CENTER OF TERRITORIAL DOMAINS AND THE NETWORK OF THE INCA ROAD - QHAPAQ ÑAN, IN THE PROVINCE OF TUMBES - PERU

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ABSTRACT

The present research aims to mathematically determine an archaeological site through spatial range-size analysis of limits and cultural boundaries. The methodology used collects information from archaeological sites in the province of Tumbes, identifies the urban centers of more significant extension, are spatially located using ArcGis software with ArcMap tool; with the spatial model, X-Tent also determined the territorial domains of attachment, in the analysis of the road network, generates the longitudinal profile and areas of influence through Thiessen polygons with which the domain areas are compared. With the values obtained, the territorial proportion has a constant K = 1/555; with these values, the domains of the archaeological sites of "Cabeza de Vaca" with an extension of 142,671.15 has an "El Guinea" with an area of 17,836.73 has been determined, located in the province of Tumbes district of Corrales and San Jacinto, separated by a distance of 60 km, linear. The boundaries intersect territorially at the Huásimo archaeological site. It is concluded that the domain "Cabeza de Vaca" has an occupation of 80.62% and "El Guineal" of 10.08% of the province of Tumbes; it was determined that in the intersection of both is located an archaeological site that was used as Tambo by the Incas, currently called Huásimo at an altitude of 787 meters above sea level.

KEYWORDS

Domains, Networks, Nodes, X-Tent, Thiessen Polygons.

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1. INTRODUCTION

The great Inca empire was interconnected by a network of roads called "Quapaq Ñan," this network is distributed throughout Peru, including neighboring countries, the major network of the Inca road that goes from Cuzco - Cajamarca - Quito, has a detour in Piura (Poechos) to the west to intercept the Qda. Cuzco, continuing along this road you reach the archaeological site known as Guineal, continues through the dry forests of the protected natural area Cerros de Amotape, arriving at Rica Playa (CCPP), the road continued westward to reach the archaeological site of Cabeza de Vaca (Province) (Esenarro *et al.*, 2021).

During Inca times, the Inca provinces were a critical territorial unit of imperial organization and administration (Vitry, 2017) These provinces were not mapped or physically restricted due to border limitations, and there is no clear information in ethnohistoric sources about their administrative and economic role. Regarding the Inca provinces, there is little discussion of their participation in the Tawantinsuyo and rarely an archaeological analysis of the provincial organization (Chacaltana *et al.*, 2017).

Tumbes was peacefully annexed to the great Tahuantinsuyo Empire during the rule of the Inca Tupac Yupanqui, who, after subjugating Quito, decided to incorporate the "valleys of the plains" (Tumbes). The Incas introduced the customs of the Inca Empire, teaching to worship the Sun (Inti) and the Moon (Killa), so it was ordered to build a temple for the worship of the Sun, a house for the chosen virgins, a fortress where they were located as a garrison of war to people loyal to the Inka, a residence for the Inka "Huayna Capac" during his stay in the region (Hernandez, 2012). Likewise, many warehouses were built with supplies for the people who resided there or the warriors who passed through. All this represented the central city of Tumbes - Inka, which today is known as the monumental archaeological complex Cabeza de Vaca.

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Commercially Tumbes - Inka, and its city Cabeza de Vaca-, was a port of exchange, where it entered by sea from the north; the Spondylus heading south, by land by means of llama herds by "The way of the plains or Inca Trail." For this, it is presented as evidence over the entire scope of the project between Cabeza de Vaca and Rica Playa that, during the late horizon, "the Spondylus entered in rafts through ancient Tumbes, were transported by land and were carved in the tambos, also considering the findings of these shells along the coastal road between Poechos and Serran that confirm this transport" (Marcone, 2020).

The Guineal Center is located 8 km southwest of the hamlet of Capitan Hoyle and 64 km from Tumbes, in the lower middle course of the Quebrada Cusco, the current boundary between the Departments of Tumbes and Piura. It is located at 250 masl, UTM coordinates 9 543 363 N and 551 195 E.

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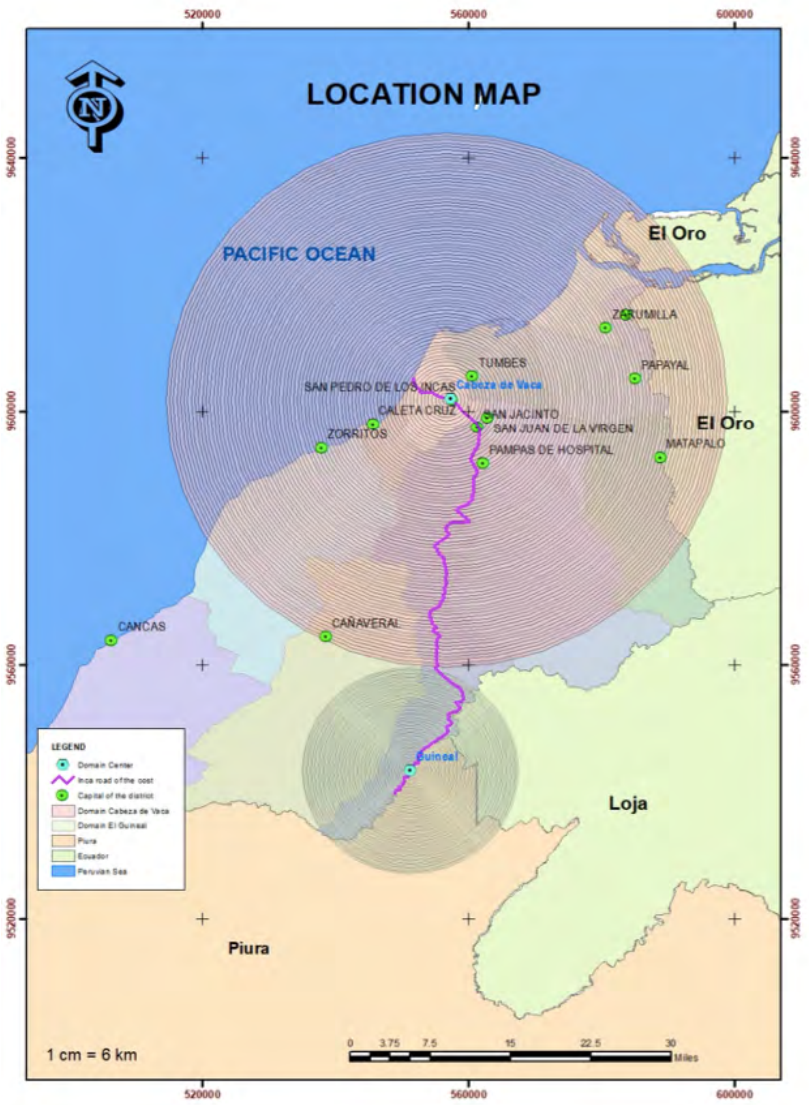

Figure 1. Location Map.

Source: own elaboration.

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The Inca Road

Approximately five hundred years ago, when Europe was on its way to the American coasts, a vigorous process of development and integration was taking place in large part of the territory now occupied by the countries of the Andean region, which was the product of one of the greatest civilizations in the world, the Incas (Ministerio de la Cultura, 2013).

The Inca empire was the most crucial state in American history, and its creation would have been impossible without the road system that served transportation, communications, and administration. Elevated roads in the Andean region take on particular importance when compared to those of other societies. For this reason, early Europeans repeatedly praised Inca roads and found them superior to those of 16th century Europe (Sternfeld, 2007).

Many of the Inca roads are still intact, and some are in excellent condition. Using this road system, diverse activities were developed, which are indispensable in the development and functioning of a state. It was as if a single, enormous entity replaced our air, rail, and land networks, our postal and telephone system, as well as part of the national administrative system (Vilchez, 2013).

The Inca roads represented the power of a state around not only its space articulated by 23,000 km of roads but also the link between the natural and the supernatural, within a cultural universe that stretched from the north of Argentina and Chile to the plains of Venezuela.

