Localization to sow bamboo guadua oriented to the furniture market in Bogotá

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Abstract
Working look for the less distance between Bogotá to towns in Cundinamarca, approximate area with potential of sowing and distribution channels oriented to the furniture market in Bogotá. Using the Arc GIS program, layers with different variables are subtracted and lengths are measured. The areas are grouped in relation to a populated center. Closest town where can be grown is San Francisco (Cundinamarca) town, with 43,5 km, from the agglomeration market until center town with pave road. The potential area is 175 389 ha, but near to San Francisco are 11 550 ha grouped four towns. There are 21 points for distribution channels near to agglomeration market in Chile Avenue cross Boyacá Avenue in Bogotá.

Keywords: sow bamboo; localization theory, furniture market, Cundinamarca

Resumen
El trabajo busca la menor distancia desde Bogotá hasta municipios en Cundinamarca del área aproximada con potencial para la siembra, y los canales de distribución orientados al mercado de muebles en Bogotá. Usando el programa Arc GIS se sustraen las capas con diferentes variables y se miden las longitudes. Las áreas se agrupan con relación a un centro poblado. Como conclusión, el municipio más cercano donde puede se puede cultivar guadua es San Francisco (Cundinamarca) con 43,5 km desde la aglomeración de mercado hasta el centro poblado con vías pavimentadas. El área potencial es 175 389 ha pero cerca de San Francisco hay 11 550 ha agrupados cuatro municipios. Hay 21 canales de distribución, cerca de la aglomeración de mercado en la Avenida Chile con Avenida Boyacá en Bogotá.

Palabras clave: siembra de bambú; teoría de la localización, mercado de mobiliario, Cundinamarca

1. Introduction

Bamboo guadua (guadua angustifolia Kunth) Fig.1 is an important resource in Colombia especially in the coffee region. Laminated Bamboo can replace hard wood in furniture according to [1]. In Bogotá is a furniture market located in agglomeration at the interior of the city, but bamboo sources are so far from this. Less distance has been found in this paper through Arc GIS ® ArcMap ® software, area with the potential of sowing and distribution channels were studied too. The main variable taked into account are, distance to agglomeration market, center towns,height above sea level, between 1200 and 1500 m.a.s.l. (meter above sea level), paved roads, not natural parks, eroded areas and bodies of water. Most of distribution channels are located on Bogotá main avenues such as Boyacá Av. and Caracas Av. Work concluded that the closest towns to Bogotá, where guadua can be grown are: San Francisco, San Antonio de Tequendama and Tena. The results can foster bamboo guadua location and replace hard wood in furniture by bamboo guadua growing closer to Bogotá.

Figure 1. Bamboo guadua growing overview.
Source: The authors.

2. Review

2.1. Laminated bamboo

Laminated bamboo is an innovation that mix bamboo and adhesives. Like fig. 2 shows it is made jointing bamboo layers or slats and it can replace hard wood in furniture. The size and the increase of bamboo and wood market was studying by Montoya J. [7], According to him the potential impact on the employment generation is big in laminated bamboo products, $ 2,500 US$/ha and one jobs per hectare, compared with the raw material for construction, 500 dollars and 0,2 jobs per hectare. The world´s bamboo market´s size is 14 million dollars of the total wooden market over 135 million dollars, mainly crafts and furniture. The growing in 10 years had been 45% with panels and laminates as the highest demanded products.

Figure 2. Laminated bamboo guadua.
Source: [6]

In Bogotá Colombia, boards according to the needs can be structural or not. OSB (oriented strand board) resists high loads, but does not have aesthetic final finish. Plywood boards, LVL (laminated veneer lumber) Triplex®, are used in construction and furniture. They have final finishing, high strength and workability. Particleboard MDF (medium density fiber) or Tablex® are used in furniture, and have low strength. Others as Super T ® Tablemac ® for recoverable concrete forms have a high demand. Particle board combined with Formica® or melamine laminates for finishes are high value-added products.

