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The use of air photointerpretation in archaeological landscape research: the case-study of a Colombian Andean plateau

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Abstract

The aim of this paper is to use historical aerial photographs for the reconstruction of archaeological areas nowadays disappeared due to urban growth; this is supported by data from excavations and colonial documentation. In this case, we intend to reconstruct and analyze the raised fields system built by the pre-Hispanic groups in the Bogotá savanna, located in the Colombia Andean highlands. The results show that the hydraulic system significantly transformed the ecological environment: it controlled the mobility of rivers and seasonal floods, blocked water flows and flooded specific areas of the savanna. The objective of the pre-Hispanic groups was not to drain the savanna, but to manage the water to get the most out of it, coexisting with it.

Keywords

Aerial Archaeology
Photointerpretation
Landscape Archaeology
Bogotá savanna
Pre-Columbian raised fields

El uso de la fotointerpretación en la investigación de paisajes arqueológicos: el caso de estudio de una meseta andina colombiana

Resumen

El objetivo de este trabajo es mostrar el uso de la fotografía aérea para la reconstrucción de áreas arqueológicas hoy en día desaparecidas por el crecimiento urbano, apoyada por los datos provenientes de las excavaciones o de la documentación colonial. En este caso se pretende reconstruir y analizar el sistema hidráulico de campos elevados de cultivo construidos por los grupos prehispánicos de la Sabana de Bogotá en los Andes colombianos. Los resultados muestran que el sistema hidráulico transformó significativamente el medio ecológico: controló la movilidad de los ríos y las inundaciones estacionales, bloqueó flujos de agua e inundó zonas específicas de la Sabana. El objetivo de los grupos prehispánicos no fue desecar la Sabana sino manejar el agua para sacar el máximo provecho, conviviendo con ella.

Palabras clave

Arqueología aérea
Fotointerpretación
Arqueología del paisaje
Sabana de Bogotá
Campos elevados precolombinos

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Introduction

Throughout our time on the planet we have left traces of our actions, creating layers that overlap and form a palimpsest. This has been achieved through an intimate relationship between people and the environment whose synthesis is the landscape (Crumley, 1994). One of the tasks of archeology is to discover, understand and explain this particular interrelationship over time. Each human group, from hunter-gatherers to city dwellers, have lived in a specific ecological environment, transforming it for years or centuries according to their needs and the potential of nature, making it their home, their place of resource exploitation, the abode of their gods, in short, the space of creation and recreation of their social, political, economic, cultural and symbolic worlds (Balée, 2006; Crumley, 2007).

However, today, when we look at the space that surrounds us, it is hard to imagine that it might reveal something of the life of human groups that lived there before us. In fact, most of the remains of this activity are currently found in the subsoil (with the exception of cases such as abandoned architectural structures or rock art found in rocks and caves). How can we reveal them when they are invisible to our eyes? In the main, archaeologists dig, searching for traces of human activity in the past. But, there are also other methodologies that allow us to "see" and study from the surface what is buried: aerial archeology is one of these (Parcak, 2009).

The savanna is a lacustrine fluvial plain, difficult to drain, with a high number of seasonal and permanent water bodies. There, the pre-Hispanic groups built raised field systems, whose vestiges today have disappeared due to the urban growth of the country's capital —Bogotá—over the last fifty years (Figure 1). However, we have an important collection of aerial photographs, taken in the decades from 1930 to 1960, where vestiges of the hydraulic system are still visible allowing us to reconstruct and analysis them. These remains, which represent the last phase of the pre-Hispanic period (Late Muisca: AD 1000 – 1550) were analyzed through aerial photography, with the support of data from excavations and colonial documentation, the aim being to understand how Muisca society transformed their ecological environment; how was their relationship with the water through the hydraulic system; how the process of human occupation took place and what was the spatial relationship between settlements and local croplands.

Background: raised fields in the Bogotá savanna and its environment

The Bogotá savanna is a plain of 1.413 km², located at 2600 m high in the eastern mountains of the Colombian Andean System (Figure 2). It was formed 25,000 years ago from the emptying of an ancient Pleistocene lake. The presence of multiple tributaries, whose only drainage valley was the Bogotá River, and its sandy-clay soil that was hard to drain, made of the savanna a floodplain with numerous marshes and lakes (Van der Hammen, 1995).

The Bogotá River Basin crosses the plateau, cutting it in half in a northeast-southwest direction and running a length of 90 km (CAR, 2006), it constitutes the savanna's main waterway. It is fed by several rivers such as the Frio, Chicú, Juan Amarillo, San Francisco, Fucha, Tunjuelito, and Balsillas. It also has wetlands such as La Conejera, Juan Amarillo, Jaboque, La Florida, El Guali, Cordoba and Tibanica, and Lake La Herrera (Figure 3). The plateau has a flat slope in the east-west, north-central and south-central directions. This makes the Funza-Bosa area the lowest and most prone to flooding of the plain, the altitude of which ranges from 2600 m at the foot of the eastern mountains to 2545 m on the floodplain of the Bogotá River (Boada, 2006, p. 26; Etayo, 2002, pp. 32-33).

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Figure 1. Aerial view of the Bogotá savanna plateau from east to west. In the central area it can be seen the Bogotá River limiting the expansion of Bogotá D.C. city. © L. Rodríguez Gallo

Figure 2. Location of the study area. © L. Rodríguez Gallo

It has an average annual temperature of 15ºC and is covered by forest vegetation (Van der Hammen, 1998).

The varied geographical, morphological and ecological features of the savanna promoted the development of different types of human occupation, given that the presence of water was not a problem. The earliest human settlement in the region dates to 12400 years BC (Correal & Van der Hammen, 1977). The inhabitants were hunter-gatherers who settled in rock shelters and later on open-air settlements located in terraces or on the plain, away from the effect of floods. According to archaeological

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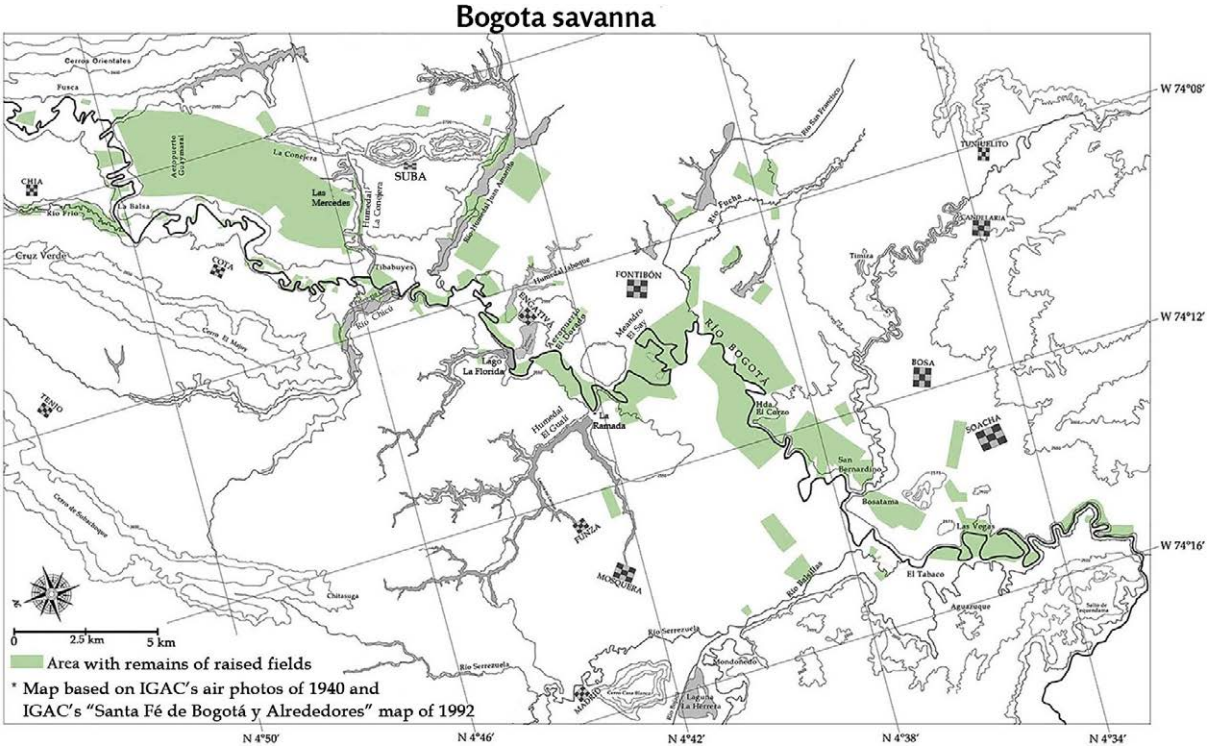

