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Unraveling the landscape of Ecuadorian pre-Columbian civilizations; a pioneer study on the Manteño Huancavilcas

콜럼버스가 미 대륙을 발견하기 이전의 에콰도르조경 규명;
만테니오 환카빌카에 대한 선도적 연구

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서울대학교 환경대학원

환경조경학과

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충실히 이수하였음을 확인합니다.

2018 년 8 월

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Abstract

Natural features have had a strong influence on space creation since ancient times. Cultural and spiritual values are not less important; thus, places and the elements that composed the landscapes have functional and spiritual meanings that allow ancient settlements to take advantage of the natural features of the environment. In fact, among all Ecuadorian pre-Columbian cultures, the Manteño-Huancavilcas, maintained a prosperous and advanced civilization from 650 to 1532 A.C. Even though this culture was located along the coast of Ecuador in an ecosystem with hazardous conditions characterized by water scarcity, they were still able to survive and create a prosperous civilization based on agriculture and trade. However, their ancient knowledge and traditional practices were almost eradicated by the cultural alienation that came with colonization. Currently, archaeological reports provide limited and isolated information without any form of systematization. Historical reports are too general without any detailed comparison with the physical characteristics of the landscape, which makes it difficult to understand the relationship of this ancient civilization with its natural environment. Therefore, the present research is a pioneer transdisciplinary study that aims to reconstruct hypothetical pre-Columbian landscape conditions and provide a retrogressive approach on how the Manteños-Huancavilcas used the natural and physical conditions of their environment in daily life by merging historical, archeological and geographical evidence.

Keywords: Ethnoecology / archeology / landscape ecology / cultural landscapes / pre-Columbian landscape management

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Chapter I: Introduction

1.1 General background

Human beings have developed different kinds of abilities, technologies, and strategies in order to survive and adapt to the adverse conditions of their living surroundings since ancient times. The adaptation process to the environment involved the learning of climate factors, and the use of biological and abiotic elements, among others aspects. Thus, many technologies and management processes have been defined and passed down through generations. In fact, history of settlements development has shown a strong relationship between culture and ecology, which is related to local skills and aptitudes (Orr, 2002).

The development of ancestral ecological knowledge, which was learned through time, has led to the awareness of the surrounding environmental conditions that some civilizations used to have. For instance, modern societies know that the shade provided by trees and the use of certain plants can influence the creation of microclimates and increase the amount of water in the air through transpiration, thus contributing to the cooling effect in cities (Walker, 1991). In addition, the wise use of environmental elements has improved the conditions of surrounding spaces. For example, trees have been traditionally utilized as natural windbreakers to reduce the wind erosion by many civilizations all over the world until the present. It was possible to attain these kinds of knowledge as previous generations noted these occurrences taking place in the environment and orally bestowed this knowledge to the following generations.

Many civilizations endured and resisted adverse environmental conditions for hundreds of years by keeping balance with the environment without destroying or altering its natural conditions (McGregor, 2015). In fact, many ancient civilizations and even some remaining indigenous cultures used to have a stronger relationship with nature. Ancient cultures showed great respect to the elements that were located in their environment, even attributing spiritual properties to plants, animals, and even abiotic elements. For these reasons, some ancient cultures were considered to have an animist perspective of the world (Wallach, 2005). On the other hand, historical reports also show that some cultures have collapsed and disappeared through time, which can be attributed to ecological mismanagement, wrong decisions, or adverse environmental conditions of the ecosystems. However, the main issue of illiterate civilizations is the lack of detailed written knowledge. Hence, as people tend to forget facts, their ancient knowledge erodes (Diamond, 2014).

Today's settlements are not only the result of the effort and commitment of previous dwellers, but also of the satisfactory and unsatisfactory decisions taken by them. Furthermore, it is important to recognize that "imagination, planning and organizational behaviors" were needed in order to develop the first civilizations (McGregor, 2015). The ecological knowledge, which has been learned or forgotten through a continuous process, has an important influence on the survival or extinction of the new settlements.

In pre-Columbian history, the Manteños Huancavilcas was one of the last coastal pre-Columbian Ecuadorian cultures during the period of integration[1]. This period is one of the Ecuadorian Pre-Columbian historical stages[2], characterized by social political complexity (Guinea, 2006), population growth and expansion of settlements (Estrada, 1962).

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[1] The rigid chronological timeline of the pre-Columbian history does not respond to the new evidences of archeological studies (Touchard-Houlbert, 2009). Different cultures can evolve in different periods. The beginning period of this culture differs from authors. Touchard-Houlbert, A., 2010 states from 650-1532 AC. In the other hand, Mc Ewan, C. and Silva, M. 2011, mentions from 800-1530 AC.

[2] The pre-Columbian era is subdivided in the preceramic period (11.000 -4.000 BC), formative period (4.000 – 300 BC), period of regional development (300 BC – 400 AC), the period of integration (400 -1470), and Inca regime (1470 -1532) (Exhibition catalog "Ecuador al Mundo. Un viaje por su historia ancestral, 2016).

The Manteños Huancavilcas may be a result of an evolution from previous cultures such as Bahia, Guangala and Chirije[3] that were located on the coastal area of Ecuador. This theory was developed based on a comparative analysis of pottery techniques in previous cultures and the ones that characterized the Manteños Huancavilcas. During this process, new techniques were developed, and others were becoming less popular so that their use was discontinued (Touchard-Houlbert, 2010).

Broken with	Continuity with
Ceramic with four legs 	Engraving 
Polychrome painting 	Burnish (Bahia and Jama Coaque) 
Very thin pottery 	Decoration over the pottery that looks like points 
	Burnish (Guangala and Bahia) 
	Moulds for figures 
	Bowl with a pedestal base 

Figure 1 Similarities and differences of pottery
After: Touchard-Houlbert, 2010.

The present research is focused on two areas of the Manteños Huancavilcas, the *Cerro Jaboncillo* (in the north) and the Chanduy Valley (in the south) that lived on the coastal area of Manabí and Santa Elena province during the period of integration. These villages were considered as important settlements of the Manteños

[3] This culture has not been clearly defined as a pre-Columbian culture or as a transitional culture from Guangala to Manteños due to the lack of studies.

Huancavilcas, and it is presumed that the Cerro Jaboncillo could have been a sacred place of great importance for ancient American pre-Columbian cultures.

The current climate of the region is affected by the Humboldt and El Niño ocean currents (Martinez, Graber, and Harris, 2006). The weather is characterized into two main seasons, the rainy period (from December to May) and the dry period (from June to November). During the rainy season, some flooding occurs in the areas of Manabí and Guayas while long periods of drought take place in the Santa Elena province (Touchard-Houlbert, 2009). The territory was characterized by low precipitation, which is why the water use efficiency was a critical factor in the development of this culture[4]. The extremely weather resilient plants that were part of the landscape composition contributed to improving the ecosystems conditions.

The hazardous conditions that characterized the area required solid ecological knowledge in order for Manteños Huancavilcas to survive and develop a great civilization.

Since archeological evidence shows that the Manteños Huancavilcas are an important part of Ecuadorian history, it strengthens the desire to protect ancient territories, and find the ancestral cultural identity. These are some of the main driving factors, which led to an ethnogenesis[5] process in some Manteños Huancavilcas' descendant communities (Bauer, 2011).

1.2 Context and problem statement

The present world would not have existed if the previous generations did not explore beyond the boundaries of their human settlements (Wallach, 2005). For several thousand years, many people have learned to use the features of their

[4] Because the management of the space was based on water conservation, these landscapes could be considered as xeriscapes (Walker, 1991).

[5] Ethnogenesis: Reconfiguration of cultural identities.

surrounding environment on behalf of their settlements so that their living conditions were significantly improved. However, it is necessary to recognize that some civilizations have looked for short-term revenues rather than long-term benefits, in which some decisions have caused the collapse of societies (Diamond, 2014). It seems that there is a strong correlation between higher levels of civilization and increasing damage to the natural environment (Orr, 2002).

Currently, the world is facing several challenges that are threatening the existence of humankind and other species that coexist on Earth. In addition, many contemporary societies have lost values that have allowed previous societies to have a harmonious relationship with nature (Laudine, 2009; Miller, 2007).

Cultural narratives that came with the industrialization era have focused on an optimization process to gain more monetary revenues rather than to preserve the environment or to guarantee the welfare of human beings. For instance, western agricultural practices were carried out on Bali Island without considering previous cultural values, ancestral practices, and local needs. Those practices eradicated the valuable knowledge of Bali's ancient civilizations and contributed to the deterioration of the environment (Orr, 2002). In fact, when the colonization process took place in many South American countries, the use of new practices caused the erosion of cultural values related to landscape management.

Additionally, impervious areas in cities have increased in recent times. The lack of well-designed rainwater harvesting systems has generated flooding issues during rainy seasons and droughts in dry seasons due to the speed of water movement over soil and the failure to boost adequately underground aquifers (Orr, 2002). The detrimental effects that human settlements have generated in the environment in the recent few centuries cannot be solved immediately. However, if measures to control and reduce their undesirable impacts on the environment are not implemented, it can lead to the irreversible destruction of nature (Orr, 2002). It is at this point that looking into the past can be a great opportunity to find alternative cultural narratives and solutions to overcome issues such as loss of cultural identity, lack of water, food insecurity, etc.

Nevertheless, understanding the process of how ancient societies used to live and how their life patterns were involved and influenced by space can help us to rediscover insights that can contribute to comprehending the development of current societies. Moreover, many valuable themes can be learned from the “art of longevity” of previous cultures and other societies that used to cohabit hundreds of years ago (McGregor, 2015; Bonnemaison, 2005; Orr, 2002) in order to build better societies in the future. For example, ancient water management systems allowed first settlements to develop agriculture in dry ecosystems, guarantee water supply in the drier season and prevent flooding in the rainy season. It is therefore possible to rediscover ancestral landscape meanings and values that were lost through time.

Despite this, traditional practices are no longer enough to satisfy large populations. However, through the revitalization of traditional ecological knowledge, it will be possible to create alternative cultural narratives that can lead to a social awareness of the relevance of the landscape as the only life support system that human beings have to survive.

1.3 Purpose of research

The present research aims to provide a better understanding of the relationship between the Manteños-Huancavilcas and their environment through a retrogressive approach and a transdisciplinary study. It is based on the landscape analysis of archeological surveys, map analysis, map overlay and settlements' history. Moreover, this study intends to clarify if the Manteños Huancavilcas present a convincing and richly illustrative case study to develop a new cultural narrative based on the landscape as a sustainable survival system.

1.4 Scope of the research

The present research describes the hypothetical landscape of pre-Columbian settlements of Manteños-Huancavilcas of Cerro Jaboncillo, and Chanduy Valley. Moreover, this study intends to clarify the relationship of the Manteños Huancavilcas with the natural environment, and to research the differences and similarities of two settlements' areas that formed part of the same culture, but in different locations and natural environment.

1.5 Research question

The present research aims to answer the following question: How did the Manteños Huancavilcas survive in their landscape?

1.6 Hypothesis

The settlements in Cerro Jaboncillo were more successful than the settlements of Chanduy Valley area due to landscape diversity and natural resources. Cerro Jaboncillo was more developed up to the point that spiritual and political thinking was institutionalized in sacred places and buildings. This was due to landscape diversity.

Chapter II: Perspectives towards landscapes

2.1. Landscape capital

Landesque capital or landscape capital was defined by Brookfield in 2001 as manufactured innovations that are aimed to improve the soil quality to generate productive soil areas by an infrastructure (Erickson, and Walker, 2006). For several hundreds of years, people have modified natural landscapes into cultural landscapes (Erickson, 1992). Once the landscape infrastructure has been implemented, used and maintained, it has been inherited by the new generations that can benefit from the implemented infrastructures (Erickson, and Walker, 2006). Much landscape capital has been mismanaged or abandoned, and worldwide soil degradation has increased due to the mismanaged agriculture.

For instance, currently, Mexico is facing severe soil degradation and desertification issues due to the overgrazing (23.9% of the territory) and agricultural overexploitation (18.8%) (SEMARNAT cited in Basurto, 2014). In the area of the Zacatecas, environmental problems have been registered since colonial times when tree clearance was done to support mining activities, causing a high grade of deforestation (Basurto, 2014).

Furthermore, the United States is facing severe soil degradation and loss of agricultural land due to overexploitation based on chemical fertilizers and pesticides, which have triggered an agricultural emergency that caused million dollars losses (Baumhardt, Stewart, and Sainju, 2015). Moreover, cattle ranching and the expansion of soybean plantation have been considered as the most important trigger factors in the deforestation of the Brazilian Amazon (Barona, Ramankutty, Hyman, and Coomes, 2010).

Comparatively, 20 to 75% of the ancient terraces in the Moche Valley in Bolivia were abandoned (Erickson, 1992). The abandonment of landscape capital or even settlements can interrupt the development but provides the possibility of developing new interactions by other human civilizations in the area (Zedeño, 1997). As the people depend on the landscape for their survival, it is important to maintain the landscape capital.

Furthermore, studies by Erickson, 1992 have recreated ancient landscape techniques. These results have shown that such technologies required a considerable labor-force and time to implement the desired infrastructure but once implemented there are insignificant maintenance requirements and wide benefits. It clearly shows a high positive influence on the environment by the traditional environmental management knowledge, and labor-intensive management.

2.2. Landscape archaeology

Landscape archaeology combines theoretical and archaeological techniques in order to understand the relationships between people and their surrounding (ThoughtCo, 2018).

Land-use and human interactions within their environment have developed and transformed the natural configuration of landscapes (Zedeño, 1997; Guinea, 1982). The transformation of natural landscapes by human activities has created artificial landscapes. Cultural concepts can be understood by the analysis of living environment because those have been adapted by the influence of specific strategies, cultural meanings, and patterns of human beings that belong to a society during a specific period (Moore, 1996). For example, food remains and other types of vestiges can provide interesting clues to discover the human interactions with the natural environment (Zedeño, 1997). In addition, the integration of human activities within natural environmental characteristics is denominated as cultural or social landscapes

(Adler, 1994; Greider and Garkovich, 1994; Stoffle *et al*., 1996 cited in Zedeño, 1997).

Since the ancient days, people's adaptability to the precarious environment, the representation of their ideologies, and their relationship with their surroundings allow us to have a better notion of "their place in nature" (McGregor, 2015).

2.3. Cultural landscapes

The landscape is a non-static element, in which human beings have been modifying and creating artificial landscapes during their daily activities since ancient times. Previously, the focus was on environmental conservation with aesthetical purposes. Since 1999, there has been a shift to preserve the cultural identity that is embedded on landscapes and to guarantee the quality of life of local populations (Scazzosi, 2004).

In addition, the protection of cultural landscapes helps to enhance the concept of conservation and land-use sustainability. This ancestral knowledge reflects traditional forms of land-use based on sustainable techniques and spiritual relationships with nature that might enhance modern techniques to preserve natural values and biological diversity all around the world (UNESCO 2008 cited in Taylor and Lennon, 2011).

From the field of landscape architecture, alternative research approaches are implemented to create new types of paradigms and cultural narratives that are based on the revitalization of ancient wisdom. For instance, some approach to landscaping includes landscape of borrowing, landscape of drawing, landscape of strolling, landscape imagining, etc.; these methods aim to create meaningful landscapes (Hwang, 2003). For instance, the landscape of borrowing considers the natural environment as an independent place where many interactions take place. In which human beings have found inspiration to create new landscapes, and based on their landscape perceptions different artistic ways have been expressed (Kuitert, 2015).

2.4. Traditional Ecological Knowledge

Localized communities have gained long-term knowledge of their inhabited territories. The shared knowledge passed down through generations has helped new residents to utilize the environment better and to overcome certain ecological limitations that previous generations faced. As the inhabitants have a better notion of the environment based on continuous experience, as the time passed better coherent decisions were taken by the inhabitants (Hardoy, 1968). The United Nations has considered several discourses about the importance of traditional knowledge systems since 1992 (United Nations[1], 2014), and it has been focusing on the preservation of agricultural heritage landscapes.

The ancestral environmental knowledge has a wider perspective and it usually includes spiritual values that influenced life patterns and world-view perceptions (McGregor, 2004).

2.5. Ethno ecology

Ethno ecology, an interdisciplinary field that combines different kinds of procedures and methods from a variety of sciences such as biology, ethnology, anthropology, economy, linguistics, etc. (Gerique, 2006), aims to provide a better understanding of the relationships that exist between human beings, biotic and abiotic landscape elements (Davison-Hunt, 2000 cited in Gerique, 2006).

Even though ethno ecology and ethnography perspectives are the results of interdisciplinary approaches, it is necessary to consider the perspectives that indigenous or local people have (Snead, Erickson, and Darling, 2006) in order to get a better understanding of the site.

2.6. Environmental history

The events that were registered in the past can provide a valuable material that can allow present civilizations to evaluate new potential opportunities (Redman, 2011). The most important advantage of the historical and archeological environmental studies is that, the analysis is based on completed cycles that provide an accurate result of the influence of the studied variables. On the other hand, contemporary environmental analysis has certain limitations due to considerable risks that are based on speculations rather than registered facts. The attitude of the researcher needs to be practical with a clear purpose for the research.

2.7. Ecological design

Ecological design combines social sciences with environmental sciences in order to provide a deep approach on how humans relate to the local environment. It goes beyond a simple design strategy- it involves the collective knowledge of communities, which are based on a specific period on a determined space. The existence of environmental design strategy is important, however it becomes irrelevant if those strategies are not capable to adapt to the local necessities of the specific ecosystems and if the regenerative capacity is not guaranteed (Orr, 2002). Nevertheless, it is significantly influenced by forces of nature when natural disasters take place and destroys all the traces of the humankind (Miller, 2007). Thus, the implementation of climate resilient strategies should be considered in the design.

The adaptation of technologies to the natural process has to be carefully considered in order to find long-term sustainable strategic solutions that satisfy social, ecological and cultural narratives. Land use management and the relationship between landscape and the humans that inhabit the area can be learned through the analysis of the ecological characteristics in which the settlements were designed. Additionally, there is the chance to expand the awareness of the role of the humans to adapt into the environment; the worldview that they have and to reinforce the identity by revitalizing lost memories (Darling, Erickson, and Snead, 2006).

2.8. Geographical imagination

Harvey, 1973 in his book *Social Justice and the City* states that geographical imagination allows individuals to have a notion of their role in the surrounded space and place, and also to recognize how the interactions with other individuals and organizations are influenced by the distance that divided them (Harvey, 1973 cited in Graham, 1997).

Recorded history can be influenced by contemporary history because many events were registered based on the perspectives of a different era. In addition, as the record and discard of the historical facts were based upon the criteria of historians, there is a high possibility that other relevant historical facts were discarded and forgotten. Trying to reconstruct the appearance on the landscapes, and the relationship that people used to have in ancient times, can become a challenge (Aston, 1997). Hence, transdisciplinary studies are needed.

2.9. Landscape systems analysis

For several decades, ecologist have been studying land use without delving deeper on how social or political factors have influenced the change on the composition and use of the landscapes (Redman, 2011). The approach to the analysis of the landscape environment has the necessity to turn from a mono-analysis to a wider approach (Zonneveld, 1995).

Landscape was defined by WLO, Schroevers (ed), 1982 as a compound of relationships among the interaction of biotic and abiotic elements and human beings. The landscape can be analyzed in different ways such as the landscape perception, pattern, and eco-system (Zonneveld, 1995).

2.9.1. Map overlay

Ian McHarg introduced the map overlay method in order to provide a better approach to the land use based on the reduction of negative impacts on the environment and increasing the benefits. By overlaying maps, it is possible to have a better understanding of the systematic relationships taking place in a specific area. This kind of transdisciplinary study method should be supported by historical evidence that provides a natural, scientific, arts and humanities perspectives of the territory (Kuitert, 2013).

