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# Landscape Archeology from a geosystemic perspective: the Piracanjuba archaeological site, municipality of Piraju, state of São Paulo, Brazil

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**Abstract**
Studies on the relationship between society and the environment in past time frames have shown the relevance of interdisciplinary research between Geography and Archeology. Based on the theoretical grounds of Landscape Archeology, this study investigates the Piracanjuba archaeological site, a Guarani lithoceramic site, located by the middle course of the Paranapanema River, in the municipality of Piraju, state of São Paulo, Brazil. Within the perimeter of the archaeological site under study, four anthropogenic soil patches (ASPs), also known as indigenous black earth, were identified. In terms of results, the study produced an analysis of the environment according to the horizontal (geofacies and geotopes) and vertical (geohorizons) geosystemic concepts, examining the site's cartographic representation and spatialization as to its relationship with relevant characteristics of the physical-geographic complex of the studied area. This therefore contributes to further landscape analyses of archaeological sites, based on geoindicators, within past time frames. The heterogeneous stratification units evinced the distinguishing features of the studied environments according to the height of each vegetation stratum and their slope sinuosity and steepness towards the water body of the Paranapanema River. The analyses of the anthropogenic soil patches revealed, by means of thermoluminescence, disparity in the dating of the ceramic fragments found in ASP 1 reaching back to 1520 AD, and in the ASP 2 to 1355 AD, probably pointing to two periods of occupation of the archaeological site area.

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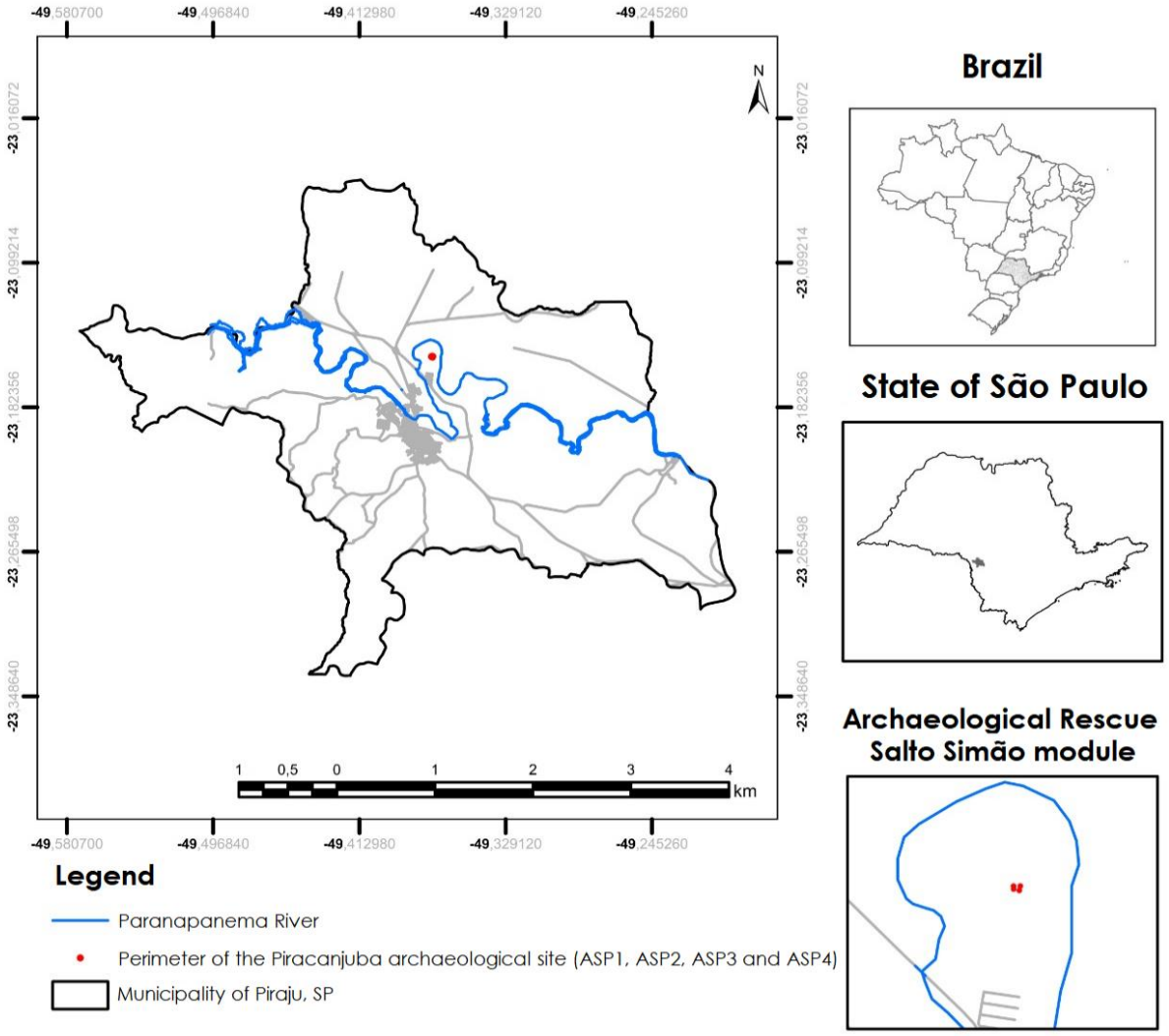
## INTRODUCTION

The present study proposes a landscape analysis of the Piracanjuba archaeological site, located by the middle course of the Paranapanema River, in the municipality of Piraju, state of São Paulo (SP), Brazil (Figure 1).

The Piracanjuba archaeological site is located in a middle-slope area near the Paranapanema River course. It is a Guarani lithoceramic site. Within the perimeter of this Guarani settlement, four anthropogenic soil patches (ASPs), also known as indigenous black earth, were identified. In the ASPs, poorly-structured combustion remnants were found, around which most of the ceramics observed in the site area were concentrated.

Figure 1 - Location of the Piracanjuba archaeological site, municipality of Piraju, SP, Brazil




Source: Daves (2018).

