRA, 2019).

The topographic position where the Palm swamps are found is definied by the localization of the water sheet. Due to the high depth of the water in the upper aquifer of Araripe Plateau, the Palm swamps will occupy the intermediate positions of the relief, with a complete absence on the summit of the Plateau Araripe and the leeward side, turned to the State of Pernambuco (GUERRA, 2019).

It is ratified the trait of exception of the enviroments under influence of the windward side of Araripe Plateau, which still receives water flow from the subsurface that forms the exudation zones. The natural differentiation of this area does not happen due to a climatic differentiation, as it was pointed out by Nimer et al (1971), when they stood out that "it is very likely that outcrops of water tables linked to disposition of rock layers and to the differences of the water absorption capacity by the subsoils substratum have, in this case, a more important role" (NIMER *et al*, 1971, p. 21).

Therefore, that happens much more due to hydrogeological conditions than to climatic conditions, even if the rainfalls hold higher annual averages than the typical sertaneja areas; as example, the annual totals recorded in the townships of Crato and Barbalha which surpass 1.000m. However, the bad distribution of the precipitation in time and space, so like the wide year-on-year variation, obeys the rythm of the semi-arid climate with long drought season reaching up to 8 rainless months. The rainy period is concentrated on the first four months, as March and April beeing the more rainy ones. During the most part of the year, it has a negative hydric balance (GUERRA, 2019).

According to Nimer (1971, p. 19), "Cariri Ceará is a region wich insuficiente rainfall. This insufficiency is much more due to the irregularity or anual variability than from their standard rainfall indices [...] the deviations and fluctuation, to which this precipitation is subject, to are the biggest ones in the world".

Howoever, it is the hydrogeological behaviour that guarantees the perenial of the springs wihich are maintained by the water exposition of the upper aquifer of the Araripe Plateau, even if it is inside the "drought polygon". This way, it allows the coexistence and co-evolution of the Araripe Plateau Palm swamps refuges (GUERRA, 2019).

Palm swamps are typical environmental subcompartments of plateau areas covered by Cerrado and they are, in particular, the expression of the high humidity of the soil, derived from the abundance of groundwaters. The Araripe Plateau is a "big water container" in Ceará semi-arid and, for that, the existence of Palm swamps on its eastern hillside and on the western boundary on the Cariri sub-basin is justified, where the waters of the upper aquifer spring that flow to the peripheral depression of the Cariri (GUERRA, 2019).

There is a marked occuried in these refuges of Veredas the peculiar presence of Gleysols, according to Ramos et al (2006, p. 193), "[...] it is justified by the occurrence of a deep drain, which provided better drainage conditions, favoring the formation of these soils". However, it is a class of soils that frequently no occurred inside the drought polygon. Note the singularities expressed in this exceptional environment.

It was analyzed 3 types of Palm Swaps of Araripe Plateau. They were classified according to Brazilian System of Soils Classification - SiBCS, in Brazilian Portuguese - (EMBRAPA, 2018). 1 type of Pantohyperdystric Episomeriumbric Pantotidalic Gleysol and two types of Pantohyperdystric Anosomeriumbric Pantotidalic Gleysol. The chemical characteristics revealed by the analyses performed at Laboratório de Análise de Solo, Tecido Vegetal e Fertilizante da Universidade Federal de Viçosa (UFV) indicate that the Gleysols from the Palm swamps of Araripe Plateau present strongly acid pH, low natural fertility, low sum of bases, high exchangeable aluminum contect, low capacity of cation changes and very low base saturation. Therefore it is dystrophic soils, but with high concentration of organic carbon, maintained in functions of the physical and chemical proprietys of the soils, with influence of the groundwater and the bad drainage (GUERRA, 2019).

In summary, the variations analized contribute to the occureance of soils very weathered, acid, with low natural fertility and high content of organic matter, with absence of iron between the clays. The results are uncommon for soils in the Brazilian semiarid, even though they are submitted to climate conditions typical of semiarid. Notebly it has characteristics of soils that belong to others phytogeographic Domains, like Cerrado and Atlantic Florest (GUERRA, 2019).

The Gleysols occupy sectors of the hillside and foothill of Araripe Plateau, depending on the upper aquifer hydric supply in combination to the landform that forms shallow amphitheaters and the low energy of the relief. These soils house a vegetation complex very diverse including, specially, phreatophytes, like Mauritia fleuxosa and Dicksonia sellowiana, among other unusual species at semiarid region, that are disconnected amid the great axis of floristic disjunction of the Brazilian Northeast.

