Architectures, spaces, and territories of illicit drug trafficking in Colombia and Mexico

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Abstract
This research applies an interdisciplinary approach to the bidirectional relationship between illicit drug trafficking activities (specifically, cocaine and opioid trafficking in Colombia and Mexico) and the architectures, spaces, and territories in which they are located. Certain spaces that determine or are determined by the actions of drug trafficking organizations are described, analyzed, and classified based on various methodologies and the use of academic, official, and press information. In addition, case studies are reconstructed using architectural and geographic representation mechanisms to exemplify and illustrate the main arguments. The paper examines the three stages of activity that constitute the illegal drug economy: production (involving the placement of crop fields and laboratories), distribution (which entails exploitation of mobility infrastructure), and cross-cutting activities in relation to drug trafficking support spaces. The research provides an articulated interpretation of the various drug trafficking activities from a spatial perspective, the characterization of spaces that are important to criminal organizations and to the performance of their activities, and insights into the spatial thinking strategies and tactics associated with drug trafficking.

Keywords
Architecture, cocaine, Colombia, drugs, heroin, Mexico, spatial thinking, territory, trafficking

Introduction
Illicit drug trafficking (IDT) leaves evident imprints on the space in which its actions unfold. However, the relationship between space and the activities of this illegal economy is bidirectional, as spatial characteristics also impact the actions of drug trafficking organizations (DTOs). Although
the physical environment can facilitate or hinder IDT, the spaces used are usually interpreted as a given, neutral element that receives little discussion or analysis. This research contributes to the interdisciplinary analysis of the spatial behavior of IDT, so as to identify and understand the spatial patterns that characterize this illicit economy.

DTOs do not take space for granted; on the contrary, they consider it from a strategic perspective, impacting and building on space in accord with their interests. They also engage in spatial thinking, displaying a sharp and strategic perception of their surrounding physical environment, as well as its characteristics and components.

This work applies an interdisciplinary approach, derived mainly from architecture and the social sciences, to address two cases: Mexico, the third-largest poppy producer in the world, and Colombia, the world’s largest cocaine producer (UNODC, 2017: 15). DTOs in both countries are in constant interaction, and they produce plant-based drugs that undergo similar chemical processes and are destined for the same markets (Benítez-Manaut, 2014). The study addresses IDT in terms of the three main stages of activity recognized in the legal frameworks of both countries (Law 30 of Colombia, Mexican Federal Criminal Code article 194) as well as by academics (Kenny, 2007; Natarajan et al., 2015) and international organizations (ONUDC, 2018): production, distribution, and support spaces associated with cross-cutting activities.

The impact and interrelationship of economic activities in space have been addressed through different approaches. Classic economic theorists such as Adam Smith or Thomas Malthus considered the importance of territory for economic activities. In political science and in classic definitions of the state, sovereignty is exercised in space; in international relations, geography is linked with history, politics, and economics; and the fields of philosophy (Lefebvre, 1978), psychology (Foucault, 2006), and sociology (Bauman, 2009) have analyzed the relationship between urban developments and various socioeconomic phenomena. Human geography analyzes how territories are configured or transformed on behalf of economic activities, social networks (Cruz, 2014), culture, power (Rossi, 2014), social movements, and conflicts (Mançano, 2005), among others, and it focuses on the analysis of spatial conditions that affect or determine the performance of specific activities (Florida, 2009).

Economic, political, and social relations are carried out and reacted to (Borja and Castells, 2004; Sassen, 1998), and both their positive effects (innovation, competitiveness, economic growth, development) and negative effects (poverty, pollution, inequality) are expressed, in space (Bauman, 2009; Florida, 2009). The link of social relations with space is influenced by the availability of resources (Lezama, 1998), both natural and human, to configure ecosystems in such a way as to promote economic growth and human development (Florida, 2011; Köhler & Gonzalez, 2014; Scheel and Pineda, 2015) but also to configure unique spaces, landscapes and territories according to specific activities performed and social relationships established (Fitzsimmons, 2004; Mançano, 2005). Physical space, spatial thought and social practice are to be thought and analyzed together (Lefebvre, 1991). From this perspective, space can encourage or inhibit the performance of certain human activities, including those carried out in a hidden or illegal manner.

Studies of the relationship between space and illicit activities have applied several methods and approaches. One important group of studies has analyzed organized crime and its operations from a perspective that considers social networks, individuals, and their relational links, influenced by anthropological and historical methods (Bureau of Justice Assistance (BJA), 2008). From a different perspective, organizational analyses have examined how groups and organizations make decisions, gather resources, and participate in collective actions within competitive environments (Kenny,
2007). At the intersection between geography, criminology, and law, some analyses have studied the influence of the built environment on the spatial patterns of crime (Anselin and Rey, 2009), using tools of spatial econometrics and crime maps that contain information obtained through Geographic Information Systems (Brantingham and Brantingham, 1995; Grinstein and Levkovitz, 1995), building the environmental criminology academical trend (Porter, 2010). This last group of studies has been developed and intensively used by governments to design public policies and to promote intelligence-led policing or problem-oriented policing. However, this approach pays little attention to the relationship between social factors, space and territory. In this direction, Soja (2010) proposed a socio-spatial dialectic to balance the relationship between the physical environment and social conditioning factors, contending that what is social is simultaneously and inherently spatial. Meanwhile, the Space Syntax academic approach provides tools for urban planners to simulate the likely social effects of their designs (Hillier and Hanson, 1984), and the Forensic Architecture multi-disciplinary research group applies advanced architecture and media techniques to reconstruct spatial scenarios that enable further social and environmental research (Weizman, 2017).