Landscape research approaches should consider three main important components, which are abiotic, biotic and cultural aspects. Firstly, factors such as climate, geology, hydrology, soil are on the initial level of analysis. Secondly, flora and fauna include biotic elements of the space. Finally, land use and landscape structure have been included on the last level of analysis, which is related with cultural factors (Mücher, Klijn, Wascher and Schaminée, 2010).

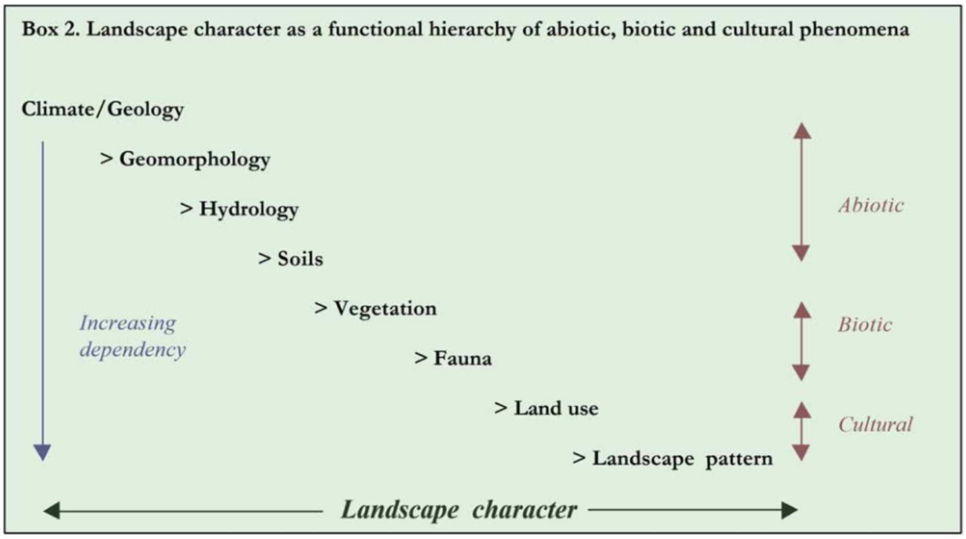


Figure 2 Diagram of landscape analysis
Retrieved from: Mücher, Bunce, Jongman, Klijin, Koomen, Metzger, and Wascher (2003).

Chapter III: Pre-Columbian settlements

3.1. Pre-Columbian settlements in America

Pre-Columbian and Pre-industrial societies were strongly related to the land (Zedeño, 1997). In the Andean Region, natural landscapes were transformed into cultural landscapes through human intervention. Intensive land modifications were carried out to transform marginal lands into highly productive areas, which have left substantial traces on the natural landscapes. Raised fields have been considered as one of the main pre-Historic techniques in the agricultural activities along the Andean Region. These techniques were based on the accumulation of soil of nearby areas in order to create artificial platforms that allow turning water logged soil areas into productive areas. This infrastructure was subjected to a continuous process of expansion of dimension and height. The construction process required labor-intensive intervention but once implemented it does not need a high maintenance (Erickson, 1992).

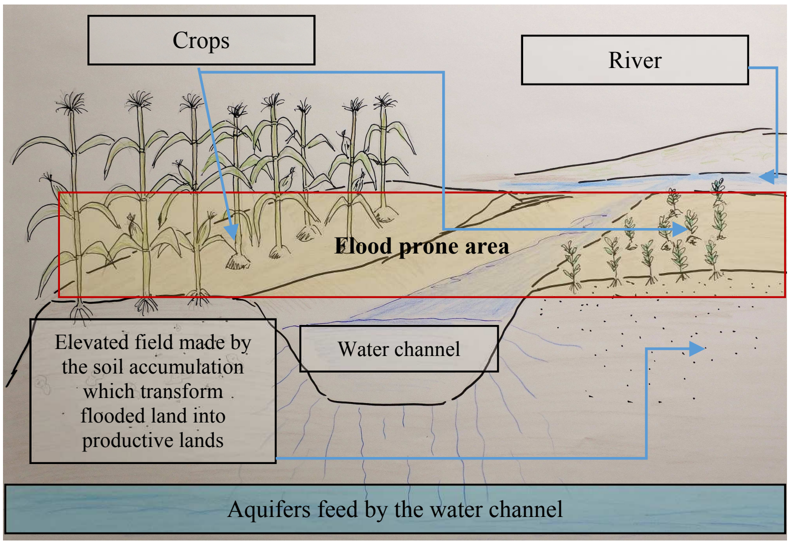


Figure 3 Raised fields diagram (by author)

Looking through the American pre-Columbian history, different types of civilization development can be recognized. Examples are those that modify the landscape, cultivate foreign species and employ agricultural techniques that led to environmental degradation, others are practices of barter trade, and these are clear evidence of different types of development paradigms.

In Bolivia, in Koani Pampa, there is evidence that large-scale river channelization is associated with raised fields (Kolata 1986 cited in Erickson, 1992). These types of artificial wetlands are more productive in biomass compared to the natural ones (Erickson, 1992).

Maize, beans and squash were introduced to North America in the early pre-history. This type of food, especially maize, became an important element on the food diet of Anasazi[6]. The development of agriculture gave the first settlements a guaranteed food source, because of which it became proper settlements. However, as the populations increased, the pressure on the natural ecosystem had a negative impact on the landscape whereby forests were destroyed, and long-term cultivation caused the depletion of soil nutrients and indigenous animals to be decimated (Kohler, 1992).

Furthermore, in Rio Blanco - another settlement of Valdivia culture[7], there was a high density of dwellings in the places close to river basins. It can be attributed that ancient cultures realized that those areas were more suitable for agriculture (Damp, 1984 cited in Graber, 2010).

[6] North American Prehistoric culture, that was located on the northeast of Arizona, United Stated from 1800 B.C until 1300 A.D. Anasazi are the ancestors of the current communities of the Colorado Plateau. Anasazi created agricultural landscapes based on a yearly maize harvest. Computational simulations modelling show that this population could be able to survive on the original place, however, they decided to move and abandon the Long House Valley after 1300 A.D. (Axtell, Epstein, Dean, et al., 2002).

[7] Valdivia is a pre-Columbian Coastal Ecuadorian Culture that was developed between the years 3500 and 1800 BC.

Using Ecuador as a case study, the Salango and Rio Chico settlements of the Valdivia culture were distributed in two main areas: the first was located near the mangrove areas that provided the dwellers timber and food (*Anadara tuberculosa* (G. B. Sowerby), and crabs). The second was located near the river basin; these areas had enough nutrients that helped developed the agriculture. There is the theory that an exchange of products between the two areas were done in order to provide a variety in their diets (Graber, 2010).

3.2. Manteño Huancavilcas

Manteños Huancavilcas were organized on powerful political confederations with a high navigation expertise that led them to take control of long distance maritime commerce[8] (Mc Ewan, and Silva, 2011). Environmental changes such as droughts or the presence of volcanic ashes influenced Manteños settlements to remain in a place or migrate (Touchard-Houlbert, 2009).

Fishing and farming were important activities, which over the centuries, remained as part of the Manteños descendants' activities (Bauer, 2011; Ventura 1997 cited in Martinez, Graber, and Harris, 2006). The Manteños Huancavilcas epoch can be identified by population concentration, hierarchical relationships, specialization of activities, and new architectural techniques development (Graber, 2010). Stones seats, stelae and other sculptures are some of the most representative cultural manifestations found of this pre-Columbian culture (Mc Ewan, and Silva, 2011) which remain as archeological evidence of their presence.

[8] Wooden mast and cotton sails were part of the balsa rafts that this culture used (Ayaga, Odie, and Brooks, et. al., 2018).

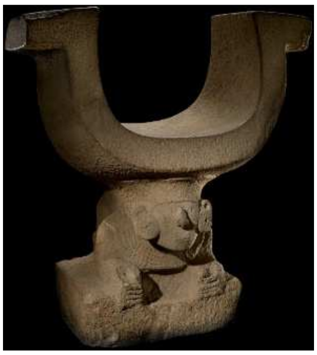


Figure 4 Manteño seat from Cerro Jaboncillo (500–1500 AD)
Retrieved from National Museum of the American Indian, 2018

However, after the Spanish colonization in Ecuador, new diseases were introduced. Native populations were not biologically or physically prepared for them, so there was a dramatic decrease in population and in some places; the whole population was wiped out (Graber, 2010). For instance, around 97.5% of the native population of Portoviejo disappeared in a couple of years after the Spaniard Colonization (Klumpp, 2015 cited in Veintimilla-Bustamante[2], 2016). Graber, 2010 mentions that it was not until the 20th century that the population started to recover and grow again.

3.2.1. Spatial distribution

Around 161 archeological settlements of Manteño Huancavilcas were located on the central coastal part of the Ecuadorian mainland (Touchard-Houlbert, 2010, and Cedeño, 2017). Manteños could be divided into two main cultural groups: the north from the Central to northern Manabí; and the south in the Santa Elena Peninsula (Delabarde, 2015). Touchard-Houlbert, 2010 states that there was a homogenized occupation process in the Ecuadorian coast rather than an expansion from south to north. Though, different cultural practices characterized the Manteños-Huancavilcas' settlements from the north to the south (Gutierrez, 1998).

The below figure shows 10 km radius buffer zones[9] considering as a reference the Manteños Huancavilcas settlements with coordinates stated on Touchard-Houlbert, 2009. In addition, through a Kernel density analysis[10] of the archeological sites and the Manteños Huancavilcas affiliation sites, it could be determined that the most populated communities were on the north: Jaramijo, Jipijapa, Montecristi, Portoviejo, Puerto Lopez, Rocafuerte, and in the south: La Libertad, Salinas and Santa Elena.

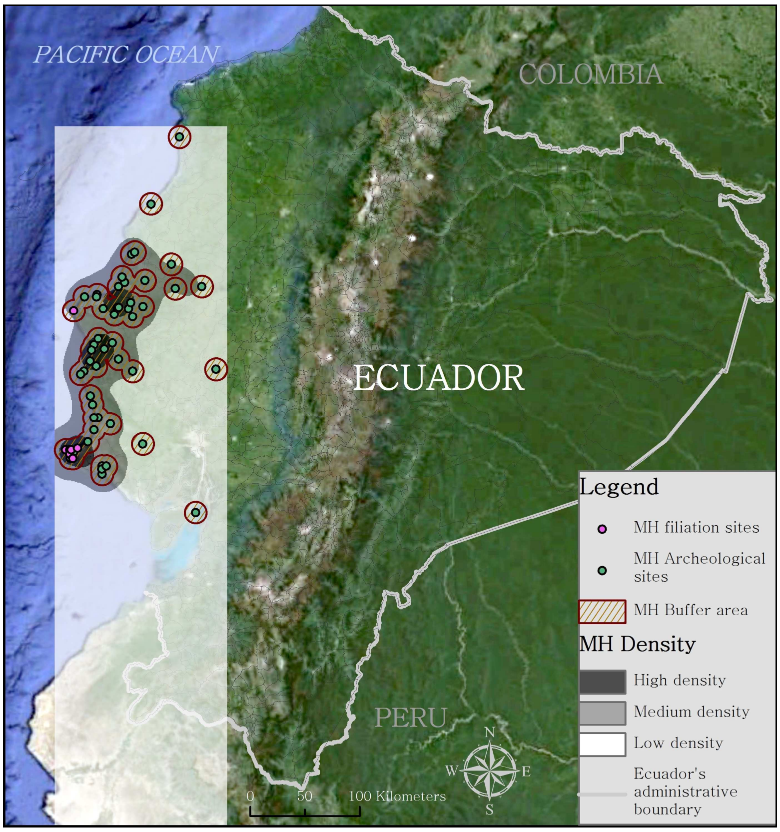


Figure 5 Density of Manteños-Huancavilcas Settlements and buffer areas map Data from Touchard-Houlbert 2009, and Google Earth 2018 by the author

[9] 10 kilometers radius buffer zones have been considered because within this area people can move easily in a day by walking.

[10] An ArcGIS tool that helps to calculate the density around a feature over an specific area (Desktop.arcgis.com, 2018)

3.2.2. Settlement composition

Land use distribution was based on geographic location and different altitudinal levels (Cedeño, 2017). The archeological prospection carried on Rio Blanco area concluded that settlements were distributed vertically on four sections: the maritime area, coastal border, lowlands and mountains (Graber, 2008 cited in Touchard-Houlbert, 2010) in which each area has had a specific role on the production of culture (Murra, 1975 cited in Touchard-Houlbert, 2010). The presence of settlements in different kind of environments showed that human communities exploited natural resources of several types of ecosystems (Martinez, Graber, and Harris, 2006).

Early settlements were built over *tolas*[11] or artificial accumulation of soil (Touchard-Houlbert, 2010). For example, in the archeological site of Japoto, 60 artificial earth mounds were found (Delabarde, 2015 and Guinea, 2006) whose dimensions and forms change from one to other. Their height goes from one to five meters and until 60 meters wide. In addition, these structures were shaped in circular, rectangular and oval forms (Guinea, 2006) which have shown flooding resilience during El Niño natural phenomena (Delabarde, 2015). The present research focuses on two settlements of Manteño Huancavilcas, Cerro Jaboncillo and Chanduy Valley.

a) Cerro Jaboncillo (Study area A)

The first archeological research in Cerro Jaboncillo was done by Marshall Saville, and as a result, two archeological reports were published in 1907 and 1910. This site is considered as the main political and ceremonial center of Manteños-

[11] This terminology is used commonly in Ecuador to refer to artificial earth mounds. These kind of mounds were the foundation of buildings, dwellings, temples and funeral burials (Larrain, 1980; Verneau and Rivet, 1912; Buchwald, 1917; Jijon y Caamaño, 1914, 1920, 1952; Oberem, 1970, 1975; Meyers, 1976; Jaramillo, 1968; Athens, 1980; Salomon and Erickson, 1979; Plaza, 1977; cited in Echeverria, 2011).

Huancavilcas. From this area, 84 stones seats[12] were taken for the private collections in the United States (Marcos, 2007). Cerro Jaboncillo was an important hill for religious purposes (Mc Ewan, and Silva, 2011). In fact, mountains are not common features on the topography of the coastal areas, for this reason, those are considered as important spiritual places for this culture (Touchard-Houlbert, 2009).

The village composition in Cerro Jaboncillo reflected that hierarchical relationships had a strong influence on the spatial organization of the settlements. The three main levels on the distribution of the layout of the settlement were as below:-

(I) First level used for residential purposes and the number of dwelling was quite dense;

(II) Second level had few and more dispersed buildings;

(III) Third level was located on the highest altitude and used for political, administrative and religious activities (Bohórquez, 2012, Graber, 2010 cited in Cedeño, 2017).

Due to the potential of the territory for agriculture, it is assumed that lower areas were perpetually occupied by farmers that worked on terraces. On the other hand, the higher areas, spiritual and ritual areas were used just on special occasions (Stothert, 2001).

[12] It is assumed that those seats were utilized by spiritual leaders, and were related to astrophysical observation, weather forecast, and public rituals. Those seats were commonly places over the top of the hills (National Museum of the American Indian, 2018).

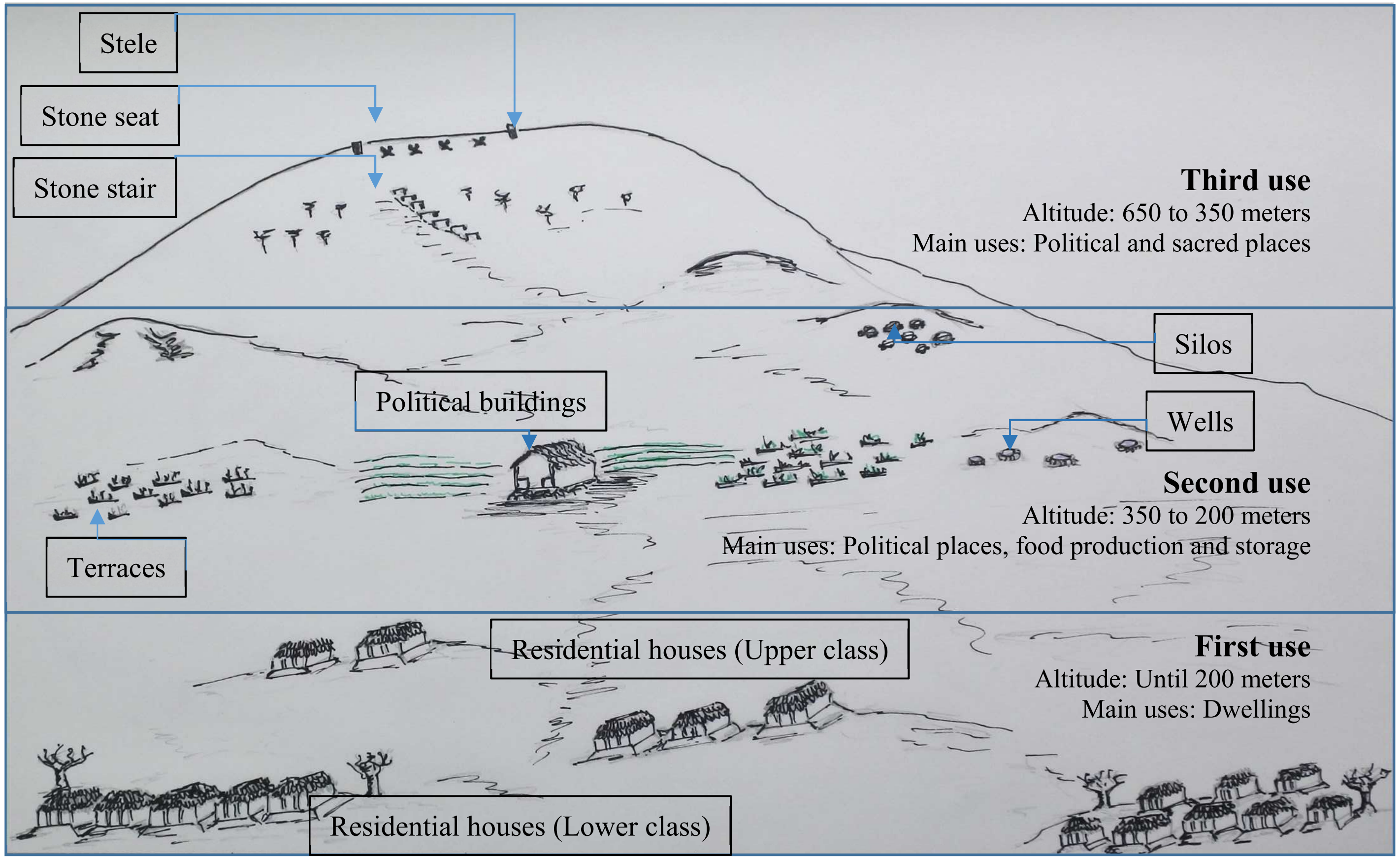


Figure 6 Space arrangement on Cerro Jaboncillo (sketch by author, after Hojas-jaboncillo.gob.ec., 2017.

b) Chanduy Valley (study area B)

Chanduy was considered an important port for Manteños. Carbon dates stated that this place was inhabited since 900 and 1000 AC (Gutierrez, 1998).

In this area, people raised earth platforms to build their houses that were created with calcium carbonate in order to give a concrete-like consistency. These structures were maintained and cleared on periods (Ayaga, Odie, and Brooks, et. al., 2018). Funerary urns and rectangular tombs were also found in this area (Gutierrez, 1998; Marcos 1981 cited in Stothert, 2001).