The Palm swamps in Araripe Plateau are, possibly, a lost link in the transition between Cerrado and Amazon Forest. These disconected spaces denounce a past clímax and today, mantened to refuges, isolated by a semiarid climate and surrounded by Caatingas.

This way, the presence of a phytoecological mosaic is revealed, possibly established during the transition Pleistocene/Holocene, maintained in today conditions as enclaves/refuges. It is suggested that initially the cerrados have occupied a much more vast area mixed or associated to Caatingas in a subhumid climate condition, possibly with long areas domained by the Palm swamps landscapes, organized on the peripheral depression of Cariri (GUERRA, 2019).

On the time-spatial sequece, due to the pulses of humidity climatic and the great expansion of the rainforest dispersion routes, is settled the forest, specially, on the northern

hillside of the Araripe Plateau, associated to the Palm swamps and it is treated as a hydrosere case as Rizzini (1997) suggests on a similar situation to the Central Brazil.

Rizzini (1997, p. 344) claim: “an interesting example of hydrosere we have is the one in the moriche palm tree camps or Palm swamps, so typical in Central Brazil, under a form of groups absolutly domained by the palm tree *Mauritia vinífera* (moriche palm tree)”. For this author, the Palm swamps is singularite environment and conceptualizes them as a hydrophilic commnunity located on depressions where water is stuck and “through gradual landfill, the community becomes enriched with species and ends up becoming a swampy forest, with trees and, even later, into rainforest. It is not for any other reason that sometimes buriti is found in the forest” (RIZZINI, 1997, p. 344).

This sequence of vegetation succession (Cerrado/Forest) is the same one indentified by Andrade-Lima (1966) to Amazon Forest, although it does not have a definied chronology, but confirming that the cerrado preceded the installation of the ombrophilous forest itself.

Considering the presence of Mauritia flexuosa in Araripe Plateau, being in many cases associated with the rainforest it is an example of hydrosere as highlighted by Rizinni (1997), it means an evolutionary and successional stage of the environment, in which, at first, possibly was covered by cerrado, and afterwards it was under influence of an increased humidity and the expansion of the rainforests, the Mauritia flexuosa kept streaky to forest, in refuge form, amid the semi-arid climate today.

The Palm swamps refuge origin is due to the decrease of the humidity and the dry climate reexpansion, where the environment becomes hostile as to the Mauritia flexuosa as to the rainforest (GUERRA, 2019). De Oliveira et al. (1999) observed, on the paleodunes of the São Francisco river, the gradual and simultaneous decrease of the Mauritia flexuosa and the rainforest taxa untill the middle Holocene. This way, it conditioned the instalation of the modern caatingas, as well the adaptation, extinction and isolation of the Mauritia flexuosa as some of rainforest, originate, sometimes, enclaves and/or refuges. The Mauritia flexuosa presence in Araripe Basin was, at first, described by Gardner on his trip from 1836 to 1841 (GARDNER, 1975).

The phytophysiognomy proper to the Palm swamps of Araripe Plateau result from past floristic connections and it went through at least, two great evolutionary stages (cerrado/forest) of expansion and retraction of the forest tissues. Today, they are fragmented, isolated in refuges and subject to current climatic tensions and the effects from the forms of land use and occupation (Figure 03).