The landscape components near the site perimeter proved relevant in the identification of Guarani settlements, be it regarding the size of the village, the location of the archaeological remains, or the natural resource sources used for their subsistence. The physical and geographic characteristics of the Paranapanema River, especially its morphology and lithology, conditioned how the Guarani indigenous groups appropriated the geographical space.

Archaeological research can contribute to the understanding of the formation of said space and its past transformations due to human action. From the theoretical perspective of Landscape Archeology, the present study relies on an interdisciplinary approach between Geography and Archeology, especially regarding landscape. As a result, the proposed analysis reflects upon the environment these indigenous groups inhabited in the past.

Therefore, this study analyzes the landscape of the Piracanjuba archaeological site by resorting to the Theory of Geosystems, and Landscape Archeology, in what concerns the existing relationship between the physical-geographic aspects of the area in question and the distribution of archaeological remains, to identify relevant characteristics of this Guarani settlement.

The studied environment was horizontally and vertically analyzed according to geosystemic concepts, to address the site's cartographic representation and spatialization, thus constituting a landscape analysis. In other words, the spatial distribution of the studied phenomena will be understood both in terms of their vertical stratification and their horizontal structure.

## MATERIALS AND METHODS

### *Landscape: interdisciplinary concept of Geography and Archeology*

Geography, since its institutionalization as a science, has had as its central epistemological axis the quest to understand the society-nature relationship (SUERTEGARAY, 2009; CASSETI, 2009). In this context, landscape has proved to be an essential theme for the debate that underlies these two categories (PASSOS, 2003; 2006).

In this scenario, the Theory of Geosystems allows a look at the existence of systems and their functioning in relation to the geographical space, mainly through an integrative and polysemic vision (PASSOS, 2006). On the other hand, Landscape Archeology is the study of the human interventions that build landscape, based on the archaeological remains left by such interactions with the environment (BOADO, 1999).

Archeology aims to study the prehistoric landscape to demonstrate how the subsistence of a certain human group took place, and it makes use of material culture within socio-cultural contexts that are archaeologically documented. In other words, it investigates the organization of space and how human experience occurred in a given area, with a view to discussing the historical, social or cultural context (ASHMORE; KNAPP, 1999).

In the face of new analytical needs, Archeology has resorted to methods based on the concept of landscape, thus substantiating its instrument of study in the field of natural sciences. According to Bertrand and Bertrand (2009), Landscape Archeology must be understood as an attempt to rediscover remnants of the historical relationships between society and nature (BERTRAND; BERTRAND, 2009, p. 171).

However, contemporary geographers and archaeologists are close especially when they consider landscapes as material constructs, as they raise information about the structure and organization of past occupations, highlighting them as a type of historical textualization (KORMIKIARI, 2000). In this way, each science provides an essential component for the study of environmental systems, therefore interdisciplinarity plays a fundamental role in archaeological research (WATERS, 1992).

Bertrand and Bertrand (2009) argue that researchers, when using Landscape Archeology as a method of analysis, should take Geosystems as a reference point so as to reconstitute the existence of the systems and their functioning in relation to the geographical space. The authors state that "Landscape Archeology" should undertake spatial inquiries focused not only on reading geometric limits, but also on production units.

Accordingly, Landscape Archeology can be defined as the study of human interventions, which can be regarded as landscape originators, based on the archaeological remains resulting from human actions in past times (BERTRAND, 2009).

Landscape Archeology, when used as a research strategy comprising the study of all social and historical processes in their spatial dimension, is about interpreting the archaeological landscapes and the objects that specify them. This encompasses the registration of the archaeological and material culture of a spatial matrix and, at the same time, the conversion of space into an object of archaeological investigation (VICENT, 1991; BOADO, 1993).

### *Vertical and horizontal scaling for the analysis of the Piracanjuba archaeological site*

Carried out from a landscape perspective, this study of the Piracanjuba archaeological site drew on an environmental analysis, as well as on horizontal (geofacies and geotopes) (BERTRAND, 1968) and vertical (geohorizons) (BEROUTCHACHVILLI; BERTRAND, 1978) geosystemic concepts.

Bertrand (1972) proposed a landscape scale of analysis based on a dynamic typology

considering the hierarchy of elements, classified as upper units (zone, domain, and natural region) and lower units (geosystem, geofacies, and geotopes). According to the mentioned author, the concept of geosystems consists solely of a model – therefore an abstraction – which is why land units were defined in a hierarchical way, as follows: geotopes, geofacies and geocomplexes (PASSOS, 2006).

Therefore, this study aimed to identify the geosystemic complex of the studied site at the level of geofacies, geotopes and geohorizons. Analog stereoscopy was applied to aerial photos taken on a flight in the year 1972 by the company Base Aerofotogrametria e Projetos S/A, on the scale of 1:25000, to compare and analyze different geomorphological aspects over time in the area where the archaeological site is located. In terms of data systematization, Geographic Information System (GIS) software programs such as ArcGIS and QGis were used, besides the computer-aided design software AutoCAD, and CorelDraw 7.

## RESULTS AND DISCUSSION

### *The geocomplex of the Piracanjuba archaeological site*

The Piracanjuba archaeological site is located in the geocomplex of the Salto Simão hydroelectric module, damming a stretch of the Paranapanema River course, where the archaeological rescue took place, from the years 2000 to 2003. In this context, a geocomplex can be regarded as a natural system because of its environmental complex, which is related to physical characteristics of the area and its transformation over the years.

It is worth stressing that Bertrand's (1968) fourth territorial unit of analysis – geosystem – was modified by Beroutchachvilli and Bertrand (1978), who named it 'geocomplex', as they understood geosystems as a theory rather than just a territorial scale with a predefined dimension. In this way, Figure 2 illustrates the environmental context of the Piracanjuba archaeological site, and Chart 1 shows, according to Bertrand (1968), the scale levels of the site's landscape. This study, therefore, focuses on the following landscape units: geofacies, geotopes, and geohorizons. The zone, domain, and natural region units were used only for the classification as per Bertrand's (1968) scale levels.