In the other hand, there are guadua slats like a basic component of multiples design, manufactured boards, structural beams, floors, forms and ceilings, constructive elements such as doors, windows, railings and stairs. Furniture such as tables, chairs, beds and cabinets. Fig. 3

Figure 3. Laminated bamboo guadua.
Source: [5]

2.2. Localization theory

The history of localization theory has been treated by Von Thünen, Weber, Hotelling, Isard and others. [2] In 1820 Johann Heinrich von Thünen argued that, "optimal location of agricultural activities is a function of income"... "which is in the function of the distance from the place of production to the market due, mainly, to transport costs". In Duch, N. [2] Harris (1954) is cited: "localization of a productive unit depends on access to markets and their quality of access can be described by an index of potential market" Potential market Harris said, is for the purchasing power of all possible locations, and is "an inverse function of distance". The distance between market agglomerations and productive units, therefore, is the externality that can explain or understand the cost overruns of raw materials. These overruns costs make value-added products incompetent and can been taken them out of the market.

2.3. Guadua bamboo plantation on demand

Colombia have half of it´s area covered by rain forest. Less than 140 000 ha are plantation. Guadua is in 50 000 ha which 2500 ha are plantations. Bogotá is the largest consumer of guadua in Colombia, near Tequendama, Gualiváand Sumapaz regions are grouped 32 towns, in 428 000 ha. But guadua grown only in a specific m.a.s.l. range. If 30

000 ha produce 250 guaduas by year, is necessary sow bamboo guadua plantations near to Bogotá to cover the demand.

Building activity in Bogotá is 8,63 million m^2 2017, it´s 16,6% higher than ten years ago. Wood industry should have a similar behavior. In Bogotá, the wood market is linked to the construction industry. Fifteen years ago Bogotá had 114 carpentry shops, 44 artisan factories, 342 factories, of which 142 were furniture factories that consumed 20 000 m^3 of wood by year. [7]. In the future, market need more bamboo guadua plantations, because one hectare of bamboo guadua produce 5m^3 laminated guadua, using cross laminated guadua technology see in [6]. Then for 20 000 m^3 Bogotá need 4.000 ha of bamboo guadua every year.

3. Methodology

Arcmap® from Esri's ArcGIS® a geospatial processing programs, is used to view, and analyze geospatial data. It were used for measure the less distance from Bogotá until towns in Cundinamarca, make a layer with area between m.a.s.l., calculate area of each town, and cross with natural parks, eroded areas and bodies of water. Using Geographic Information Systems (GIS) each town is represented by a point in the map. The end point is the market agglomeration, located in Avenue Chile crossing Boyacá Avenue according [3] where is located the planning unit zone (UPZ by initials in spanish) named Boyacá Real U.P.Z. it is a neighbour with 243 point of units productive formed by carpentry, shops, artisan, factories, and furniture makers' fig. 4