For the Incas, the Capac Ñan or Inca Ñan (Great Road or Inca Trail) was a complex administrative, transportation, and communications system and a means of delimiting the four primary divisions of the Empire. The main road led from the capital, Cusco, to each of the four suyos into which the Inca Empire was divided (Antisuyo, Contisuyo, Chinchaisuyo, and Collasuyo). The Inca roads also described the geography of the state and the control it exercised over the peoples that formed it (Moralejo, 2012). For the conquered peoples throughout the empire, the roads constituted an omnipresent symbol of the power and authority of the Inca state. There must probably have been very few individuals subject to

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the empire who had not at some time seen an Inca Trail. The vassal populations also understood that the roads were built and maintained with their labor; as part of their obligations to the dominant state, the Inca Empire had to be seen as a symbol of the power and authority of the Inca state.

The Inca road system had two major longitudinal roads, one from the coast, which linked the current Chilean territory with Tumbes; the other, the backbone of the kingdom, linked Cusco with Quito, crossing the entire highlands; in many sections, it was paved and equipped with drains, bridges, retaining and defense walls, embankments and steps. The Great Road or Capac Ñan of the Sierra was up to 16 m wide in some places. Some passes had a double roadway, one paved and wide and the other narrow and solid; through one passed the Inca and his court and through the other the supplies and helpers. On the southern coast of Peru, in the Waca ravine, there is a transversal road that carried fresh fish from the sea to the imperial capital of Cusco.

The Chinchaisuyo road was the most important of all. Its construction under the government of Tupac Yupanqui was the most significant state work of the imperial phase of the Quechua Cusco. When the territory of the Cañaris and the humid mountain ranges of the north were incorporated, the Incas weaved their network of roads according to the social system, and thanks to this way of organizing themselves, they developed an admirable road technology, which knew how to take advantage of previous traces and left, paradoxically, a precious inheritance to their European conquerors (Matos, 2017).

At its northern end, from Cajamarca, the Capac Ñan took the Ecuadorian province of Loja to Tomebamba (now Cuenca). In Loja, the road passed through the Mariviña and Bola tambo. In Cuenca, a place of admirable roads, the great tambos were Tambo Blanco, Tomebamba itself, Paredones and Ingapirca, in the area called Hatun Cañar.

The transformation of the social organization accompanied the Inca entrance to the current Ecuadorian territory; the organization of work was made according to the Inca rotation systems to supply goods and services to the state structures (especially roads and tambos) (Pino, 2016). That is why this road appeared

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due to the last conquests, in the highest phase of Inca development, and its construction is of excellent quality.

In Inca times, the journeys were measured so that at the end of a trip (more or less every 30 km), there was a large inn or Tambo. The Tambos Reales were equipped with authentic palaces with deposits for food, called colcas, meeting spaces and rooms for permanent service personnel. In addition, there were also post-like way points, the chasquiwasis, used by travelers and couriers (chasquis) (Smith, 2017).

2. METHODOLOGY

2.1. THE INCA DOMAIN

His political-social organization responds to the needs of a population, considering the potentials that the soil, air, and water give us; in this sense, urban growth was fixed since Inca times in good soil (agricultural) and water sources. In addition to the connectivity provided by a good road, the analysis of the streets should be carried out with the integration of multiple layers of information that include the review of data from archaeology, history, toponymy, ethnography (oral tradition), photographic and cartographic documentation, whether historical or recent, as well as other sources related to these that allow us to recognize the characteristics of the object of study: in our case, the Inca road network (Verhagen, 2018).

In the archaeological sites of the province of Tumbes, 99 vestiges were identified among mounds, enclosures, headwalls, tambos, canals, roads, among others, of which 25 are recognized as sites that housed population (Diaz, 2013).

A historical identification of these sites is made to determine the centers that had a more significant extension or larger structures over the other archaeological sites; in this sense, the El Guineal Center is identified, which has an attachment of 0.45 has and Cabeza de Vaca with 2.5 has; the constant (k) is

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calculated, placing the smaller area over the larger one, obtaining the value of k = 1/x where x is the value of small size over a large area.

$I = f(C) = k * d$ X-Tent Model

I = Measure of Potential Political Influence of the Population Center

f(C) = Domain Center (size of infrastructure)

k = Constant (proportional size of the comparison of the structures of the centers)

d = Distance from the radius

Obtained the values we accept that our constant is K = 1/5.55 this value we multiply it by 100 getting a deal of 100% for Guinea and 555.55% for Cabeza de Vaca, with these values the domains are determined through the Arc Gis program.

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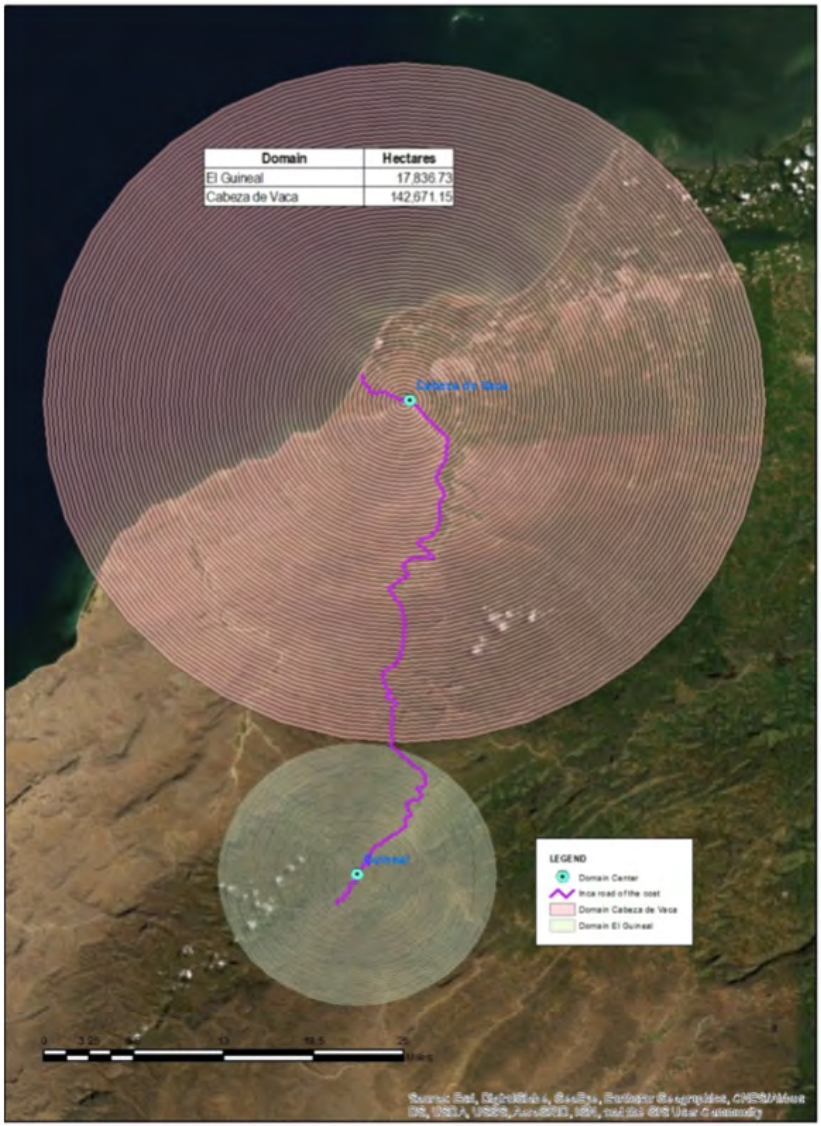

Figure 2. Territorial Domain of Cabeza de Vaca and El Guineal.

Source: own elaboration.

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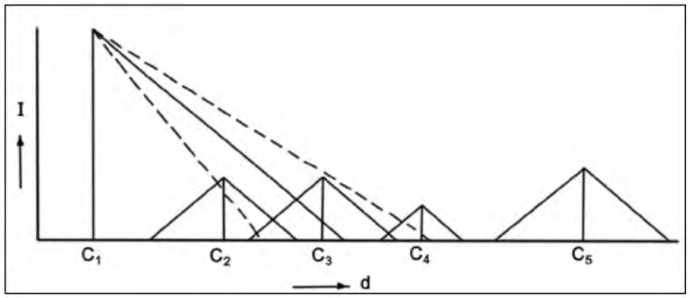

Figure 3. The X-Tent model.