This study of the relationship between IDT, space and territory required the construction of an interdisciplinary method. First, with the use of statistics provided by the governments of Colombia and Mexico; crops and laboratories were located geographically. Since it is not possible to know in detail all the spaces associated with the activities of an elusive population that tries to remain hidden, the nature of illegal actions can be tracked by means of the legal actions that seek to prevent or control it (UNODC, 2016). Illicit crops can be studied from evidence obtained in the course of eradication, laboratories and areas associated with production or distribution can be identified from seizure records, and support spaces are identified through expropriation acts. Second, we analyze the locations, identifying the spatial elements and characteristics necessary for the realization of the illegal economic activities, as well as the associated social and territorial components. Finally, we create spatial models to visualize and analyze the spatial thinking and behavior of DTOs in space.

Since the spatialities of the narcotics sector have a hidden character, relevant information is difficult to compile, and the data available are predominantly qualitative and subject to critical interpretation (Holden-Rhodes, 1997). On the other hand, spatial thinking associated with IDT is subjective in nature, sometimes intuitive, and therefore not always quantifiable. In this research, we have used some quantitative information but have also applied a qualitative method complemented by original three-dimensional spatial reconstructions, following the recommendation of Allen (2005), who argued for the usefulness of this type of approach provided that it draws on diverse sources, methods, and theories. Since our research involves specific case studies, caution must be observed in drawing any generalizations from our conclusions. To present our findings, this document is structured in three parts according to the IDT value chain. In the first part, the spaces and territories related to the production stage are analyzed. The second part refers to distribution, presenting specific spaces such as tunnels and shipyards as well as vehicles for transporting drugs. The third part considers some important transversal spaces, such as places of violence, burial sites and houses of the leaders of the DTOs.

Production: crops and laboratories
The first spatial scenarios of plant-based IDT are crops. The location of illicit crops depends on factors that are not constant in space or time and that vary from one cultivating area to another.
After mapping the information provided by UNODC (2016), the authorities of Colombia and Mexico, our findings indicate that poppy and coca crops tend to have a territorial concentration (see Table 1).

There are several geographical locations with the adequate conditions to grow coca in Colombia or poppies in Mexico, but cultivation is concentrated in few specific regions. In consequence, this geographical concentration must be explained by political, social, and environmental factors. Both the analysis of Colombia conducted by (Rincón-Ruiz et al., 2013) and the model built by Jaén and Dyner (2014) showed that the areas of coca cultivation in Colombia are far from densely populated areas and near or within primary forests. Likewise, the analyses of Mexico performed by Medel and Lu (2015) and UNODC (2016) identified similar conditions of altitude, humidity, and rainfall for different poppy fields. To explain the concentration of coca or poppy production in certain regions, the authors also cited four social or environmental factors: (1) high levels of poverty, (2) weak and scarce state presence, (3) violence and armed conflict, and (4) territorial inaccessibility.

With regard to the first of these four factors (high levels of poverty), municipalities that produce coca and poppy usually have populations with unsatisfied basic needs, relatively low Gross Domestic Product per capita, and a Human Development Index below the national average (Rocha, 2011). As noted by Reyes (2014), low public spending per capita and difficult access to the market are associated with higher levels of coca cultivation. The state of Guerrero, which has the largest poppy production in Mexico, is also characterized by high poverty and low levels of human development (CONEVAL, 2017).

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| Colombia Department | Municipality          | Number of eradicated hectares | Mexico State | Municipality          | Number of eradicated hectares |
|---------------------|-----------------------|-------------------------------|--------------|-----------------------|-------------------------------|
| Nariño              | San Andrés de Tumaco  | 143,750.7                     | Chihuahua    | Guadalupe y Calvo    | 28,077.43                     |
| Nariño              | Roberto Payán         | 61,093.6                      | Guerrero     | General Heliodoro Castillo | 19,229.58                   |
| Putumayo            | Valle del Guamuez     | 55,549.6                      | Durango      | Tamazula              | 18,219.04                     |
| Nariño              | Magüí                 | 54,770.9                      | Sinaloa      | Badiraguato           | 13,617.73                     |
| Guaviare            | San José del Guaviare | 49,911.6                      | Guerrero     | San Miguel Totolapan  | 10,937.75                     |
| Antioquia           | Tarazá                | 45,839.6                      | Guerrero     | Ayutla de los Libres Chilpancingo de los Bravo | 9728.70                      |
| Putumayo            | Puerto Asís           | 43,071.6                      | Guerrero     | Chilpancingo de los Bravo | 7230.97                     |
| Vichada             | Cumaribo              | 43,046.5                      | Nayarit      | Del Nayar             | 7171.99                       |
| Nariño              | Barbacoas             | 42,328.6                      | Guerrero     | Coyuca de Catalán    | 6052.32                       |
| Meta                | Puerto Rico           | 36,970.4                      | Guerrero     | Leonardo Bravo       | 5187.59                       |

Sources: Ministry of Defense of Colombia, Armed Forces of Mexico.
The second variable, weak and scarce state presence, enables DTOs to find territories that they can control (Ayers, 1998; Valenzuela, 2013). Their presence in turn leads to violence and armed conflict, the third factor. In the case of Colombia, several authors such as Boville (2004), Reyes (2014), Villar and Cottle (2011) or Gootenberg (2019), found an increase in guerrilla and paramilitary presence in places with a high concentration of drug cultivation. Mexico exhibits a similar relationship, as the state of Guerrero has the lowest level of rule of law in the country (ITESM, 2018) and suffers from high ungovernability associated with violence. The southeast of Mexico has served as a refuge for guerrilla groups and has been the site of numerous violent religious, territorial, and political conflicts (Gaussens, 2018), causing the region to have the highest number of homicides in Mexico associated with the struggle of DTOs to control those territories but also the government’s war on drugs (Astorga, 2015; Calderón, 2014).