In this context, the study presents the geosystemic complex regarding the levels of geofacies, geotopes and geohorizons. In the scope of geofacies, the analysis sought to delimit the perimeter of the archaeological site (location and pattern of the Guarani settlement). In terms of geotopes, the analysis compares and differentiates each anthropogenic soil based on the concentration of archaeological material (ceramics, chipped lithics, polished lithics, and faunal remains). Finally, geohorizons regard the relief, vegetation cover, and hydrology in the vertical structure of the archaeological site.

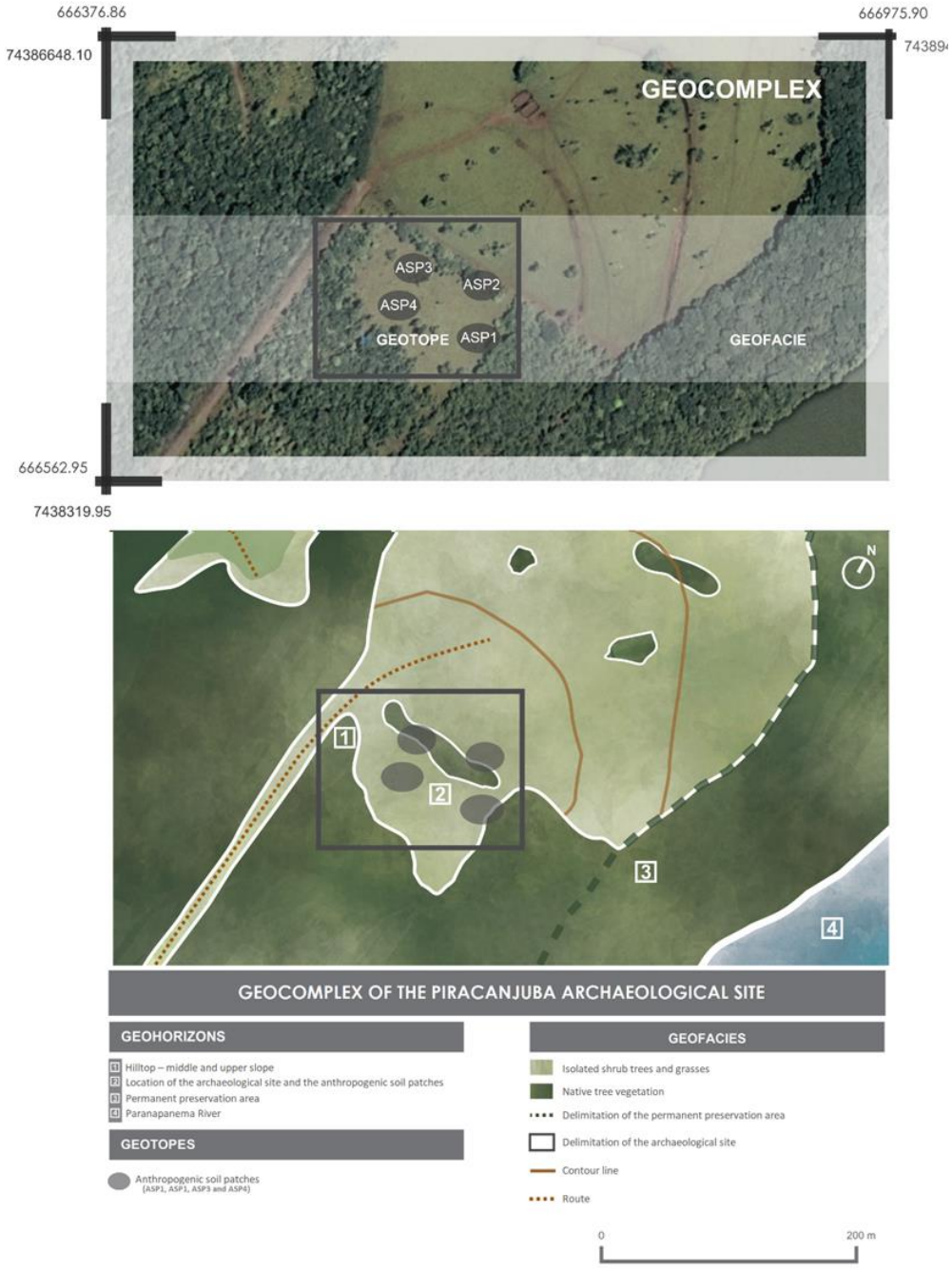
**Chart 1 -** Landscape of the Piracanjuba archaeological site according to the scale levels proposed by Bertrand (1968) and Beroutchachvilli and Bertrand (1978).

| | |
|---|---|
| **ZONE** | Transitional area (MONTEIRO, 1973) of polar and tropical air masses. Climate criteria |
| **DOMAIN** | Paranapanema River basin. Area of the Paranapanema River's middle course. Geological criteria considering textural characteristics, depositional environments, and material sources (geoindicators) |
| **NATURAL REGION** | Cuestas Basálticas geomorphic province. The Serra Geral geological formation |
| **GEOCOMPLEX** | Piracanjuba archaeological site. Salto Simão hydroelectric module. Piraju, SP, Brazil |
| **GEOFACIES** | Delimitation of the settlement pattern of the archaeological site |
| **GEOTOPES** | Anthropogenic soil patches (ASP 1, ASP 2, ASP 3 and ASP 4 |
| **GEOHORIZONS** | Topographic position of the Piracanjuba archaeological site's relief (upper, middle, lower slopes) and its vegetation strata |

Source: the authors (2018).

The geomorphological aspect of the region where the Piracanjuba archaeological site is located has a hilly relief, with valley bottoms and predominantly concave and convex slopes close to the Paranapanema River, in addition to atural resources such as basaltic rocks, silicified sandstones, and clay sources.

Figure 2 - The geocomplex of the Piracanjuba archaeological site, Piraju, SP, Brazil




Source: Daves (2018).