Figure 3. Study area. Bogotá savanna. © L. Rodríguez Gallo. Note: The rivers and wetlands as they looked in the 1950s; In green color: areas with remains of raised fields identified during the photointerpretation analysis.

and bio-anthropological evidence, these same groups eventually shifted to horticulture and later agriculturalists organized into chiefdoms (Rodríguez Cuenca, 1999, 2011). Nevertheless, in order to successfully inhabit the floodplain, they had to transform its ecological structure by building raised fields. Throughout Latin America raised fields systems were constructed by pre-Hispanic societies. Both in the highlands and low tropical lands, from Mexico to Peru, these people transformed floodplains into productive agricultural systems (Delgado-Espinoza, 2002; Denevan, 1970; Erickson, 1988; Gassón, 1998; Hammond, 1984; Plazas et al., 1993; Valdez, 2006).

The raised fields are earth structures with channels for drainage interspersed with elevated platforms for cultivation, built with the residual land of the channels. These channels distributed water in a controlled manner along the plain during winter. During summer, they could act as reservoirs, ensuring good harvests throughout the year. The raised fields system permitted not only the cultivation of flooded areas but also an increase in the productivity compared to traditional methods, since the organic matter accumulated in the channels during the floods was subsequently deposited on the platforms, enriching them with silt sediments. The raised fields system also helped to solve a problem that even today affects farmers in Andean regions: frost. During warmer months, from December to February and June to August, the temperature ranges from daytime maximums of 22 °C, to night temperatures of -5 °C. Consequently, the crops can get frost-damage. This hydraulic system neutralized this adverse effect, since the water channels were heated during the day, thereby keeping the earth warm at night, and thus preventing frost from damaging the plants.

In the Bogotá savanna, the axis of the hydraulic system was the Bogotá River. Throughout its course, and those of its tributaries, various agricultural people (Herrera, 800 b.C. – AD 100; Early Muisca, AD 100 – 1000; Late Muisca AD 1000 – 1550) built a set of channels and elevated platforms for cultivation. According to the oldest dates available,

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the hydraulic system began to be built around 1324 ± 40 b.C., probably still linked to the development of horticulture (Boada, 2006), and was in operation until the Spanish colonization in the Sixteenth Century, by then covering an area of over 15,800 hectares (Boada, 2006; Rodriguez Gallo, 2011). It occupied the site of the present-day city of Bogotá and the municipalities of Chia, Cota, Funza, Mosquera, Soacha and Sibaté. However, as aerial photographs used for reconstitution and study of the hydraulic system only show its last operational phase, just before the Spanish colonization, our analysis will focus on the last Pre-Hispanic period, the Late Muisca.

The morphology and size of the channels and platforms vary according to the gradient of the plain, the volume of water to be controlled, soil characteristics and the shape of the river. In the Bogotá savanna, we find four types of structures: linear channels, parallel raised fields, irregular raised fields and checkerboard raised fields (Rodriguez Gallo, 2015) (Figure 4).

The linear channels, perpendicular to both the Bogotá River and some of its tributaries, could reach up to 2 km in length by 12 m in width in the lower areas of the savanna. The main function was to quickly control the large volumes of water during periods of flooding, storing them in the channels themselves or directing them into the plain for mitigation purposes. According to colonial data, channels could have also been exploited for fishing, either by trapping the fish inside the channels or diverting them into wells (Simón, [1625] 1981, pp. 254- 256).

The checkerboard raised fields are sets of three to ten platforms with a height of 70-90 cm, length of 20-50 m, and a width of 2-5 m, with channels between them of 50 cm to 2 m wide on average. Each set was separated from the other by small channels. They were built on the plain above the flood level, where flooding was produced by the high groundwater level (Figure 5).

On the floodplain of both the Bogotá River and its tributaries we can find two other types of raised fields: parallel and irregular. The former where built using the sedimentation bars that the rivers' meanders left behind, transforming them into cultivation platforms. Their size could vary according to the 'wave length' of the meander. The so-called irregular raised fields do not show a clear morphologic pattern. They are spread out at random across the floodplain, isolated or in small groups, without drainage channels and with quite different shapes such as circular, rectangular or trapezoidal. From our point of view, this apparent chaos is the result of the partial destruction of the hydraulic system and not the result of a predetermined construction standard, since, as the irregular raised fields are located in the floodplain, they have been exposed in recent centuries to seasonal flooding and a constant process of sedimentation.

However, the fact that both the parallel and irregular raised fields were constructed along the Bogotá River floodplain (from Chía to Soacha) demonstrates the effectiveness of the hydraulic system to prevent the flooding of the plain and crops. The archaeological evidence also confirms this flooding control, since settlements from the Herrera, Early and Late Muisca have been found in the Bogotá River alluvial valley (Bernal, 1990; Boada, 2000, 2006; Kruschek, 2003).

With the beginning of the Spanish colonization the agricultural system was abandoned. The swampy and marshy plain was converted into pastureland for livestock production and the hydraulic system was no longer used. Only in the mid-twentieth century was it rediscovered thanks to the use of aerial photography, since the ground, leveled and under other uses, revealed nothing of these remains. But when archaeological work in the area began to be developed systematically in the second half of the twentieth century, many of the remains present in the subsoil had been destroyed due to the rapid urban growth