The fourth factor, territorial inaccessibility, is environmental in nature but has important social implications. Tropical forests separated from urban areas provide ideal environments for illicit crops, because they are very hard to access and because plants are more easily concealed there (Rincón-Ruiz et al., 2016). In this regard, Moreno (2018) pointed out that in Colombia coca-producing municipalities are farther away, on average, from the capitals of their respective departments than non-producing municipalities. In Mexico, Maldonado-Aranda (2013) and Medel and Lu (2015) reported a similar finding and also highlighted the limited presence of government authorities due to the rugged terrain and the difficulty of reaching it by land (Díaz and Sánchez, 2004; Rincón-Ruiz et al., 2013) confirmed that areas with few primary roads and difficulty of access by other land-based means of transportation had a greater presence of coca crops. Along the same lines, Zuleta (2017) stated that municipalities with a coca-growing presence had fewer tertiary roads than municipalities without coca production. Territorial inaccessibility, largely due to the rugged terrain, is also observable in Mexican drug production especially in the states of Guerrero, Michoacán, Sinaloa, Chihuahua, and Durango (CMDPDH, 2014; Maldonado-Aranda, 2013).

Although territorial inaccessibility is a contributing factor to the selection of illicit cultivation areas in both Colombia and Mexico, we detected differences in the scale and characteristics of the physical context of crops in the two countries. Coca cultivation requires a larger land area than poppy, and thus coca fields are located farther away from the urban centers. Also, in both cases illegal crops are often combined with legal crops (Maldonado-Aranda, 2013). Finally, cultivation areas tend to be geometrically irregular, immersed in forested areas, and close to water sources (Figure 1).

The second phase in the production stage is the conversion of the coca leaf and opium gum into cocaine and opioids, respectively. This stage increases the value of the product and violence associated with traffic control (Aguilar et al., 2012). To conduct the chemical transformation, associated spaces are designed according to highly specific technological and logistical requirements. To study this stage, we combined the mapping and morphological observation of poppy and coca leaf crops with the location and analysis of destroyed cocaine and opioid laboratories, primarily in the Nariño area of Colombia and in Jalisco-Nayarit-Aguascalientes in Mexico (Table 2).

As shown by the data in Tables 1 and 2, the locations with the greatest number of Colombian laboratories seized or destroyed coincided with the areas that had the largest extent of illicit crop cultivation, with the top municipality in both cases being located in Nariño. Since the production of cocaine requires a large volume of coca leaves and since attempts to transport the raw material
could expose the activity, the laboratories are usually close to the cultivation areas (see Figure 1). In Mexico, however, the production of heroin requires opium gum in volumes smaller than those of coca leaf. The raw material is easily transportable from the cultivation areas (mainly the state of Guerrero), enabling the laboratories to be located in areas not necessarily associated with illicit crops.

Laboratories in both countries must be carefully concealed from law enforcement, leading to their strategic placement in remote and sometimes densely forested areas. Rural laboratories in both countries (A, B, C, D, F, and H in Figure 1) are close to water tributaries to facilitate transportation of drugs, supplies, and DTO members, or to get rid of chemical residue—an act that results over time in the pollution of water sources (Roa et al., 2014). In addition, poppy and coca eradication efforts through the aerial spraying of different chemicals like glyphosate have caused deforestation, soil erosion, pollution of superficial water, destruction of flora and fauna, as well as negative human health effects (Camacho and Mejia, 2017; del Olmo, 1998; Wilhite, 2006).

Laboratories vary not only by location, but as to the specific activities that they house and that characterize their interior space. With regard to processing, we identified eight spatial typologies (Figure 2). The first typology corresponds to those laboratories where the coca leaf is processed to

Figure 1. Location characteristics of drug processing laboratories in Colombia and Mexico. A: coca leaf to paste laboratory; B: coca paste to hydrochloride; C: coca leaf to hydrochloride; D: underground crystallizers; E: urban cocaine labs; F: rural heroin labs; G: urban heroin labs; H: mixed processing labs.
obtain coca paste (item A in Figure 2) by crushing and “salting” the leaves (adding substances such as cement, urea, lime, sulfuric acid, and caustic soda), followed by dissolution in gasoline, acidification, basification with magnesium permanganate and sodium bicarbonate, and finally filtering. All the above activities are performed using canisters in a space that is sufficient for crushing the leaves and has adequate ventilation and manipulation conditions (Brigada Especial contra el Narcotráfico, 2015).