The most representative archeological place is “Loma de Los Cangrejitos” (Ayaga, Odie, and Brooks, et. al., 2018). This archeological settlement is located 5 km from Chanduy (Gutierrez, 1998). In “Los Cangrejitos”, the local people used water and other types of resources that were located on the hilly areas. In ancient times, the alluvial areas were suitable for farming, whereby artificial terraces created productive areas. A mangrove estuary located 4 km from the settlement, was supposed to be a resource for shells for alimentation purposes (Stothert, 2001).

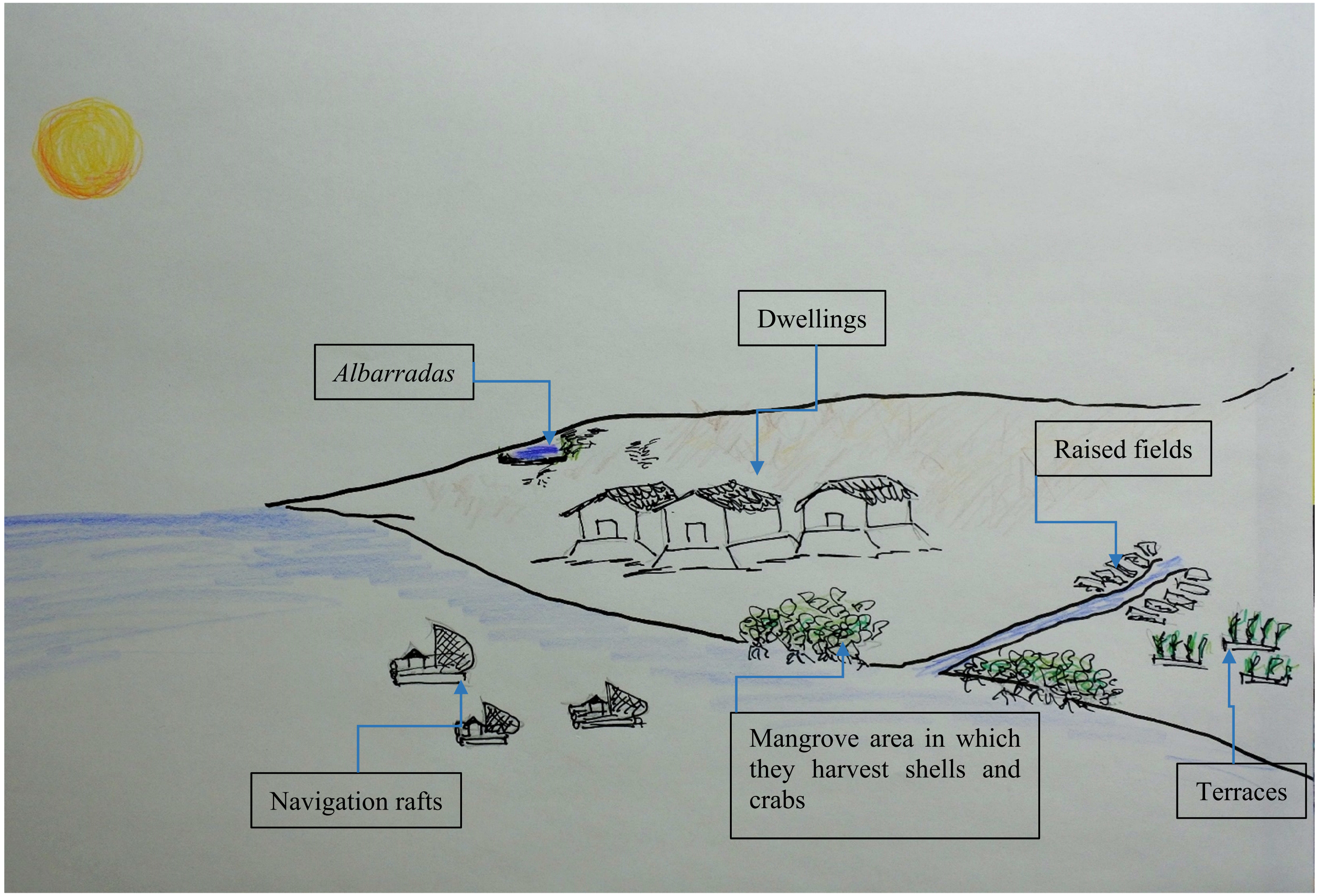
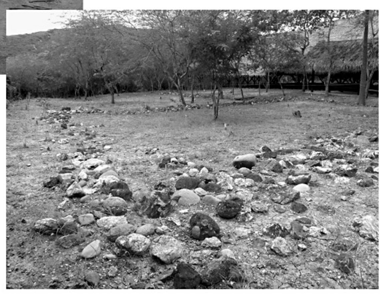


Figure 7 Space arrangement on Chanduy Valley (by author)

3.2.3. Dwellings

The Manteños Huancavilcas' dwellings usually had rectangular shapes whose dimension reached 50 meters long and 12 meters wide (Graber, 2010). Building columns were made of stone with the Manteños as one of the few pre-Columbian cultures in America that used this material for dwellings (Serrano, Gordillo, Guerra, et al., 1999). New techniques such as the use of the adobe[13], which was introduced around the XII century (Touchard-Houlbert, 2010) and *bahareque*[14](Veintimilla-Bustamante1, 2016) were implemented on the construction process of walls. Furthermore, rocks were used as architectural elements on the buildings since 1100AC (Touchard-Houlbert, 2010).

a. Adobe constructions in Japoto Archeological Site



b. Stone foundation "corrales" in Agua Blanca Archeological Site

Figure 8 Differences in the construction techniques

Retrieved from: Touchard-Houlbert, 2010.

[13] Adobe: A mud composition that is usually mixed with grass and stubble. The selected soil is mixed with water, and then is stepped by humans and animals, upon the addition of grass. The mixture is put on molds that will be dried under the natural environmental conditions (Echeverria, 1990 cited in Echeverria, 2011) In addition, these buildings walls has been described in some ethno historical reports as being earthquake resilient.

[14] Bahareque: A type of wall that is composed with wood crosslinked sticks covered internal and external by a composition of mud and grass. These type of structure has earthquake resilient properties (Veintimilla-Bustamante[1], 2016, and Vernau and Rivet 1912; Childe, 1973 cited in Echeverria, 2011).

The distribution of structures known as "*silos*" is widely spread along the different altitudinal levels (Vargas, 2016, Delgado, 2009, Veintimilla, 2011 cited in Vargas, 2016). The definition or the exact use of this type of structure is not clear yet, but some studies suggest that these structures were related to agricultural activities (Vargas, 2016), others consider them as having a funerary use (Saville, 1910).

Figure 9 Silos on Cerro Jaboncillo
Retrieved from: Bravo and Vargas, 2009

Lack of oxygen, CO_2 saturation, low humidity and low temperature were characteristics of these structures (Miret, 2015 cited in Vargas, 2016). It created an environment that helped to preserve seeds for long periods (Ajamil, 2014; Teira, Brión, et., al. 2010 cited in Vargas, 2016).

"Silos" are distributed by groups of 10 to 15 units, and are located especially near dwelling areas. The research conducted on 2008 by INPC registered 30 holes, which were mainly located on considerable slope areas. The entrance is 60 cm wide and the interior 1.5 to 3 meters of depth. (Lopez, 2008 cited in Vargas, 2016). Inside the structure, no remains were found, the walls had no cover, and some internal walls are covered by rocks (Delgado, 2009). It can be supposed that not all the holes have had the same functions (Vargas, 2016).

The archeological prospection research on the sector 2 of "La Y" of a *silo* has brought cultural and natural evidence. Among the evidence are: one "*tortero*[15]", 10 shells beads, one shell of *Anadara tuberculosa* which could be a scraping tool due to the abrasion on one side of the shell, 20 rodent fragment bones, burnt wood, seeds, and one metallic decoration which was presumed to be abandoned by accident in this area.

Figure 10 Archeological evidence found on a silo
Retrieved from: Vargas, 2016

3.2.4. Productive activities

Fishing, farming, and crafts were the main activities of Manteños Huancavilcas (Cedeño, 2017; and Saville, 1907). The south settlements economy was based on trading and fishing activities (Gutierrez, 1998). The items that were found suggested there was an interchange of products among inhabitants from the coast and the mountains (Serrano, Gordillo, Guerra, et al., 1999).

The coastal sites played an important role in the commerce of marine shells (Martinez and Martin, 2002; Luniss, 2001; Marcos, 1995; Currie, 1995; Norton, 1986; Murra, 1982 cited in Martinez, Graber, and Harris, 2006). However, the pearl fishing was abandoned through time (Saville, 1907).

The Atacames archeological site, a 5000 inhabitants Manteño Huancavilca settlement, occupied around 127 hectares (Jerez, 1972 cited in Touchard-Houlbert,

[15] Clay spindle (Delabarde, 2015) used in the textile production (Smith and Piña Chan, 1962 cited in Echeverria, 2011).

2010). On this semi-urban village, the main activities were fishery and the commerce of Spondylus Shell (*Spondylus*) (Guinea 1993, 1989, 1988 cited in Guinea, 2006).

Water scarcity for crops and human consumption was one of the main challenges that Manteños-Huanvilcas had to face (Bouchard, 2010). Nevertheless, farming activities were developed in arid areas and fertile soils by using artificial water reservoirs called "*albarradas*[16]" which were used to store water from the atmosphere (Cedeño, 2017; and Marcos and Bazurco 2006), and rainwater. This water management technique prevents the rainwater run-off, minimizes flooding issues, increases the underground waters, and avoids soils erosion. In contrast to past technics, today's systems use plastic layers to recreate the walls of the ancient reservoir, which does not guarantee endurance of the water resource.

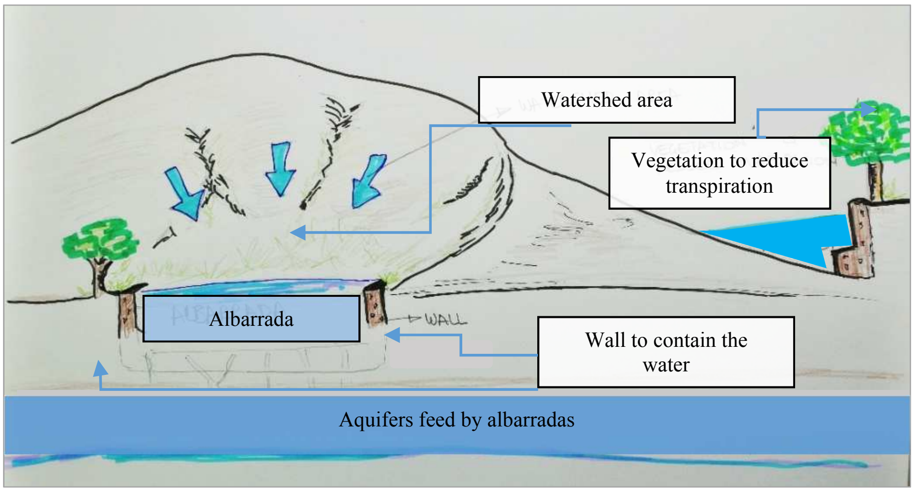


Figure 11 Albarradas diagram (sketch by author)

New studies have shown that water management systems were developed to enhance the agricultural productivity rather than to prevent flooding issues (Erickson,

[16] *Albarradas*: Artificial water reservoirs were installed to overcome the lack of water in their territory. This type of system had an important influence in the social and ecological areas since 1800 B.C (Marcos and Bazurco 2006).

and Walker, 2006). Landscapes were modified in order to transform non-productive areas into productive lands.

3.2.5. Feeding habits and traditional medicine

Due to the environmental conditions, macro organic materials decompose easily, so the only evidence that remains is those materials that were carbonized or the ones where anaerobic processes have taken place[17]. However, microfossils such as pollen, phytoliths, and starches are more prevalent; and that evidence can provide some clues to reconstruct the ancient flora (Veintimilla-Bustamante[1], 2016).

Due to the small amount of food leftovers and their conservation status, the rediscovery of ancient civilizations diets becomes a great challenge (Guinea, 1982). It could be determined that maize (*Zea mays* L.*)* and cassava (*Manihot esculenta* Crantz) were the main products registered as part of this culture diet (Guinea, 2006). They also consumed beans and squash (Ayaga, Odie and Brooks, et. al., 2018). Seafood was a primary food resource, but there is few evidence that indicated that hunting provided animal protein (Graber, 2010; and Guinea, 2006). The archaeological evidence states that mountainous communities relied on agriculture and hunting, while coastal communities fed mainly on marine resources.

In addition, recent archeological findings in two settlements of Manteños have provided interesting facts. In Atacames and Japoto archeological sites, around 500 pieces of slightly baked clay bread were found, relating these pieces of evidence as if this culture used to have soil and earth minerals as a nutritional supplement (Guinea, 2006).

[17] The anaerobic process avoids the proliferation of microorganisms that decompose organic materials, so in this way they can be preserved.

Figure 12 Objects found in the Japoto excavations.
Retrieved from Guinea, M. (2006).

The clay bread was slightly cooked, which eliminated the possibility of bacteria growth. The composition of this bread presents some similarities with edible earth that some indigenous in Bolivia consume in these days (Guinea, 2006). However, this custom has almost disappeared as an indigenous cultural practice. In fact, some historical chronicles state that the consumption of edible earth, which was used as medicine, was banned in the Spaniards occupation (Castello, 1986 cited in Guinea, 2006).

The size and type of leaves that were used to prepare the clay bread do not have a pattern; however, the mineral composition tends to have a similar quantity of minerals. In order to prepare the clay bread, some leaves such as *Calathea sp* G.Mey., *Heliconia bihai* L, *Canna edulis* Ker Gawl, *Zea mays* L. were used as moulds and container in the baking process (Guinea, 2006).

The studies by Zevallos Menendez of pre-Columbian medicine in America has shown that coca (*Erythroxylum coca* Lam.), tobacco (*Nicotiana tabacum* L.) and barbasco (*Jacquinia armillaris* Jacq.) was used as an analgesic by the Manteños community during dental procedures due to their sedative properties (Estrella, 1990).

3.2.6. Fiber and clothing

Manteños Huancavilcas had a considerable production and trade of textiles (Gutierrez-Usillos, 2002 cited in Tirira and Burneo, 2012). The great development of the Manteños' textile activity has been registered since 1500 to 500 B.C (Veintimilla-Bustamante[2], 2016).

Among the chronicles, Samano-Xerez (1967) mentions that during the first meeting between Spaniards and Manteños in 1526, the navigation raft had a great amount of cotton and wool cloths with red, blue and yellow color tones designs (Klumpp, 2015 cited in Veintimilla-Bustamante[2], 2016). Even though the colonization reduced the variety of products, traditional weaving techniques were still used to make hammocks, mats, and saddlebags. However, the current change of productive activities, the cultural cringe, and gender stereotypes have resulted in the almost eradication of this practice (Veintimilla-Bustamante[2], 2016).

During the pre-Columbian times, *torteros* or clay spindle were commonly used on the weaving process; however, the present citizens do not use them anymore, and even there is uncertainty on how these instruments were used. The fabrics were made of *Gossypium barbadense* L., which was the cotton species that was domesticated in South America. Currently, around 11 vegetal species are used as dyes, which are detailed in the table below.

ORDER	FAMILY	Scientific name	Common name	Uses
Rosales	Moraceae	*Chlorophora tinctoria* Gaudich.	Dyer's mulberry	Yellow and brown tones
Fabales	Fabaceae	*Prosopis juliflora* DC.	Mesquite tree	
Malpighiales	Salicaceae	*Salix humboldtiana* Willd.	Humboldt's willow	
Malvales	Malvaceae	*Guazuma ulmifolia* Wall.	West Indian elm	
Malpighiales	Rhizophoraceae	*Rhizophora mangle* L.	Mangrove	
Malpighiales	Euphorbiaceae	*Jatropha curcas* L.	Physic nut	
Arecales	Arecaceae	*Cocos nucifera* L.	Coconut	
Laurales	Lauraceae	*Persea americana* Mill.	Avocado	
Malvales	Bixaceae	*Cochlospermum vitifolium* Spreng.	Buttercup Tree	
Sapindales	Anacardiaceae	*Spondias mombin* L.	June plum	
Fabales	Fabaceae	*Indigofera sp.* L.	El tinto (Spanish)	Dark blue tones

Table 1. Species used as dyes on textile production
By the author using the information of Klumpp, 2015 cited in Veintimilla-Bustamante[2], 2016.

While necklaces were used for ornamental purposes, beads made of shells were produced for commercial purposes (Ayaga, Odie, and Brooks, et. al., 2018).

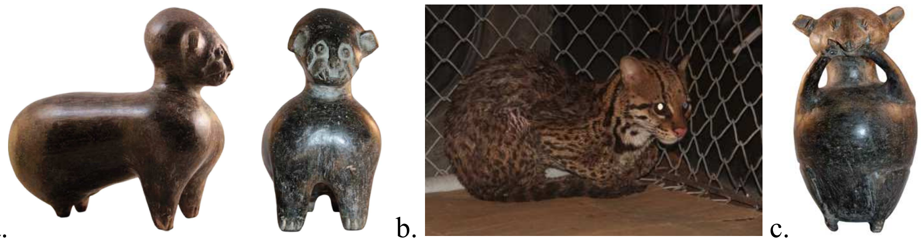
3.2.7. Cultural, spiritual and religious values

The Manteños Huancavilcas had two main temples that were located in the Manabí province; one was located on Manta (25 km from Cerro Jaboncillo (Stothert, 2001)) and the other in the Puna Island. The temple located on the Ecuadorian mainland venerated the Umiña Goddess, which has been attributed to having healing properties. This temple was frequented by different people from even other countries (Velasco, 1789). No such temples are found on the two sites of the present thesis.

Since ancient times, the animist culture was reflected in the adoration of the ocean, and other elements that were part of the landscape (Serrano, Gordillo, Guerra, et. al, 1999). This kind of behavior could be interpreted as if cultural values were related to the surrounding environment since the pre-Columbian villages. In current indigenous societies, the relationship between nature and society has been based on reciprocal concepts, so several kinds of rituals were done to acknowledge the benefits provided by nature (Erickson, 1992).

Bats are associated with power, fertility and masculinity (Tirira and Burneo, 2012). Bats had been found as decorations of many artifacts that were used in the textile production, which were called "*torteros"*, and in musical instruments. The representation of the Order Chiroptera was characterized by simple and not stylized representations. Moreover, an artifact that represented a bat surrounded by two fishes had been found. Some biologists consider that those designs were representation of *Noctilio leporinus* L., a bat which diet is based on the fish consumption (Tirira and Burneo, 2012).

Some cultural manifestations based on local fauna were found in Chanduy. For instance, *Nasua narica* L. and *Leopardus pardalis* L. were found on the pottery (Marcos, 2013).



a. b. c.

Figure 13 Local fauna on the archeological evidence
Retrieved from: (A, and C) Marcos, J. (2013). (B) Ministeriointerior.gob.ec. (2018).

ORDER	**FAMILY**	**Scientific name**	**Common name**	**Uses**
Carnivora	Procyonidae	*Nasua narica* L.	White-nosed Coati	Pottery figures
Carnivora	Felidae	*Leopardus pardalis* L.	Ocelot	Pottery figures

Table 2. Fauna in the study area B
By the author by using information of Marcos (2013).

Even though several archeological studies have taken place about the Manteños Huancavilcas, most of them have been focused on humans rather than a wider perspective considering the landscape as a system. For these reasons, it is still not possible to determine how the landscape affected sustainability of the local communities.