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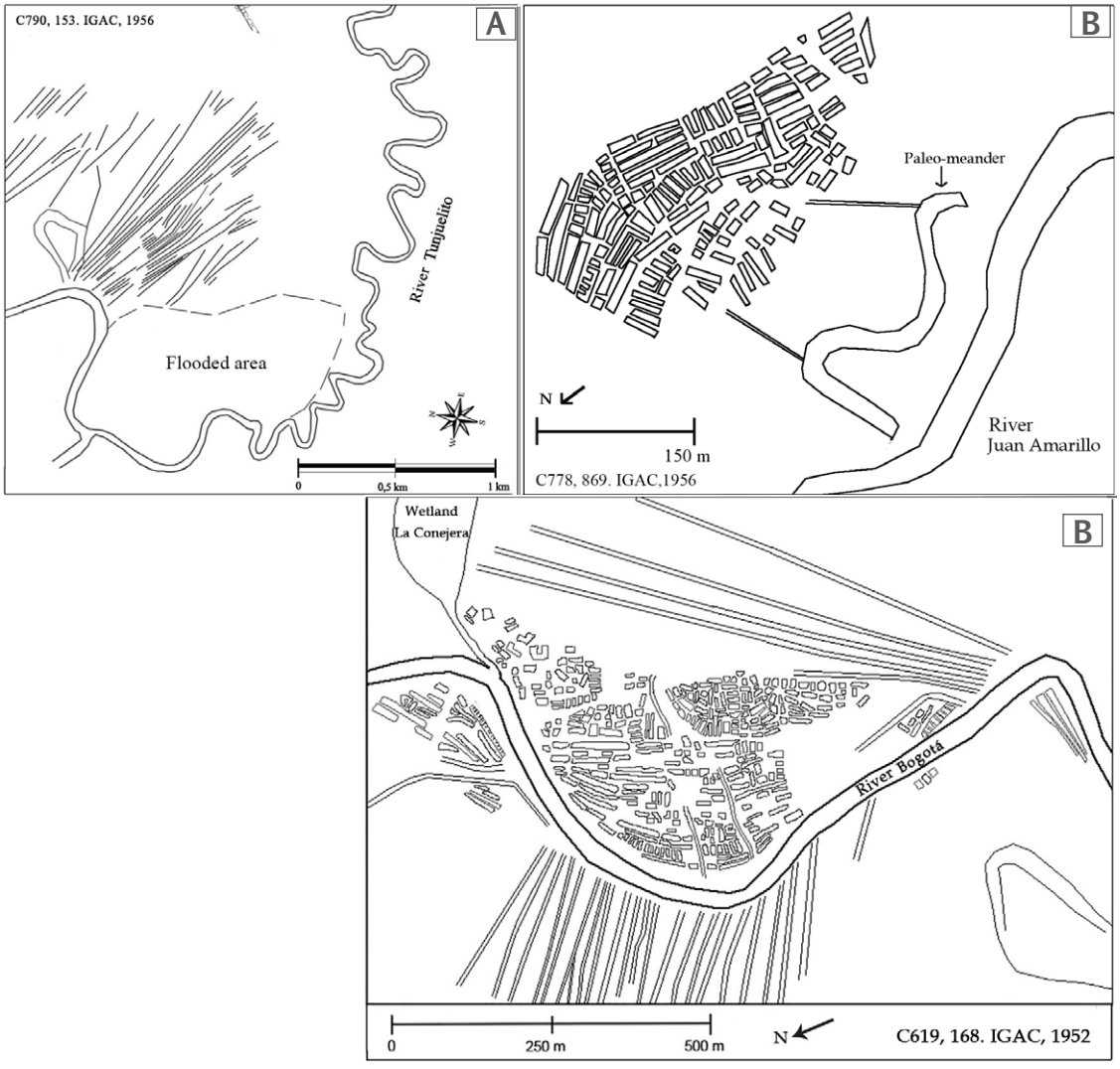

Figure 4. Examples of raised fields reconstructed from aerial photographs of IGAC. © L. Rodríguez Gallo. A) linear channels (Soacha sector); B) checkerboard raised fields (Juan Amarillo Sector); C) parallel and irregular raised fields and linear channels (Suba-Cota Sector).

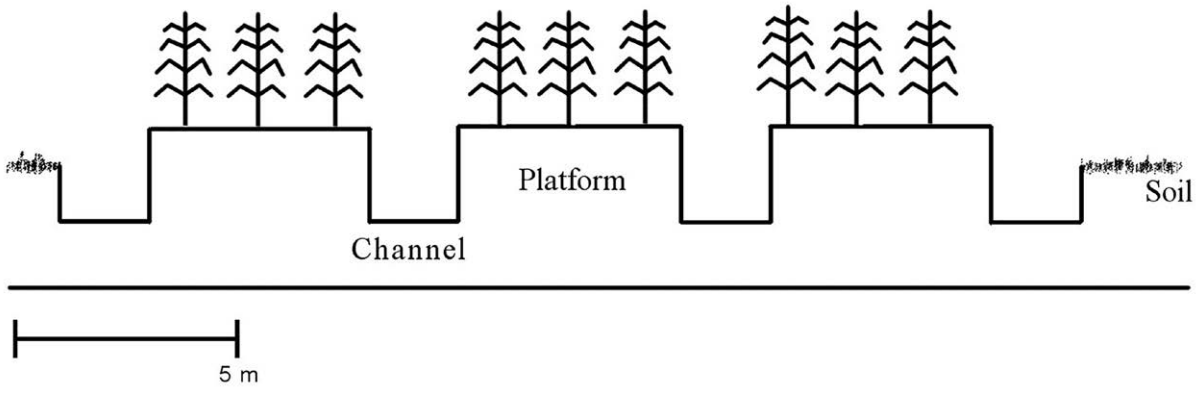

Figure 5. Schematic drawing of checkerboard raised fields. © L. Rodríguez Gallo.

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of the capital, Bogotá, during this period. Thus, air archeology showed another facet of its potential as a tool for the study of destroyed archaeological landscapes.

Although nowadays it is possible to obtain geo-referenced aerial photographs and high-resolution satellite images that can be used on computer programs in combination with other data, the old aerial photographs still retain a great advantage: the fact that they were taken at a time when heavy machinery was still not being used or employed heavily. The first aerial photograph of an archaeological site was taken by P. H. Sharpe in 1906. It was Stonehenge. But it was in the Interwar period (AD 1918 – 1939) that began the real development of photography with different purposes, such as for the military and archaeology (Wilson, 1982). However, the changes that came after the Second World War, with the creation of a mass society and technological development, brought with it the rapid transformation of large areas. A mechanized agriculture and an urban expansion caused the destruction of archaeological remains that until that moment had suffered only minor impacts.

As a result, today there are archaeological sites whose existence is only known though the older aerial photographs or, at least, we only have a fuller picture through these. This is the case of the Bogotá savanna. Today, the city occupies much of what was once the area of the hydraulic system. Small sites are still undeveloped, but farming has been so intense that the satellite images reveal nothing of the ancient remains (Figure 6). Therefore, although one can carry out excavations at specific sites of the plateau, we can only have a fuller picture of the ancient agricultural system through the use of aerial photographs of the Bogotá savanna, taken between the 1930s and 50s.

Therefore, the use of aerial photographs from the first half of the twentieth century is in this case essential. Without them, nowadays we would hardly have any news about the raised fields system that covered the entire plain, since once the Spanish colonization began the system was abandoned and forgotten (Figure 6). Only in the 1960s it was rediscovered thanks to the work of Sylvia Broadbent (1968), followed by the works of Broadbent (1987), Bernal (1990), Etayo (2002), Boada (2006) and Rodriguez Gallo (2011), all of them based mainly on the analysis of old aerial photographs. However, their work was partial, dealing with the photointerpretation of some areas of the savanna, and not of its totality. In this article, an analysis of the whole system is presented.

There is an excellent photographic collection, consisting of more than 35 boxes with aerial photographs, which belong to 25 flights made by the *Instituto Geográfico Agustín Codazzi* (IGAC) over the period 1938-1956, at different times of the year and with different types of tilt (oblique and vertical). Since photographs were taken in a period prior to the urban sprawl and the use of modern machinery for agricultural purposes, the remains of the hydraulic system are still visible in many sectors of the plain, especially along the alluvial valley of the Bogotá River.