Coca crystallization labs are those spaces in which coca paste (B in Figure 2) or coca leaves (C in Figure 2) are transformed into cocaine, reaching purification values close to 98% by repeating the process of separation of alkaloid impurities using ether, hydrochloric acid, and acetone (Roa et al., 2014). The substance is filtered, dried, pulverized, and packed inside environmentally controlled spaces. Industrial utensils and household appliances such as microwaves, weights, and vacuum packers are used for drying and packaging. In the laboratories in category C, the processes corresponding to both categories A and B take place (Brigada Especial contra el Narcotráfico, 2015). The underground laboratories (D), a typology of recent appearance, lack peripheral ventilation, making coca leaf processing difficult (Goel et al., 2012). As a result, they serve only as coca crystallization labs. Despite their limited size, the difficulty of detecting underground labs makes them an attractive option. Urban cocaine laboratories (E) are usually created through the renovation of home kitchens (ODC, 2015).

As for heroin production, there are minor variations in the spatial arrangement of the processes, and therefore the nature of each site depends on its location. Rural heroin laboratories (F) are environmentally controlled spaces, much smaller than those used for cocaine processing, because the volume of opium gum required to produce opioids is significantly smaller than that

| Table 2. The ten municipalities in Colombia and Mexico with the largest number of cocaine and heroin production laboratories dismantled from 2006 to 2017. |
|---|---|---|---|---|
| Colombia | | | Mexico | |
| Department | Municipality | Number of laboratories | State | Municipality | Number of laboratories |
| Nariño | San Andrés de Tumaco | 2797 | Sinaloa | Culiacán | 358 |
| Norte de Santander | Tibú | 1819 | Michoacán | Apatzingán | 100 |
| Vichada | Cumaribo | 1492 | Michoacán | Buenavista Tomatlán | 67 |
| Putumayo | Puerto Asís | 1061 | Michoacán | Parácuaro | 47 |
| Meta | Puerto Rico | 968 | Durango | Tamazú | 47 |
| Antioquia | Tarazá | 688 | Sinaloa | Cosala | 44 |
| Putumayo | San Miguel | 673 | Michoacán | Aguillla | 41 |
| Antioquia | Valdivia | 654 | Sinaloa | Badiraguate | 37 |
| Putumayo | Puerto Leguizamo | 635 | Sinaloa | Mocorito | 35 |
| Guaviare | San José del Guaviare | 556 | Michoacán | Uruapan | 27 |

Source: Observatory of Drugs of Colombia and CONACID Mexico.
of coca leaves. To purify opioids, laboratories use activated charcoal, tartaric acid, and heat-radiating devices such as stoves (Observatorio de drogas Colombia and UNODC, 2016). Urban heroin laboratories (G), like urban cocaine laboratories, are usually refurbished kitchens but are more difficult to hide from authorities because of the noise, smoke, and residue disposal involved in processing. For this reason, urban heroin laboratories tend to be smaller than rural ones and are more frequently discovered and destroyed by the authorities.

Finally, the laboratory for mixed processes (H in Figure 2) is the largest among the different laboratory types. In Colombia, these labs produce heroin, synthetic drugs, and cocaine (McDermott,
Aschner and Montero (2018); in Mexico, mixed laboratories process coca paste arriving from Colombia and therefore do not have coca leaf processing areas (CICAD and OEA, 2015). In both cases, these labs tend to be rural because of the scale of the equipment required.

As shown in Figures 1 and 2, laboratories are usually temporary spaces, constructed rapidly with materials that can be obtained locally, mainly wood and plastics. Their single function is to facilitate drug manufacturing on the largest scale and in the least notorious way possible. Consequently, the external configurations of all laboratories share a common objective, namely concealment from the authorities and enemies, while the interior space is structured in accordance with the type of process taking place (UNODC, 2005). Concealment tactics will be maintained throughout distribution, which is the next stage, but the character of related spaces will change from static parameters to infrastructures of a mobile nature.

Available resources, both natural and social, configure space according to the needs and actions conducted by DTOs to produce, hide and transport illicit drugs, and that derive in effects such as pollution or violence. In the relationship between Spatial thought and social activities (Lefebvre, 1991), physical space is transformed by DTOs and by the Colombian and Mexican governments in their eradication efforts.

**Distribution: mobility infrastructures**

The distribution stage requires optimization and risk minimization of transports from the location where illicit drugs are produced and manufactured (but where they have little market value) to one where they can be sold to a highly appreciative consumer market while avoiding detection by law enforcement agents or rival groups (Nieto-Gomez, 2016). During this stage, DTOs sharpen their spatial thinking with two objectives in sight: diversifying their strategies for placing their merchandise and dealing with the coordinated, interdependent, and adversarial relationships with competing DTOs and the government authorities who seek to arrest them (Bailey and Godson, 2001). Spatial thinking is used to minimize risks and expenses and to guarantee maximum operational secrecy.

Understanding the spatial reasoning used in the distribution stage entails recognizing the DTOs as complex structures consisting of networks of collaboration between multiple individuals and groups, who are responsible for certain processes and in charge of determined spaces and territories (Kenny, 2007). The importance of territory for DTOs is so great that they name themselves, or are named by the authorities, based on the regions or cities under their control (Valenzuela, 2013). Since responsibilities are segmented, the adjustments made in response to interdiction risks do not imply modifications to the entire DTO but only to those specific spaces affected by the risk and the individuals responsible for protecting those spaces (Dell, 2015). Because of the effort involved in making these adjustments, a certain space will remain in operation until the transportation route associated with it has been discovered by authorities (Basu, 2014).