Chapter IV: Case study sites and methods

The research is conducted on two case studies, sites of two settlements of Manteños-Huancavilcas along the Coast Region of the Republic of Ecuador – South America. “Cerro Jaboncillo” (Site A) is one of the main settlements of Manteños located in Portoviejo canton, Manabí province. Meanwhile, site B is a group of scattered lower density settlements in Chanduy Valley, Chanduy canton, Santa Elena province

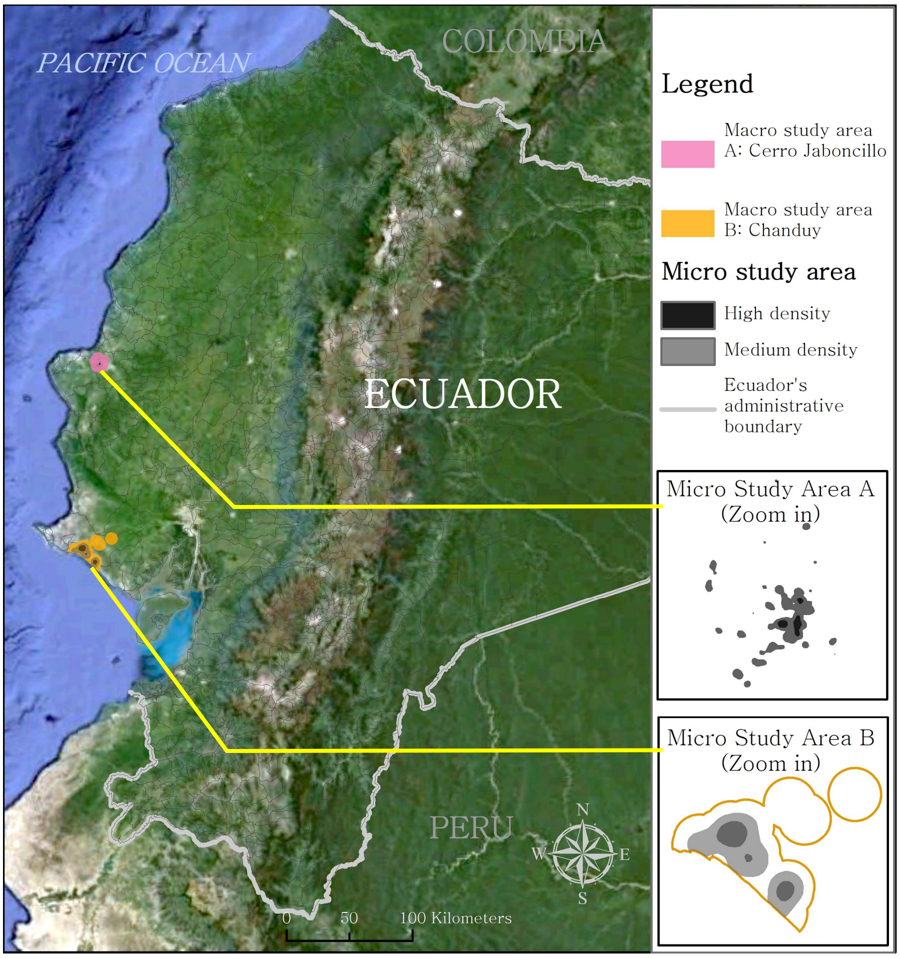


Figure 14 Study areas

Data from the INPC 2018 and Google Earth 2018 by the author

4.1. Study sites overview

4.1.1. Site A: Cerro Jaboncillo

"*Cerro Jaboncillo*" is a chain of hills, where several archeological structures of Manteños Huancavilcas are located in the southern area of Manabí province. The main ecosystem is a dry tropical savanna; however, the presence of drizzle fog can create potential conditions to develop agriculture (Stothert, 2001).

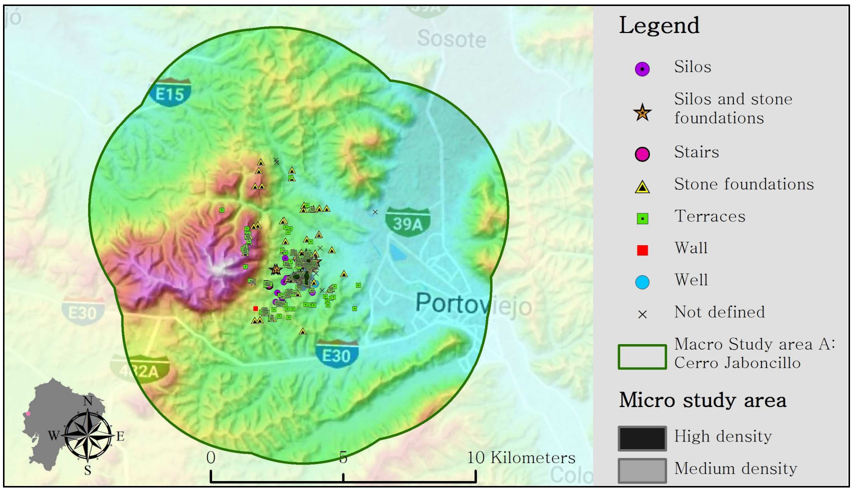


Figure 15 Topography of Cerro Jaboncillo
Data from the INPC 2018 and theTopographic-map.com. (2018) by the author

Among the archeological remains in the area of *Cerro Jaboncillo* were some remains of dwellings, water wells, corrals[18], etc. The figure below shows the distribution of the archeological evidence in the high-density and medium-density areas on Cerro Jaboncillo.

[18] Corrals are a type of terrace, which has stone foundations (Stothert, 2001).

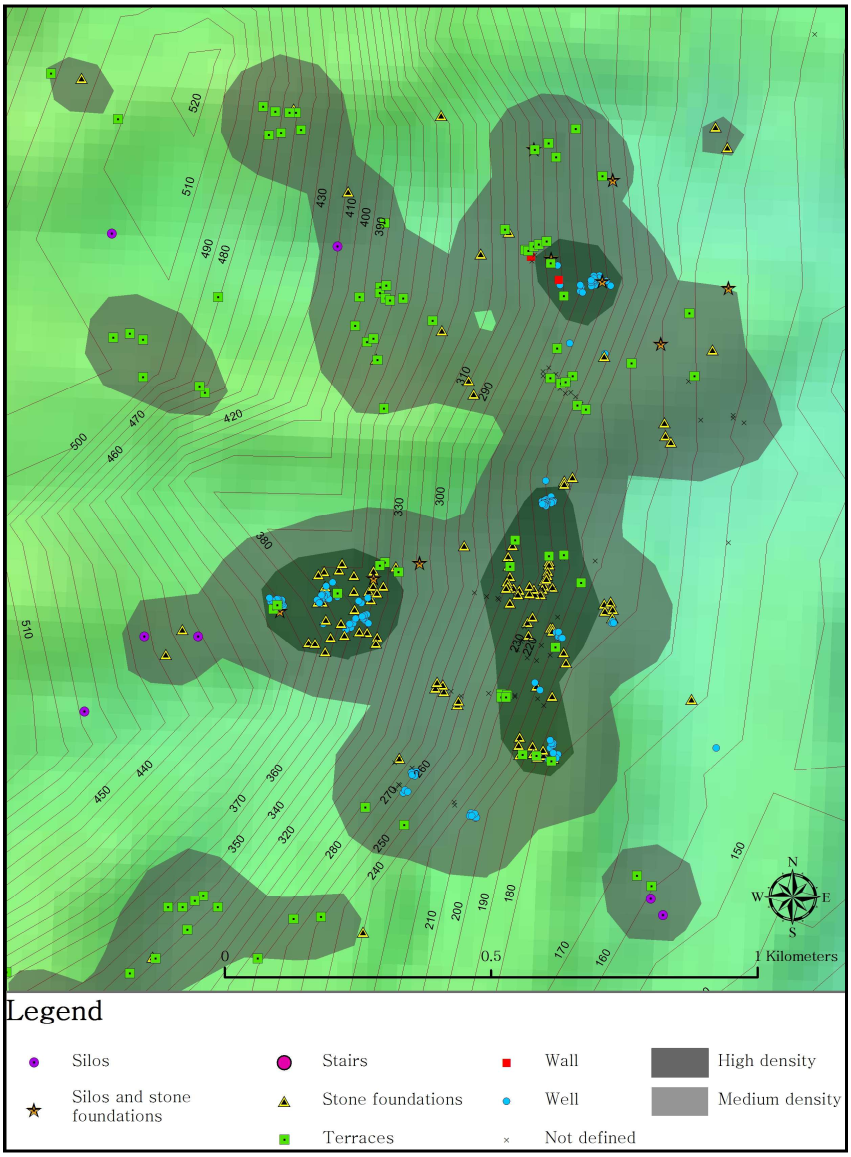


Figure 16Micro study area site A
Data from the INPC 2018, Google Earth (2018), and theTopographic-map.com. (2018) by the author

Cerro Jaboncillo is considered as one of the main settlements of the prosperous culture of Manteños Huancavilcas. Even though the area was inhabited by considerable number of habitants in the pre-Columbian times (Estrada, 1962), currently there are no human settlements located inside the area of Cerro Jaboncillo because during the colonization, the Spaniards forced the indigenous people to abandon the aboriginal settlements (Saville, 1907 cited in Estrada, 1962). However, in other settlements that were located near the area, the Spaniards established the first colonial cities[19]. The area was declared as National Heritage in 2009 because of its archeological value in Ecuadorian history. However, despite many local preservation efforts, the archeological area is at risk due to the mining activities taking place in nearby areas.

4.1.2. Site B: Chanduy Valley

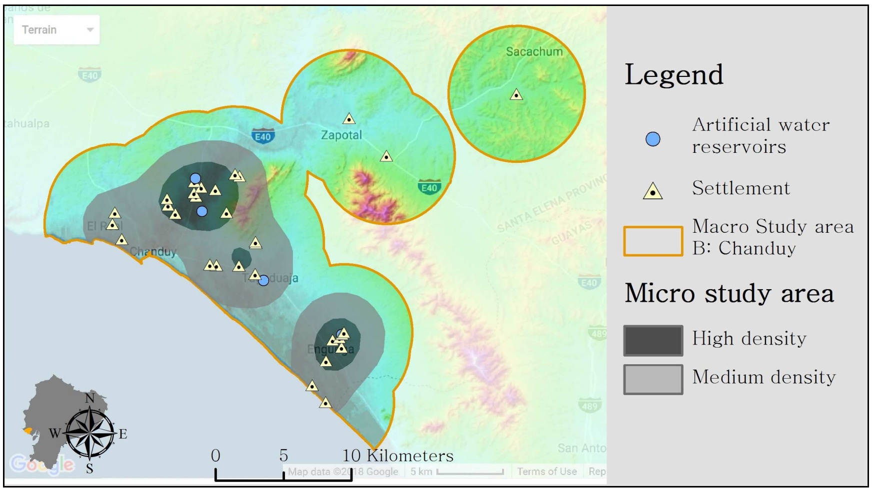


Figure 17 Topography of Chanduy
Data from the INPC 2018 and theTopographic-map.com. (2018) by the author

Chanduy Valley is located in the current Santa Elena Province. This area has suffered negative effects of treasure-hunting gravediggers and the deterioration of archeological sites due to urbanization, colonization processes and climate factors. The low hill valley is located between 0 and 30 meters above the sea level on a semi-

[19] The occupation of the new colonial cities on the same location of ancient villages can be recognized as having been influenced by ancient settlements (Hardoy, 1968).

arid ecosystem, located near the alluvial areas of Zapotal and Verde River (Stothert, 2001).

Ethno historical archeological reports state that this started as a well-organized civilization settlement but then it went through a process of deterioration and disorganization. Understanding the variations and evolutions that this settlement went through can provide a more detailed understanding of the relationships between pre-Columbian individuals and the landscape.

4.2. Methodology

4.2.1. Methods and practice

The research is conducted in three main steps. First, the literature review to synthetizes information such as archeological reports, historical documents, and academic publications to develop a better understanding of the Manteños-Huancavilcas settlements located on the Coast of Ecuador with an emphasis on Cerro Jaboncillo and Chanduy Valley. The results have been introduced in Chapter III under 3.2.

Second, the literature review is contrasted with a map overlay analysis using ArcGIS to derive the interrelations between the environmental management techniques, settlement locations with the physical and ecological characteristics of the environment. Map analysis is done using a map overlay of different features such as soil maps, hydrology, etc., together with old maps, which were digitalized, and georeferenced using ArcMap 10.4.1. The macro study areas were defined by a buffer radius area of 5 km considering each central reference of the coordinate points (registered in the database of the National Institute of Cultural Heritage of Ecuador) for the two sites. As a result, site A: Cerro Jaboncillo, the macro study area comprehends 198 km^2, while for the site B; the macro study area has 498 km^2.

Furthermore, a micro study area was defined by using Kernel density analysis. Regarding to the size area, the site A has 0.13 km^2 as a high dense area, and 1.33km^2 as medium dense area. In the other hand, site B has 35.35 km^2 as a high dense area and 125.75 km^2 as medium dense area.

Finally, a critical and comparative analysis has been conducted based on the following conceptual framework. It is through comparison of the two sites that we can gain profound insight into the landscape and survival strategies of the Manteños Huancavilcas.

4.2.2. Conceptual framework

In order to have a better understanding of landscape, the present research considers three independent variables that are detailed in the table below:

Dependent variable	Independent variables for the comparison analysis			Data source
Manteño-Huancavilcas Landscapes	Abiotic factors	Geomorphology	*Physical landscapes*	Winckell, Zebrowski, Sourdat, Zavgorodnyaya de Costales, S. (1989)
		Hydrogeology	*Permeability, available water*	Instituto Geofísico Militar del Ecuador (2018)
		Soil	*Soil order, slope*	Ministry of Agriculture and Livestock of Ecuador (2018)
	Biotic factors	Vegetation	*Schematic vegetation,*	Frei (1956)
			Vegetation	PRONAREG (1978); *CEDEGE – ECUADOR (1978)*

<table>
<tr><th>Dependent variable</th><th colspan="3">Independent variables for the comparison analysis</th><th>Data source</th></tr>
<tr><td rowspan="5"></td><td rowspan="5">Cultural aspects</td><td rowspan="3">Agricultural aspects</td><td>Agricultural landscapes</td><td>Gondard, Huttel, Lopez, Winckell, and Zébrowski (1999)</td></tr>
<tr><td>Agricultural suitability,</td><td>Ministry of Agriculture and Livestock of Ecuador (2018)</td></tr>
<tr><td>Water management, Land use and resources management</td><td></td></tr>
<tr><td>Human basic needs</td><td>Feeding habits and clothing</td><td></td></tr>
<tr><td>Site selection</td><td>Location, building material, building design and forms</td><td>INPC 2018 (location of archeological evidence)</td></tr>
<tr><td>Intervening disciplines</td><td colspan="3">Archeology, History, Geography, Anthropology</td><td></td></tr>
<tr><td>Study areas</td><td colspan="3">Manteño-Huancavilcas settlements in Cerro Jaboncillo, and Chanduy</td><td></td></tr>
</table>

Table 3. Conceptual framework

Chapter V: Analyzing the landscape of the Manteños-Huancavilcas

Some chronicles state that linguistic, ethnic associations and cultural practices of the Manteños settlements that were located in the south area differ from the northern part (Cieza de Leon, 1550 cited in McEwan and Delgado, 2008). From the analysis of the abiotic and biotic aspects of the landscape, surrounding the archaeological sites, it is possible to conclude that the characteristics of the landscape were crucial in thriving or failure of these two communities of this Ecuadorian pre-Columbian culture.

5.1. Abiotic factors

5.1.1. Geomorphology

a) Physical landscapes of study area A

Based on the map analysis of Winckell, Zebrowski, Sourdat, and Zavgorodnyaya de Costales (1989), the macro study area is covered by four physical landscapes that include landscape subclasses such as ancient volcanic rock, forms inherited from marine quaternary transgressions, river valleys with complex undifferentiated terraces, and clayey hills. The area is mainly covered by hills over tertiary sediments (62.94%). (See figure 18&36).

The entire high-density micro study area is located over coastal ranges over volcanic rocks. On the other hand, the medium-density micro study area includes hills over tertiary sediments and coastal ranges over volcanic rocks. Figure 18 shows the coastal ranges of the physical landscape that covers most of the micro study area. (See figure 18&37).

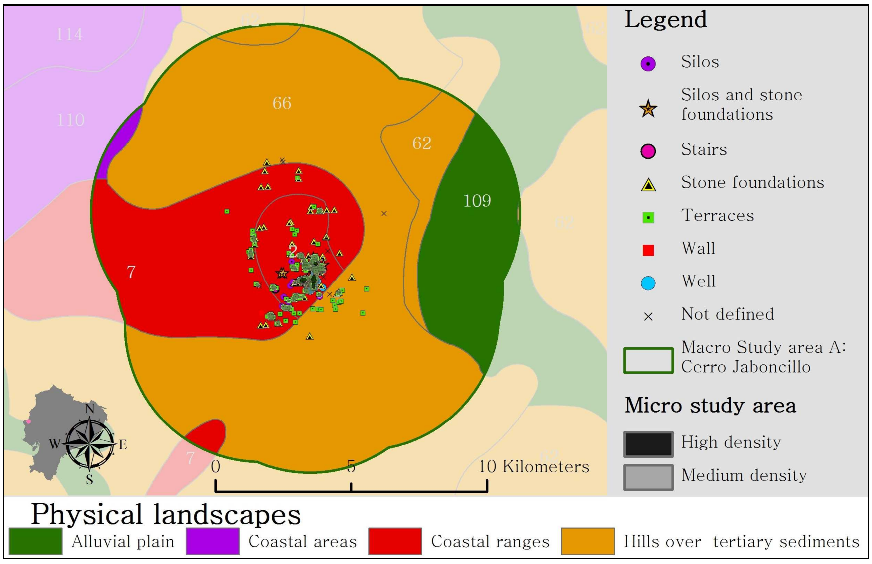


Figure 18 Physical landscapes of study area A
Data from the digitization of Winckell, Zebrowski, Sourdat, Zavgorodnyaya de Costales, S. (1989) and INPC (2018) by the author

b) Physical landscapes of study area B

Analyzing the map of Winckell, Zebrowski, Sourdat, and Zavgorodnyaya de Costales (1989), the macro study area B includes five types of physical landscapes. Coast areas (35.15%), foothills (24.13%), and hills over tertiary sediments (21.21%) are most significant physical landscapes that cover the larger part of the territory. (See figure 19&36).

Regarding the micro-study area, coastal areas cover a great part of the territory in the high and medium density areas. (See figure 19&37).