However, we should note the following points before starting our photointerpretation. We cannot forget that the landscape we see in aerial photographs of the first half of the twentieth century does not exactly match the one that existed 500 years ago. The deactivation of the pre-Hispanic hydraulic system changed completely the characteristics of the savanna. Many sectors of the plain, that in the pre-Hispanic period remained dry, were flooded, while the course of the rivers and the growth and migration of meandering, which was restricted by the hydraulic system, could now freely move and change. After the Spanish colonization, there has also been strong attempts at "gagging" the water of the rivers, wetlands and lakes, including the elimination of meanders, the complete change of the course of some rivers, desiccation of wetlands and the transformation of rivers into channels "drawn to the rule" or into underground streams.

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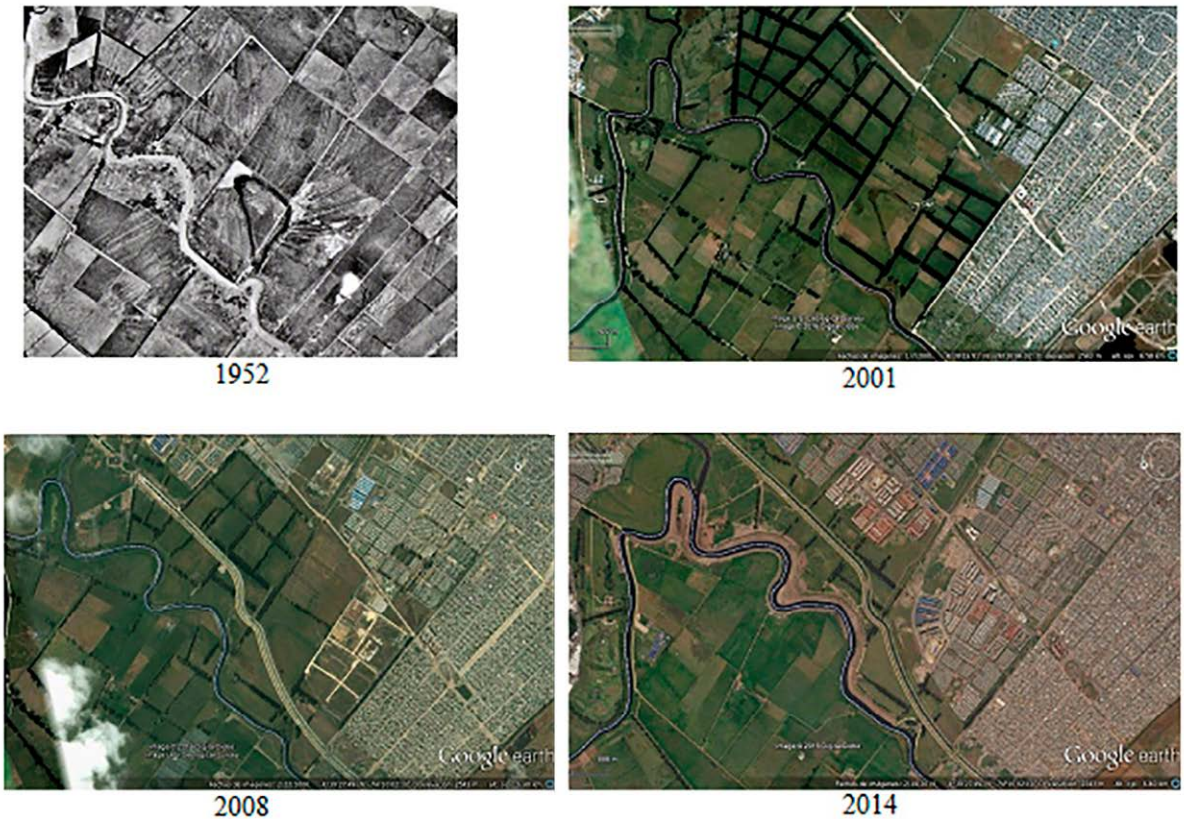

Figure 6. Example of the progressive loss of the visibility of pre-Hispanic raised fields, as consequence of the growth of urban Bogotá and agricultural works. Tintal-Patio Bonito sector. 1952: it is still possible to see linear channels on both sides of Bogotá River, including a paleo-meander, which was active in the pre-Hispanic period. IGAC, fly C-619, Scale 1: 18.000; 2001: the paleo-meander and some lineal channels are still partially visible. The urban growth is evident; 2008-2014: the remains of raised fields have disappeared. The paleo-meander has been covered by a road and buildings.

Furthermore, the water table level has declined by excessive use of groundwater sources. So, what we see today in the aerial photographs is an image of the raised fields at the time of their abandonment in the Sixteenth Century, but transformed by the constant changes of space in the following centuries, which also include urban growth and modification of the original biota. We call attention to this point because foregoing analyzes where aerial photographs were used did not take into account the transformations on the land, once the hydraulic system has been deactivated (see Boada, 2006; Broadbent, 1968).

Methodology: Reconstructing destroyed archaeological landscapes by photointerpretation

Photography from the air is an essential tool in Landscape Archaeology, since by providing an aerial view of a place it allows us to have an objective and intelligible record of a disappeared archaeological site (Cox, 1992; Joseph, 1945; Harp, 1975; Musson, 1994). For proper use of this tool it is necessary to note that:

a) Aerial photography must be geo-referenced so that one can then insert its data onto a GIS:

b) It is important that the photos are made under weather conditions that ensure the visibility of traces under the soil. Clear sky and adequate sunshine are essential.

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Taking the aerial photography with the soft light of the beginning or the end of the day allows a skimming effect that casts shadows with a slight unevenness on the soil, making visible underground structures;

c) Comparative study is essential. We must have aerial photographs taken at different times of the day and the year of the same site, since atmospheric conditions such as cloud cover, the degree of photo tilt or the fact that the land surface is sunny, snow-covered or waterlogged will influence the visibility of the remains. We should also contrast the data obtained in photointerpretation with another type of graphic record such as satellite imagery or old and current maps, because the eye tends to see more than what actually exists (Figure 7);

d) It is essential to check the data of photointerpretation in the field. We must remember that photointerpretation is only a tool of archaeological research and it needs to be linked with others. A suitable combination of field research (excavation, geological and soil analysis, paleo-environmental analysis, ceramics analysis, etc.) and photointerpretation allows us not only to reconstruct the archaeological landscape under study, but it also explains the construction of this landscape holistically, linking production areas with other areas, such as places of residence, or of natural resources (Musson, 1994, pp. 12-17);

e) In the case of landscape studies on old land structures relating to agriculture, the use of aerial photography is critical due to their fragility and difficulty of preservation over time. Since most of the time there are no solid structures, such as stone walls, their remains often end up disappearing completely from the surface, covered by sedimentation and subsequent land leveling works. In these cases, the identification of the earth structures depends solely on differentiation in the ground color or on growth patterns of currently existing plants. In the case of ground color differentiation, former crop areas in grassland used for livestock, for example, can be identified through a more yellowish color caused by the soil erosion they suffered. In the case of growth patterns of plants, currently cultivated areas in formerly cultivated sectors will be eroded and will be poorer in nutrients, meaning that modern plants will grow less well due to inferior soil quality. On the contrary, where there were structures such as wells, ditches or channels, the greater depth of the soil and its consequent higher capacity to accumulate moisture and nutrients will stimulate the growth of higher and leafy plants. While these differences in height and density are very difficult to identify in the field, an aerial view allows such subtle differences to translate into color differences that show the original shape of the structure in the ground.

Taking these aspects into consideration, the photos were initially digitized to a resolution of 600 dpi and their analysis started with the individualization of each period of time (Parcak, 2009) by "removing" modern layers: streets, roads, terrain fences, crops limits, mechanical plow marks, changes in the course of rivers, channeling of waterways, recent truncation of meanders, canals for irrigation or drainage and all kinds of building or urban infrastructure.