In the planning of routes, DTOs avoid places with a history of seizures and use their economic resources to bribe agents in governmental and social institutions, either to obtain information that facilitates distribution (Chabat and Bailey, 2003) or to avert the seizure of illegal drugs at checkpoints, terminals, or customs checkpoints (Toth and Mitchell, 2018). The selection of a certain route and of the transportation mode used depends on the interdiction risks—especially at international borders—as well as the potential profits to be gained and proximity to desired markets.
Therefore, the spaces described in this section are not limited to the territories of the two countries where production occurs, to static regional locations, or to fixed architectural dimensions, because distribution is transnational in nature and may be carried out by air, water, or land, or even by underwater or underground means (Figure 3).

DTOs adjust their routes and modes of transport according to social, environmental, and spatial factors (Nieto-Gomez, 2016). Therefore, the various spaces are subject to changing circumstances, but their selection and use are guided by a common exercise of anticipatory and strategic spatial thinking. This spatial thinking permeates all scales of activity. On a small scale, it involves the three-dimensional understanding of an object, equipment, or furniture to hide drugs inside; on an intermediate scale, it entails, for example, determining the context and location of a warehouse to avoid seizure of the products contained inside, and on a large scale, it concerns the planning of national and transnational routes.

Independent of the scale, all these distribution infrastructures can be divided into two types: (1) pre-existing and subsequently adapted or (2) created specifically for IDT. DTOs usually adapt existing infrastructure to the particularities of the associated activities, but as detection and seizure strategies have become more refined, DTOs are more frequently building new and complex spaces.

Spaces associated with distribution serve for storage, dispatch, or reception and are characterized by the type of transportation. They can be categorized as hangars, heliports, airports, and clandestine airstrips for air transport; shipyards, ports, and legal and illegal piers for maritime

Figure 3. Spatialities associated with the different stages of illegal drug trafficking.
transport; and distribution centers, which can be either formal or informal, for land transport (Figure 3).

Land mobility involves previously developed infrastructure such as roads and trails, which reduce the logistical cost for DTOs but increases the frequency of possible encounters with the authorities. In contrast, maritime and air modes reduce detection risks but are more expensive (Dell, 2015; Giommoni et al., 2017). In recent years, journalistic and academic investigations have documented that the authorities have gained greater control over air distribution. Consequently, the competition for land and sea routes has increased (Gootenberg, 2009; Shirk and Wallman, 2015; Villar and Cottle, 2011).

Each transportation mode and scale, whether local, national, or transnational, involves a diversity of vehicles (Escalante, 2012) (see Figure 3). The service life of a certain type of vehicle tends to be short, and the manufacturing of vehicles is directly related to the technological advances available. The vehicles used include small planes, commercial airplanes, helicopters, and drones for air transport; private vehicles, cargo trucks, and passenger buses for land transport; and ships, boats, submersibles, and semi-submersibles for maritime transport.

Semi-submersible marine vessels, which allow drug traffickers to stealthily move large loads over long distances, can submerge approximately 80% of their volume (Anderson, 2015; Guerrero, 2016). These artifacts are manufactured with lead components to avoid detection by infrared systems, and with fiberglass or aluminum sheets in colors that mimic those of the sea. The interior space shown in Figure 4, contains separate areas for the crew, machines, and a load of 2–10 tons of cocaine (Guerrero, 2016), which occupies more than half of the vessel (Figure 4). Although they have been used since the end of the 20th century, the first seizures of semi-submersibles took place from 2005. The tracking by the authorities is hindered by the aforementioned materials and because they emit little noise. Although they are slower than other vehicles, because they sail at a speed of up to 12 knots per hour, semi-submersibles are used in transnational distribution (Guerrero, 2016).

Given their complexity and specificity, these semi-submersibles require special shipyards for their manufacture, storage, and testing. Narco-shipyards are located in strategic areas of the Colombian fluvial network that have easy sea access but are not on the routes used by naval authorities. The sites have environmental and spatial conditions suitable for carrying out tests of buoyancy, waterproofing, and the vessels’ electrical, propulsion, and ventilation systems (Anderson, 2015).

Figure 4 displays a reconstruction of a narco-shipyard located in a densely vegetated area, away from main roads and other human settlements, in which a significant amount of illicit drug cultivation occurred and which has multiple river outlets from the interior of the department of Nariño to the sea (Sistema Integrado de Monitoreo de Cultivos Ilícitos (SIMCI), 2017). The building complex consisted of two shipyards, a cocaine crystallization laboratory, and support buildings. The narco-shipyard had interior open spaces and ramps to assist in moving the semi-submersible to the water. Narco-shipyards are temporary palafitte buildings (i.e. on stilts), connected to each other by bridges and built with materials that can be obtained locally (Vélez, 2012).

Probably the best two illustrations of the elaborate and recursive spatial thinking applied to the distribution of illicit drugs are these Colombian narco-shipyards and the narco-tunnels constructed on Mexico’s border with the United States. The US–Mexican border is a tense spatial boundary with numerous checkpoints located as much as 70 miles inside US territory, border patrol stations,
infrared cameras, watchtowers, and other modes of spatial control and patrolling (Grabowska, 2016). Successfully crossing the border is of enormous importance to both DTOs and law enforcement authorities, because the economic value of illicit drugs increases substantially once they enter the United States (Boville, 2004).