During the archaeological rescue in the Salto Simão area, referring to the Piraju HPP in the year 2000, twenty-six archaeological sites were revealed, with evidence of hunter-gatherer groups and Guarani ceramist groups in the region in past times (MORAIS; FACCIO; PIEDADE, 2000).

The watercourse of the Paranapanema River, before the construction of the Piraju HPP, was smaller in depth and width when compared to the current context. The archaeological sites, were submerged after the construction of the dam. Other modifications include the fluvial environment and the vegetation cover near the

watercourse, now with new permanent preservation areas, following the new shaping of the river banks.

It is noteworthy that the group that inhabited the area of the Piracanjuba archaeological site probably used a clay pit to obtain the raw material for their ceramic vessels, and used rocky outcrops for the making of lithic artifacts.

Given its noted archaeological potential, the studied site plainly favored the settlement of said indigenous groups in past times. This environment, before its biotic system modifications, was approximately 300 meters away from the archaeological site. These are conditions highly valued by indigenous Guarani groups (MORAIS, 1986).

The situation of the archaeological sites in question is intrinsically related to the environment of the Paranapanema River. For instance, the sites located, in past times, in valley bottoms with quaternary sandy-clay deposits in the lower-slope areas, namely Tucum, Monjoleiro, Bucuvá, Benjoeiro, Tambuí, Salsa, Pintado, Lambari, Pirambeba, Surubim, Bagre and Ingá.

Among these archaeological sites, located in the lower concave portion of topographic slopes, whose environmental context was altered and submerged due to the construction of the dam, are Bucuvá, Benjoeiro, Salsa, Tambiú, Pintado, Lambari, Canelinha, Joá-Bravo, Ingá, Bagre and Engenho do Salto.

Figure 3 shows the archaeological sites revealed in the referred archaeological rescue and the area surrounded by the course of the Paranapanema River, with the presence of geoindicators, such as gravel pits, basalt dykes, intertrappean sandstone, and clay sources in the environment submerged as a consequence of the dam construction. The Salto Simão module, where the Piracanjuba archaeological site is located, demonstrates the situation of the sites' relief prior to the implementation of the dam and after anthropic action in the environment.

The Jatobá, Ingá, Canelinha, Tambiú, Pintado, Joá Bravo and Lambari archaeological sites correspond to pre-colonial indigenous hunter-gatherer camps, producers of chipped stone instruments, with archaeological records dated between 6000 BC and 750 AD (MORAIS, 2006).

The context of the Piapara and Piracanjuba archaeological sites, both located in a mid-upper slope area, on the top of a hill, with undulating relief, corresponds to villages or camps of indigenous farmers of the Guarani regional system, ceramic producers and agroforestry practitioners, dated between the 1st century BC and the 16th century AD (750 AD and 1500 AD) (MORAIS, 2006).

The possible sources of clay used in the making of ceramic utensils, in past times, may be located in concave lower-slope areas, where most of the fine and coarse sediments are concentrated, hence propitious places to find clay. Considering that the watercourse banks were totally altered by the construction of the Piraju HPP, no clay source was found close to the Guarani settlement, however it might have existed and is submerged there.

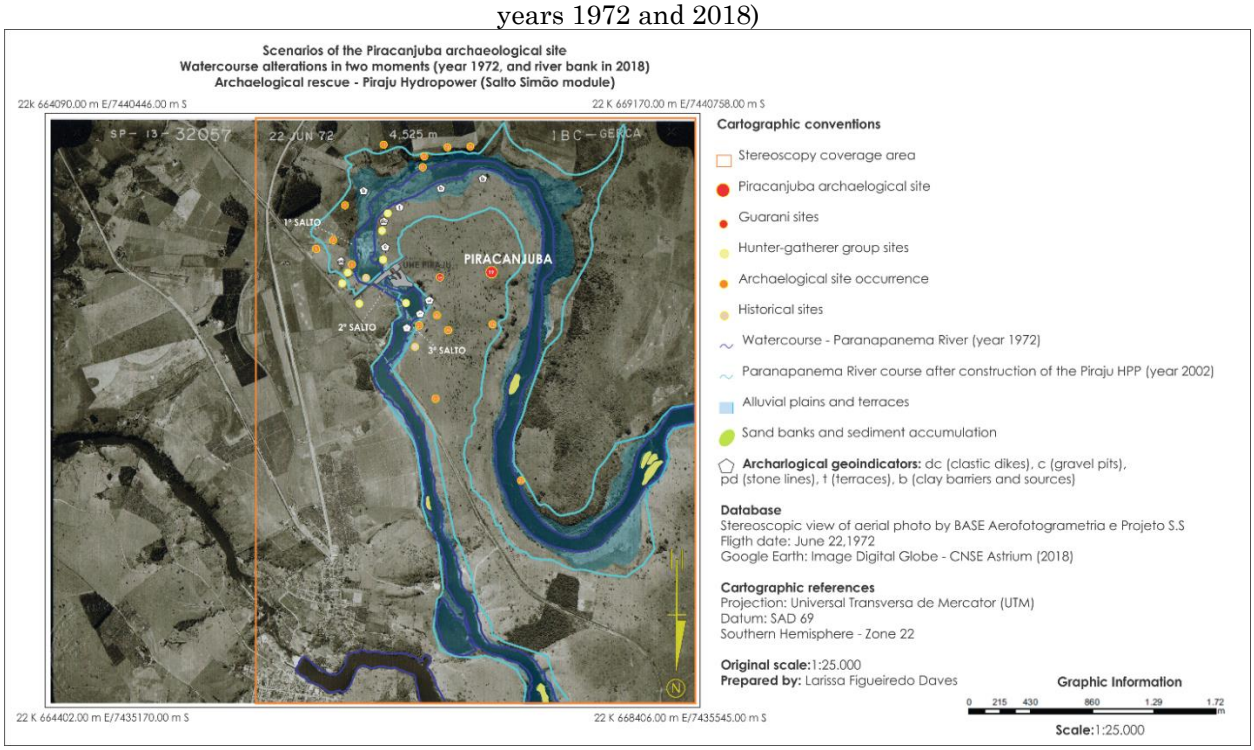
The Fazenda Velha and Engenho do Salto historic sites presented structures representative of national society of local and regional significance, located in upper and mid-slope areas. The archaeological occurrences in this region (Samambaia, Salsa, Caetê, Paineira, Surucubim, Pirambeba, Mandi, Benjoeiro, Bucuvá, Guariroba, Monjoleiro, Corvina, Tucum, Bagre and Peixe Canivete) comprised few remains with the presence of chipped ceramics or lithics. The construction of the Piraju HPP dam allowed, to date, the discovery and knowledge of the archaeological heritage of this region, however some archaeological sites are submerged, as they were located in the area of greatest concavity before the establishment of the dam (MORAIS et. al., 2002).