Next, we identified the remains of the agricultural landscape of the early Sixteenth Century, starting with the identification of the original riverbed of the Bogotá River and its tributaries. To this end, it was crucial to establish which of the paleo-meanders visible in the aerial photographs were active at the time. This process was achieved through the identification of traces of raised fields adjacent to paleo-meanders: The continuity of the traces of raised fields in paleo-meanders with traces of raised fields in today's water line would indicate that those paleo-meanders were part of the river at the time when the hydraulic system was in operation. After that, we identified ancient

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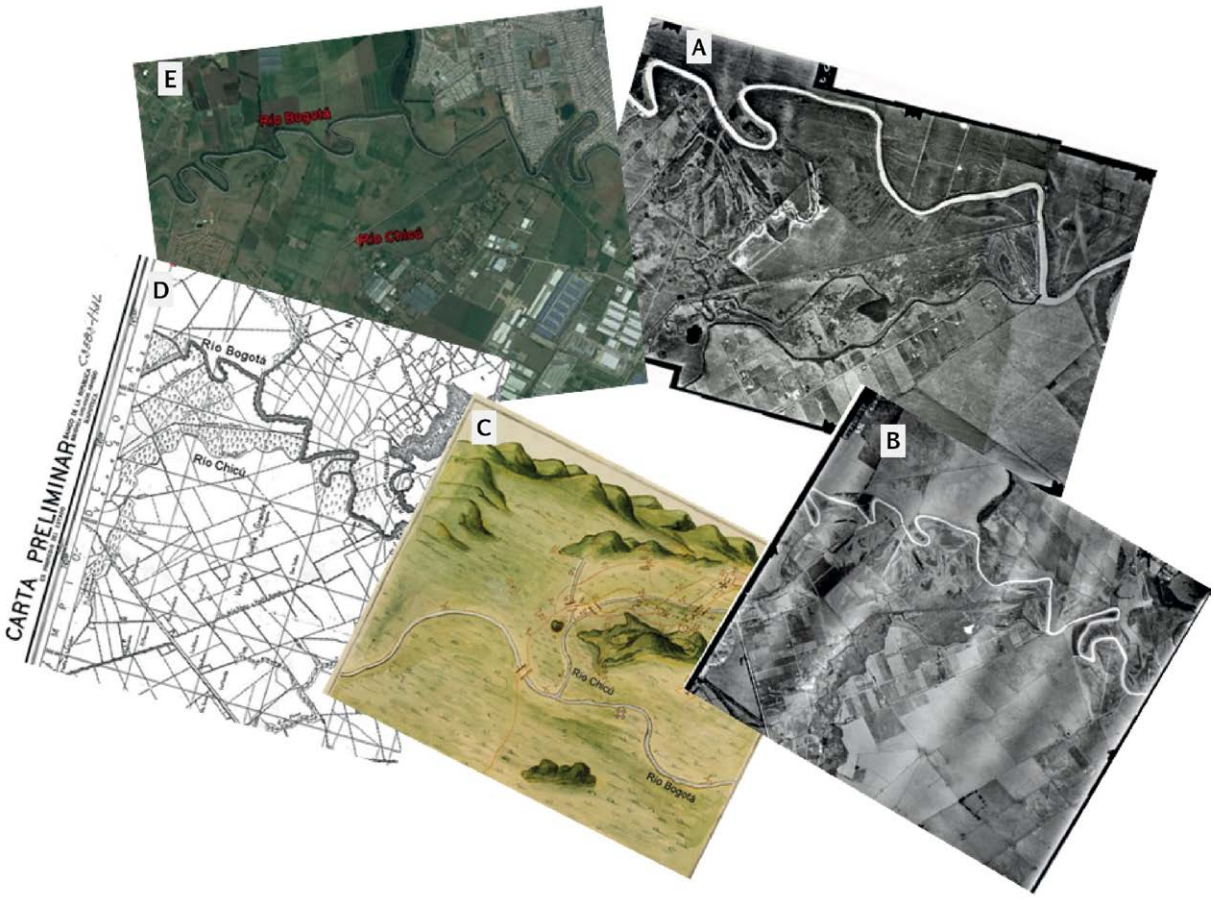

Figure 7. Example of comparative analysis. Bogotá River and its Chicú tributary. Cota – Suba Sector. A) assemblage of aerial photographs C-773, no. 232, 234, 236, scale 1:9.000, Feb. 20-1956, IGAC; B) aerial photograph C-619, no. 168, scale 1:18.000, March 21-1952, IGAC; C) map "Tierras de Tenjo, Cota y Tabio", 1807, Archivo General de la Nación; D) map "Engativá", 1940, scale 1:25.000, Plan 227-IV-B, IGAC; E) satellite image, 2016, Google Earth.

drainage valleys. In this case, the presence of a darker color of the old water lines, associated with raised fields, would indicate that in fact it was a drainage valley in the Pre-Hispanic period.

Subsequently, we searched for current wetlands to determine if they also existed in the Pre-Hispanic period, and how far they extended. In order to identify traces of ancient wetlands now gone, we used maps from the early 20th century and paleo-environmental research. We identified traces of the hydraulic system (channels and elevated platforms), paying attention to their location in relation to rivers, the predominance of channels or some kind of raised field morphology in specific areas, and testing if the system could be extended to areas where photointerpretation failed to recognize traces. Then, possible diachronies in the construction of the hydraulic system were detected through the analysis of overlaps in channels and elevated platforms, and the relationship of paleo-meanders and paleo-rivers with archaeological remains. A deactivated riverbed with raised fields alongside a present-day active riverbed also with raised fields indicates, for example, that the paleo-river raised fields belong to a different and earlier period in the construction of the hydraulic system.

The last stage of the analysis consisted in the correlation of the photointerpretation results with the archaeological data related to settlements of the Late Muisca period

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and the ethno-historical data. By gathering and analyzing all this data, we sought to explain how the Muisca society transformed this environment, turning the water into the axis of its hydraulic system.

Results: the Pre-Hispanic agricultural landscape of the Bogotá savanna

To carry out the analysis of the hydraulic system, the Bogotá savanna was divided into three areas: the northern sector, the central sector and the southern sector.

The northern sector showed little mobility of the Bogotá River, with some growth and truncation of meanders, but no real migration or changes in the river course. Most paleo-meanders recorded in photographs were active in the Late Muisca period, since it is possible to observe traces of raised fields that articulate well with raised fields of active meanders shown at the time the photos were taken. The sector is also characterized by the predominance of checkerboard raised fields and a few drainage channels. This is because in this region the alluvial valley is narrow and therefore the plain is sheltered from floods. However, because it had a high-water table that generated constant flooding, it was necessary to build platforms to keep the roots of the plants dry. According to photointerpretation, the raised fields covered the entire area between Guaymaral–Las Mercedes and small isolated groups which are still identifiable in La Conejera, Juan Amarillo, the Suba hill and the left bank of Chicú River, revealing therefore that the whole northern region was cultivated (Figure 3).

Also, archaeological evidence demonstrates dense population living in a number of nucleated settlements and other habitations scattered around the raised fields for the Late Muisca period (Boada, 2006). This area of the savanna has excellent soil quality for farming, *andisols* type[1], which reinforces the hypothesis of the entire northern region was cultivated, but only in some sectors are earthen structures still visible on the ground.