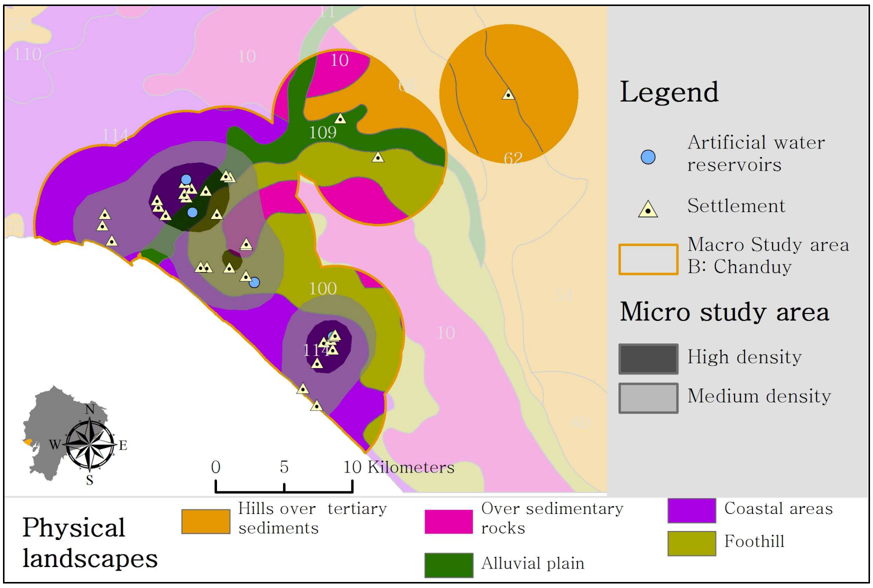


Figure 19 Physical landscapes of study area B
Data from the digitization of Winckell, Zebrowski, Sourdat, Zavgorodnyaya de Costales, S. (1989) and INPC (2018) by the author

5.1.2. Hydrogeology

a) Hydrogeology of study area A

Looking through the data of the Instituto Geofísico Militar del Ecuador (2018) in the macro study area, perennial rivers such as Portoviejo and Golden River can be found. Intermittent water bodies mainly cover the northwestern area of the macro study area. In the area medium (40.82%) and low (33.16%) permeable soils covers a considerable part of the area. (See figure 20&39).

In the case of the micro study area, the archaeological evidence is commonly positioned on low permeable soils, in the high-density study area (43.25%) and on the medium density study area (59.87%). (See figure 20&40).

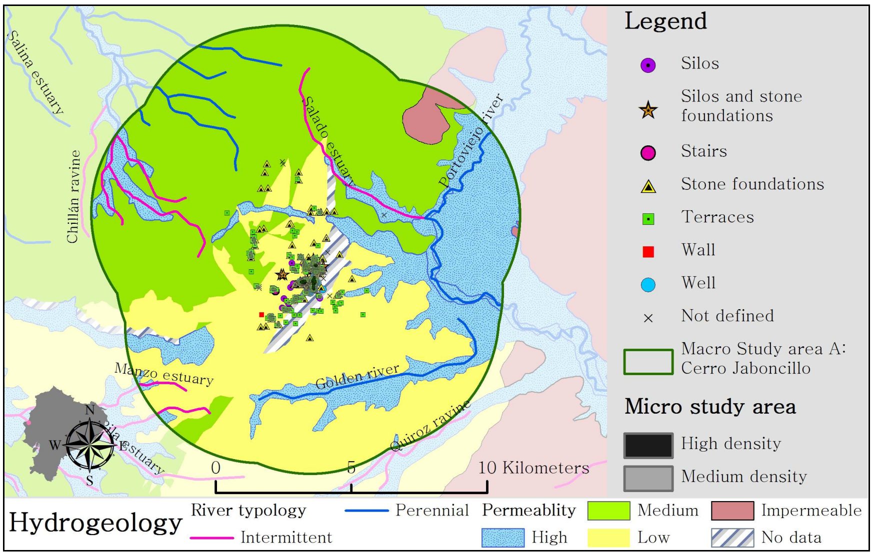


Figure 20 Hydrogeological map of study area A
Data from the Instituto Geofisico Militar del Ecuador (2018) by the author

b) Hydrogeology of study area B

Along the macro study area, a variety of intermittent water bodies can be found in the area. Zapotal River, Azucar River and Tugaduaja River are the perennial water bodies in the area. The settlements are placed near the water bodies, and artificial reservoirs are situated on soils with medium permeability. (See figure 21&39).

The high and medium density areas of the micro study area are mainly positioned over medium permeable soils (67.71% and 87.31% respectively). (See figure 21&40).

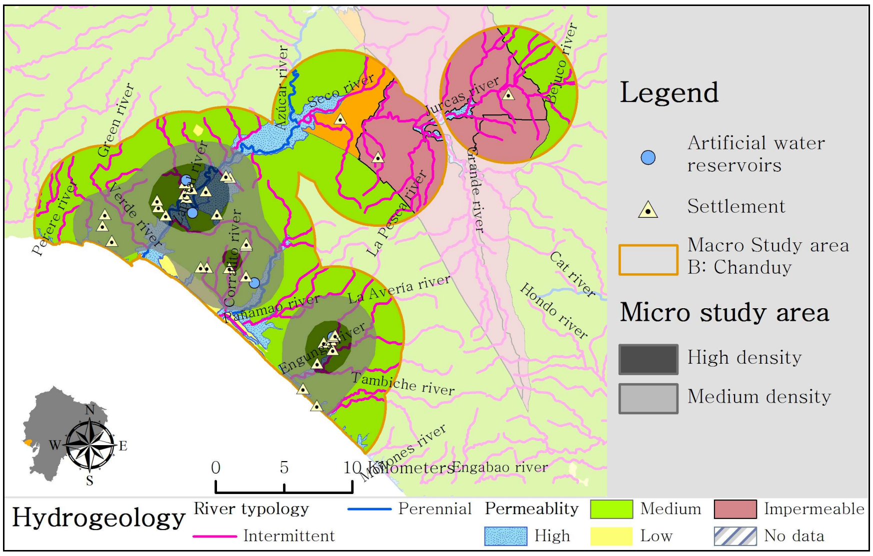


Figure 21 Hydrogeological map of study area B
Data from the Instituto Geofisico Militar del Ecuador (2018) by the author

5.1.3. Soil

The soil characteristics have a considerable influence on the type of vegetation that can be found in the area. The inner characteristics that most of the soils of the study areas have such as the insufficient nutrients, lack of humidity, the recent development, etc (Soil Science Society of America, 2018); posed a considerable challenge to agricultural development.

a) Soil of study area A

Based on the data of the Ministry of Agriculture and Livestock of Ecuador (2018) the macro study area has five different types of soil orders: alfisol, entisol, inceptisol, mollisol and a combination of inceptisol and entisol. Inceptisols covers more than a half of the macro study area (66.54%). Most of the settlements are located on inceptisol and on the combination of inceptisol and entisol. (See Figure 22&43).

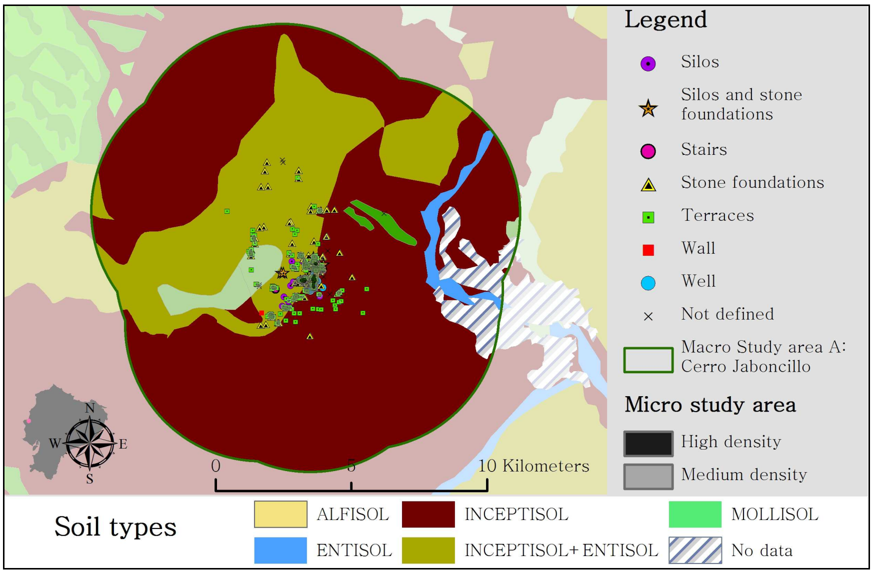


Figure 22 Soil map of study area A

Data from the Ministry of Agriculture and Livestock of Ecuador (2018), and INPC (2018) by the author

b) Soil of study area B

Three soils order types can be found in the area, aridisol, entisol and inceptisol. Aridisol covers the main area of the macro study area. The settlements are generally located on aridisol and some of them prefer to stay close to inceptisols. (See figure 23).

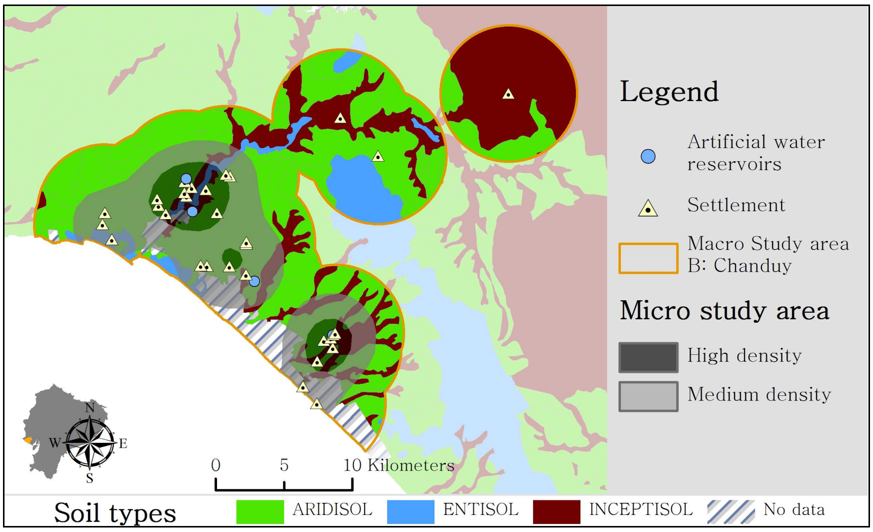


Figure 23 Soil map of study area B
Data from the Ministry of Agriculture and Livestock of Ecuador (2018), and INPC (2018) by the author

5.1.4. Slope

The slope variability determines the presence of diverse ecosystems, in which specific biodiversity and microclimates take place (Martinez, Graber, and Harris, 2006). The slope percentage is defined by doing a correlation between the highest and lower points of a specific area (Ministerio de Agricultura, Ganadería y Pesca, 2016).

a) Slope in study area A

In 1907, Saville stated that the territory was characterized by moderate mountainous range (Saville, 1907). Through analysis of the map generated by the data of the Ministry of Agriculture and Livestock of Ecuador (2018), the territory is mainly located on slopes areas of >25-50 slope percentage (42.06% of the area), and in > 50-70 slope percentage (30.22% of the area). (See figure 24&46).

In addition, the medium to high density of the study area shared similar characteristics with the macro study area, as it comprises 25-70 slope percentage soils. (See figure 24&47).

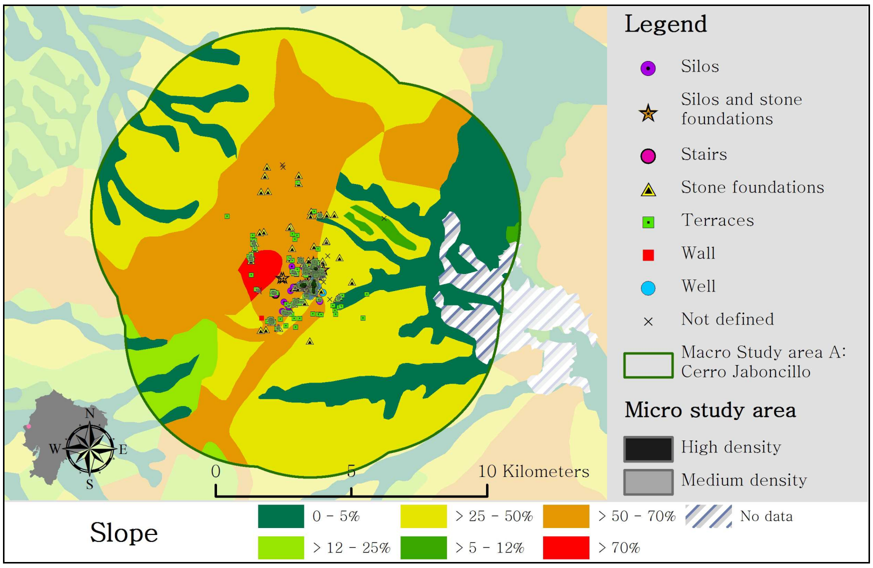


Figure 24 Slope map study area A
Data from the Ministry of Agriculture and Livestock of Ecuador (2018), and INPC (2018) by the author

b) Slope in study area B

The macro study area of site B is located on gentle slopes that goes from 0-5% (35.74%), and from >12-25% (30.69%). The settlements tend to be located on low slope areas. (See figure 25).

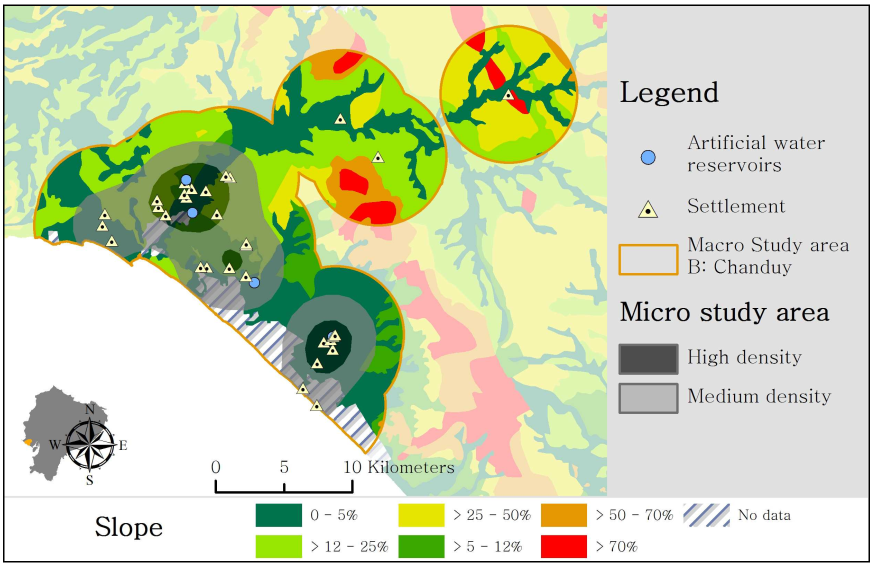


Figure 25 Slope map study area B
Data from the Ministry of Agriculture and Livestock of Ecuador (2018), and INPC (2018) by the author

5.2. Biotic factors

5.2.1. Schematic vegetation

a) Schematic vegetation in study area A

Based on the map analysis of Frei (1956), the macro study area was covered mainly by summer dry forest and savanna (80.89%) and the remained was desert and semi-desert cactus bush vegetation. (See figure 26&49).

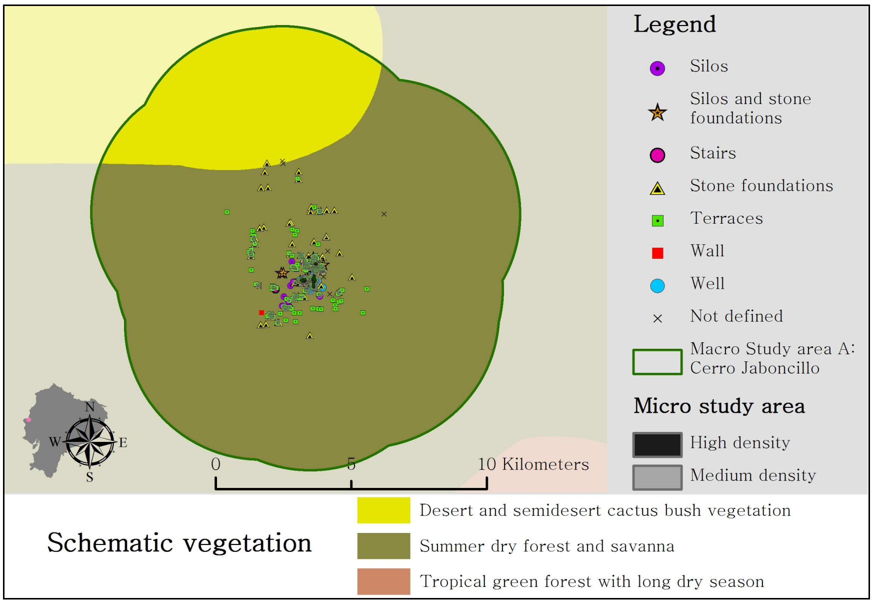


Figure 26 Schematic vegetation in study area A
Data from the digitization of Frei (1956) and INPC (2018) by the author

b) Schematic vegetation in study area B

In the macro study area, three schematic vegetation composed the area during 1956. From the border of the coastal zone, desert and semi-desert cactus bush vegetation covered around 34% of the territory. Near this area, the summer dry forest and savanna composed 51% of the vegetation, and finally, tropical green forest with a long dry season covered 14.83%. (See figure 27&49).

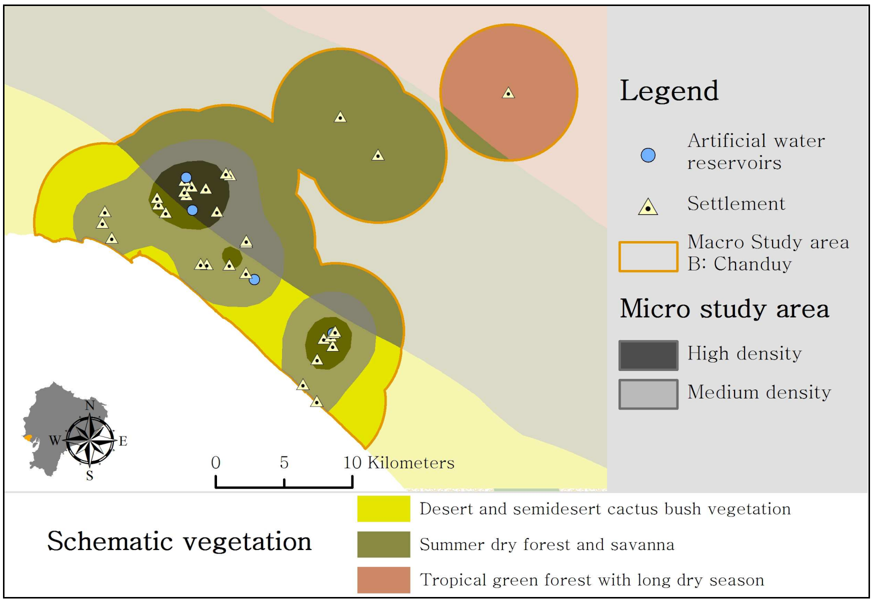


Figure 27 Schematic vegetation in study area B
Data from the digitization of Frei (1956) and INPC (2018) by the author

5.2.2. Vegetation

a) Vegetation in study area A

The flora of the macro study area was composed by 11 types of vegetation composition based on the data of PRONAREG (1978). Very dry arboreal vegetation is mainly positioned over the macro study area covering 41.94% of the area. (See figure 28&52).

Regarding the micro-study area, the territory is similarly covered on a greater area with very dry arboreal vegetation (73.74%). (See figure 28&53).