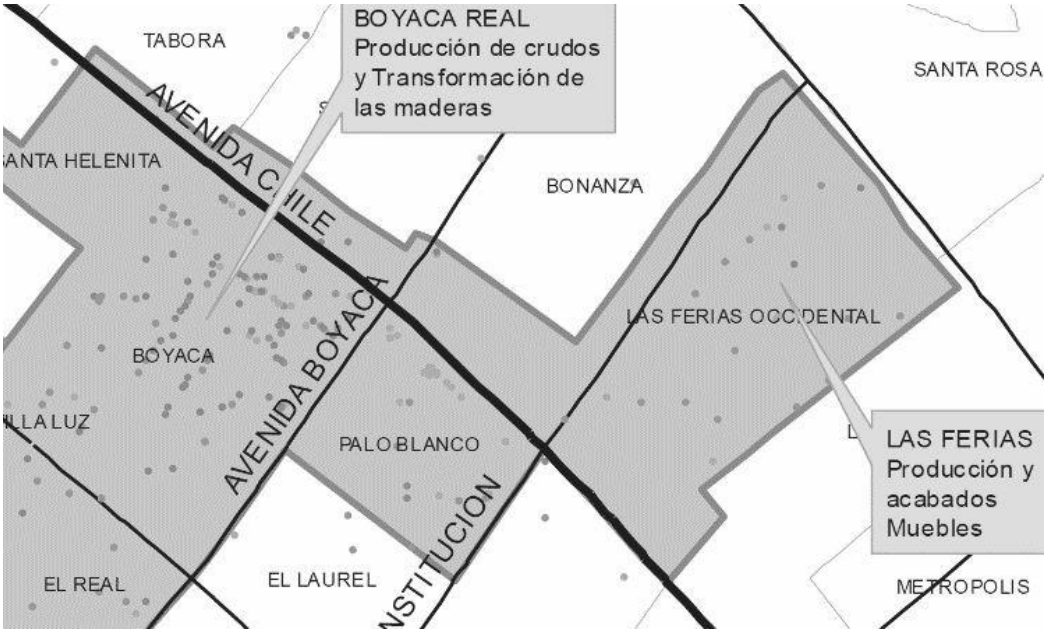

Figure 4 Productive units in Boyacá Real U.P.Z.
Source: [3]

Second, the approximate area with potential of sowing. It was a high between 1200 and 1500 m.a.s.l. Coverage was created using aerial photography and geospatial data. Others layers were created, like Bogotá limits, natural parks, eroded areas and bodies of water. Using measure tool area was subtracted and classified by each town.

Finally, points were located with as less 21 distribution channel. The coordinates was charged in the map from Google earth® including nine points of Homecenter ®, four points of Madecentro ® Constructor - Sodimac ® and

eight points of Massisa Placacentro ®. This points, the areas of each layer, the less distance in km and starts and end point was generated for subsequent analysis.

4. Results

4.1. Main variability

The Main variables are the distance to market agglomeration, in this case Boyacá Real U.P.Z. Center towns or "cabecera" height above sea level, between 1200 and 1500 m.a.s.l. (meter above sea level), natural parks, eroded areas and bodies of water. Fig.5 show eight center towns near to the specified high gap m.a.s.l. out of national park and eroded areas: El Peñon, San Francisco, Guayabal de Síquima, Cachipay, Tena, San Antonio del Tequendama, Silvania, Manta y Caqueza.