1. Black soil with high volcanic ash content and organic matter; it has good water retention (Van der Hammen, 2003)

In the Pre-Hispanic period, the current wetlands of La Conejera, Juan Amarillo and Chicú were probably drainage valleys with a well-defined basin, since in these three cases we observed platforms for cultivation partially covered by water, showing that the permanent flooding of the floodplain took place after the abandonment of the hydraulic system. We also established that the current course of the Chicú River was modified in modern times, since, in the photographs, we can still see in the middle of flooded lowland, traces of the original paleo-course with checkerboard raised fields on its left bank. This also shows that the current wetland did not exist during the pre-Hispanic period, since the hydraulic system would have kept the water flows under control, avoiding the flooding of this sector (Figure 8).

As we move towards the central sector, we observe some changes in the hydraulic system. The floodplain widens considerably, mainly on the east side of the Bogotá River, leaving much of the sector at the same river level. Consequently, the number of channels for drainage increases with an average of 10 channels each 150 m and with a length of up to 900 m (the original length of the channels was probably larger, extending to the interior of the plain, if we take into consideration that their traces are only visible in the floodplain).

The number of checkerboard raised fields diminishes considerably, being visible only in small areas along the rivers' banks and in wetlands. However, the fact that they are scattered over various parts of this sector, and because this area also has *andisols*, leads us to believe that elevated platforms covered much of this ground.

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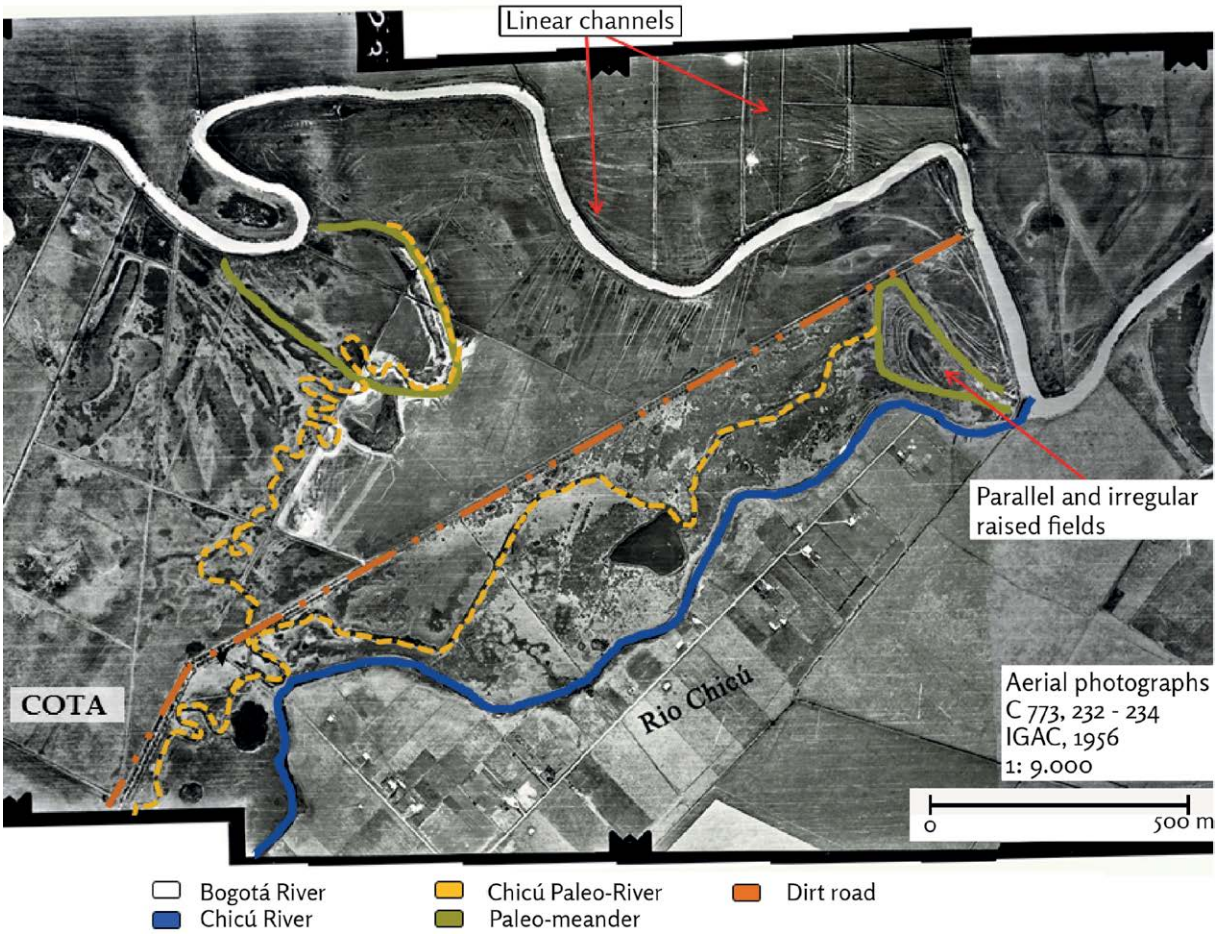

Figure 8. Photointerpretation Chicú River Sector.

Archaeological evidence again demonstrates the existence of dense settlements on the west side of the Bogotá River and along its floodplains. Scattered settlements and nucleated villages were recorded not only within the plain and on natural terraces, but also along the flood valley itself (Boada, 2006; Kruschek, 2003). It is important to note that the wetland El Guali was most likely blocked by pre-Hispanic groups to prevent flooding around it, suggesting the existence of a complex management system of the floods that guaranteed that crops and settlements both remained safe, even when located in the floodplain. Analysis of maize pollen taken from a column of sediment extracted from a wetland showed that the accumulation of sediment began only in the agricultural phase, since there is pollen along the whole column (Van der Hammen, 2003). This means that El Guali was not initially a wetland but a drainage valley. For this reason, there was no accumulation of sediments. The need to obstruct the drainage valley at the confluence of the Gauli with Bogotá was due to the fact that when there were floods, water overflowed at this point, flooding the Funza valley. This situation was confirmed by colonial documentation. In 1704 the administrators proposed to block this same point because of the periodic flooding of the Funza valley as a result of Bogotá River overflowing through the El Guali (Testimonio de Autos, 1704).

On the eastern side of the lowland, the archaeological remains are minimal. Except for two natural terraces along the Bogotá River, the rest of the plain is located at the same level of this river. It is likely that this area was used mostly for drainage, with large mitigation areas (water reservoirs to prevent the water from spreading across the plain).

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The southern sector has two special characteristics: an area between the sectors Tibaitatá and San Bernardino which is the lowest point of the savanna and therefore susceptible to flooding, and another which is also the driest region of the savanna, especially in the southwest mountains.

Regarding the first feature, the photointerpretation showed that, in fact, this region was mainly dedicated to drainage works. A high density of channels radiated from both banks of the Bogotá River and the Tunjuelito River reaching, in the best-preserved areas, two kilometers in length (San Bernardino area). However, traces of cultivated fields in the meander El Corzo, the Balsillas River and around Soacha village area are also visible. The San Bernardino channels extend to the beginning of a small area of cultivation, which indicates that these channels not only drained the excess water into the plain, but that they also irrigated these fields. This example must have been repeated across other areas of the Sabana.