### *Geofacies: the Guarani settlement pattern*

From the 17th to the mid-19th century, the Paranapanema lands were nearly depopulated, remaining just small groups of the Guarani, Kaingang, and Xavante indigenous peoples (MORAIS, 2010). The Paranapanema River region was colonized by groups of migrants from the state of Minas Gerais and from the Northeast region of Brazil, between the late 19th century and the early 20th century; back then, coffee cultivation and other consolidated agricultural cultures in other regions of the state of São Paulo expanded to the west of the state, which resulted in an extraordinary demand for "land" by farmers (ABREU, 1972).

This occupation process, according to Abreu (1972), Monbeig (1984) and Leite (1983), stemmed from an intense process of environmental and soil degradation due to deforestation, followed by the extermination of traditional indigenous and caboclo populations.

Figure 3 - Landscape scenarios of the Piracanjuba archaeological site (Environmental context – years 1972 and 2018)




Source: Daves (2018).

The occupation in the area where the Piracanjuba archaeological site is located had different uses: in a first moment, it was occupied by the Guarani group, and in a second moment by coffee plantations and pastures and, finally, by the undertaking of the Piraju HPP.

The villages of Guarani ceramist populations settled, in general, in hillside areas with gentle slope reliefs. In the areas of the middle and upper courses of the Paranapanema River, the Guarani occupied mid-slope spaces and hilltop areas. Regarding the lower course of the Paranapanema River, the Guarani occupied terraces, located on gentle mid-slope areas, with some river nearby in case the place was distant from the Paranapanema River (FACCIO, 2011).

Faccio (2011) stresses that population systems have always been closely linked to landscape and its components, as human groups of the past used to choose their occupying locations guided by parameters such as accessibility to natural resources. As regards the Piracanjuba archaeological site, there are some common characteristics with the settlement pattern of the Guarani archaeological sites around the middle course area of the Paranapanema River. It shows occupancy in concave and convex slope areas of hilly relief, fitted by the highly sinuous channel of the Paranapanema River, indicating the possibility of greater visibility and access to the watercourse by the Guarani group, in comparison to its surrounding areas.

Most of the Guarani sites occupied mid-slope relief areas in the Paranapanema River basin. This attribute characterizes the environment of the ceramist groups. This interpretation denotes a full insertion of those sites into landscape, influenced by the morphology of the relief and physical-geographic characteristics (MORAIS, 1986).

The perceived characteristics of the settlement pattern and the analysis of the environment allow raising the hypothesis that the Guarani group that inhabited the place developed agricultural management, evidenced by the large concentration of ceramic fragments with shapes and sizes typical of cooking utensils (NOELLI, 1993).

Based on the Guarani Regional Settlement System, as proposed by Morais (1999), the shape of the indigenous village with anthropogenic soil patches is indicative of remnants of *tapy' iguassu'* (big houses). These houses, known as 'big huts', are characterized, in terms of their floor plan, by structures of ellipsoidal elongated shape, and elongated rectangular with rounded ends, with a quadrangular base and roofs thatched down to the ground, constituting a solid and resistant construction (NOELLI, 1993).

Likewise, Noelli (1993) points out that the characteristic pattern of Guarani housing structures is elongated. The rounded floor plan of such structures, also called *ogapua* (round houses), appears in two shapes: ellipsoidal elongated, or elongated with rectangular sides and rounded ends. The ellipsoidal rounded oval shape of the "black earth" patches on the surface of the sites' revolved soils seems to derive from the type of collapse of those houses (NOELLI, 1993).

### *Geotopes of the Piracanjuba archaeological site*

During the period of archaeological excavation in the Piracanjuba settlement, 15,288 ceramic fragments were collected from four remnant house foundations and surrounding areas (MORAIS, et.al. 2002). The following presents the analysis of the anthropogenic soil patches that form the geotopes according to the relevant landscape unit and the geosystem.

In the area with anthropogenic soil patches at the Piracanjuba site (ASP 1, ASP 2, ASP 3 and ASP 4), poorly-structured combustion remnants were observed, around which most of the ceramics found were concentrated (PANACHUK et. al., 2010).

Each ASP has a different ellipse-shaped diameter and extension, as in other Guarani archaeological sites studied, along the upper, middle and lower courses of the Paranapanema River (PALESTRINI, 1975; MORAIS, 2000; FACCIO, 2011). The "black earth" patches are collapsed structures from ancient Guarani dwellings. The ceramic fragments in the perimeter of the archaeological site are distributed and organized into two hierarchies: in the northern area (ASPs 2 and 4) they are dispersed; in the southern area (ASPs 1 and 3), they appear in a compact form but only in ASP 1 (Figure 4).

The anthropogenic soil patches of the Piracanjuba site are 50 cm deep, with the presence of organic matter and archaeological remains. The dimensions of the geological belts of each ASP are different, with ellipsoid oval and/or elongated shapes (ASP 1: 20 m long, 10 m wide; ASP 2: 15 m long, 11 m wide; ASP 3: 12 m long, 8 m wide; ASP 4:10 m long, 8 m wide).