Source: own elaboration.

Figure 3 presents the domain influence between the centers named C1, C2, C5, with a distance separating them (d); the size of each center is represented by a vertical line (I), The domain radius of each is given by the intersection of the continuous oblique line, which corresponds according to the size and growth constant. The dashed lines indicate the variation effect. In the figure, it is seen that C2 and C3 is influenced by C1, while part of C4 is out of reach and C5 totally out of the influence of C1.

2.2. CURRENT AND INCA ROAD NETWORK

The road network analysis is focused on identifying the connection of these with the various current and Inca population centers. To do this, using the geographic information system tool, we will spatially identify the current roads and the position of the population centers from which we will obtain the areas of influence through Thiessen's polygons (Martinez, 2010).

To obtain the measures of centrality, I will base myself on the current map of the Inca Road Network of the study area (Figure 2-3), dividing this network into sections defined by nodes and the connections between them; each identified Inca center corresponds to a node (point or vertex). Each unit is defined by two nodes located at the ends and the Inca Trail that links them.

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The Thiessen polygons (interpolation method, based on the Euclidean distance) are constructed from nodes (population centers) and networks (straight lines that join the nodes), with the nodes unions, are generated forming triangles and finding the point of the circumcenter from this point the perpendicular bisectors are traced to each segment, the intersections of these perpendicular bisectors determine a series of polygons of two-dimensional form (Peña *et al.*, 2019).

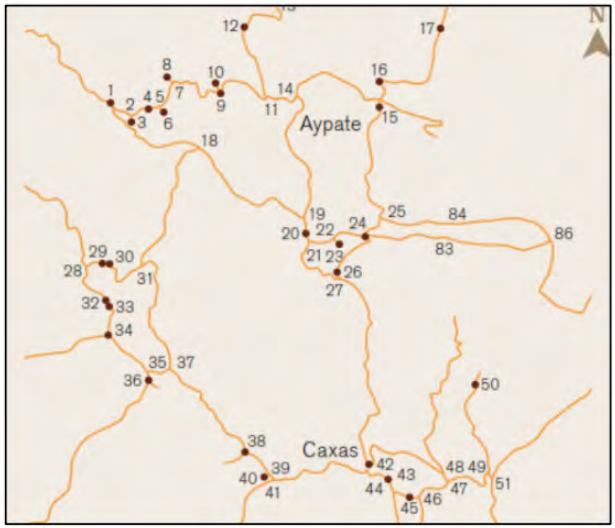

Figure 4. Inca roads in the highlands of Piura and associated sites.

Source: own elaboration.

The Inca road was understood as a road network. This network served as the articulator of a hierarchical administrative system of sites, including administrative centers and tambos. At the end of the day, these were the imperial structures that allowed an adequate administration of the imperial area. The Inca Trail and Inca archaeology in general, allowing not only to change the scale of analysis and link the past with the present, but also to give meaning to heritage management by linking the trail with its territory and its people. Figure 4 shows the Inca road network that reached Tumbes (Bernabe, 2017).

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Figure 5. The Red Inca of Quapaq Ñan.

Source: own elaboration.

The great Inca Trail was an extraordinary achievement in design and engineering, unifying the Empire both physically and conceptually. Four main roads led from Cusco, the capital, to the four parts of the kingdom, while two longitudinal roads on a north-south axis formed the backbone of the entire territory.

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Figure 6. Typology of Inca roads and associated centers in southern Ecuador and northern Peru, considering the environmental characteristics.

Source: own elaboration.

Figure 6 shows the red line, a longitudinal road (Qhapaq Ñan) that associates the leading and most significant urban centers. In contrast, the Inca road of study in this research is a transverse road (orange color) but transcendental for the Inca commercial period and the area's locals (Bar, 2017).

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3. RESULTS

3.1. CENTER OF DOMINION

According to X-ten, the urban centers gave the Inca Domain Centers respect to their size, which considers that the dominance of the provincial centers is related to their size or the distance between these centers.

3.2. CABEZA DE VACA CENTER

Location, It is located on the left bank of the Tumbes River, Lower Valley. In the current hamlet of Cabeza de Vaca, district of Corrales, province, and department of Tumbes. It rises above 23 meters above sea level. With UTM Coordinates of 9 602 000 N and 557 300 E., It is bordered on the north by the Pan-American Highway, on the east by the town of Corrales, on the west by La Garita hill, and the south by Loma del Viento.

It is accessed from Tumbes, 5 km from the Pan-American Highway north to the Corrales intersection. Take the Via de Evitamiento for 500 meters to the Cabeza de Vaca intersection and continue along a dirt road to the Cabeza de Vaca Sur hamlet. It is located at the junction of the hilly area with the plain; the site is bisected by the current irrigation canal and the Pan-American Highway North.

Type of Site: It is a Monumental Complex (Ceremonial Administrative Center), which currently occupies a space of approximately 100 hectares and consists of a series of stone and adobe structures, from which sectors are defined with functional and hierarchical differences (Administrative - religious - productive), such as:

The Huaca del Sol: It is the monumental structure of greater volumetric not only within the Archaeological Complex of Cabeza de Vaca but in the Valley of Tumbes; it is a truncated pyramid of adobe, erected in staggered levels, it is of rectangular plant oriented from southwest to northwest, it measures 250 meters long, 100 meters wide and 15 meters high. However, it appears to be a solid body inside. There

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are enclosures, passageways, patios, with walls 3 meters high, currently buried, whose heads are barely drawn on the ground as slight longitudinal elevations (González, 2017).

Malacological Workshop: Located in one of the hills located to the east of the Huaca del Sol. On the surface, there are a large number of malacological remains such as bivalves (Spondylus, Anadara, Ostrea) and shells (Strombus, Conus, Melongena) in different stages of work: complete, cut, totally or partially polished fragments; likewise, nodules, silhouettes of figures (preforms) and beautiful tiny figurines with anthropoid, Phyto and zoo morph representations have been recovered from this workshop; as well as lithic instruments that served to polish, cut, scrape and drill the raw material. Private collectors in the Department of Tumbes have valuable samples obtained in this workshop.

Huacas Menores: A group of mounds, whose floors do not exceed 40 x 30 meters and their height ranges between 3.8 and 1.5 meters, erected on the plain that extends to the north of the Huaca del Sol. These structures have been built with adobe and stone foundations, and their original size and shape have been destroyed by farmers using heavy machinery (Vilchez, 2015).

Irrigation Canal: It crossed the archaeological zone from east to west. Its line has disappeared, although versions indicate that the modern canal that runs parallel to the west side of the Huaca del Sol is the same line of the pre-Hispanic channel.

Associated Material and Cultural Filiation: Surface concentrations of cultural material are observed, both ceramic fragments of local style, tallán, Chimú, and Inca; malacological remains, both carving debris and remains of food, in addition to bone remains and stone tools (Albeck, 2016).

State of Conservation: The site is in a deplorable state of conservation. Currently, the Monumental Archaeological Zone of Cabeza de Vaca is subject to systematic destruction, accelerated during the last few years due to natural factors but, above all, to human action. Population growth and the expansion of the agricultural frontier are currently the significant impacts, as the need to install services for the population settled on the ruins (water and sewage networks, electrification, access roads, street paving,

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land clearing, etc.) have a significant impact on the destruction of archaeological contexts and the deterioration of the movable and immovable property.

In recent months, the population, instigated by some politically motivated individuals, has been demanding the execution of public works, threatening the Regional Cultural Directorate of Tumbes if they are not granted the permits they are requesting (Alessandri, 2016).