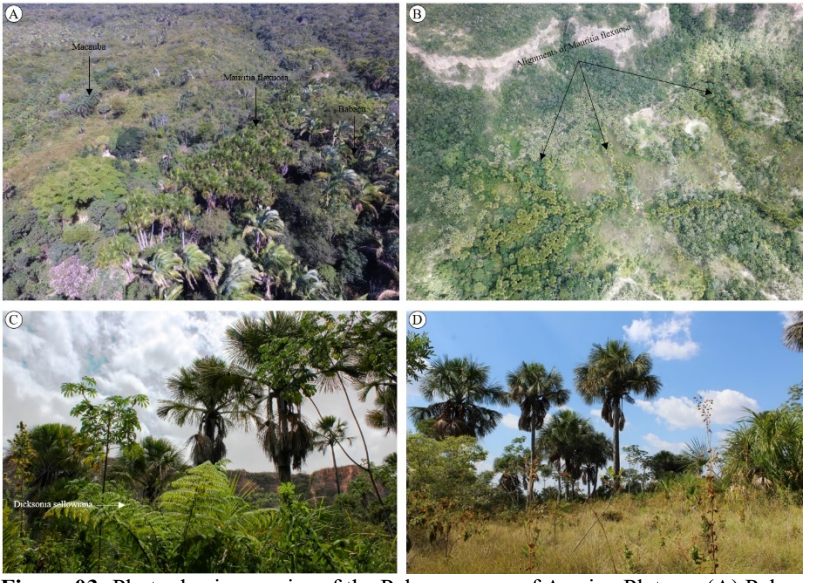

Figure 03: Phytophysiognomies of the Palm swamps of Araripe Plateau. (A) Palm swamp interspersed with rainforest and surrounded by babaçual. (B) alignments of Mauritia flexuosa following the waters path. (C) Dicksonia sellowiana associated with Mauritia fleuxosa (D) herbaceous carpet in the around zone of one of the Palm swamps of Gameleira de São Sebastião, Missão Velha.
Source: Guerra (2017, 2018 and 2019)

It is outstanded by Boaventura (2007) that "in each of its evolutionary stages, geomorphological, hydrological and pedological changes and adaptations occur, accompanied by gradual changes in its vegetation cover" (BOAVENTURA, 2007, P. 40).

As it was seen on the Figure 03, the phytophysiognomy of the Palm swamps of Araripe Plateau present differentiate, characteristics specially on the around zones, with a phytofloristic diversification well significated with, sometimes, an absence of an expressive shrub-herbaceous stratum that differs from the typical characteristics of a Palm swamp in Cerrado in Cental Brazil. However, understand that this difference is due to the evolutionary stage, and maybe a transitional, of the Palm swamps of Araripe Plateau, once the climate oscillations and the ecological successions submitted this area to new ecological adjustment stages.

It is important to highlight that all areas in conditions of enclaves/refugees, cannot be considered stables, neither in the point of view climatic, nor botanical, but they remain forested. These areas are subject to frequent reorganizations of the vegetable assemblages depending on climatic variability (MONTANE et al., (2004). About the Palm swamps of Araripe Plateau, that fact points out to a even more distant balance, once the Palm swamps are fragmented, isolateds and with spatial dimensions very restricted.

Geomorphological classification of the Palm swamps of Araripe Plateau

The distribution and spatial arrangement of the Veredas are quite different, ranging from foothill Chapada do Araripe, arranged in alignments, and following the hillside, in order, to confined on headwaters in dale form in an area of enclosed valleys.

According to Boaventura (2007, p. 40) "the Palm swamp is a transitive form of valley that survives in time and space, comprised between the capture, upstream, of subsurface water pockets ('suspended' water levels) and the progressive deepening of its valley, downstream".

Based on the geomorphological classification proposed by Ferreira (2003; 2008), Guerra (2019), it is defined that the Palm swamps of Araripe Plateau are classified as stepped surface – Patamar in portuguese (identified on profile A-A'); foothill (identified on profile B-B'); hillside (identified on profile C-C'); and Chapadão Depression (identified on profile D-D') (figure 04).