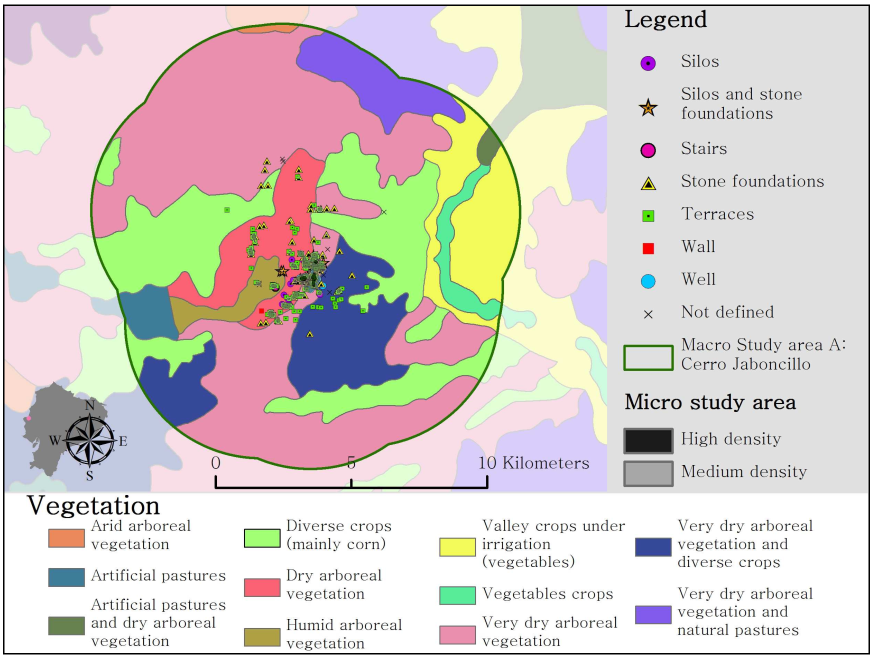


Figure 28 Vegetation map area A

Data from the digitalization of PRONAREG (1978) and INPC (2018) by the author

In the 1900s, the primary products in the area were cacao, coffee, sugar cane, tobacco, Indian rubber, cotton, fine-grained hard woods, various textile plants, and vegetables. *Phytelephas* Ruiz & Pav or ivory nut was the most economically important export (Saville, 1907).

Furthermore, in 2013 some biological studies to analyze the current vegetation have been taken place (Tobar, 2013), a brief description is detailed on the Appendix N.1. Among these vegetable species, *Cordia lutea* Lam. have been found as a vegetable specie related with the ancient artificial reservoirs (Marcos and Bazurco, 2006), it can be inferred that the presence of this plant goes back from ancient times.

b) Vegetation in study area B

Mangrove patches cover the coastal area, while grasses and arid tropical forest are the prevalent types of vegetation in tropical savannas. These forests have almost disappeared due to deforestation (Stothert, 2001). Analyzing the vegetation map of 1978, in the macro study area herbaceous vegetation (33.24%) and herbaceous and arid shrub vegetation (30.62%) are covering a larger part of the territory (See figure 29&52). This also has a similar pattern with the micro study area that is also greatly covered by the previous mentioned vegetation types. However, herbaceous and arid shrub vegetation is more commonly in the high-density (53.29%) area than in the medium density (30.69%). On the other hand, herbaceous vegetation is less common in the high-density (44.26%) area than in the medium density (58.10%). (See figure 29&53).

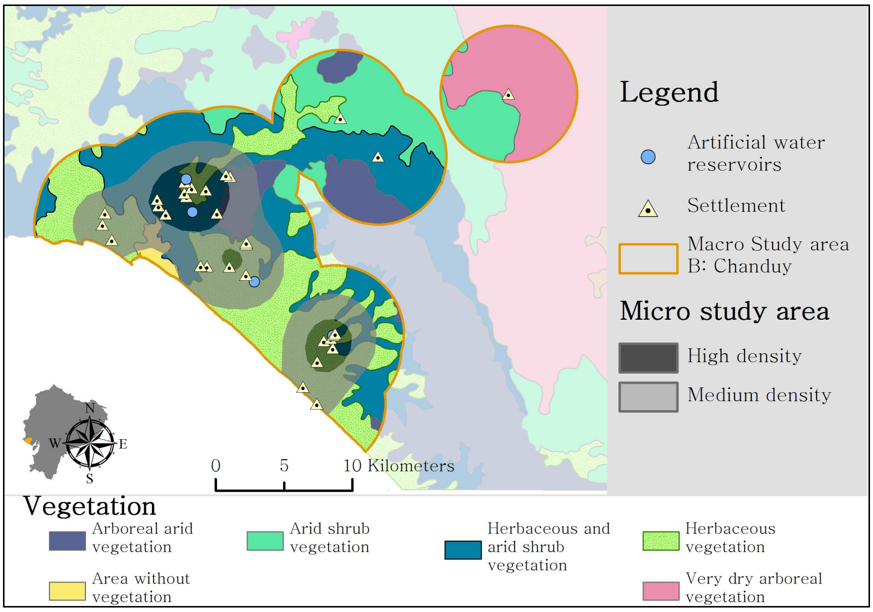


Figure 29 Vegetation map area B
Data from the digitalization of Comisión de Estudios Para el Desarrollo de la Cuenca del Río Guayas CEDEGE –ECUADOR (1978) and INPC (2018) by the author

The current plants that are cultivated in this area are coffee (*Coffea* L.), toquilla straw (*Carludovica palmate* Ruiz & Paz), plum (*Spondias purpurea* L.), banana (*Musa paradisiaca* L.), lemon (*Citrus limon* L.), guadua (*Guadua angustifolia* Kunth), papaya (*Carica papaya* L.), mango (*Mangifera indica* L.), orange (*Citrus* L.), pineapple (*Ananas comosus* L. Merr.), achiote (*Bixa orellana* L.), etc. In the pre-Columbian evidence, there is no clear evidence that those plants were cultivated by Manteños.

5.3. Agricultural aspects

5.3.1. Agricultural landscapes

There are certain limitations to know accurately about pre-Columbian agricultural landscapes but analyzing the agricultural feasibility of today we can get added information that allows hypothesizing pre-Columbian agricultural landscapes. However, today's agricultural technology blurs the image of ancient agricultural production.

a) Agricultural landscapes in study area A

Analyzing the agricultural landscapes map of 1999, dense and deciduous forest (39.12%), and arboreal shrub formations associated with corn crops (31.82%) are mainly positioned over the macro study area. (See figure 30&55).

Regarding the micro study area, both sites are commonly located on arboreal shrub formations associated with corn crops. In site A the complete territory is covered by this agricultural landscape, while site B has 84.44% followed by arboreal, dense, semi-deciduos formation (15.40%). (See figure 30&56).

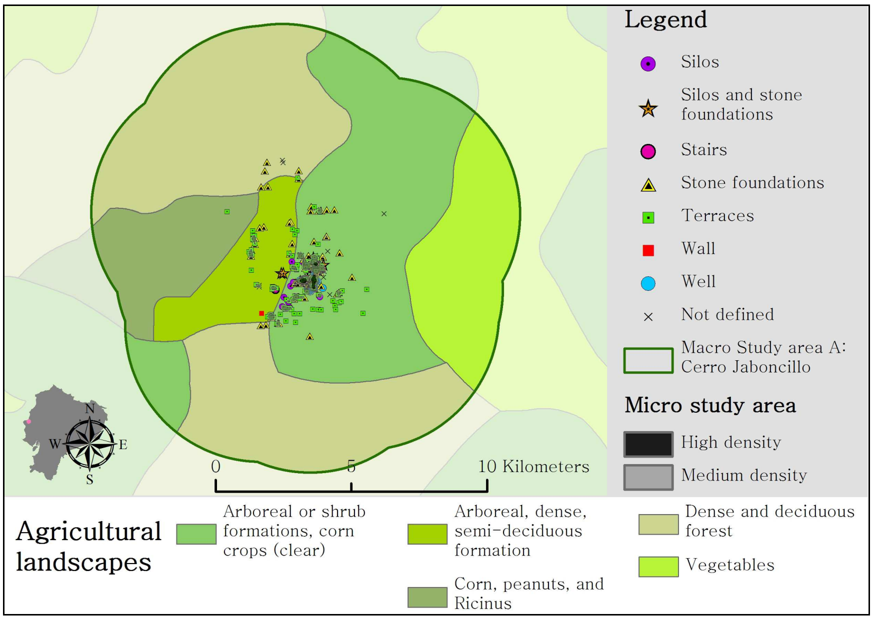


Figure 30 Agricultural landscapes in study area A
Data from the digitization of Gondard, Huttel, Lopez, Winckell, and Zébrowski (1999) and INPC (2018) by the author

b) Agricultural landscapes in study area B

The macro study area is considerably cover by herbaceous, open, seasonal, thorny shrub patches by 40.38%. (See figure 31&54). In consideration with the micro study area, herbaceous, open, seasonal, thorny shrub patches also composed a significant portion of the agricultural landscapes, 70.52% on the high-density areas and 49.08% on medium density areas. The coverage of herbaceous, open, seasonal formation, with 26.06% on the high-density areas and 40.55% on medium density areas, has a significant relevance on the agricultural landscapes composition. (See figure 31&56).

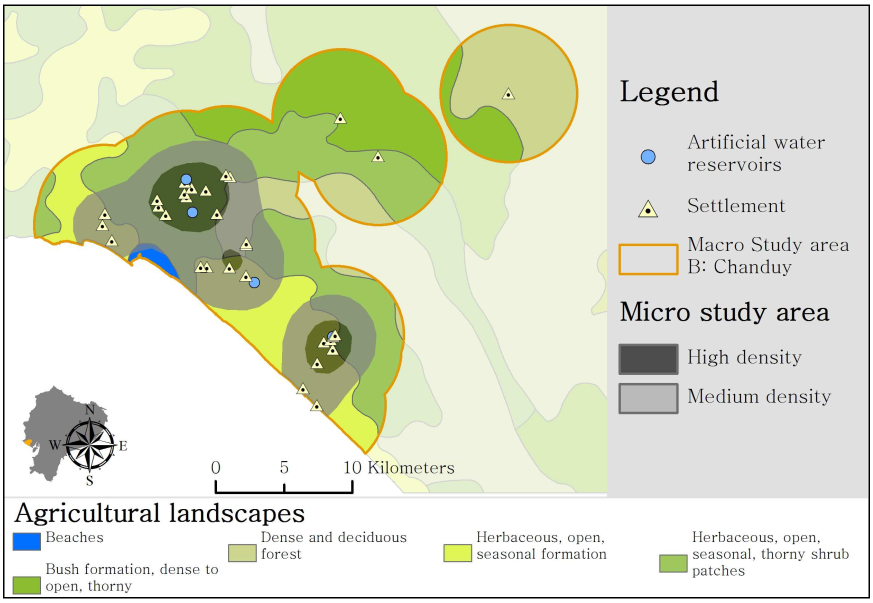


Figure 31 Agricultural landscapes in study area B
Data from the digitization of Gondard, Huttel, Lopez, Winckell, and Zébrowski (1999) and INPC (2018) by the author

5.3.2. Agricultural suitability

Current agricultural paradigms considered flat or smooth sloping areas as feasible areas to develop agriculture because land mechanization is easier. Moreover, the use of fertilizers increases the possibilities to produce better crops. However, since ancient times, the mountainous areas were ideal places for cultivation because of the landscape and types of soil allow diversifying crops production.

a) Agricultural suitability in study area A

Based on the data from the Ministry of Agriculture and Livestock of Ecuador 2018, the macro study area is suitable for crops (69.34%), pastures (69.34%), and forest (6.05%). (See figure 32&58).

Regarding the micro-study area, forest covers a great part of the territory in the high (56.90%) and medium density areas (68.07%). (See figure 32&59).

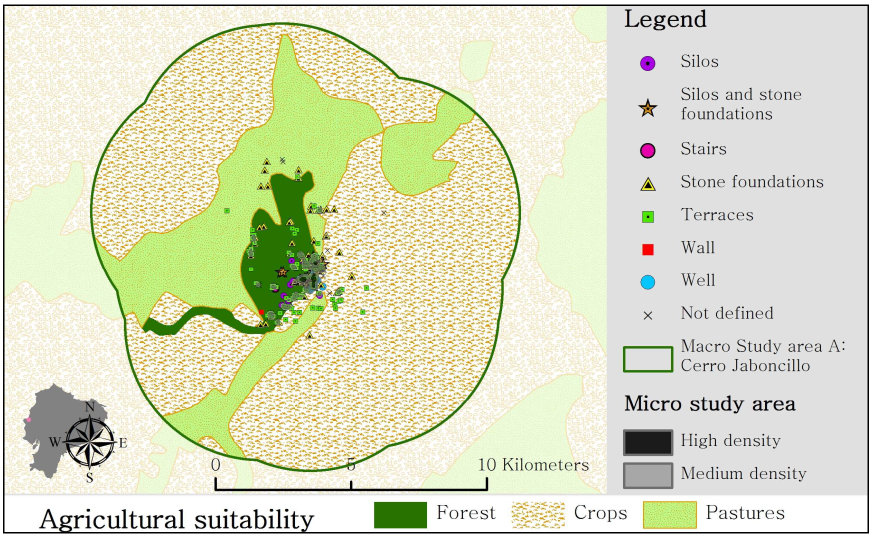


Figure 32 Agricultural suitability in study area A

Data from the Ministry of Agriculture and Livestock of Ecuador 2018, and INPC 2018 by the author

b) Agricultural suitability in study area B

A high percentage of the territory has been defined as suitable for crops (81.28%) in the macro study area (See figure 33 &58). While, micro study areas are considered as spaces suitable for crops and forest. (See figure 33&59).

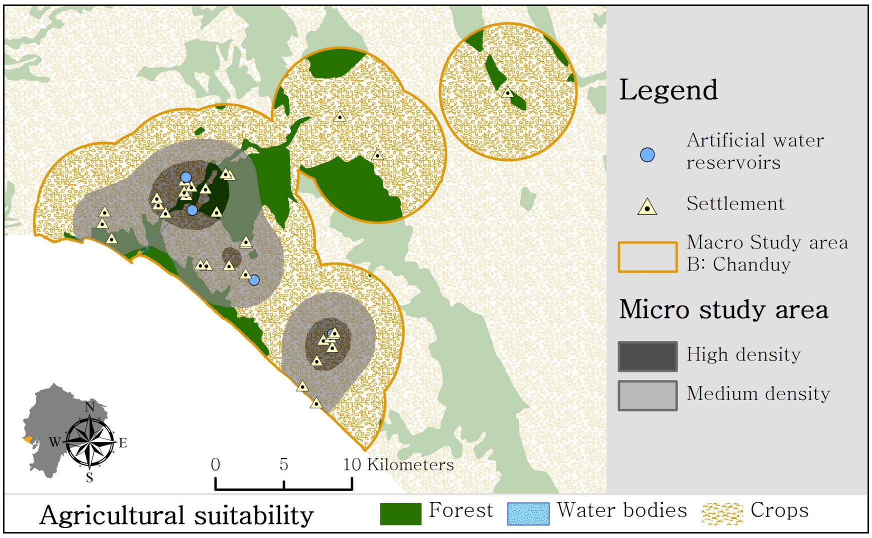


Figure 33 Agricultural suitability in the study area B

Data from the Ministry of Agriculture and Livestock of Ecuador 2018, and INPC 2018 by the author

5.4. Comparative analysis of hypothetical pre-Columbian Landscapes

5.4.1. Comparative analysis based on the secondary information

Looking through the archeological reports related to site composition, the settlements of Cerro Jaboncillo (A) were located on mountain areas while Chanduy (B) settlements were on gently sloping valley area. The spatial distribution for site A was done horizontally, with hierarchical and power relations being the fundamental factors in the spatial distribution. On the other hand, site B settlements were distributed in a vertical way, with the type of productive activities being the main driving factors for the land use of the territory.

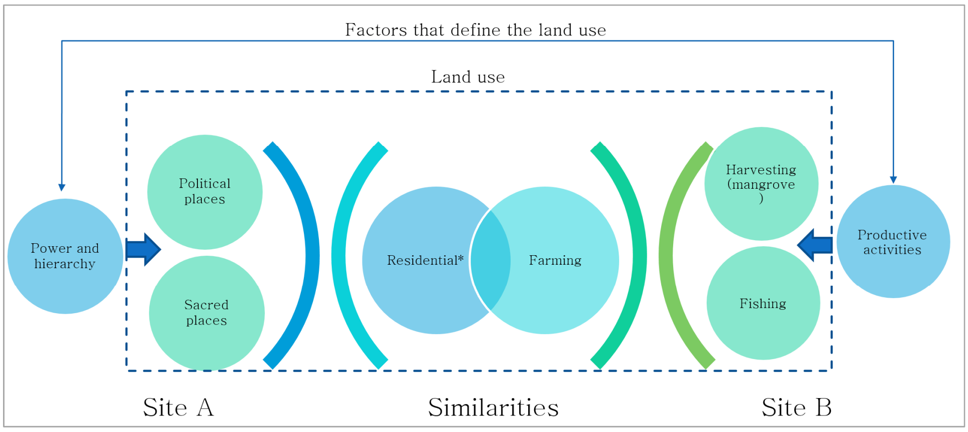


Figure 34 Comparison of the site selection between study areas

Moreover, site A has a greater density of dwellings and those tend to be concentrated in specific areas, while site B has a lesser density and the settlements are spread throughout the territory. The archeological evidence is distributed on a small area in Cerro Jaboncillo; while the archeological evidence in the Chanduy area was dispersed sporadically compared to Cerro Jaboncillo. In Cerro Jaboncillo, it can be deduced to have a more complex organization that allowed them to manage big populations in a relatively small area, and that there was a preference to live in the site A rather than in site B.

5.4.2. Comparison of physical landscapes in study areas

Even though the macro study areas shared three types of physical landscapes, the amount of area located in the study areas differs drastically as detailed below (See Figure 36). For site A, the hills over tertiary sediments cover more than half of the study area, while in site B, the coastal area covers a third part of the region.

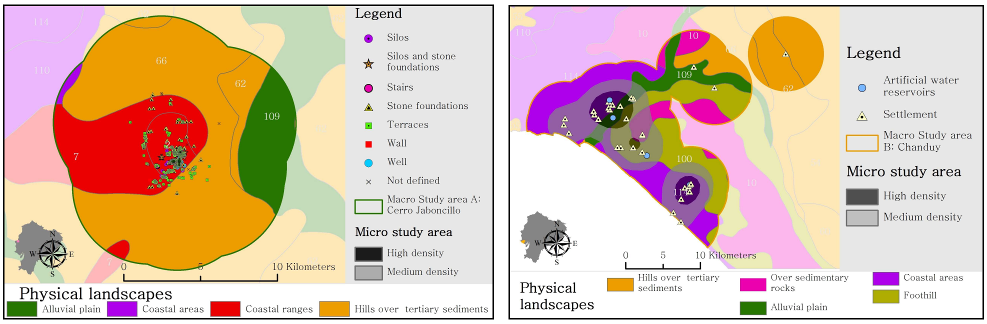


Figure 35 Physical landscapes in study areas

Type	Site A Area_km2	Site A %	Site B Area_km2	Site B %
Alluvial plain	23.07	11.61	50.95	10.22
Coast	1.29	0.65	175.17	35.15
Coastal ranges	49.28	24.80	n/a	n/a
Hills over tertiary sediments	125.07	62.94	105.69	21.21
Foothill	n/a	n/a	120.23	24.13
Over sedimentary rocks	n/a	n/a	46.34	9.30
TOTAL	198.70	100.00	498.38	100.00

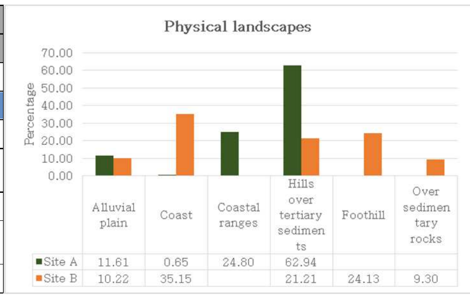


Figure 36 Comparison charts of physical landscapes (Macro study area)

In the case of the micro study areas, the archaeological evidence on site A is situated on the coastal ranges; while on site B, it is considerably located on the coast. For the two study areas, on each site for the high and medium density areas tend to share similar physical landscapes conditions. (See figure 37).