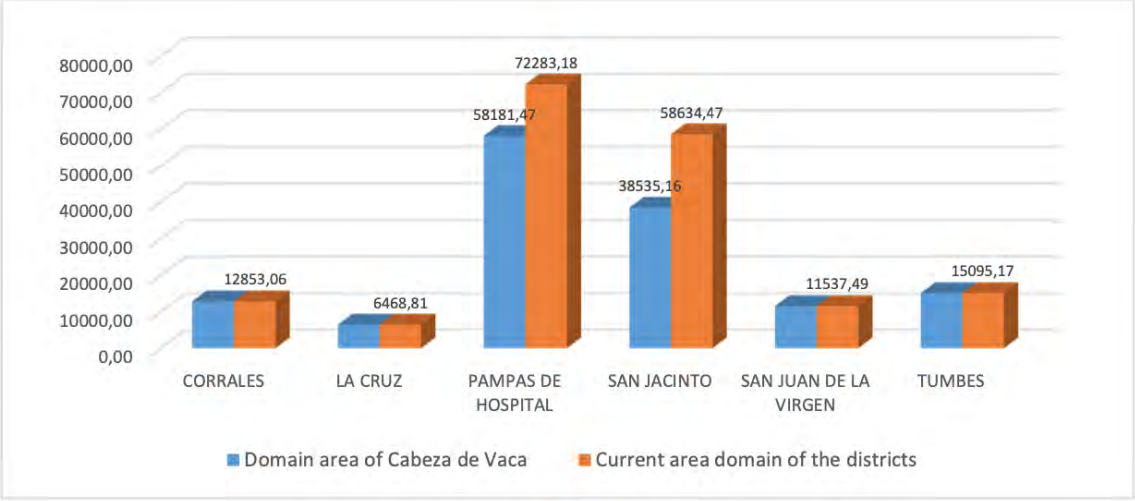

Figure 7. Areas of the Cabeza de Vaca Center domain and the current locations of the districts of the Province of Tumbes.

Source: own elaboration.

Figure 7 shows that the districts of Corrales, La Cruz, San Juan de la Virgen, and Tumbes were dominated, while the communities of Pampas de Hospital (80.5%) and San Jacinto (65.7%) were overwhelmed by the Cabeza de Vaca Center.

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3.3. GUINEAL CENTER

Politically it belongs to the Province of Tumbes, District of San Jacinto in the Department of Tumbes, and the Province of Sullana, District of Lancones, in the Department of Piura. It is located 8 km southwest of the town of Capitan Hoyle and 64 km from Tumbes, in the lower middle course of the Quebrada Cusco, the current boundary between the Departments of Tumbes and Piura. It is located at 250 masl, in UTM coordinates 9 543 363 N and 551 195 E.

It is accessed from the city of Tumbes by following the Pan-American Highway North for 35 minutes to Bocapán. At this point, take the paved road to Casitas for 1 hour until the turnoff to Huásimo. After 3 hours, you arrive at the town of Capitán Hoyle, formerly Cazaderos, where you begin a 2-hour hike along the Cusco Creek upstream to the Guineal sector (Bernal, 2020).

In this section, the Cusco Creek has a regular surface, wide, sandy-stony bed. In contrast, the Guineal or El Mango Creek, which flows into the left bank, has an irregular surface, winding course, and a narrow, rocky bed with permanent water even in years of extreme drought. On the right bank, the surrounding hills are of medium elevation (sector 1); the lower part is an alluvial terrace with flat relief (sector 2), while the opposite side is higher with a moderate slope at the bottom (sectors 3 and 4). The vegetative cover consists of carob, pego pego, black huayacán, lion's ear, barbasco, charán, pasallo, polo polo, angolo, huápala, negrito, huarapo, sapote, hualtaco, palo santo, and shrubs such as aserrilla, frejolillo, and tongo (Diaz, 2013).

Type of Site: It is an archaeological complex composed of several stone structures, occupying approximately 14 hectares, on both banks of the Quebrada Cusco. To facilitate the study and description of the site, the site has been divided into four sectors. Each occupies a defined topographic location and shows peculiar characteristics in terms of the structures' density, shapes, and sizes.

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Table 1. Divided into four sectors.

Sector 1	On the top of a hill, on the right side of the Quebrada Cuzco, there is a small structure of 5 x 4 meters, built with two staggered levels of one meter high, from where the environment is visually dominated, on both sides of the slope there are retaining walls of rustic manufacture.
Sector 2	At the foot of the hill mentioned above, a set of rectangular structures with a series of internal divisions associated with a stepped design on a relatively flat relief. The slope towards Cuzco Creek has been protected with retaining walls.
Sector 3	It is the sector of greater hierarchy; it is a truncated Pyramid, achieved with three staggered levels; it is approximately 100 meters long, 45 meters wide, and 6 meters high. The upper part is flat and is divided into three large rectangular rooms; the second and third rooms have smaller enclosures in one of its corners and an oval-shaped mound inside these enclosures. There is a stairway in the front of the pyramid that connects with an epimural path on the lower level. Towards the sides of the pyramid, there are attached in the lower part, expansive rooms of rectangular plan erected with quite wide walls (1.20 meters) which are of double facing and have been built with stones of significant size (80 x 90, 78 x 82). The front of the pyramid is located in front of the Quebrada Cusco, while the Quebrada Guineal delimits the back and the right side.
Sector 4	On the slope located on the left bank of the Quebrada Guineal, there is a set of three architectural structures with internal divisions defined by walls of different dimensions, which are separated from each other by runoffs of 2 to 3 meters wide, which have been channeled. Associated Material and Cultural Filiation: The surface cultural material has always been very scarce; however, during the last visit, a forging made by a local some weeks ago in sector 4 allowed finding abundant ceramic fragments in the corner of one of the enclosures, which corresponds to the Inca and paleteado style, confirming our initial appraisals on the place (20).

Source: own elaboration.

The state of Conservation. During the last few years, there has been an increase in visits, especially from high school students, which affects the conservation of the site because they spend one or more nights there: they use the stones from the walls to build fire pits and campsites, they walk on the top of the walls causing them to come loose, and they leave non-degradable garbage such as bags, cans, and bottles.

The nearest town is located 2 hours away on foot (Capitán Hoyle, Ex Cazaderos), but they have always felt great respect for the site, which explains why they have not depredated it; however, the progressive increase of visitors to the site has also awakened their curiosity, especially the younger ones, being the cause of the mentioned forging that allowed the identification of the ceramic material (Chacaltana *et al.*, 2017).

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Figure 8. The Guineal Archaeological Center.

Source: own elaboration.

On the other hand, a destructive agent in Guineal has always been natural: the growth of trunks and roots of trees and bushes have managed to dislocate the masonry in varying degrees of intensity in the four sectors. In sector 4, it is observed that the descent of mud and stones that clogged the natural drains have affected the nearby architectural units, especially in the upper level.

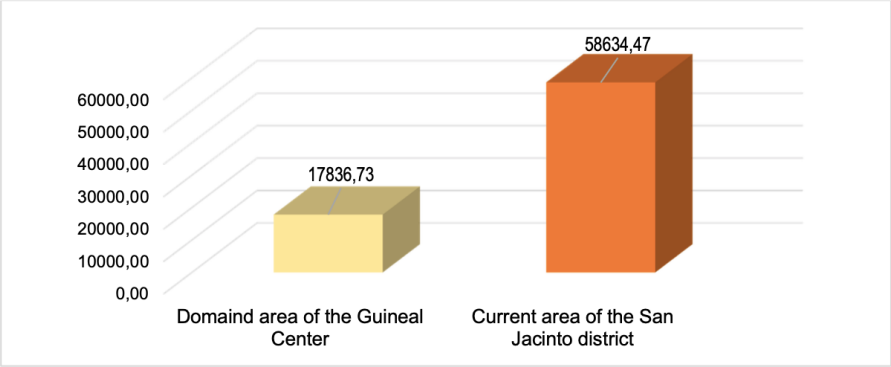

Figure 9. Areas of the domain of the Guinean Center and the current.

Source: own elaboration.

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Figure 9 shows that the only district influenced by the environment was the district of San Jacinto (30.4%).