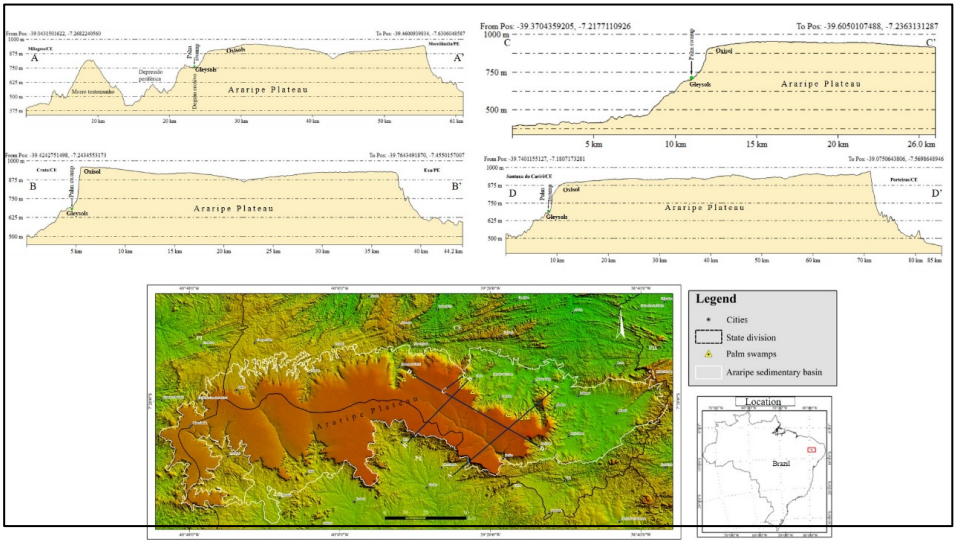

Figure 04: Topograhpic profiles of patches where Palm swamps of Araripe Plateu are found.
Source: Guerra (2019)

As it was seen on Figure 04, the Palm swamps are on isolated areas, as on the hillside as on foothill Araripe Plauteau in Crato, Missão Velha and Santana do Cariri townships, in the State of Ceará. It is highlighted a gap on the occurence of the Palm swamps on patches where there is a slope gradient more abrupt on the buttresses of the plateau, which form drainage arches with expressive features of remounting erosion (GUERRA, 2019).

In relation the Palm swamps of stepped surface it is the type more found, where the Mauritia flexuosa forms diffuse alignments on an erosive stepped on foothill the

Araripe Plateau, with a light slope gradient, which favors the slow water flow on the surface and a greater waterlogging on the headwaters that form small erosion amphitheaters. This morphology holds a greater humidity on subsurface, subject the area to gleisation processes. So, the Melanic Gleysols originate and give support to the permanence of Mauritia flexuosa and the preservation of the Palm swamp itself. (GUERRA, 2019).

The stepped surface on surrounding Araripe Plateau, in function to its morphologhy, favors a flow slow hydric by downstream of the areas of exudation, what conditione the soils to the hydromorphism and to the developing of the Palm swamps (Figure 05A).

The formation of Palm swamp of hillside and foothill, have a singularity determined by the depth of the groundwater. The Palm swamps of the hillside are definied by Ferreira (2008) as remains from old Palm swamps of stepped surface, having evolutionary process is strictly linked to the erosion system and sometimes, to the escarpment retreat.

The Guaribas Palm swamp, located in Crato township, fits into this class (Figure 05B). The landform and the direct influence of the exudation area, provided the develope of the Palm swamp on hillside, that has a section with inexpressive escarpment, a fact that favors the low gravitational energy of the relief and the development of the Palm swamp developing (GUERRA, 2019).

The upper aquifer waters depth provides the existence of dry conditions on the summit of Araripe Plateau and the overflow of the waters next to the contact with the waterproof layer of the Santana Formation (aquitard), which favors the conditions to the developing of Palm swamps on foothill (Figure 05C) (GUERRA, 2019).

The Palm swamp of Chapadão Depression corresponds to the Palm swamp of Vale do Buriti, in the township of Santana do Cariri, resulting from the readjustment from the last recoil of headwaters in the Holocene, as stated by Boaventura (1981) in a similar situation in the Minas Gerais plateau. The localization of the Palm swamp of Buriti Valley is conditioned to the groundwater flow of the upper aquifer to W and to the river work responsible for the modelling of headwater in *dale*, which favors the hydromorphism and gleization (GUERRA, 2019) (Figure 05D).

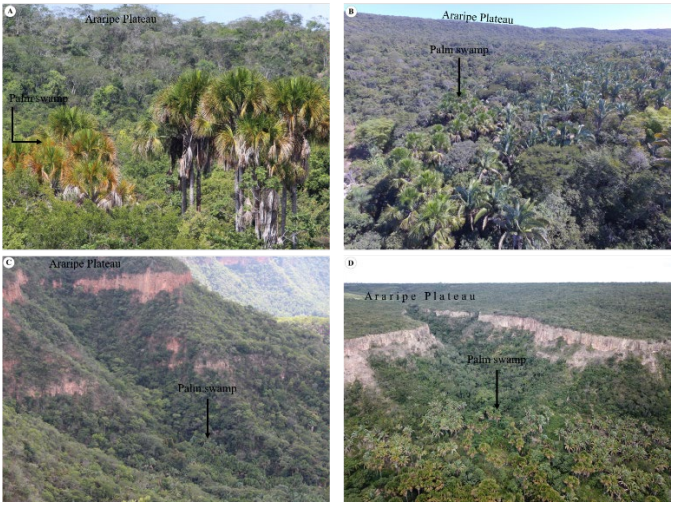

Figure 05: Typology of Palm swamps: (A) Palm swamps of stepped; (B) Palm swamps of hillside; (C) Palm swamps of foothill; (D) Palm swamps of Chapadão Depression.
Source: Guerra (2017, 2018)