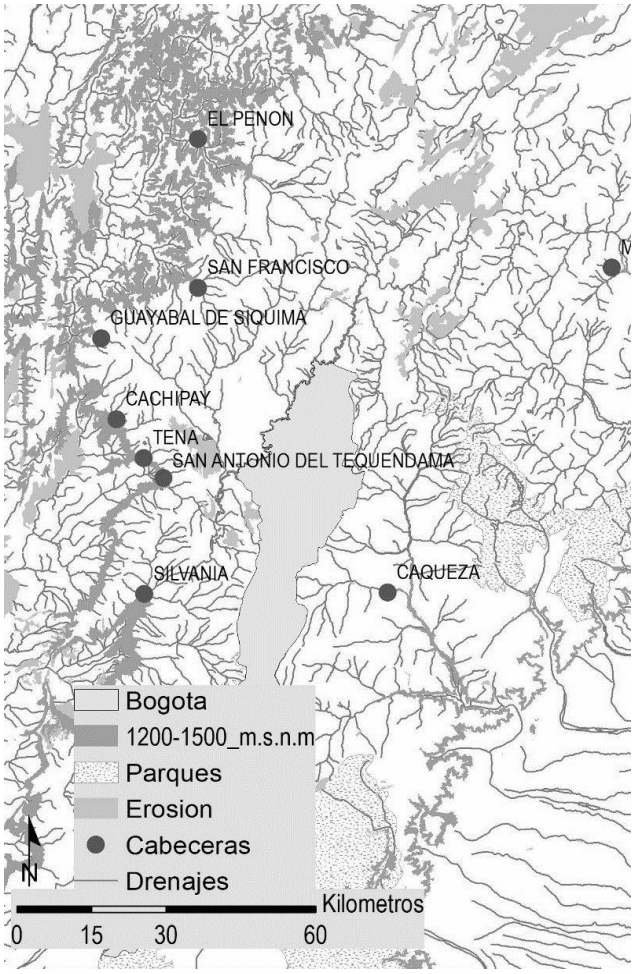

Figure 5. Mainly variability
Source: The authors
Note: Bogotá limits, 1200-1500 m.a.s.l., national parks, areas eroded, center town, and bodies of water (Drenajes). Each of the eight points is a center town municipality or "*cabeceras"*

For this case were drawn paved roads, only for "*cabeceras*" points close to layer between 1200 and 1500 m.a.s.l, out of national park and eroded areas Fig. 6