With reference to the location of the Piracanjuba archaeological site, near the Paranapanema River, it can be seen that ASP 4 is positioned in the highest area of the site (571m), followed by ASP 1, ASP 2 and ASP 3 (570, 569 and 567 m, respectively). It was found that the highest concentration of archaeological remains outside the ASPs appears in the northern area of the site, and that the site has an altitude of 567 to 571 meters.

In the archaeological site area, besides the large quantity and variety of ceramic fragments found, the list comprises a hatchet, a fragmented quartz tembetá, and a quartz crystal, with probable anthropic alteration. There is a large concentration of ceramics in ASP 1 and ASP 2, while in ASP 3 and ASP 4 the ceramic fragments are dispersed around the black-earth patches.

The lithic materials found in ASP 3 are chips, splinters and cores made on silexite pebbles, probably derived from gravel from the Paranapanema River. No rescue of archaeological pieces was carried out in ASP 4.

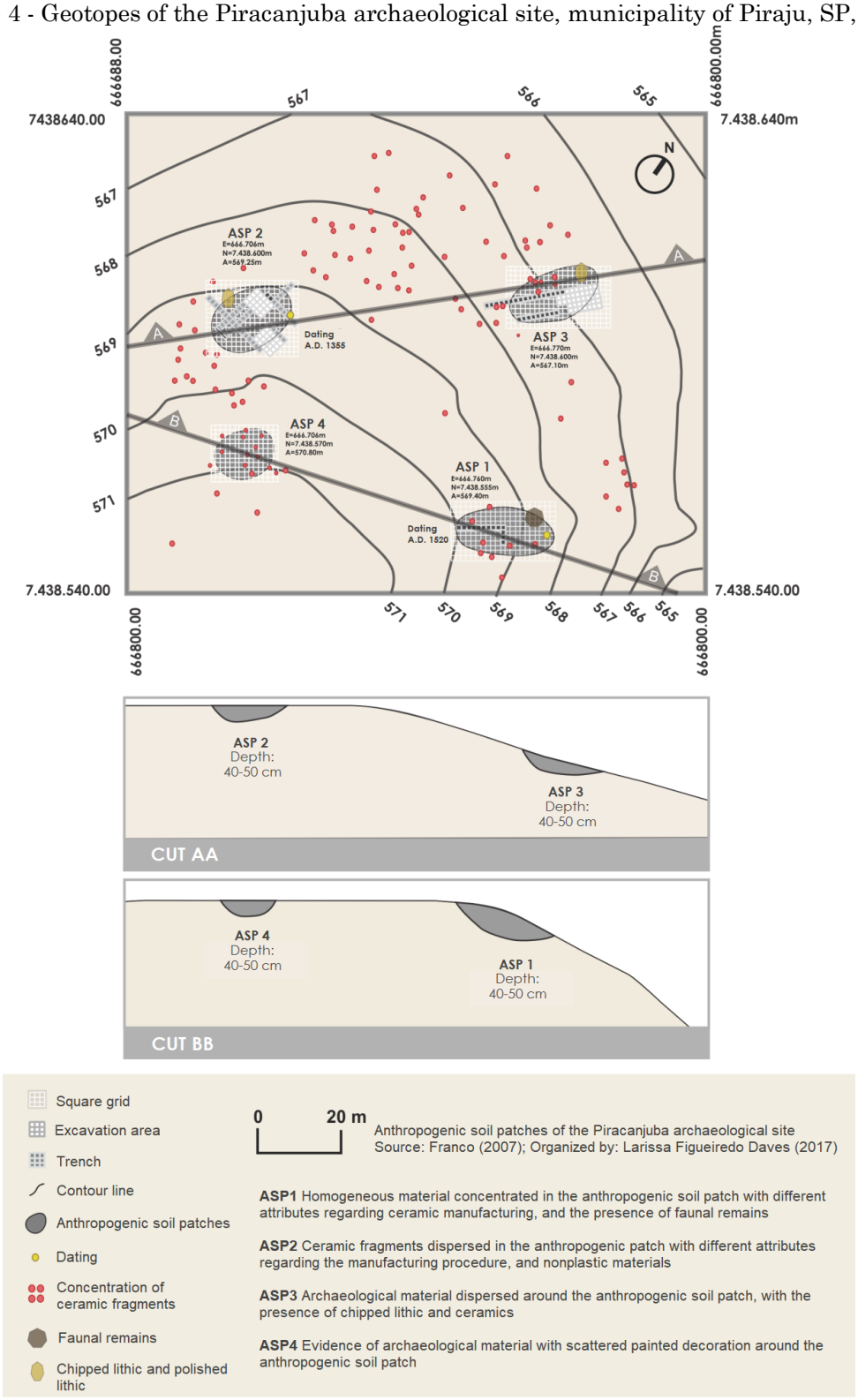
The archaeological site did not present any bonfire structure associated with the anthropogenic soil patches in the excavated square-grids. Therefore, the concentration of black-earth patches may have been formed by the disposal of bonfire residues with food scraps and broken pottery.

The dating of the ceramic fragments in ASP 1, carried out in 2000, and that of ASP 2 in 2004, point to the years 1520 AD and 1355 AD, respectively, and such a disparity may indicate the expansion and the over-dimensioning of the population in the Guarani settlement area (NOELLI, 1993). Faunal remains were also found in ASP 1, however restricted to small burnt bone fragments and a monkey canine tooth, sectioned and burned.

### *Geohorizons as a subsidy for the vertical analysis of the Piracanjuba archaeological site: perspectives on relief, climate, vegetation and soil*

Geohorizons imply landscape strata with the same combination of geomass, that is, their differentiation involves not only the sequence of plant strata and soil horizons, but should also include the conditions of the hydrosphere and atmosphere (BEROUTCHACHVILI, 1989). However, the concept of geohorizons is important for the present analysis of the vertical structure, and will be associated with the landscape components and the geocomplex of the studied archaeological site.

Figure 4 - Geotopes of the Piracanjuba archaeological site, municipality of Piraju, SP, Brazil




Source: Franco (2007). Organized by the Daves (2018).