Site A	High density		Medium density	
Type	Area_km2	%	Area_km2	%
Alluvial plain	n/a	n/a	n/a	n/a
Coast	n/a	n/a	n/a	n/a
Coastal ranges	0.14	100.00	1.29	97.49
Hills over tertiary sediments	n/a	n/a	0.03	2.51
Foothill	n/a	n/a	n/a	n/a
Over sedimentary rocks	n/a	n/a	n/a	n/a
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Type	Area_km2	%	Area_km2	%
Alluvial plain	6.85	19.38	7.16	5.70
Coast	22.38	63.32	71.87	57.16
Coastal ranges	n/a	n/a	n/a	n/a
Hills over tertiary sediments	n/a	n/a	n/a	n/a
Foothill	5.85	16.56	36.61	29.11
Over sedimentary rocks	0.26	0.74	10.10	8.04
TOTAL	35.35	100.00	125.75	100.00

Figure 37 Comparison charts of physical landscapes (Micro study area)

5.4.3. Comparison of hydrogeology in study areas

The macro study areas of both sites are commonly located on medium permeable soils. Based on Figure 38&39, site A shows that one third of the area has low permeable soils whereas on site B, it is only 5%.

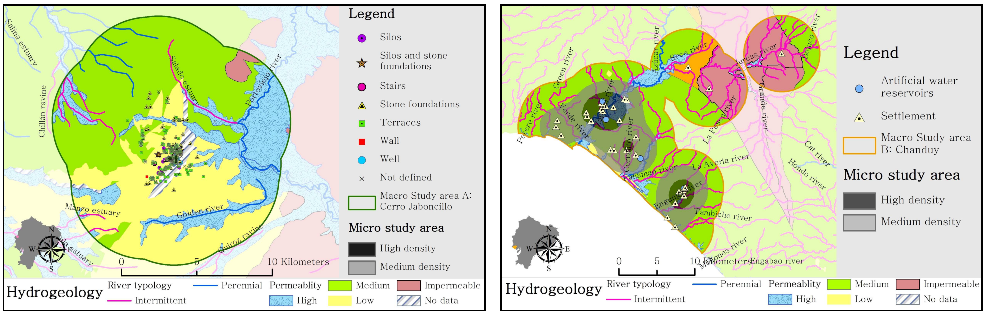


Figure 38 Comparison of hydrogeology in study areas

Permeability	Site A		Site B	
	Area_km2	%	Area_km2	%
High	44.00	22.45	48.17	9.68
Medium	80.00	40.82	333.77	67.05
Low	65.00	33.16	25.37	5.10
Impermeable	3.00	1.53	90.51	18.18
No data	4.00	2.04	n/a	n/a
TOTAL	196.00	100.00	497.82	100.00

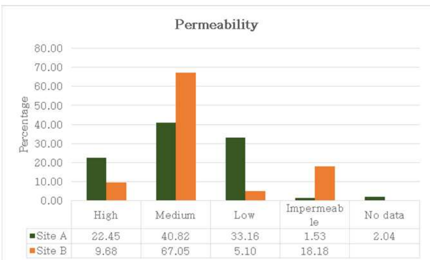


Figure 39 Comparison charts of permeability (Macro study area)

As shown by Figure 40 with the micro study area, in site A, the higher density of the settlements is located on low permeable soils. On the other hand, in site B the higher density of settlements is placed on medium permeable soils. The permeability of soils could be related with the type of water management techniques used by Manteños. The main water management techniques in Cerro Jaboncillo were wells, which are assumed that due to the low soil permeability, those structures were better for trapping the air moisture and storage of water for long periods. On other hand, in Chanduy, the main water technique was artificial water reservoirs (*albarradas*). Chanduy was characterized by long-term droughts and the occasional presence of heavy rains; hence, these systems (*albarradas*) allowed the dwellers to catch a great amount of water, boosting underground reserves, and safeguard water resources during the long periods of droughts.

Site A	High density		Medium density	
Permeability	Area_km2	%	Area_km2	%
High	n/a	n/a	n/a	n/a
Medium	n/a	n/a	0.10	7.50
Low	0.06	43.25	0.79	59.87
No data	0.08	56.75	0.43	32.63
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Permeability	Area_km2	%	Area_km2	%
High	11.42	32.29	12.32	9.81
Medium	23.93	67.71	109.59	87.31
Low	n/a	n/a	3.61	2.88
No data	n/a	n/a	n/a	n/a
TOTAL	35.35	100.00	125.52	100.00

Figure 40 Comparison charts of permeability (Micro study area)

5.4.4. Comparison of intermittent and permanent rives in study areas

Site B is mainly characterized by the presence of intermittent rives. While, perennial rivers on site A guaranteed water resource. Considering the dimensions of the study areas, site B is much bigger than site A, however both areas have a similar length of perennial rivers.

Permeability	Site A		Site B	
	Length_km	%	Length_km	%
Intermittent	25.22	42.11	302.70	89.84
Perennial	34.67	57.89	34.23	10.16
TOTAL	59.89	100.00	336.93	100.00

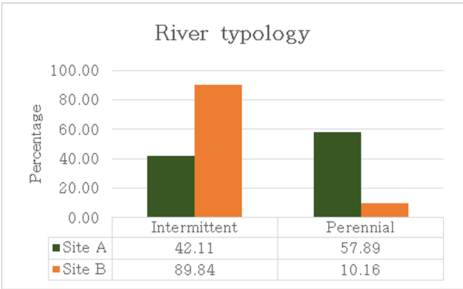


Figure 41 Comparison charts of river typology (Macro study area)

5.4.5. Comparison of soil in study areas

Based on the analysis, Cerro Jaboncillo has more variety of soil types than Chanduy Valley. Entisol and Inceptisol are the common soil types that are located on both areas. Most of the settlements in site A are located in inceptisol soils. In Chanduy, the settlement are mainly located on aridisol, with preference to be close to inceptisols. (See Figure 42&43).

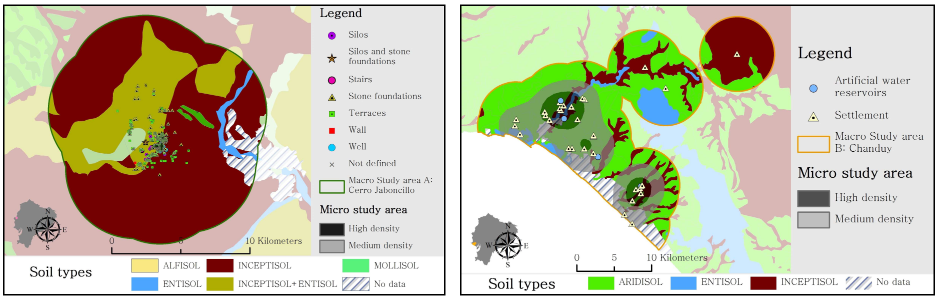


Figure 42 Comparison of soil in study areas

Soil type	Site A		Site B	
	Area_km2	%	Area_km2	%
ARIDISOL	n/a	n/a	290.04	58.20
ALFISOL	1.27	0.64	n/a	n/a
ENTISOL	3.10	1.56	37.18	7.46
INCEPTISOL	132.22	66.54	134.41	26.97
INCEPTISOL+ ENTISOL	50.86	25.60	n/a	n/a
MOLLISOL	4.81	2.42	n/a	n/a
No data	6.45	3.24	36.75	7.37
TOTAL	198.71	100.00	498.38	100.00

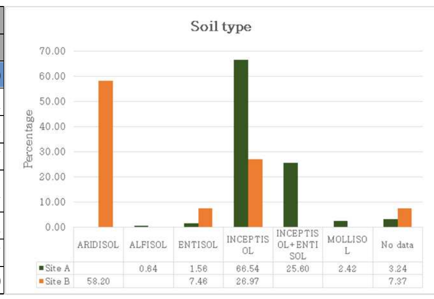


Figure 43 Comparison chart of soil types (Macro study area)

Due to the geographical location of the settlements, the soils types that are located on the area are different. Inceptisol and entisol are found on the two areas, but the amount on site A is much greater than in site B.

Site A	High density		Medium density	
Soil type	Area_km2	%	Area_km2	%
INCEPTISOL+ ENTISOL	0.06	42.50	0.76	57.56
INCEPTISOL	0.08	57.50	0.49	37.30
ARIDISOL	n/a	n/a	n/a	n/a
ENTISOL	n/a	n/a	n/a	n/a
MOLLISOL	n/a	n/a	0.07	5.15
No data	n/a	n/a	n/a	n/a
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Soil type	Area_km2	%	Area_km2	%
INCEPTISOL+ ENTISOL	n/a	n/a	n/a	n/a
INCEPTISOL	8.27	23.40	16.55	13.16
ARIDISOL	23.59	66.73	83.99	66.80
ENTISOL	2.30	6.51	7.05	5.61
MOLLISOL	n/a	n/a	n/a	n/a
No data	1.19	3.36	18.14	14.43
TOTAL	35.35	100.00	125.75	100.00

Figure 44 Comparison chart of soil types (Micro study area)

5.4.6. Comparison of slope in study areas

In site A, more than a 72.28% of the area has a slope from 25 to 70 %, whereas on site B the most predominant slopes are from 0-5% and >12-25% (35.74% and 30.69% of the area respectively). (See figure 45&46).

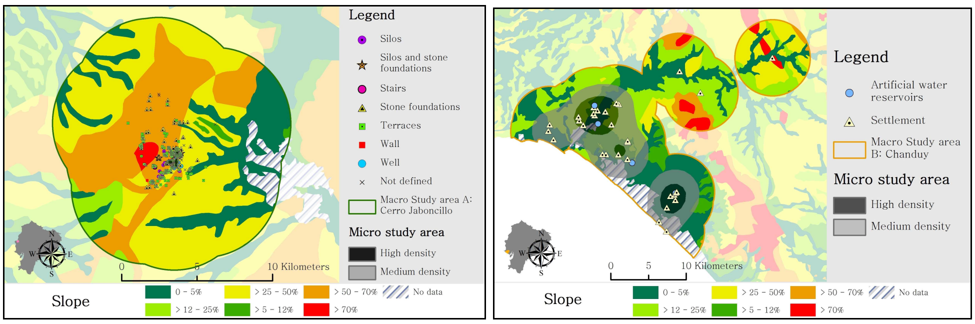


Figure 45 Comparison of slope in study areas

Slope	Site A		Site B	
	Area_km2	%	Area_km2	%
0 - 5%	38.19	19.22	178.14	35.74
> 5 - 12%	1.58	0.79	43.46	8.72
> 12 - 25%	6.98	3.51	152.97	30.69
> 25 - 50%	83.57	42.06	54.24	10.88
> 50 - 70%	60.05	30.22	18.83	3.78
> 70%	1.89	0.95	13.99	2.81
No data	6.45	3.24	36.75	7.37
TOTAL	198.71	100.00	498.38	100.00

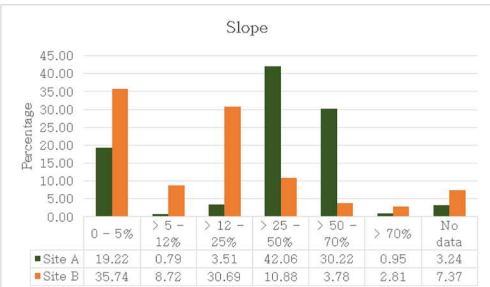


Figure 46 Comparison chart of slope (Macro study area)

The medium to high density of the micro study areas shared similar characteristics with the each macro study area. (See figure 47). However, in site A values differs slightly, because the highest percent on high-density area is positioned on >25-50% slopes, whereas on the medium density area is located on >50-70% slopes areas.

Site A	High density		Medium density	
Slope	Area_km2	%	Area_km2	%
0 – 5%	n/a	n/a	0.03	2.59
> 5 – 12%	n/a	n/a	n/a	n/a
> 12 – 25%	n/a	n/a	n/a	n/a
> 25 – 50%	0.08	57.50	0.43	32.75
> 50 – 70%	0.06	42.50	0.79	59.51
> 70%	n/a	n/a	0.07	5.15
No data	n/a	n/a	n/a	n/a
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Slope	Area_km2	%	Area_km2	%
0 – 5%	16.75	47.39	52.49	41.74
> 5 – 12%	7.73	21.86	17.82	14.17
> 12 – 25%	9.68	27.39	37.29	29.66
> 25 – 50%	n/a	n/a	n/a	n/a
> 50 – 70%	n/a	n/a	n/a	n/a
> 70%	n/a	n/a	n/a	n/a
No data	1.19	3.36	18.14	14.43
TOTAL	35.35	100.00	125.75	100.00

Figure 47 Comparison chart of slope (Micro study area)

5.4.7. Comparison of schematic vegetation in study areas

The macro study areas of both sites are generally located on summer dry forest and savanna. However, in site B a third part is positioned over desert and semi desert cactus bush vegetation, whereas on site A it is only 19.11% of the area. (See figure 48&49).

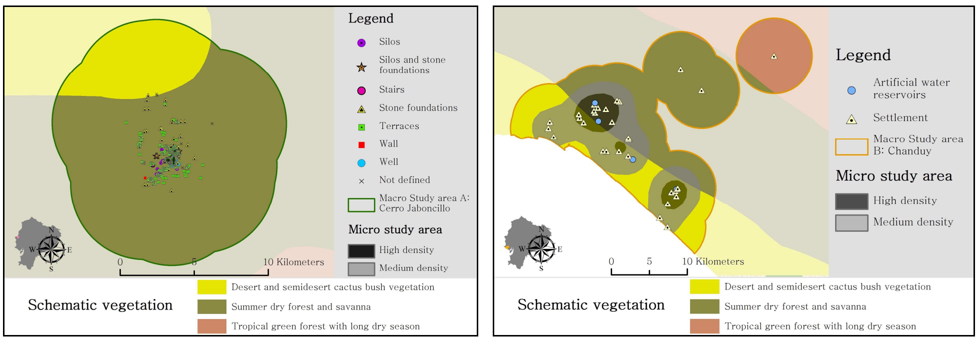


Figure 48 Comparison of schematic vegetation in study areas

Schematic vegetation	Site A		Site B	
	Area_km2	%	Area_km2	%
Desert and semidesert cactus bush vegetation	37.96	19.11	170.52	34.21
Tropical green forest with long dry season	n/a	n/a	73.93	14.83
Summer dry forest and savanna	160.74	80.89	253.93	50.95
TOTAL	198.70	100.00	498.38	100.00

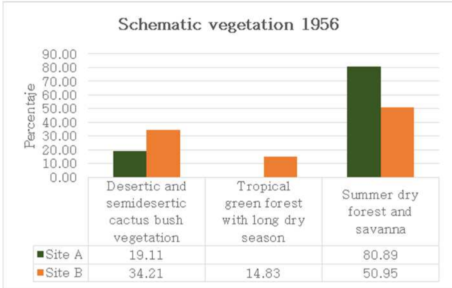


Figure 49 Comparison chart of schematic vegetation (Macro study area)

In case of micro study areas, site B has lesser number of types of schematic vegetation, from three to two comparing with the macro study area. Even though the composition of the macro study area is mainly cover by summer dry forest savanna, it turns out that in the case of micro study level a higher percentage of area is covered by desert and semi desert cactus bush vegetation. On the other hand, in site A the whole cover of the area has been reduced only to a summer dry forest and savanna. (See figure 50).

Site A	High density		Medium density	
Schematic veg	Area_km2	%	Area_km2	%
Desert and semidesert cactus bush vegetation	n/a	n/a	n/a	n/a
Summer dry forest and savanna	0.14	100.00	1.33	100.00
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Schematic veg	Area_km2	%	Area_km2	%
Desert and semidesert cactus bush vegetation	18.30	51.76	84.23	66.98
Summer dry forest and savanna	17.05	48.24	41.52	33.02
TOTAL	35.35	100.00	125.75	100.00

Figure 50 Comparison chart of schematic vegetation (Micro study area)

5.4.8. Comparison of the vegetation in study areas

The macro study area of site A is mainly covered by very dry arboreal vegetation (41.97%) followed by diverse crop (21.34%). On the other hand, site B very dry arboreal vegetation covers a small territory (11.53%), and it does not have diverse crops areas. In addition, while on site B, the herbaceous vegetation (33.24%), and, herbaceous and arid shrub vegetation (30.62%) cover a considerable part of the area, whereas site A do not present these type of vegetation. (See figure 51&52).

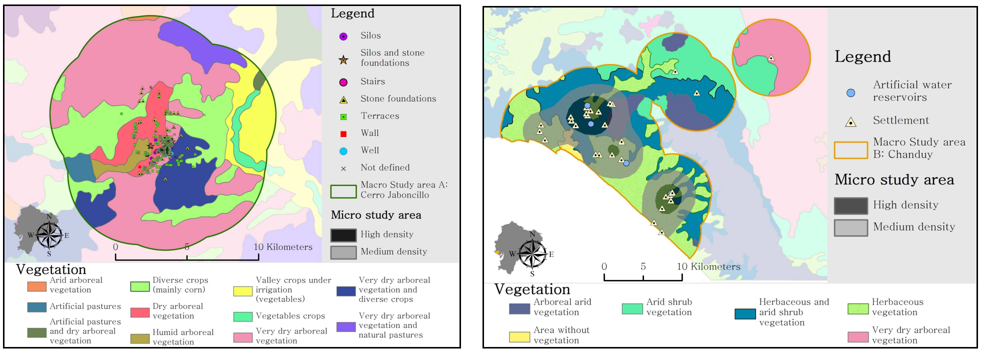


Figure 51 Comparison of the vegetation in study areas

N.	Vegetation	Site A		Site B	
		Area_km2	%	Area_km2	%
a	Area without vegetation	n/a	n/a	5.95	1.19
b	Arid shrub vegetation	n/a	n/a	76.20	15.29
c	Arid arboreal vegetation	0.58	0.29	40.46	8.12
d	Artificial pastures	3.25	1.63	n/a	n/a
e	Artificial pastures and dry arboreal vegetation	0.78	0.39	n/a	n/a
f	Diverse crops (mainly corn)	42.41	21.34	n/a	n/a
g	Dry arboreal vegetation	13.87	6.98	n/a	n/a
h	Herbaceous and arid shrub vegetation	n/a	n/a	152.63	30.62
i	Herbaceous vegetation	n/a	n/a	165.68	33.24
j	Humid arboreal vegetation	3.93	1.98	n/a	n/a
k	Valley crops under irrigation (vegetables)	16.61	8.36	n/a	n/a
l	Vegetables crops	3.76	1.89	n/a	n/a
m	Very dry arboreal vegetation	83.40	41.97	57.47	11.53
n	Very dry arboreal vegetation and diverse crops	21.09	10.62	n/a	n/a
o	Very dry arboreal vegetation and natural pastures	9.04	4.55	n/a	n/a
TOTAL		198.71	100.00	498.38	100.00

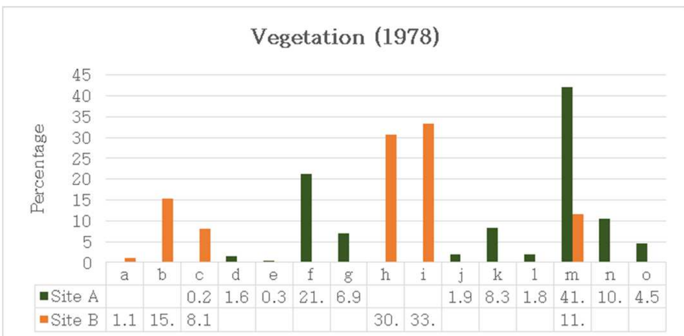


Figure 52 Comparison chart of vegetation (Macro study area)

Regarding the micro-study areas, five types of vegetation can be found in site A, while on site B four types are identified. It is important to highlight that the micro study areas A and B do not share a common type of vegetation.