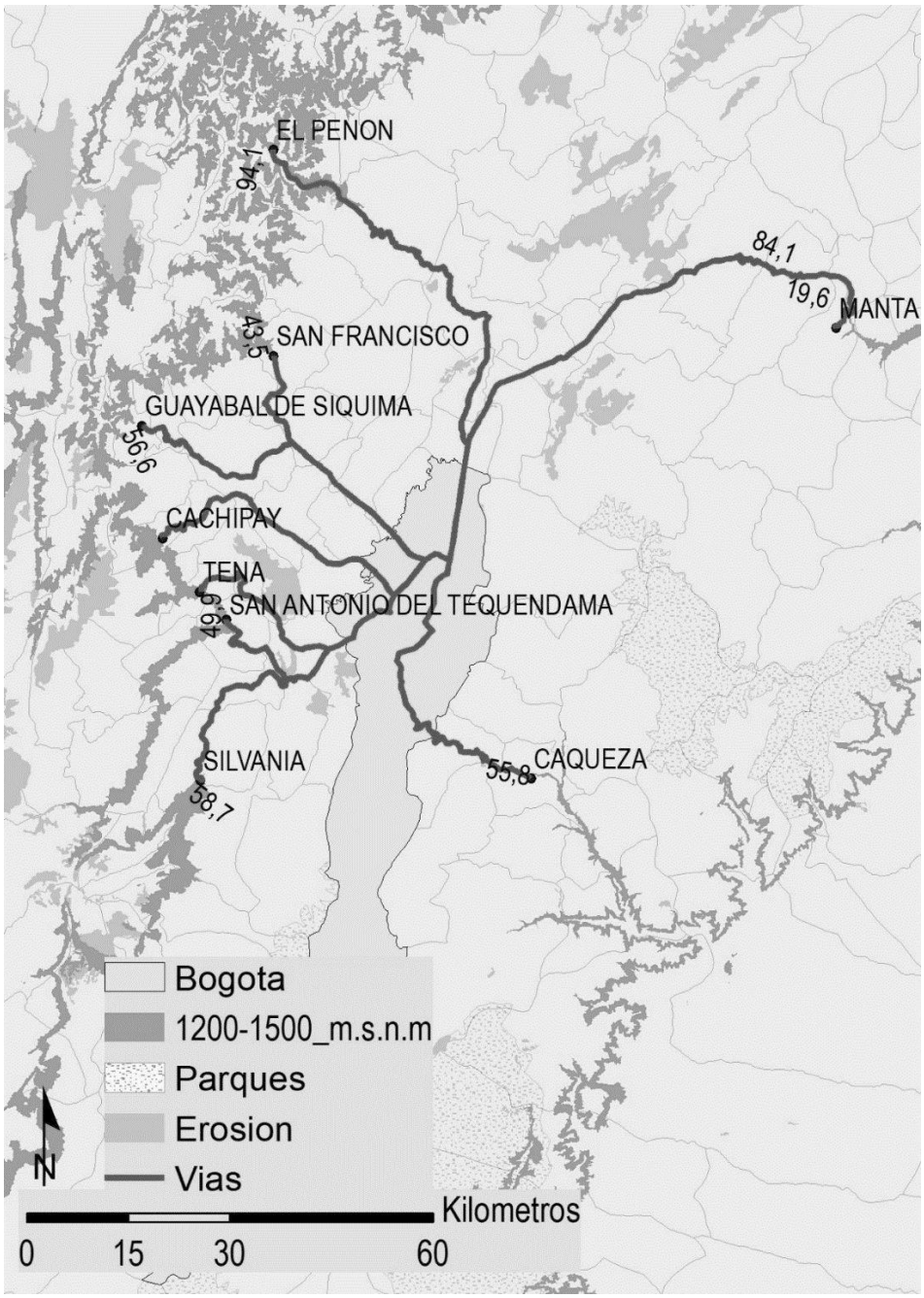

Figure 6. Paved roads

Source: The authors

Note: Bogotá limits, 1200-1500 m.a.s.l, national parks (Parques), eroded areas (erosion), paved roads (Vías) including distance in kms.

Area between 1200 and 1500 m.a.s.l. (meter above sea level) near to bodies of water, out of eroded area have 175389 ha is Cundinamarca, Municipality and all the variable. Fig. 7