Understanding why an archaeological site has a given geographic position offers supporting elements for evidence analyses of subsequent colluviums as regards the physical-chemical traits of the correlative deposits. In this way, surface structure analyses allow archaeologists to substantiate chronogeomorphological studies using data obtained from the dating of archaeological remains, and geoindicators (such as gravel pits, basalt dykes, clay sources, and rocky outcrops) with evidence of habitation in past times (CASSETI, 1983).

A different dynamics applies to prehistoric archaeological sites, depending on their position in relation to the relief. On concave-convex slopes, the rupture of gradient may result in a level where the prehistoric archaeological site rests. Slope analyses should be subdivided into three scales: lower, middle and upper (RUBIN, 2011).

In this way, topographic compartmentalization is evidenced as an indispensable reference for the characterization of areas of archaeological sites, since surface structure analyses seek to observe the soil and the vegetation deposits present on the slopes (CASSETI, 1983).

With regard to the Piracanjuba archaeological site, the concave slope area was analyzed from three taxonomic units of landscape, namely: hilltop/upper slope, middle slope, and lower slope. In the relevant site, the decreasing steepness towards the Paranapanema River evinces middle and lower slopes. The dynamics underlying each of the slopes allowed representing the vegetation strata in three different environments, based on recommendations by Beroutchachvilli and Bertrand (1978).

The method used in the vegetation strata analysis drew on the phytosociological analysis proposed by Braun-Blanquet (1979) and Bertrand (1966). Initially, a plant species survey and observation of the studied environment were carried out. After defining the area for biogeographic characterization, the most important plant species occurring in the vegetation formation of the area were listed according to their respective strata and with emphasis on the description of each environment of the archaeological site in question.

The classification of the vegetation drew on the guidelines presented in the study "Classification of Brazilian Vegetation, adapted to a universal system" by Veloso, Filho and Lima (1991). It also considered the discussion proposed by Eiten (1983), Odum (1988), Troppmair (2012) and Figueiró (2015) regarding the vegetation species occurring in the area of the Piracanjuba archaeological site.

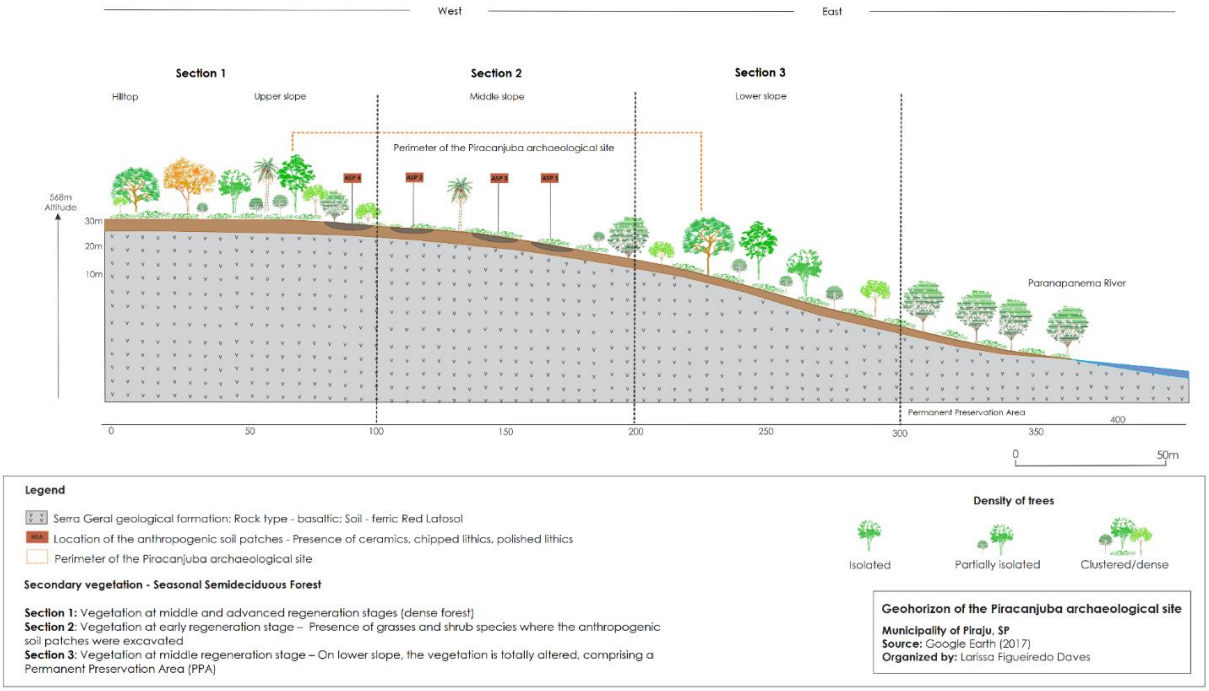
During fieldwork in April 2017, geographical characteristics of the area were observed to describe in detail the biogeographic factors interfering in the vegetation formation, and to identify ecological potential factors intervening in the landscape.

Regarding its physical aspects, the Piracanjuba archaeological site presents macro relief formed by the São Paulo State peripheral depression (depression of Paranapanema) and the morphosculpture of the São Paulo State western plateau (midwestern plateau and residual plateau of Botucatu). Meso relief, in turn, is characterized by wide hills, thus making it a hilly relief. The delimitation of micro relief is represented by the convex (upper, middle and lower) slope of the Serra Geral geological formation. The type of soil on this slope is formed by ferric Red Latosol developed from basaltic rocks, in addition to the concentration of anthropogenic soil patches (FÚLFARO; SUGUIO, 1974).

The geographical position of the Piracanjuba site reveals that its population occupied the top and middle area of the hill. In view of that, the characterization of its vegetation and physical aspects focused on the diversity of vegetation cover in four sectors of the hill, namely hilltop, upper, middle, and lower slope areas.

The geohorizon of the Piracanjuba archaeological site is formed by three different units (upper, middle and lower slopes) of heterogeneous stratification, containing some similar vegetation species that are repeated in upslope and downslope areas. The distinction of each environment was evinced by the height and other characteristics of the vegetation, in addition to the decreasing steepness of the slope towards the water body of the Paranapanema River (Figure 5).