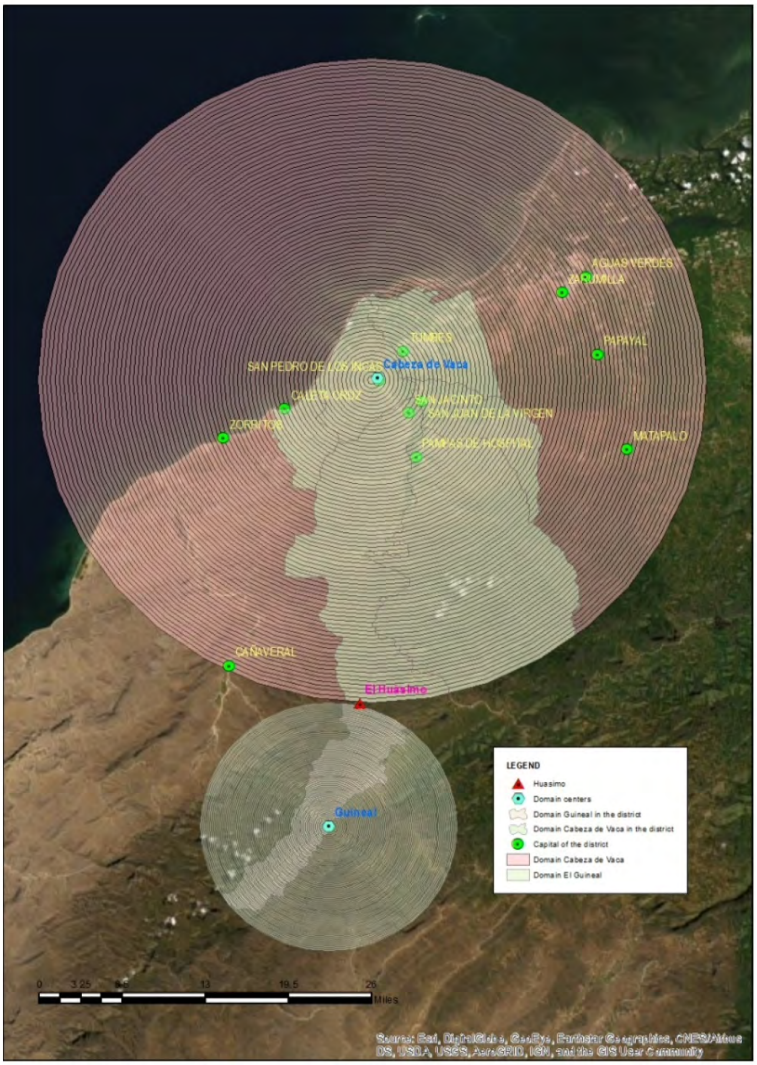

Figure 10. Cabeza de Vaca and Guineal Spatial Domain Center.

Source: own elaboration.

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The spatial domain of the Cabeza Vaca Center covers an area of 142,671.15 ha, while the Guinea Center amounts to 17,836.73 ha; the sums of both areas represent 90.70 % of the current province of the city of Tumbes.

The Centro de Cabeza de Vaca had a territorial extension of 100 ha; while Guineal was represented by 14 ha; the city of Cabeza de Vaca was 2.5 ha, while that of Guineal was 0.45 ha; with this information, the constant was obtained.

$I = f(C) = k * d$ X-Tent Model

I = Measure of the potential political influence of the population center.

f(C) = Domain Center (size of the infrastructure)

k = Constant (proportional size of the comparison of the structures of the centers)

d = Radius distance

Considering the data of both centers, it was obtained that the constant was 1/5.55, which is applied progressively on both centers until its cohesion; this cohesion spatially coincides with the archaeological site called "Huasimo" according to the archaeological information this place had multipurpose (surveillance center, warehouse, rest) considered at that time as a Tambo (Tambo).

3.4. THE ROAD NETWORK

According to the spatial information of the Ministry of Transportation and Communications, the current road network in the province of Tumbes is represented by roads considering a classification into national, provincial, and district; in addition to the carriage roads, there are 301,309.10 meters of roads in the province.

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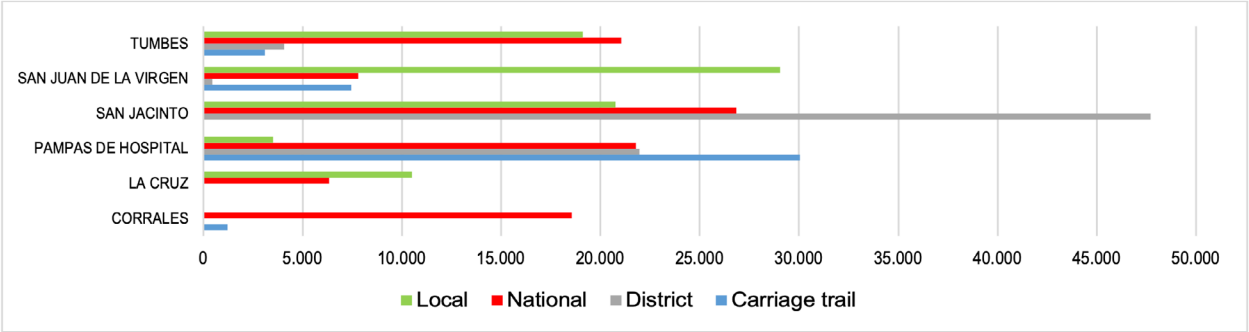

Figure 11. Current Road Network.

Source: own elaboration.

Figure 11 shows that national roads represent 33.97%, while local roads represent 27.33%, district roads represent 24.62%, and dirt roads represent 13.88%. The most significant number of roads is in the district of San Jacinto with 31.64%, while the community of Pampas de Hospital represents 25.66%, Tumbes with 15.71%, San Juan de la Virgen with 14.85%, Corrales with 6.56%, and La Cruz with 5.58% (Moralejo, 2012).

The detailed classification of the local road network is shown in Figure 11, while Figure 12 shows the spatial distribution of the roads according to their classification.

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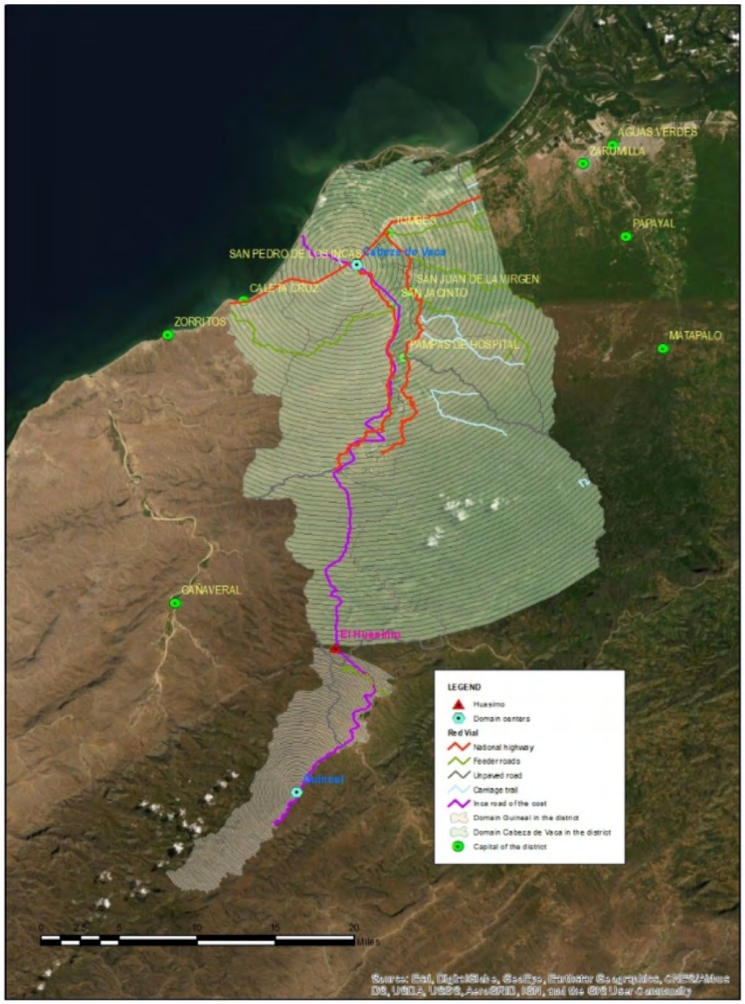

Figure 12. National Road Network and Inca Road Network in the Province of Tumbes.