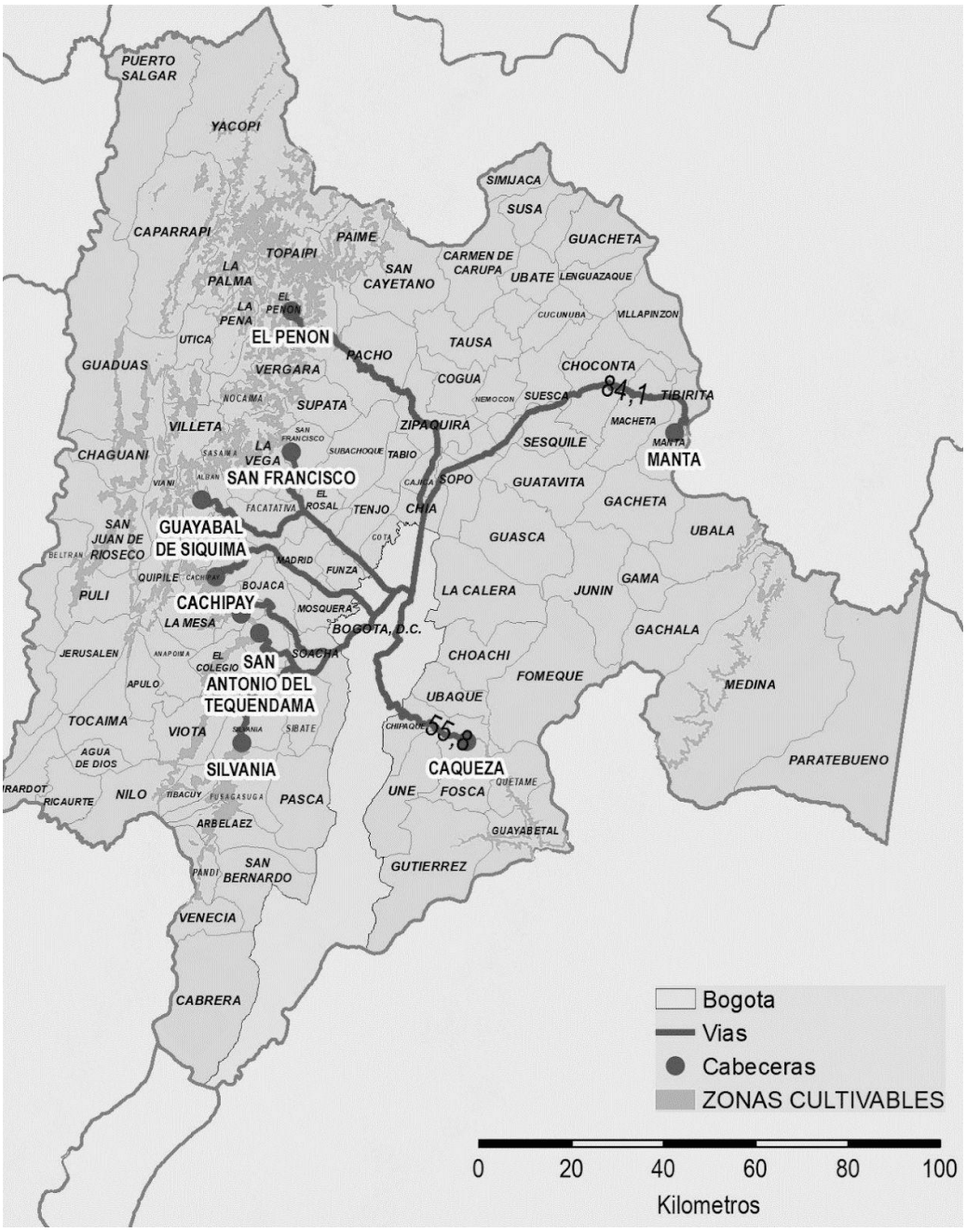

Figure 7. Cultivable areas in Cundinamarca
Source: the authors
Note: Bogotá limits, 1200-1500 m.a.s.l. national parks, eroded areas, paved roads, center towns. It include distance in km, Municipality and Department limits.

According to Diaz et al 2012 [4] Gualivá, Magdalena bajo, centro y Rionegro regions had research projects for productive and transformation purposes, and "temperature between 20 °C y 23 °C, average annual rainfall between 1800 and 2500 mm and sunshine 1800 to 2200 hour each year" also 1200 and 1500 m.a.s.l. are better environment for development and growth".

Cundinamarca's municipalities which have the greatest amount of ha for guadua are five, in order: Yacopí, La Palma, Medina, Topaipí and El Peñon.

Table 1.
Highest area towns, in hectare

Name of municipalities	Area in hectare
Yacopi	16 749
La Palma	9 702
Medina	9 460
Topaipi	9 441
El Peñon	7 406

Source: authors

4.2. Less distance

For each town distance was measured fig. 8. Start point are Av. Chile crossing Av. Boyacá according to the agglomeration identified by Acuña *et al* 2014. [3]. The end points are center towns "cabecera" of the municipalities near to the best environment for development and growth guadua.

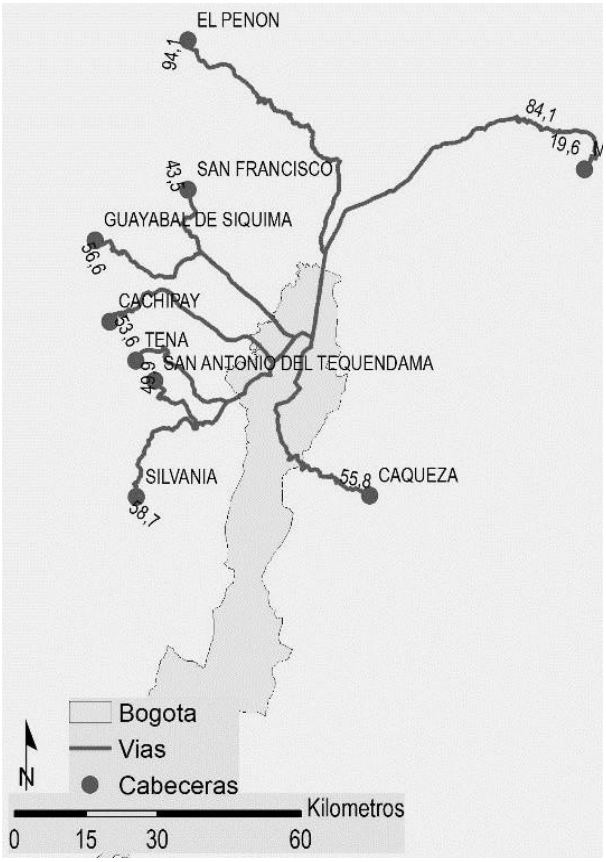

Figure 8. Distance from Center towns - Av. Chile cross Av Boyacá.
Source: authors