Figure 5 - Geohorizon of the Piracajuba archaeological site




Source: Daves (2018).

The environments can be differentiated by the height of each vegetation stratum and by the decreasing steepness towards the water body of the Paranapanema River. At the top of the slope, the vegetation contains the following species: canjerana (*Cabralea canjerana*), cambuci (*Campomanesia phaea*), stinkingtoe (*Hymenaea courbaril*), ambay pumpwood (*Cecropia pachystachya*), macaúba palm (*Acrocomia aculeata*), silk floss tree (*Chorisia speciosa*), jequitibá (*Cariniana estrellensis*), cedar (*Cedrella fissilis*) and canela-amarela (*Nectandra oppositifolia*). (Section 1).

The predominant tree species in this region are macaúba palm (*Acrocomia aculeata*), silk floss tree (*Chorisia speciosa*), beggarticks (*Bidens alba*), tick-trefoil (*Desmodium triflorum*) and canela-amarela (*Nectandra oppositifolia*) (Section 2).

Near the water body, the environment is characterized as humid, with the presence of deposits and sediments, mainly due to the concentration of sand residues around the river channel.

The current vegetation of the landscape consists of dominant species of angiosperms and grasses, with plants of various sizes and isolated individuals. At the bottom of the slope, riparian vegetation was formed in the process of regeneration. Its vegetation stratum is formed by grass and shrub (5 cm to 1 meter), and contains the following species: beggarticks (*Bidens alba*), tick-trefoil (*Desmodium triflorum*), Brazilian peppertree (*Schinus terebinthifolius*), guava (*Psidium guajava* L.), assa-peixe (*Vernonia polysphaer*) and juazeiro (*Ziziphus joazeiro*).

In the southern portion of the archaeological site, at the limit with the Paranapanema River, there is secondary vegetation without remnants of native vegetation. Among the species in the lower portion of the slope, the predominant ones are: ambay pumpwood (*Cecropia pachystachya*), albizia trees (*Albizia haslerii*), ice-cream-bean (*Inga edulis*), golden trumpet tree (*Tabebuia chrysotricha*), araribá (*Centrolobium robustus*), pau-jacaré (*Piptadenia gonoacantha*), genip tree (*Genipa americana*) and canjerana (*Cabralea canjerana*) (Section 3).

As concerns vegetation regeneration, Resolution No. 1/1994 of the National Environment Council (Conama) defines primary and secondary vegetation species as to their early, "middle and advanced stages of regeneration in the Atlantic Forest biome, specifically seasonal semi-deciduous forests, and describes types of species native to the state of São Paulo and the characteristics under which such vegetation regenerates on a local scale" (CONAMA, 1994, p. 1684). Based on that, the characteristics of secondary vegetation undergoing the early and middle stages of regeneration were observed for the Piracanjuba archaeological site.

Vegetation at the early stage of regeneration was found in the middle-slope area of the Piracanjuba archaeological site, showing low biological diversity, with the predominantly-occurring species being grass and shrub, especially in the area where the ASPs were excavated.

Vegetation at the middle stage of regeneration was found in the upper and lower-slope area of the archaeological site. On the upper slope, the observed species compose a forest physiognomy, with trees of various sizes, in addition to layers of different heights, with each layer having a vegetation cover ranging from open to closed. The surface of the upper layer is uniform, with emerging trees. The diametric distribution of the tree trunks shows moderate amplitude, with a predominance of small diameters, and a reasonable potential for timber production.

At the top of the hill, the closed forest extends to the upper slope, with secondary vegetation showing characteristics of the middle stage of regeneration, considerably ahead of the other two environments analyzed at the Piracanjuba archaeological site. This occurs because this portion of the environment suffered less impact over time. Climbing vines and lianas were observed on the medium-sized and tall trees situated where the forest is closed. There was also plant litter, forming a 5 cm thick layer on the soil surface.

On the lower slope, the vegetation was totally altered. Based on the steepness percentage along the slope, secondary vegetation at different stages could be observed, forming strata of understory and canopy of trees with arboreal size (4 to 6 meters) at the edges, while inside there was predominantly grasses and isolated shrub trees (2 to 4 meters). Caused by anthropic action, the changes in the ecosystem allows observing some species of native trees at the top of the hill and on the upper slope, as well as in the permanent preservation area. In the vicinity of the Paranapanema River, the environment is humid and drenched with riparian vegetation.

## FINAL CONSIDERATIONS

The observed settlement pattern and the analysis of the environment allowed raising the hypothesis that the Guarani group that inhabited the site developed agricultural management, evidenced by the large concentration of ceramic fragments with shapes and sizes typical of cooking utensils.

With reference to the big house (*tapy' iguassu'*), it can be said that it was located in a middle-slope area within the perimeter of the studied archaeological site, as shown by the analysis of the anthropogenic soil patches (geotopes). The ellipsoid shapes found and the characteristics of said anthropogenic soil patches correspond to ancient dwellings.

The analyses of the anthropogenic soil patches revealed, by means of thermoluminescence, disparity in the dating of the ceramic fragments found in ASP 1 reaching back to 1520 AD, and in the ASP 2 to 1355 AD, probably pointing to two periods of occupation of the archaeological site area.

In conclusion, the present study analyzed heterogeneous stratification units with the purpose of distinguishing the studied environments according to the height of each vegetation stratum, in addition to slope sinuosity and steepness towards the water body of the Paranapanema River, thus contributing to further landscape analyses of archaeological sites, within past time frames, and based on geoindicators. Thus, this study emphazises the relevance of landscape from the perspective of a time scale, given that a landscape analysis should be comprehensive, observing the process by which the place in focus evolved through time until its current context.

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Larissa Figueiredo Daves contributed with Methodology, Data Curation, Form of Analysis, Visualization, Writing (original draft; revision and editing). Neide Barrocá Faccio contributed with the Writing (revision), Methodology, Resources for analysis of the materials.