Given their technical complexity, the construction of narco-tunnels requires participation by specialists with professional and technical or practical experience who can apply strategic spatial thinking to the assessment and undetectable transformation of the territory.

These specialists carry out topographic and geotechnical surveys and define the entrance and exit points of the tunnel so as to make the vertical distance between the tunnel and the surface as small as possible, reducing vertical digging efforts (Bell, 2007). Building and population density in the surrounding area facilitates the concealment of entrance points and reduces the risk of detection in the construction and operation of tunnels. Entrances are generally located within houses, warehouses, or commerce buildings, within 300 meters of the border.

Narco-tunnels are built by different DTOs in Mexico but especially by the Cartel of Sinaloa. The one built for Joaquín “Chapo” Guzmán to escape from the maximum security federal prison of “El Altiplano” on 2015 had a length of 1.5 meters, illumination and ventilation systems and a motorcycle on a rail. Guzman had different tunnels built in the state of Sinaloa in order to connect his safe houses with drainage systems of both Culiacan and Mazatlan. To conduct this part of the research, 97 tunnels were traced and 1 specific case near the US border was reconstructed and represented.

The entrance from Mexico to the tunnel shown in Figure 5, for example, was located in a cemetery 120 meters from the border. The removal of soil began there and was concealed by the cemetery’s daily practices. The excavation extended 3.20 meters deep, so as not to interfere with
drainage infrastructure (see item B in Figure 5). The tunnel traveled beneath a 20 meter-high promontory until it reached an exit point at the same level as the entrance, 100 meters from the border and within a warehouse surrounded by trees (see the cross-section in Figure 5).

The analysis of different tunnels has indicated that construction is performed with basic tools that do not produce vibrations. In contexts of desert geology, as in Nogales, the soil has a level of compression and moisture content suitable for underground excavation by hand (Goel et al., 2012).

Similar interior proportions were found in the tunnels analyzed, which were generally about 1 meter wide and 1.80 meters high. Without the use of a reinforced concrete structural system, which would greatly complicate construction logistics, a tunnel of any larger size would tend to collapse. In the interior of the Nogales narco-tunnel, ventilation and air circulation issues were addressed with polyvinyl chloride (PVC) pipes and high-powered fans. In other tunnels studied, rails for motorcycles and wheelbarrows that could transport drugs with greater ease and speed were observed (Goel et al., 2012).

The development of semi-submersibles and narco-shipyards, as well as the construction of narco-tunnels, reflects the application of spatial thinking to strategic insertions in the territory and to the implementation of highly specialized professional and technical capacities (Redacción El Zócalo, 2013).
Tiempo, 2008). These achievements demonstrate that DTOs are highly resourceful and can use technological and traditional construction knowledge in multiple spatial settings (Guerrero, 2016; Nieto-Gomez, 2016).

Cross-cutting activities: support spaces

The two stages discussed above, production and distribution, require a set of spaces that differ from each other in scale and use, but both types of spaces must be linked to cross-cutting, supportive activities within the IDT process. We developed an inventory of logistical and real-estate activities and infrastructure, identifying the following eight major categories (also listed at the bottom of Figure 3).

First, narco-camps are spaces for the training of rural and urban militias who protect DTO leaders and who perform and supervise production and distribution tasks. These spaces help DTOs develop and maintain their capabilities to exert violence, settle disputes within the organization, and to protect their territories from their enemies. In Mexico, based on the analysis of 10 such camps in the states of Nuevo León, San Luis Potosí, Veracruz, and Tamaulipas, we can describe the typical nature of these camps. The buildings are provisional in character; criminal groups occupy them temporarily after coercing or expelling the original owners. In the states of Nuevo León or Tamaulipas, people have been killed or gone missing after defending their properties against occupation by criminal groups such as the Cartel del Golfo or Los Zetas (Ansolabehere, 2017). The selection of locations for narco-camps considers two factors: they should be distant from the main urban centers but in the vicinity of laboratories or crops, making them ideal spots for logistical support and for short-term refuge. In the case of Mexico, narco-camps are inhabited by DTO operations personnel; in Colombia, they serve diverse purposes, including the training of militias or temporary housing for high-ranking DTO members (Echandía, 2013).

Places of violence are spaces constructed or adapted to enable the hidden exercise of iterative violence. At these sites, DTOs deprive individuals of their freedom and conduct interrogations, torture, and executions. The spaces can be of various sizes, including rooms within larger structures, complete buildings, open urban or rural spaces, or entire urban areas. The reconstructions and spatial analyses demonstrate that spatial thinking is applied to the concealment of certain violent actions, and to the subsequent disappearance of any evidence of use. Some of these spaces also function as narco-camps and narco-housing. Because of their variation in scale, their character, and the fact that the actions occurring there define new significances of these locations, we refer to them as places rather than spaces.

Complementary to or derived from places of violence, several types of burial spaces associated with the final disposition of dead bodies have been found. On one hand, there are threatening spaces, characterized by the visible placement of bodies to send messages to rivals or authorities. On the other hand, hidden spaces are used to dispose of corpses through chemical processes, such as those at the La Gallera farm in the outskirts of Tijuana and clandestine graves, also characterized by their secluded and concealed location. Meanwhile, DTOs also build narco-tombs that contrast with the need for concealment and the inconspicuous condition of the previously described spaces. Narco-tombs are graves and mausoleums intended for the practice of personality cults and for the explicit display of wealth in honor of the people who commissioned
them—and who are now dead and therefore no longer at risk of being discovered and prosecuted by the police. For example, the tombs of drug traffickers in Culiacán, Mexico glorify their occupants with shapes and materials that evoke or symbolize their lives of excess (Misra, 2018).