4.3. Distribution channels

Bogotá limits include a high population urban area and rural area. The municipalities Soacha, Cota, Chía, Cajicá, Funza and Mosquera are functionality part of Bogotá. There wood is sold in places that does not fulfill all environmental permits for its transportation and commerce. Only some DIY center (do it yourself) similar to Home Depot had e-commerce and legal sales. Fig. 9

Through Placacentro Masisa® distribution points went from 1 (Industrial Zone) in 2003 to 10 points in Bogota; and at national level points in two cities (Medellín and Bogotá) in 2013 to 20 points in all of Colombia. Other distribution points are Homecenter ®, Madecentro ® Constructor - Sodimac ®. 21 in Bogotá limits urban Fig. 9

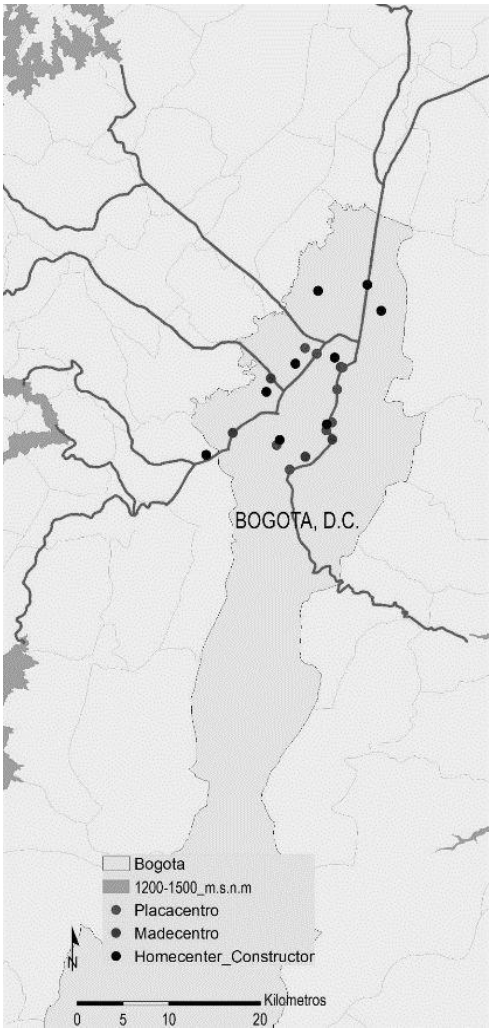

Figure 9. Distribution channels
Source: The authors
Note: Homecenter ®-Constructor ® **9**, Madecentro® **4**, Placacentro ®**8**

5. Discussion and analysis results

Taking the selected municipality centers proximity to the distribution channels and closest municipalities, the most potential areas are presented in the table 2.

Table 2.
Municipalities closer than Bogotá

Name of municipalities	Distance (km)	Area (hectare)
El Peñon	94,1	55 577
San Francisco	43,5	11 584
Silvania	58,7	10 236

Source: The authors

With reference to the topography versus the cultivable areas, it can be identified that potential areas for cropping are mainly located in mountainous areas. The other towns are close but it has a low area, for example Cáqueza, Guayabal de Siquima y Cachipay. Other towns with greater areas have more distance or do not have paved ways like Yacopí, La Palma, Medina and Topaipí.

Center town like Silvania has near potential area by another town called Fusagasugá, it's the same case for Manta which big area is in Boyacá region. Then in this paper create points in region for collect bamboo guadua.