Source: own elaboration.

The Inca road network enters the Tumbes Region in the southern area of the Cerros de Amotapepe National Park following upstream along the Cuzco Creek near the hamlet called Captain Hoyle, which

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moves along the summits of the am tapes until reaching the Huasimo, an essential point because it is considered the limit of the domain and watershed, the road continued to get another critical population center called Rica Playa, from there the road moves parallel upstream left bank of the Tumbes River passing through San Jacinto and Corrales, in the latter, is located the Monumental Archaeological Zone Cabeza de Vaca, from there the road continued to reach near the Estero la Chepa, continuing to the seashore.

Table 2. Comparison of the National Road Network and the Coastal Inca Trail (meters)

TYPE OF NETWORK	San Jacinto (Stretch in mt)	Corrales (Stretch in mt)	Total (mt)
NATIONAL ROAD NETWORK	95325.76	18557.88	113883.65
INCA TRAIL	79922.47	11837.83	91760.30

Source: own elaboration.

Table 1 shows data on the Inca road network in the San Jacinto district, which covers 83.84% of the national road network, and in the Corrales district, which covers 63.79% of the national road network. In general terms, the Inca road network covers 80.57% of the national road network (no dirt roads or carriage roads were considered).

Figure 13 shows the coincidence of the limits of the domains of the two main archeological sites in the province of Tumbes and the Inca road, which according to its longitudinal profile, this intersection occurs at the highest altitude (787 m.a.s.l.), which is 29.7 km from the El Guineal Center (Chacaltana *et al.*, 2017).

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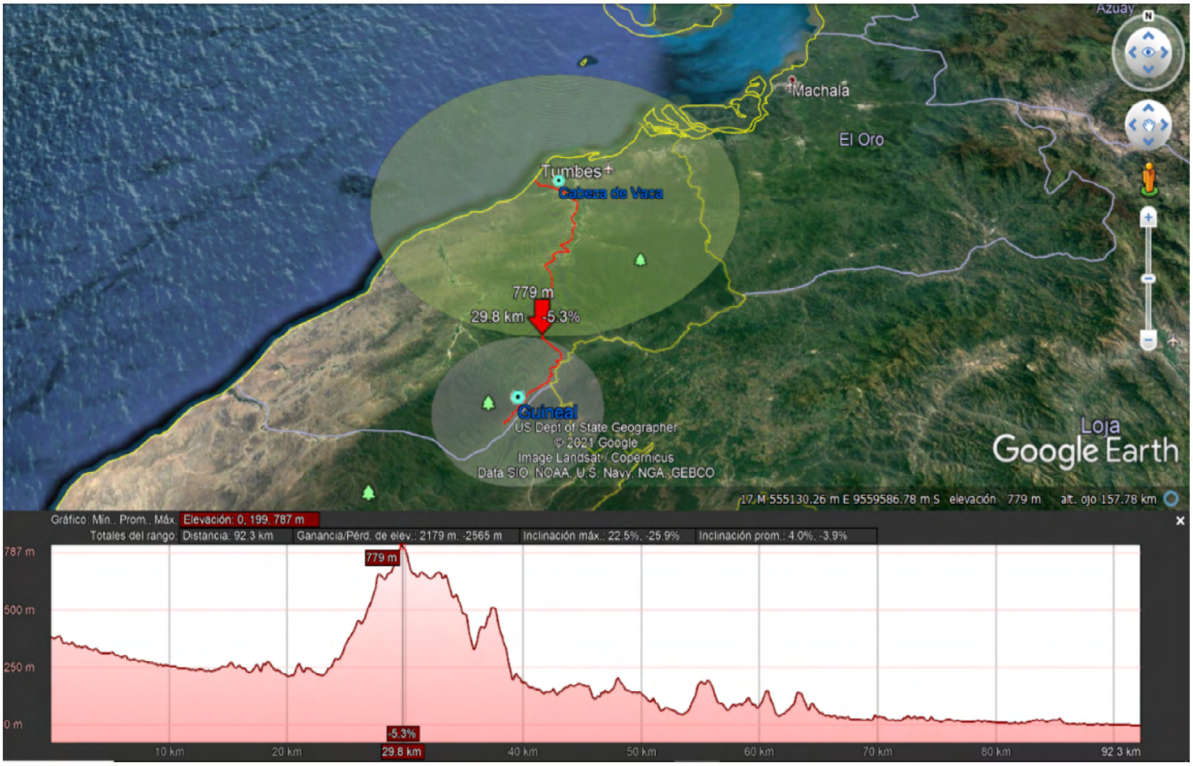

Figure 13. Profile of the Inca Trail and coincidence of Dominio de Cabeza de Vaca and El Guineal.

Source: own elaboration.

The maximum elevation of the Inca road profile is 787 meters above sea level. This coincides with the domains of the centers, which have been estimated from a constant due to the size of the structure of these archaeological sites.

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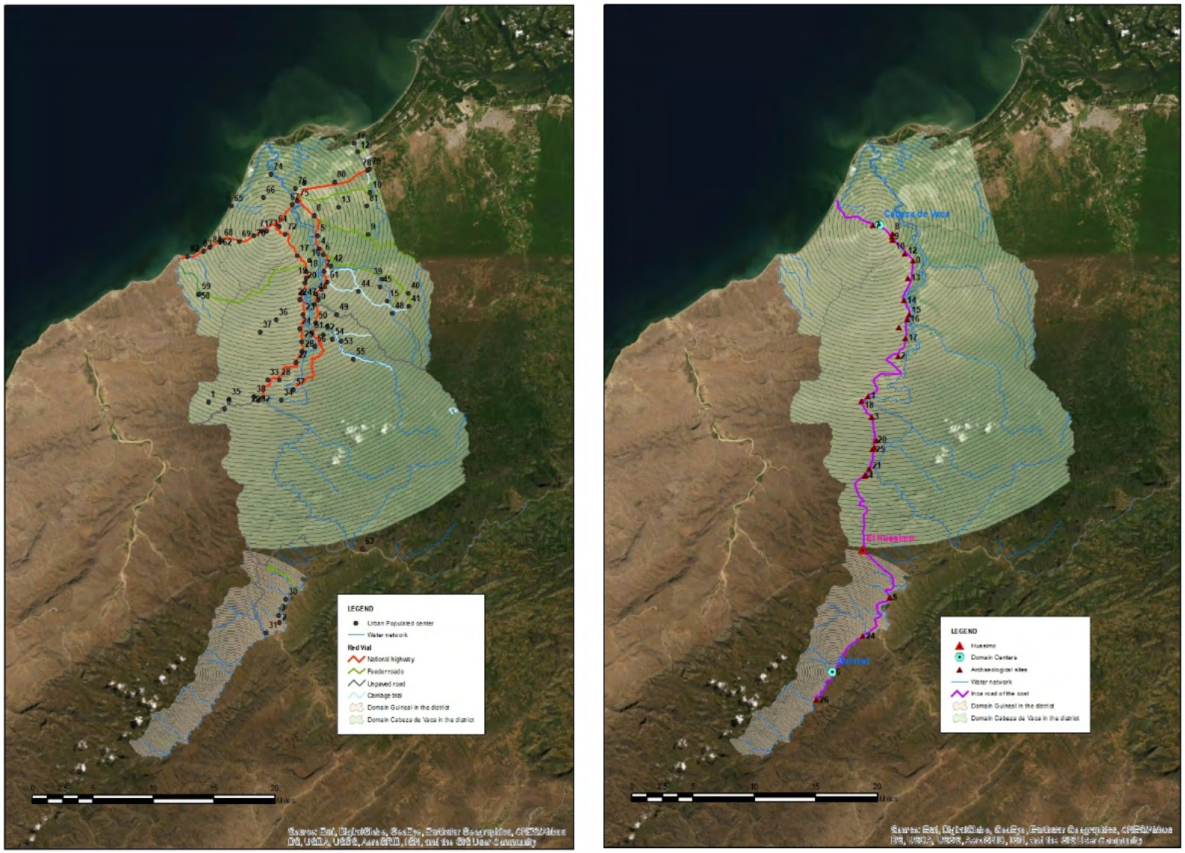

Figure 14. Current road network (right) and network in Inca times (left) in Cabeza de Vaca and El Guineal Center domains.