In addition to burial spaces, we find warehouses and caches where weapons, chemical precursors, money, drugs, supplies, or people may be stored. These spaces are located in both urban and rural areas. The storage of chemical precursors for later use in laboratories, for example, is located in the industrial areas of cities such as Naucalpan, State of Mexico and Ciudad Juárez, Chihuahua. From the outside, large-scale buildings occupied by DTOs are indistinguishable from legal warehouses. Smaller-scale caches are characterized by the spatial application of strategies that can guarantee concealment and invisibility. Such caches are often the last hideout of a drug trafficker being pursued by authorities. These hiding places are difficult to detect, and those who build them are often killed to ensure that they do not become informants. Drug trafficker Gilberto Rodríguez Orejuela’s cache was a 16-inch-wide space hidden under a sink and accessible only by inserting a pin into a slot to dislodge a fragment of the wall (Serrano, 1999).

Another relevant type of infrastructure used in synchrony with or complementary to narco-camps and in the vicinity of other different support spaces is surveillance and control sites. These function as tactical architecture on an intermediate scale that assists in the possession and control of a given rural or urban territory. They include sentry posts, viewpoints, trenches, and suitable spots in buildings, in corner shops, or on roofs. They are strategically located with a broad field of vision and in a direct relation to territorial access points, so as to permit the observation of movements by other DTO or law enforcement agents. The surveillance and control sites are also directly related to the nearby fluvial, aerial, or terrestrial access routes. Gaining a thorough spatial understanding of the surrounding area and its vehicular infrastructure is of utmost importance to traffickers when they take possession of a territory. The surveillance points allow them, among other things, to monitor their routes and, insofar as possible, to minimize the number of entrances into and exits from the areas they control. Hence, programs that seek to improve access or circulation or to better integrate neighborhoods into the urban fabric are contrary to the interests of DTOs (Valenzuela, 2013).

Illicit narco-retail sites play an important role in the IDT market chain. The commercialization of illicit drugs occurs in two spatial scenarios. On one hand, the supply of drugs to illegal organizations usually occurs in closed and improvised spaces, separated visually and physically from citizens’ daily lives; on the other hand, direct retail sales to consumers generally take place outdoors or in contexts with well-defined escape routes (in case of detection) and ways to prevent surveillance (Durán-Martínez, 2018; Escudero and Boris, 2018).

Even though drug retailers seldom operate in dedicated spaces, spatial patterns or location characterizations for their activity can often be determined. In fact, the academic literature has recognized that DTOs evaluate space considerations highly as a decisive factor in their commercialization activities. The first observation that can be derived from this analysis is the direct relationship between illicit drug retail spaces and mobility infrastructure. In their study of drug retail locations for consumers in Delaware, United States, Rengert et al. (2000) found that the largest number of arrests related to drug sales occurred in spaces adjacent to or near road crossings. This finding can be explained by the fact that IDT sale locations require escape routes and places where vigilance and control can be exercised, and also because drug users are interested in arriving at and leaving retail settings easily and quickly to avoid being spotted or arrested. Consequently, the
spatial characterization of illicit drug retail sites is shaped by both the seller and the buyer and is triggered differently in each context.

Second, the selection of drug sale locations is affected by the level of stability of the surrounding area. Osorio (2015), Barnum et al. (2016), and Escudero and Boris (2018), who evaluated urban environmental variables that increase the risk of drug activity, indicated that mortgage auctions, problematic owners, low housing quality, broken streetlights, precarious socioeconomic status, and short residential tenures all provided favorable circumstances for outdoor illegal drug commercialization. However, along with these socioeconomically degraded settings, there are also non-degraded locations such as bars, schools, and parking lots scattered throughout cities (Escudero and Boris, 2018). Consequently, the strategic proximity of a population vulnerable to drug abuse can make a retail site attractive even if the surrounding area is not degraded.

A seventh group of support spaces is money-laundering assets. Money laundering tends to inflate real-estate prices, distort export figures, create unfair competition conditions, accentuate the distortion of income and wealth distribution, and aggravate corruption (UNODC, 2017). Concrete examples of these negative effects were found in Cali, Colombia at the beginning of the 21st century and persist in present-day Zapopan, Mexico (Escalante, 2012; Montero, 2002).

Money-laundering assets are prone to abandonment, hasty selling, or handover. The occupation and usufruct of real estate for short periods of time is in most cases a direct effect of the lack of planning or of an investment principle, but not for DTOs. As for the goods derived from money laundering, they are of interest solely at a transactional level and not because they are directly related to IDT activities. In some cases, drug traffickers see the real-estate business as a path toward establishing legitimacy or as a way to create a legacy for generations to follow. However, it is difficult to reinsert these assets into the legal economy. Few buyers show up at auctions of seized real property, and given their dimensions and ostentation, DTOs’ buildings are often difficult to maintain. As a result, many of them fall into disrepair and are eventually demolished.