Fig 10 is the area of each collect point. First El Peñon, has 55577ha. This point groups five towns, Pacho 5.624 ha, Vergara 6.655 ha, La Palma 9.702 ha, Yacopi 16.749 ha and Topaipí 9.44 ha.

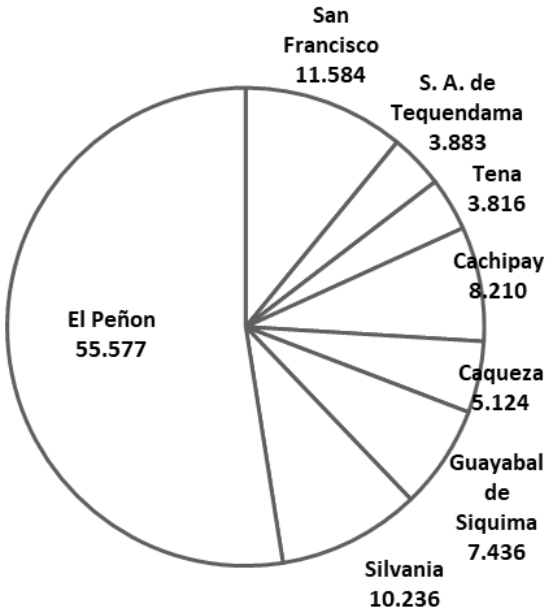

Figure 10. Surface per collect point in regions
Source: The authors

Distances between Bogotá to this points are from 43,5 km (San Francisco) until 94,1 km (El Peñon) Table 3. Others points group different town´s areas. Table 4 Area of each point which are in Fig. 10, San Francisco, San Antonio de Tequendama, Tena, Cachipay, Caqueza, Guayabal de Siquima, Silvania, El Peñon.

Table 3.
Municipalities closer than Bogotá

Name of municipalities	Distance in km
El Peñon	94,1
San Francisco	43,5
S. A. de Tequendama	49,9
Tena	49,9
Cachipay	53,6
Caqueza	55,8
Guayabal de Siquima	56,6
Silvania	58,7

Source: The authors

Table 4
Sum of area of each eight points and towns

Town	Area in ha	Total in ha
El Peñon	7 406	
Pacho	5 624	55 577
Vergara	6 655	
La Palma	9 702	
Yacopi	16 749	
Topaipi	9 441	
San Francisco	606	
Sasaima	4 146	11 584
Nocaima	2 104	
La Vega	4 728	
Silvania	1 199	
Fusagasuga	3 825	10 236
Tibacuy	2 040	
Viota	3 172	
Cachipay	1 898	8 210
Anolaima	2 573	
Quipile	3 739	
Guayabal De Siquima	2 040	
Viani	1 951	7 436
Alban	819	
Bituima	2 626	
Caqueza	700	5 124
Quetame	1 094	
Guayabetal	3 330	
SA de Tequendama	1 370	3 883
El Colegio	2 513	
Tena	964	3 816
La Mesa	2 852	

Source: The autors

Most of distribution channels are located on main avenues such as Boyacá Av. and Caracas Av. Close to the Doce de Octubre neighbor and Boyacá Real area They were found nine points of Homecenter ®, four points of Madecentro ® Constructor - Sodimac ® and eight points of Massisa Placacentro ®.

6. Conclusions

Closest municipality to Bogotá, where guadua can be grown in over is San Francisco. Available area for guadua grow is 175 389 ha in all Cundinamarca, but near to San Francisco is 11 584 ha, satisfying for furniture market in Bogotá. Shortest distance from the UPZ (Boyacá Real) to center Town (San Francisco) is 43,5 km. Town with the largest amount of ha for cropping is El Peñón, which had 94.1 km distance.

21 distribution channel and markets, center of demand 635 produce units are in Doce de Octubre and Boyacá Real neighborhoods in Bogotá, confirming localization theory.

7. Acknowledgment

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