Site A		High density		Medium density	
Vegetation		Area_km2	%	Area_km2	%
a	Area without vegetation	n/a	n/a	n/a	n/a
c	Arid arboreal vegetation	n/a	n/a	n/a	n/a
f	Diverse crops (mainly corn)	n/a	n/a	0.005	0.38
g	Dry arboreal vegetation	0.04	26.26	0.63	47.76
h	Herbaceous and arid shrub vegetation	n/a	n/a	n/a	n/a
i	Herbaceous vegetation	n/a	n/a	n/a	n/a
j	Humid arboreal vegetation	n/a	n/a	0.06	4.47
m	Very dry arboreal vegetation	0.10	73.74	0.56	42.06
n	Very dry arboreal vegetation and diverse crops	n/a	n/a	0.07	5.33
TOTAL		0.14	100.00	1.33	100.00

Site B	High density		Medium density	
	Area_km2	%	Area_km2	%
a			3.38	2.69
c	0.87	2.45	10.72	8.52
f	n/a	n/a	n/a	n/a
g	n/a	n/a	n/a	n/a
h	18.84	53.29	38.59	30.69
i	15.65	44.26	73.06	58.10
j	n/a	n/a	n/a	n/a
m	n/a	n/a	n/a	n/a
n	n/a	n/a	n/a	n/a
TOTAL	35.35	100.00	125.75	100.00

Figure 53 Comparison chart of vegetation (Micro study area)

5.4.9. Comparison of agricultural landscapes in study areas

Site A is covered by arboreal related vegetation, while in site B is common the predominance of herbaceous vegetation. Regarding the macro study area, both sites have five types of agricultural landscapes; but those areas only share one type of agricultural landscape, dense and deciduous forest. However, in site B, the amount is insignificant comparing the amount with site A. (See figure 54&55).

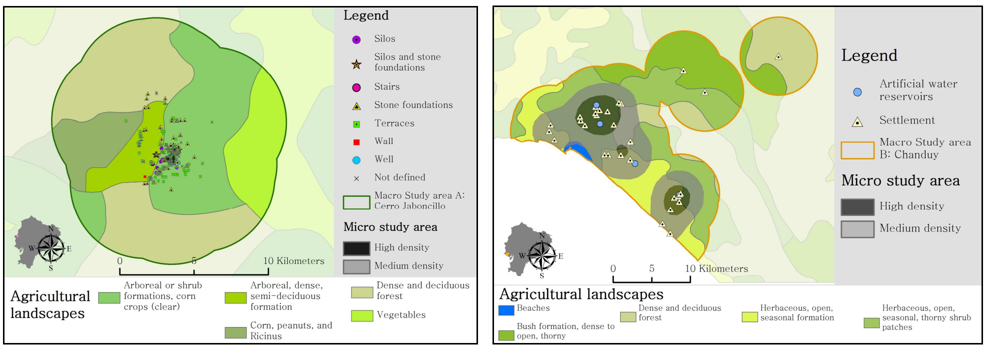


Figure 54 Comparison of agricultural landscapes in study areas

N.	Agricultural landscapes	Site A		Site B	
		Area_km2	%	Area_km2	%
a	Arboreal or shrub formations, corn crops (clear)	63.23	31.82	n/a	n/a
b	Arboreal, dense, semi-deciduous formation	14.71	7.40	n/a	n/a
c	Beaches	n/a	n/a	3.95	0.79
d	Bush formation, dense to open, thorny	n/a	n/a	93.96	18.85
e	Corn, peanuts, and Ricinus	17.96	9.04	n/a	n/a
f	Dense and deciduous forest	77.74	39.12	95.38	19.14
g	Herbaceous, open, seasonal formation	n/a	n/a	103.86	20.84
h	Herbaceous, open, seasonal, thorny shrub patches	n/a	n/a	201.23	40.38
i	Vegetables	25.06	12.61	n/a	n/a
TOTAL		198.70	100.00	498.38	100.00

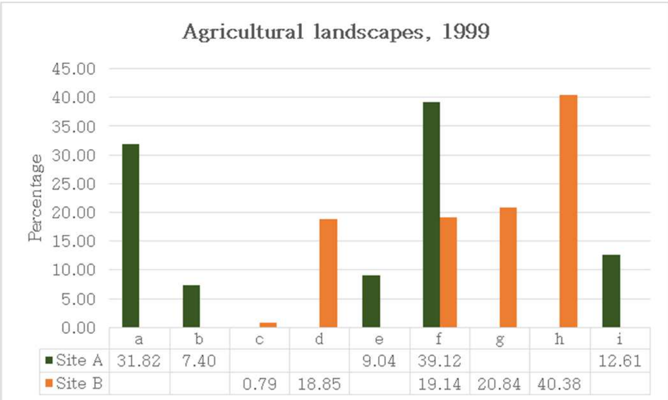


Figure 55 Comparison chart of the agricultural landscapes (Macro study area)

The agricultural landscapes that mainly covered site A are not found on site B, and vice versa. Dense and deciduous forest covered the two micro study areas.

Site A		High density		Medium density	
Agricultural landscapes		Area_km2	%	Area_km2	%
a	Arboreal or shrub formations, corn crops (clear)	0.14	100.00	1.12	84.44
b	Arboreal, dense, semi-deciduous formation	n/a	n/a	0.20	15.40
c	Beaches	n/a	n/a	n/a	n/a
f	Dense and deciduous forest	n/a	n/a	0.002	0.16
g	Herbaceous, open, seasonal formation	n/a	n/a	n/a	n/a
h	Herbaceous, open, seasonal, thorny shrub patches	n/a	n/a	n/a	n/a
TOTAL		0.14	100.00	1.33	100.00

Site B	High density		Medium density	
	Area_km2	%	Area_km2	%
a	n/a	n/a	n/a	n/a
b	n/a	n/a	n/a	n/a
c	n/a	n/a	0.92	0.73
f	1.22	3.44	12.12	9.64
g	9.21	26.06	50.99	40.55
h	24.92	70.51	61.72	49.08
TOTAL	35.35	100.00	125.75	100.00

Figure 56 Comparison chart of agricultural landscapes (Micro study area)

5.4.10. Comparison of agricultural suitability in study areas

The macro study areas of both sites are commonly located on places suitable for crops, in area A (69.34%) and in area B (81.28%). It is clearly evidenced that on site A, the grade of limitations is higher than in site B. Site B is an area with gentle slopes that facilitates the mechanization and irrigation process based on current agricultural practices.

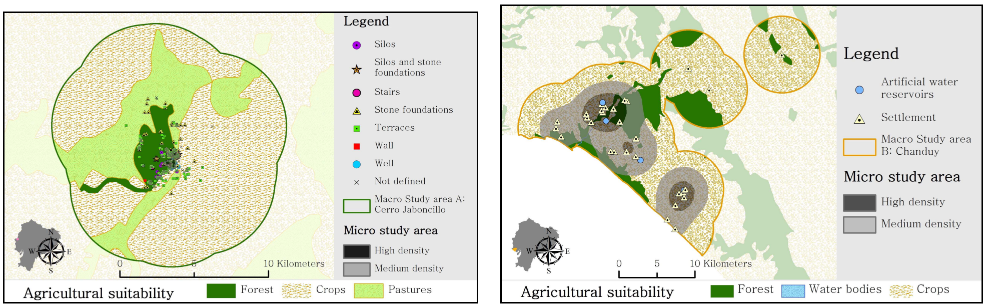


Figure 57 Comparison of agricultural suitability in study areas

Agricultural suitability	Site A		Site B	
	Area_km2	%	Area_km2	%
Forest	12.02	6.05	93.06	18.67
Crops	137.77	69.34	405.08	81.28
Pastures	48.91	24.62	n/a	n/a
Water bodies	n/a	n/a	0.24	0.05
TOTAL	198.70	100.00	498.38	100.00

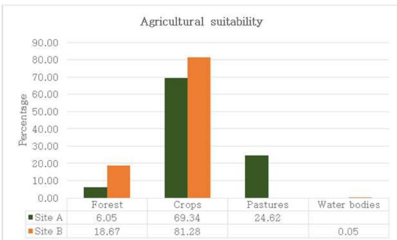


Figure 58 Comparison chart of agricultural suitability (Macro study area)

Regarding the micro-study area, a significant area of the territory of the site A is suitable for forest areas, while for site B the area is mainly suitable for crops.

Site A	High density		Medium density	
Suitability	Area_km2	%	Area_km2	%
Forest	0.08	56.90	0.90	68.07
Crops	0.06	43.10	0.37	28.23
Pastures	n/a	n/a	0.05	3.70
Water bodies	n/a	n/a	n/a	n/a
TOTAL	0.14	100.00	1.33	100.00

Site B	High density		Medium density	
Suitability	Area_km2	%	Area_km2	%
Forest	7.10	20.09	27.03	21.49
Crops	28.25	79.91	98.57	78.38
Pastures	n/a	n/a	n/a	n/a
Water bodies	n/a	n/a	0.15227	0.12
TOTAL	35.35	100.00	125.75	100.00

Figure 59 Comparison chart of agricultural suitability (Micro study area)

Chapter VI: Conclusions and discussion

6.1. Contribution to the Discussion

The landscape characteristics of the studied areas differ significantly, it is not possible to define a common specific landscape usage pattern on the two sites; however, settlements that were located on nearby areas tend to have similar conditions. Nevertheless, site A has a few intermittent rivers, while site B has many intermittent rivers. In which, long-term periods of droughts treated the dwellers' survival on site B. Site A has a diverse permeability, whereas site B has mainly medium permeability. Due to the permeability of site B, the water infiltrates easily. Site A has five soils; on the other hand, site B has three types of soils. The soil diversity increased the possibilities of developing a wide variety of crops. Site A has much slope variability, while site B has not much slope variability. The slope variability guaranteed diversity, which was an important clue on the settlements of Cerro Jaboncillo to thrive. Site A has 11 types of vegetation, whereas site B has six types of vegetation.

On microscale analysis, site B was unfortunate with difficult arid vegetation, whereas site A had various arboreal vegetation. The presence of arboreal vegetation provided more advantages to thrive because trees add stability to sustainable ecology with year round growth. Even though the territory of site A was located on a usually dry ecosystem, the presence of fog guaranteed humidity and the probabilities to have a continuous agricultural production that is not at risk of droughts. For the site B, long-term droughts and flooding due to heavy rains posed a continuously treat for agricultural production, the reliance on marine resources becomes a strategy to guarantee their survival. It is conceivable to state that site A had a lower water risk so a higher biodiversity could be found, and a diversity of crops could be grown. On the other hand, site B faced a high risk of water and within a low biodiversity.

Considering those facts, we can conclude that site A was more successful than site B, which was easier to collapse in long periods of droughts.

Landscape characteristics had a considerable influence on their life pattern. The Manteno-Huancavilcas' could utilize the landscape strategically in order to improve the hazardous conditions and to take advantage of natural conditions of their living ecosystem. Furthermore, as the Manteños Huancavilcas used to represent natural elements such as animals in their cultural manifestations, shows that Manteños were aware of the natural elements that composed their environment.

Moreover, considering the findings of Graber, 2010, it is possible to state that the settlements of Manteños- Huancavilcas that are located on the coastal areas have a similar land use pattern. Despite the difficulties, they were still able to develop agriculture by using their ancient landscape knowledge and water management techniques during dry and rainy season.

Manteños Huancavilcas survival strategy has been based on water management. However, in contrast to Manteños ancestral technics which prevent the rainwater run-off, minimize flooding issues, increase the underground waters, and avoid soils erosion; current artificial reservoirs with impermeable layers does not help with boosting underground waters. Hence, current technics does not guarantee a permanent water resource. Therefore, the application of technologies based on ancestral principles should be reconsidered in order to accomplish their ancestral functionality.

Evidence has shown that landscape use has changed significantly due to urbanization and deforestation. In site B, since ancient times dwellers depended on the marine resources that used to live in mangrove areas. However, those areas have been almost eradicated to implement shrimps harvesting tanks. Even though these type of enterprises, as other activities such as the exploitation of finite resources like oil reserves and other agricultural practices, may generate revenue for the country in the short term. Longer-term side effects of environmental degradation, reduction of biodiversity, which treats society as a whole, should be considered and mitigated.

Flipping through the pages of history, industrialization forces have been creating irreversible effects on the landscape. Further analysis on its impact studies should be done because the present actions may have indelible effects on the future generations. Hence, the planet earth is the only one that we have, and landscape is the only system that human beings have to survive.

Furthermore, the ancestor's survival story is tied to the landscape in which we live today, and that will not change. Several initiatives around the world have been trying to revitalize ancient practices to enhance ecosystem management and to provide alternative cultural narratives that can reinforce cultural identity of aboriginal people and modern man alike. The awareness of the ancient survival techniques can be a fundamental part in the construction of the cultural story that people can rely on. Perhaps, it may be able to provide some insights into alternative holistic practices that allow humanity to live harmoniously with nature in the future.

However, it is important to highlight that traditional environmental knowledge cannot solve all the contemporary issues that the world is facing and it will be quite challenging to satisfy the needs of 7.6 billion of people (United Nations[2], 2018) in the world. For these reasons, it is important to analyze critically which forgotten practices are worth revitalizing, but the commitment of each society member is needed to guarantee sustainability.

This pioneering study is focusing on landscape analysis system of historical landscapes by using current technologies and landscape analysis methods. This approach enhances archeological knowledge to show how ancient civilizations survived. With new perspectives to review history and archaeology, learning from the past can lead to the construction of sustainable cultural narratives that can enhance the survival of Ecuadorian society in the future.

6.2. Research limitations

A challenging issue that this research had faced is that most of the archaeological evidence was destroyed due to climatic factors, environmental characteristics of the area, or looting of archaeological artifacts. The evidence on which this work is based was generated in the post-colonization era, making this research a pre-Columbian study based on colonial perspectives that might not be fully accurate. Therefore, a truthful reconstruction can be influenced considerably due to the lack of information. However, the landscape system is still the same and provides clearly reliable, additional data on survival strategies of ancient cultures. However, there are still many questions to be answered for future research. Did Chanduy people were just unlucky to have chosen a less favorable place to live? Were they inferior people that had no choice?

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Appendix

7.1. Additional support references

a) Appendix 1: List of the current vegetation of Cerro Jaboncillo

ORDER	FAMILY	Scientific name	Common name
Malvales	Bixaceae	*Cochlospermun vitifolium* Spreng.	Bototillo
Malvales	Malvaceae	*Ceiba trichastandra* Mill.	Ceibo
Malvales	Malvaceae	*C. pentandra* (L.) Gaertn.	Ceibo
Sapindales	Burseraceae	*Bursera graveolens* Triana & Planch.	Palo santo
Lamiales	Bignoniaceae	*Tabebuia chrysantha* G. Nicholson	Guayacán
Lamiales	Bignoniaceae	*T. chapelle*	Madera negra
Fabales	Leguminosae	*Libidibia corymbosa* (Benth.) Britton & Killip	Cascol
Fabales	Leguminosae	*Prosopis inermis* Kunth	Algarrobo
Rosales	Rhamnaceae	*Ziziphus thyrsiflora* Benth.	Ébano
Boraginales	Boraginaceae	*Cordia lutea* Lam.	Muyuyo
Malvales	Muntingiaceae	*Muntingia calabura* L.	Nigüito
Brassicales	Capparaceae	*Capparis crotonoides* Kunth	Zapote de perro
Ericales	Primulaceae	*Jacquinia sprucei* Mez	Barbasco
Caryophyllales	Cactaceae	*Cereus* Mill	Sebastián

By the author using information in Tobar, 2013

7.2. Summary in Korean (요약본, 국문초록)

콜럼버스가 미 대륙을 발견하기 이전의 에콰도르조경 규명; 만테니오 환카빌카에 대한 선도적 연구

자연적 특징은 고대부터 우주 창조에 강한 영향을 미쳤다. 문화적, 영적인 가치 또한 자연적 특징못지 않게 중요하고, 이로 인해 조경을 구성하는 장소와 요소는 고대 문명이 환경의 자연적 특징을 활용할 수있도록 해주는 기능적이고 영적인 의미를 지닌다. 실제로, 기원전 650 년에서 1532 년까지, 콜럼버스가 미대륙을 발견하기 이전의 에콰도르 사람들은 만테니오 환카빌카 통해 번영하고 발전된 문명을 유지했다. 이 문명은 에콰도르 연안을 따라 물 부족이라는 위험한 조건의 생태계를 가지고 있었지만, 에콰도르사람들은 농업과 무역을 기반으로 풍요로운 문명을 창조하고 생존할 수 있었다. 하지만, 에콰도르 사람들의 고대 지식과 전통적 관습은 식민지화로부터 기인된 문화적 소외에 의해 거의 근절되었다. 현재 고고 학적 보고를 통해 제공되는 정보는 체계적이지 못하고 매우 제한적이다. 역사적 보고 또한 조경의 물리적 특성과의 어떠한 상세한 비교도 없이 매우 일반적인 정보만을 제공함으로써, 고대 문명과 자연 환경간의 관계를 이해하기 어렵게 한다. 이에 따라, 본 연구는 미 대륙 발견 이전의 콜럼버스 문명의 조경 조건을 가정하여 재구성하고, 역사적, 고고학적 및 지리적 증거들을 통합하여 만테니오 환카빌카 문명이 일상 생활에서 자연적, 물리적 조건 환경을 어떻게 활용했는지에 대한 역행 접근법을 제공하고자 한다.

주요어: 민족 지학, 고고학, 고대 조경 건축, 문화 경관, 콜럼버스 미 대륙 발견 이전의 조경 관리

7.3. Summary in Spanish (Resumen)

DESCIFRANDO EL PAISAJE DE CIVILIZACIONES PRECOLOMBINAS ECUATORIANAS; UN ESTUDIO PIONERO SOBRE LOS MANTEÑO HUANCAVILCAS

Los elementos naturales han tenido una influencia significativa en la creación del espacio desde tiempos ancestrales. Los valores culturales y espirituales no han sido menos importantes; por tal motivo, los lugares y elementos que componen el paisaje tienen significados espirituales y funcionales los mismos que han permitido a los asentamientos ancestrales aprovechar las condiciones naturales del medio ambiente. En efecto, entre las culturas precolombinas ecuatorianas, los Manteño-Huancavilcas mantuvieron una civilización próspera y avanzada desde 650 a 1532 DC. A pesar de que esta cultura estaba ubicada en un ecosistema con condiciones precarias caracterizado por la escasez de agua a lo largo de la costa ecuatoriana; fueron capaces de sobrevivir y crear una civilización próspera basada en la agricultura y el comercio. Sin embargo, sus antiguos conocimientos y prácticas tradicionales casi fueron erradicados por la alienación cultural que vino con la colonización. Actualmente, los informes arqueológicos brindan información limitada y aislada sin ninguna sistematización. Los informes históricos son demasiado generales sin comparaciones detalladas con las características físicas del paisaje, lo que dificulta comprender la relación de esta antigua civilización con su entorno natural. Por lo tanto, la presente investigación es un estudio pionero trans-disciplinario que tiene como objetivo reconstruir hipotéticas condiciones del paisaje precolombino y proporcionar un enfoque retrospectivo sobre cómo los Manteños-Huancavilcas utilizaron las condiciones naturales y físicas de su entorno en su vida cotidiana mediante el análisis de evidencia histórica, arqueológica y geográfica.

Palabras clave: *Etnoecología / arqueología / ecología del paisaje / paisajes culturales / manejo del paisaje precolombino*