The position of the Palm swamps on topography reveals aspects of their origin. Ferreira (2008, p. 4) highlights that "the Palm swamps, which are found in topographic positions not very elevated in relation to the current level of the regional base, evolue to shallow valleys of flat bottom or, on the contrary, evolue into the enclosed valleys formation". However, we need to consider that

> the levels of the local base that maintain the Palm swamps were all established before the last deeping of the regional drainage, occuried in Holocene. This same period of recoil of headwater enabled the installation of new Palm swamps on the planing surface [...] (FERREIRA, 2008, p. 4).

It can be seen, by the localization of the Palm swamp, the synthesis of the interelation of structure geological-relief-contribution hydric-soil-vegetation, which are combined to the Palm swamps formation. It must be highlighted that the Palm swamps of Araripe Plateau show a strong transition stage and a degradation state, caused by natural conditions, specially climate and by human actions, mainly due to the watercourse detour and its incalculable exploration, as well as by the forest fires and by the insertion of temporary crops in these areas, as inside as surrounding the Palm swamps. Naturally, they are already areas of ecological tension, as definied by Brasil/RadamBrasil (1981).

This way, it favors the drynessprocess of the soils and the expansion of non-typical species over the Palm swamps areas, what points out the transition stages of these environments, in many cases running into a mere buritizal or, in the case of the study area, it seems to point to a transition to a babaçual, considering that babaçu is found on the

surroundings of almost all Palm swamps, in its dry zone and, sometimes, mixed to the Palm swamp itself.

Conclusions

The Palm swamps of Araripe Plateau aggregate to the elements that ensure the characteristics of an environment of exception in Ceará semi-arid, once these characteristics are especially caused by hydrogeological conditions, what enables the existence of soils and phytophysiognomies differents inside the Caatinga Domain (GUERRA, 2019).

The natural singlenesses of Palm swamps of Araripe Plateau are due to the existence of Gleysols, which are an unusual soil class in Northeast semi-arid and reveal some chemical properties similar to the soils in the Cerrado Domain and the Atlantic Forest. The existence of these soils is an essential condition to the maintenance of the Palm Swaps, once the conditions of the current semiarid climate are limiting factors to the occurence the Palm swamps.

The presence of Mauritia flexuosa composing the main phytophysiognomy of the Veredas is due to a complex paleoclimatic and paleoecological evolution, which favored the dispersion of species belonging to other phytoecological Domains. However, the current vegetal cover denounces the strong evidences of Palm swamps environments in transitional stage, justified by the presence of exemplarys of Rainforest, besides the mixture of others species that belongs to several vegetation as Cerrado, Caatinga and Carrasco. Yet, they still preserve peculiar characteristic the Palm swamps, such as the delicate arrangement of the Mauritia flexuosa, following the drenage lines.

The Palm swamps naturally suffer ecological tensions due to their low capacity of support and resilience, but it is proper to their dynamic. In the specific case of the Plam Swamps of Araripe Plateu, the support capacity and the resilience potential are even more low, once they are forest fragments refuge in a dry/semiarid climate domain.

The topographic position where the Palm swamps are found reveals their relation with the groundwater level depth, with the erosion system and the escarpment retreat. On the other hand, they occupy selective spaces where the set of geological-geomorphological-hydrological-pedological-phytogeographic factors favors the maintence of these exception subspace, inside the semi-arid in the State of Ceará.

The Palm swamps of the Araripe Plateau are heritages from ecological and climatic ancient weavings that coexist and coevaluate with the Caatingas under a semiarid climate.

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Note: *Paper derived from doctoral thesis titled in portuguese "Veredas da Chapada do Araripe: contexto ecogeográfico de subespaços de exceção no semiárido do Estado do Ceará, Brasil", defended by the first author, under orientation from the second and third authors. Special thnaks to Coordination of Improvement of Higher Education Personnel (Capes – in Brazilian Portuguese) for the concessiono of the scholarship on Social Demand Program (DS – in Brazilian Portuguese).*

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Received for publication December 2019
Approved for publication April 2020