Source: own elaboration.

Figure 14 shows the road network of Tumbes and the Inca Trail and its connectivity with the population centers in current times and in Inca times. For the national grid, 85 population centers have been considered, and those near the road are 53. Table 2 shows the population centers located on the national highway or very close to it, with 33 hamlets, 07 towns, 02 annexes, one city, and one village, and 09 have no category.

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Of the villages, 33 are located on the national road, 02 in the district and one in the province, the towns with the category in the city 06 are located on the national highway, and one in the community, the villages with the type of annex are situated on the national road as well as the city and the town, of the 09 that do not have category four are located in the province, 03 in the national highway and 02 in the district.

Table 4. Inca Settlement Centers (Archaeological Remains) located along the Inca Trail.

ARCHAEOLOGICAL SITE NAME	DISTRICT	TYPE OF ARCHAEOLOGICAL SITE	UTM-Z17 COORDINATES		ALTITUDE M.A.S.L.
			EAST	WEST	
Miraflores	San Jacinto	Settlement (wall bases)	561726	9597347	31
Higuerón	San Jacinto	Head of enclosure walls	559762	9584810	78
Mal Paso	San Jacinto	Rectangular structure	556293	9576845	157
Teniente Astete II	San Jacinto	Rectangular structure	558660	9553150	232
Guineal	San Jacinto	Complex settlement	551195	9543363	311
Huaca Cabeza de Vaca	Corrales	Complex settlement	556450	9601977	23
El Rodeo (Malval)	Corrales	Settlement (mound)	559011	9600072	200
Santa Rosa (Plateros)	San Jacinto	Structure s/f	561086	9595049	200
Vaquería	San Jacinto	Settlement	561189	9590335	200
Casa Blanqueada	San Jacinto	Enclosure	560693	9587196	200

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El Tablazo	San Jacinto	Semicircular structure	554944	9578925	200
Tierras Coloradas	San Jacinto	Rectangular Enclosure	556941	9573749	200
Pellejitos	San Jacinto	Rectangular structure	556637	9572893	123
Calabacitas I	San Jacinto	Rectangular structure	555968	9570044	200
Ucumares I	San Jacinto	Rectangular structure	555360	9569120	138
Teniente Astete I	San Jacinto	Rectangular enclosures	558695	9553240	233
Capitán Hoyle	San Jacinto	Rectangular structure	555142	9548120	261
Modroño	San Jacinto	Associated enclosures	549031	9539737	357

Source: own elaboration.

Eighteen archaeological remains show signs of population centers - Archaeological Inventory of the Qhapaq Ñan Project, 2009.

Figure 14 shows the areas of influence of the main Inca urban centers in the province of Tumbes, determined by the Thiessen polygons; on this influence, the current urban population centers are shown as a result:

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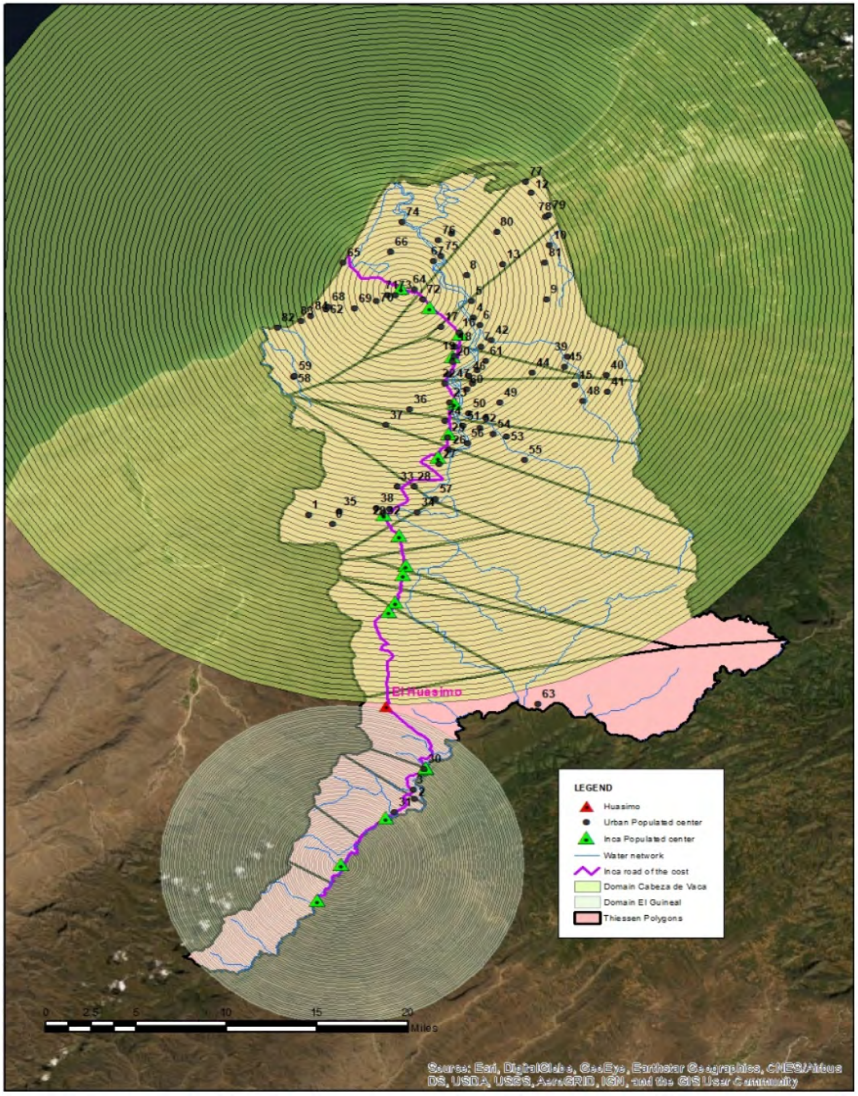

Figure 15. Areas of Influence (Thiessen polygons) of Inca Settlements and Urban Settlements (Current).

Source: own elaboration.

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The population center of Teniente Astete I is the largest in the province at 11.64%. It currently has only one population center called El Zapayal, located in the Tumbes National Reserve. Huaca Cabeza de Vaca is the second-largest population center, representing 11.08%. There are 19 urban population centers (see Table 3-2), and the third-largest in Tierras Coloradas, which currently has no population centers. This is because it is located in the Cerros de Amotape National Park.

4. DISCUSSION

The modeling methodology to determine the territorial domains of the Inca cities has not been expressed in detail since it is a hypothesis that determines the domain area through the size of the site. The X-Tent model shows the influence of a site based on the distance without knowing for sure how to handle this data.

In the investigation considering the information of the X-Tent model, it has been possible to develop the domain of two important Inca cities, Cabeza de Vaca and El Guinea based on the size of the structure that was the primary data for the calculation of the constant, applying distance according to this value through buffer the limits were determined, which coincide in an archaeological vestige called "Huasimo" that appear in Inca times was a Tambo, a place of multiple uses. It has not been done anywhere in Peru to apply this hypothesis that in the limits of domain of main Inca cities, there must be a place of vigil or control of the parts of the Inca cities.

The study and analysis of roads should be carried out with the integration of multiple layers of information that include the review of data from archaeology, history, toponymy, ethnography (oral tradition), photographic and cartographic documentation, whether historical or recent, as well as other sources related to these that allow us to recognize the characteristics of the object of study: in our case, the Inca road network.

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According to the author gives a methodological definition of the analysis of roads through the use of history and cartography, but does not present the location of nodes and networks as a practical case, in the research a current analysis of the situation of the roads (grids) and their coincidence with the population centers (nodes) is made, generating a comparison of the Inca cities and the Inca road network, including the influence of these through Thiessen's polygons, identifying the current population centers that are located in these areas of influence.