With regard to the second feature, a previous article (Rodríguez Gallo, 2011) showed that the hydraulic system did not reach the medium and high Tunjuelito due to the fact that this valley has little suitable land for agriculture, with clay soils and abundant presence of stones and gravel, this does not facilitate the organic enrichment of the land. We should add that, while the north and center of the savanna were populated by the first agriculturalist groups, the migration to the south of the savanna was only undertaken by the Muisca at the end of the Early Muisca period (the earliest date for the settlement of the South savanna is AD 770). Perhaps the arid conditions of the south discouraged an earlier settlement. However, archaeological remains show significant changes after AD 770, with predominantly nucleated settlements and an important weaving activity, the latter probably being the major occupation in this area, rather than cultivation of crops on raised fields (Bonilla 2005, 2008; Broadbent, 1961; Enciso, 1990; Langebaek, 1987, 2011).

In this southern sector, we also found an important example of diachrony in the construction of the hydraulic system. In the Bosatama area at the southern confluence of the Tunjuelito River with the Bogotá River a paleo-course was identified. We interpreted it as an old course of the Bogotá River, which would flow, thus, more to the southeast in relation to the current location of the Bogotá River, and it would therefore have a confluence with the Tunjulito more to the east, although this is not visible today on the aerial photographs (Figure 9). Still visible in the paleo-course are a number of channels for drainage radiating from the waterline, while the current confluence also features channels for drainage associated with the two rivers. This means that there were two different moments in the construction of the hydraulic system: firstly, when the paleo-river was active and secondly, after the watercourse changed direction. There were no further changes until the final abandonment of the hydraulic system.

Conclusion

The case of the Bogotá savanna is an example of how to combine old aerial photographs with data from excavations and documentation for the reconstruction of ancient landscapes. Thanks to the analysis of this information we can conclude that, as the inhabitants of the Andean highlands (Herrera and Muisca) were developing agricultural practices, they were also shaping and transforming their environment and developing a cultural system that was not limited to "gagging" the water or trying to dry the plain in order to install crops and houses in its place. Rather, it was a system that used water for the benefit of these human groups, raising the soil, building platforms for cultivation and housing and digging channels to direct its energy.

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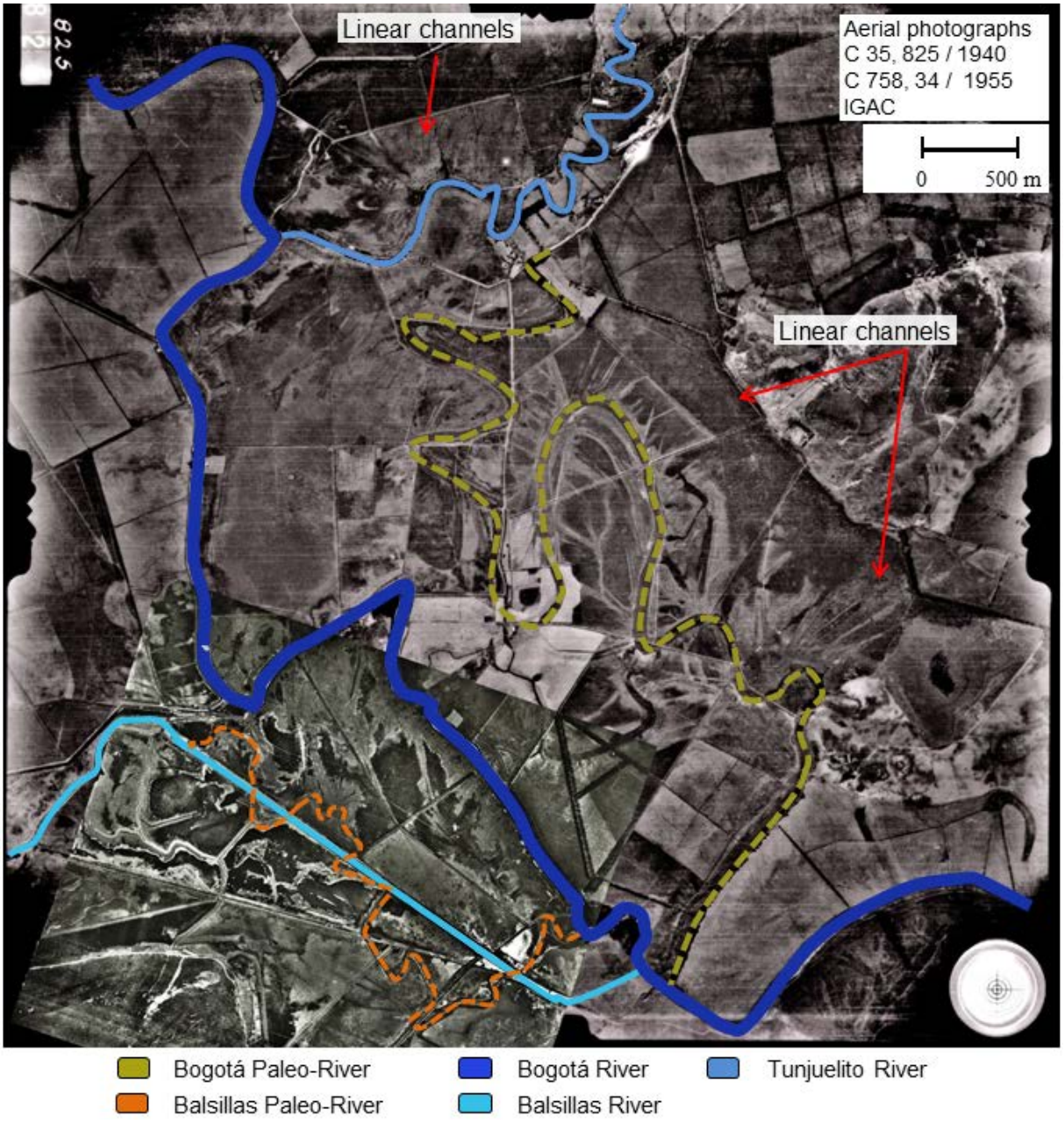

Figure 9. Photointerpretation Soacha Sector. Central Area: Paleo-River Bogotá with pre-Hispanic channels; Bottom: Paleo-River Balsillas. The watercourse was modified in modern times.

The analysis of the hydraulic system and its relationship with the settlements, allows us to conclude that for the Late Muisca period the landscape of the Bogotá savanna consisted of a channel network system that controlled the water rivers, streams and groundwater, among which land platforms for the cultivation rose from the ground; in mitigation areas, where excess water during floods was accumulated and that served as a reservoir during dry periods; in nucleated or dispersed settlements emplaced in natural or artificial terraces, located in the middle of the crops or around the nucleated towns; and areas for hunting and fishing, located in rivers, wetlands and lakes.

To achieve this, significant changes to the ecological structure of the plain were required, such as deforestation to clear areas for cultivation, obstruction of erosive valleys to

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minimize the effects of flooding, as was the case of El Guali, or seasonal flooding in large areas. This does not mean that the indigenous communities did not practice a form of responsible exploitation of the environment, but neither that they had maintained a perfect balance with nature, as this concept would imply the existence of an immobile system. On the contrary, these changes were the product of the ongoing dialogue between the human groups and their environment, a dialectical relationship between the interests of the two.

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Arqueología 25(1) enero-abril: 169-186 (2019)

References

» Balée, W. (2006). The research program of historical ecology. *Annual review of anthropology, 35*, 75-98.

» Bernal, F. (1990). Investigaciones arqueológicas en el antiguo cacicazgo de Bogotá (Funza-Cundinamarca). *Boletín de Arqueología*, *5*(3), 31-46.

» Boada, A. M. (2000). *Patterns of regional organization in the Sabana de Bogotá: Colombia. Funza, Mosquera and Fontibón municipios*. Pittsburgh: Heinz Foundation Report.

» Boada, A. M. (2006). *Patrones de asentamiento regional y sistemas de agricultura intensiva en Cota y Suba, Sabana de Bogotá (Colombia)*. Bogotá: Fundación de investigaciones arqueológicas nacionales - Banco de la República.

» Bonilla, M. (2005). *Programa de prospección, rescate y monitoreo para el lote de desarrollo urbanístico 2 manzana C2 urbanización. San Mateo segunda etapa, municipio de Soacha Cundinamarca*. Bogotá: Instituto Colombiano de Antropología e Historia.

» Bonilla, M. (2008). *Proyecto Prospección, rescate y monitoreo de la manzana E3 y prospección y rescate de las manzanas P1, H1 y G1. Terragrande 2. Hacienda Terreros, Soacha, Cundinamarca*. Bogotá: Instituto Colombiano de Antropología e Historia.

» Broadbent, S. (1961). Excavaciones en Tunjuelito: informe preliminary. *Revista Colombiana de Antropología,* 10, 341-346.

» Broadbent, S. (1968). A prehistoric field system in Chibcha territory, Colombia. *Ñawpa Pacha. Journal of Andean Archaeology,* 2, 135-147.

» Broadbent, S. (1987). En busca de los primeros agricultores del altiplano Cundiboyacense. *Maguaré, 5*(5), 99-125.

» CAR (Corporación Autónoma Regional). (2006). *Informe del recorrido por el río Bogotá, para la identificación de puntos críticos en su dinámica hidráulica*. Bogotá: CAR.

» Cox, C. (1992). Satellite imagery, aerial photography and wetland archaeology An interim report on an application of remote sensing to wetland archaeology: The pilot study in Cumbria, England. *Journal of World Archaeology*, 24, 249-267.

» Correal, G. and Van der Hammen, T. (1977). *Investigaciones arqueológicas en los abrigos rocosos del Tequendama. 11000 años de prehistoria en la Sabana de Bogotá*. Bogotá: Banco de la República.

» Crumley, C. (Ed.). (1994). *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Santa Fe: School of American Research Press.

» Crumley, C. (2007). Historical ecology: Integrated thinking at multiple temporal and spatial scales. In A. Hornborg and C. Crumley (Eds.), *The World System and The Earth System: Global Socio-Environmental Change and Sustainability Since the Neolithic* (pp. 15-28). Walnut Creek: Left Coast Press.

» Delgado-Espinoza, F. (2002). *Intensive Agriculture and Political Economy in the Yaguachi Chiefdom of the lower Guayas Basin, Coastal Ecuador*. (PhD dissertation), University of Pittsburgh, USA.

» Denevan, W. (1970). Aboriginal drained-field cultivation in the Americas. *Science,* 169(3946), 647-654.

» Enciso, B. (1990). Arqueología de rescate en el barrio Las Delicias (Bogotá). *Revista Colombiana de Antropología,* 28, 155-160.

ISSN 0327-3519 (impresa) / ISSN 1853-8126 (en línea)

» Erickson, C. (1988). *An Archaeological Investigation of Raised Field Agriculture in the Lake Titicaca Basin of Peru*, (PhD dissertation), University of Illinois, USA.

» Etayo, M. (2002). *Evolución Morfológica del Rio Bogotá durante la Parte Superior del Holoceno entre los Municipios de Cota y Soacha (Sabana de Bogotá) y su Relación con los "Camellones" Prehispánicos*. Bogotá: Universidad Nacional de Colombia.

» Gassón, R. (1998). *Prehispanic intensive agriculture, settlement pattern and Political economy in the western venezuelan llanos.* (PhD dissertation), University of Pittsburgh, USA.

» Hammond, N. (1984). Raised-Field Farming in Mesoamerica. *Science*, 224 (4650), 741-743.

» Harp, E. (1975). *Photography in archaeological research.* New Mexico: University of New Mexico Press.

» Joseph, J. (1945). Air photography and archaeology. *The Geographical Journal*, 105(1/2), 47-59

» Kruschek, M. (2003). *The evolution of the Bogotá Chiefdom: a household view.* (PhD dissertation), University of Pittsburgh, USA.

» Langebaek, C. (1987). *Mercados, poblamiento e integración étnica entre los Muiscas. Siglo XVI*. Bogotá: Banco de la República.

» Langebaek, C. (2011). *Plan de normalización del estudio arqueológico, Alameda Tibanica.* Bogotá: Instituto Colombiano de Antropología e Historia.

» Musson, C. (1994). *Wales from the Air: Patterns of Past and Present.* Aberystwyth: Royal Commission on the Ancient and Historical Monuments of Wales.

» Parcak, S. (2009). *Satellite Remote Sensing for archaeology*. London: Routledge.

» Plazas, C., A. Falchetti, J. Sáenz & Archila, S. (1993). *La Sociedad Hidráulica Zenú: Estudio Arqueológico de 2000 Años de Historia en las Llanuras del Caribe Colombiano*. Bogotá: Museo del Oro - Banco de la República.

» Rodríguez Gallo, L. (2011). *Cultivos de Agua. La experiencia Prehispánica en la Sabana de Bogotá. Sistema de Camellones en el Valle de los Ríos Tunjuelito y Bogotá*. Saarbrücken: LAP Lambert - Editorial Académica Española.

» Rodríguez Gallo, L. (2015). *Água e paisagem agrícola entre os grupos pré-hispânicos da Sabana de Bogotá, Colômbia.* (PhD dissertation), Universidade de São Paulo, Brasil.

» Rodríguez Cuenca, J. V. (1999). *Los chibchas: pobladores antiguos de los Andes orientales: adaptaciones bioculturales*. Bogotá: Fundación de investigaciones arqueológicas nacionales.

» Rodríguez Cuenca, J. V. (2011). *Los Chibchas, hijos del sol, la luna y los andes. Orígenes de su diversidad.* Bogotá: Universidad Nacional de Colombia - Alcaldía Mayor de Bogotá.

» Simón, P. ([1625] 1981). *Noticias Historiales de las conquistas de Tierra Firme en las Indias Occidentales* (Voume 2). Bogotá: Banco Popular.

» *Testimonio de los Autos Obrados Sobre Aliños del Puente de Bogotá. Camellón de las Alcantarillas* (1704). Ms. SANTA_FE, 377, folio 268. Sevilla: Archivo General de Indias.

» Valdez, F. (2006). *Agricultura Ancestral. Camellones y Albarradas: Contexto Social, Usos y Retos del Pasado y del Presente*. Quito: Abya-Yala.

» Van der Hammen, T. (1995). La última glaciación en Colombia. *Análisis Geográficos*, 24, 69-90.

» Van der Hammen, T. (1998). *Plan Ambiental de la Cuenca Alta del Río Bogotá. Análisis y Orientaciones para el Ordenamiento Territorial*. Bogotá: Corporación Autónoma Regional de Cundinamarca.

ISSN 0327-5159 (impresa) / ISSN 1853-8126 (en línea)
Arqueología 25(1) enero-abril: 169-186 (2019)

» Van der Hammen, T. (2003). Los humedales de la Sabana. Origen, evolución, degradación y restauración. En Güarnizo, A. & Calvachi, B. (Eds.) *Los humedales de Bogotá y la Sabana* (pp. 19-48). Bogotá: Empresa de Acueducto y Alcantarillado de Bogotá.

» Wilson, D. R. (2000). *Air photo interpretation for archaeologist*. Brimscombe Port: Tempus Publishing.