5. CONCLUSIONS

The X-Tent modeling gives us an approximation to the determination of the dominions of the Inca cities, based on a constant and a distance that starts from the center of each city through a buffer of proportion.

It was determined that the proportion of the Cabeza de Vaca Center with the El Guineal Center is 7 to 8 times greater in their domains and that their limits have as a meeting an Inca place, which according to current studies by archaeologists would be the Tambo called Huasimo.

The domain of Cabeza de Vaca covers an area of 142,671.15 hectares, while the El Guineal Center covers an area of 17,836.73 hectares, the addition of both fields covers 90.70% of the current province of Tumbes.

The Inca road network has an extension of 91,760.30 meters, which represents 80. 57% of the current road network travels over 18 Inca population centers, generating the same number of areas of influence determined by Thiessen's polygons, where 85 current population centers have been identified. Cabeza de Vaca has the most significant number of current population centers. El Guineal is located in the Cerros de Amotape National Park forests, a protected natural area with intangibility legislation, possibly because this fact has not allowed human settlements.

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Between the domains of Cabeza de Vaca and El Guineal is the site of Huasimo, which according to its longitudinal profile, is located at the highest point (787 m.a.s.l.) of the Inca Trail; this coincidence has been determined according to X-Tent calculations and the analysis of the Google Earth program.

REFERENCES

Albeck, M. E. (2016). Producción y lógica de la red vial incaica en el extremo septentrional del NOA. *Arqueología, 22*(1), 61-79. http://revistascientificas.filo.uba.ar/index.php/Arqueologia/article/view/2465

Alessandri, L. (2016). Exploring territories: Bubble Model and Minimum Number of Contemporary Settlements: A case study from Etruria and Latium Vetus from the Early Bronze Age to the Early Iron Age. *Origini, XXXVII*, 173-197. https://research.rug.nl/en/publications/exploring-territories-bubble-model-and-minimum-number-of-contempo

Bar, A. (2017). Perspectivas del proyecto Qhapaq Ñan en torno al registro de la red vial inca: propuestas de su sectorización y nomenclatura. *Boletín del Museo Chileno de Arte Precolombino, 22*(2), 31-46. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-68942017000200031

Bernabé, J. (2017). La ruta inca a los Huaylas. estudio de la vialidad inca en la Pampa de Lampas-Choquerecuay, en el departamento de Ancash, Perú. *Boletín del Museo Chileno de Arte Precolombino, 22*(2), 47-63. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-68942017000200047

Bernal, A. (2020). Los límites septentrionales del imperio inca y el Qhapaq Ñan vistos desde la arqueología y la historiografía del Sur Andino de Colombia. *Chungará (Arica), 52*(3), 381-94. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0717-73562020000300381

Chacaltana, S., Arkush, E., & Marcone, G. (eds.). (2017). *Nuevas tendencias en el estudio de los caminos* (2nd ed.). Conferencia Internacional en el Ministerio de Cultura. Qhapaq Ñan-Sede Nacional; 465 p. https://qhapaqnan.cultura.pe/sites/default/files/mi/archivo/Nuevas%20tendencias.pdf

https://doi.org/10.17993/3ctecno/2021.v10n4e40.51-87

Díaz, S. (2013). Qhapaq Ñan, Sistema Vial Andino: el desafío de su conservación en Chile en el marco de su nominación a la Lista del Patrimonio Mundial. *Intervención (México DF), 4*(8), 33-46. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-249X2013000200005

Esenarro, D., Martinez, R., Miranda, M., Begazo, L., & Segovia, E. (2021). Sustainable Construction of Ancasmarka and Its Functionality in the Pre-Inca and Inca Period, Calca - Cusco - Perú. *Journal of Green Engineering (JGE), 11*(2), 1244-1243. http://www.jgenng.com/volume11-issue2.php

González, C. (2017). Arqueologia Vial del Qhapaq Nan en Sudamérica: análisis teórico, conceptos y definiciones. *Boletín del Museo Chileno de Arte Precolombino, 22*(1),15-34. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-68942017000100015

Hernández, F. (2012). La Sucesión Entre Los Incas. *Chungará (Arica), 44*(4), 655-67. https://scielo.conicyt.cl/scielo.php?script=sci_abstract&pid=S0717-73562012000400008&lng=pt&nrm=iso

Marcone, G. (2020). Por las rutas del Qhapaq Ñan: el rol de los caminos en la construcción de la historia y territorio peruano. *Chungará (Arica), 52*(3), 411-25. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0717-73562020000300411&lng=pt&tlng=es

Martinez, G. (2010). Qhapaq Ñan: el camino inca y las transformaciones territoriales en los Andes Peruanos. *Ería,* (78-79), 21-38. https://doi.org/10.17811/er.0.2009.21-38

Matos, R. (2017). El gran camino Inka: construyendo un Imperio. Una exhibición sobre el Qhapaq Ñan en el Museo Nacional del Indígena Americano, Smithsonian Institution. *Boletín del Museo Chileno de Arte Precolombino, 22*(2), 9-29. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-68942017000200009

Ministerio de Cultura. (2013). *Cabeza de Vaca, investigaciones arqueológicas* (Vol. 30). Biblioteca Nacional del Perú.

Moralejo, R. A. (2012). El camino del Inka en el sector central de la provincia de Catamarca: actualización y perspectivas. *Andes, 23*(6), 19-36. https://ri.conicet.gov.ar/handle/11336/79713

Pino, J.L. (2016). Qhapaq Ñan Wamanin: los lugares de libación como hitos de la memoria en cada paisaje sagrado de la ruta principal hacia el Chinchaysuyu. *Diálogo Andino,* (49), 167-80. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0719-26812016000100018

Peña-Candia, L.Z., Baca-Zans, Y.R., & Costa, J.F. (2019). Efecto de las actividades antrópicas en la red de caminos Inka, santuario histórico de Machupicchu, Cusco, Perú. *Revista interamericana de ambiente y turismo, 15*(1), 60-71. https://scielo.conicyt.cl/scielo.php?script=sci_abstract&pid=S0718-235X2019000100060&lng=es&nrm=iso

Ramírez, S. E. (2008). Negociando el imperio: el Estado inca como culto*. *Bulletin de l'Institut Français d'Études Andines, 37*(1), 5-18. https://doi.org/10.4000/bifea.3201

Smith, M. E. (2017). *Bounding Empires and Political/Military Networks Using Archaeological Data.* OSF

Sternfeld, G. (2007). *La organización laboral del Imperio Inca: las autoridades locales básicas.* Iberoamericana Editorial Vervuert, S.L.

Verhagen, P. (2018). Spatial Analysis in Archaeology: Moving into New Territories. In: Siart, C., Forbriger, M., & Bubenzer, O. (eds.), *Digital Geoarchaeology. Natural Science in Archaeology.* Springer, Cham. https://doi.org/10.1007/978-3-319-25316-9_2

Vilchez, C. (2015). *El camino inca de la costa en el Parque Nacional Cerros de Amotape.* Ministerio de Cultura.

Vilchez, C. (2013). El Taller de Spondylus de Cabeza de Vaca, Tumbes. *Cuadernos del Qhapaq Ñan,* 1, 20. https://qhapaqnan.cultura.pe/sites/default/files/mi/archivo/Carolina%20V%C3%ADlchez%20-%20El%20Taller%20de%20Spondylus%20de%20Cabeza%20de%20Vaca%2C%20Tumbes.pdf

https://doi.org/10.17993/3ctecno/2021.v10n4e40.51-87

Vitry, C. (2017). El rol del Qhapaq Nan y los Apus en la expansión del Tawantinsuyu. *Boletín del Museo Chileno de Arte Precolombino, 22*(1), 35-49. https://www.scielo.cl/scielo.php?script=sci_abstract&pid=S0718-68942017000100035&lng=es&nrm=iso

https://doi.org/10.17993/3ctecno/2021.v10n4e40.51-87

https://doi.org/10.17993/3ctecno/2021.v10n4e40.51-87