The last group of support spaces that we identified is the homes of DTO leaders. These are the buildings most commonly associated with DTOs. Many of them are sumptuous, exemplifying the narco-culture (Duncan, 2014) and its display of drug traffickers’ enormous purchasing power, which is applied to (among other things) the acquisition and formulation of symbols and of drug kingpins’ own aesthetics. Drug traffickers’ wealth finds tangible expression in housing, vehicles, graves, and weapons as well as in intangible items such as music, parties, literature, cinema, and social relations (Astorga, 2004; Grillo, 2011; Montenegro, 2015). Narco-architecture stands out within narco-culture and expresses its symbolic nature on a large scale (Córdova, 2012; O’Neill, 2016).

Manifestations and conceptions of narco-architecture vary according to each geographical and historical moment. Although each house is unique, all of them express their owner’s intentions in one of two ways: they either emphasize the owner’s presence or help to conceal it. The dominance of these two expressions has shifted over time; as we entered the 21st century, most DTO leaders’ homes had become much less notorious and ostentatious, and they are now generally inconspicuous (Mendez Sainz, 2012). As surveillance mechanisms have evolved, DTO spaces have also changed to provide greater concealment of their inhabitants.

Most houses of DTO leaders are still ostentatious on the inside, however, as their owners have shifted from massive home sizes or glamorous façades to technological features, luxurious ornaments, works of art, and furniture. Where drug traffickers’ homes do remain ostentatious on the
outside, their presence is often accompanied by corrupt apparatuses that allow their owners to inhabit them freely or with complicit protection from the authorities. In these cases, the exploitation of corruption enables drug kingpins to maintain their “invisibility” even if their homes are visible (Mendes and Oliveira, 2013).

Some houses have a wider repertoire of support activities within them. These houses are synthetic examples of IDT as they accommodate multiple types of support spaces such as places of violence, storage, caches, and even drug processing or commercialization spaces. They also function as meeting and business sites for the DTOs. This was the case of the house in Ciudad Jardín, Cali, owned by the Rodríguez Orejuela brothers (López, 2009), the Caro Quintero ranch, the Nápoles hacienda owned by Pablo Escobar (Salazar, 2001), or the Montecasino mansion in Medellin belonging to the Castaño brothers (Ronderos, 2014). The Montecasino mansion had 33,000 square meters of space, a privileged location within the city, and a spatial autonomy that ensured the undetected development of illegal activities. A representation of the house (Figure 6) exhibits material elements of the narco-culture, such as a bath with two tubs, one of them made of gold; a cache behind one of the tubs; a safety box hidden behind a double wall and fixed furniture (items A and B in Figure 6); and a façade imitating the Casa de Nariño, the residence of the president of Colombia (item F). The house also had coca processing laboratories (D) and torture rooms (C and E).

A second residential typology is the security house. These properties are used by DTO leaders to hide from the authorities. Consequently, both location and characterization are designed to avert detection. For these purposes, they present volumetric and material features that make them indistinguishable from their surroundings. The houses also have extensive surveillance equipment and multiple escape routes. Such was the case at Gilberto Rodríguez Orejuela’s house in Santa Monica, Cali, which had two vehicle exits, visual control of access roads, and a cache (Serrano, 1999), and at Diego León Montoya’s rural house in Zarzal, an apparently unfinished building with underground caches and surrounded by trees. Even more impressively, “El Chapo” Guzmán’s house on the Sierra de Durango (Figure 7) had a private airstrip (marked by the number 3 in the figure) and surveillance posts on the mountain peaks (4) that enabled occupants to see and hear approaching aircraft. Land access was deliberately difficult, and the house was located near a forest with a pathway leading to a stream (2 and 6), which facilitated concealment and escape. The nearby buildings (5), all very similar in both material and form, made recognition more difficult. All these deliberately planned spatial characteristics proved their effectiveness in the unsuccessful capture operation carried out against El Chapo on 6 October 2016.

Concluding considerations
This article focused on the relationship between space and an illegal economic activity: IDT. We built an interdisciplinary qualitative method to identify the specific characteristics of the spatial thought associated with this illegal economic activity following proposals from different authors such as Lefebvre (1991), Sassen (1998), Soja (2010) and Florida (2011), among many others that study the relationship between space and different social activities.

First, we observed that illicit crop cultivation activities are concentrated in certain areas of Colombia and Mexico due to several environmental, physical, and social factors, including high levels of poverty, weak and limited state presence, the presence of violence and armed conflict,
and territorial inaccessibility. In addition, differences in the scale and characteristics of the physical context of crop cultivation sites in the two countries were detected.

Subsequently, the spatiality and location of eight types of laboratories used for the processing of opioids and cocaine were identified and characterized as generally temporary spaces, constructed or renovated rapidly with materials that are easy to obtain locally, and with the sole functional purpose of facilitating drug processing on the largest scale possible while attracting the least possible attention. Rural laboratories in both countries are close to bodies of water; in Mexico, laboratories are not necessarily close to crops, but in Colombia they are.

Figure 6. Reconstruction of Montecasino in Medellín. The house had a bathroom with two tubs, one of them made of gold; a cache behind one of the tubs; a safety box hidden behind a double wall and a fixed piece of furniture (A and B), torture rooms (C and E) a cocaine processing laboratory (D), and a façade imitating the Casa de Nariño, the residence of the president of Colombia (F).
At the distribution stage, the sharp, strategic spatial thinking of DTOs was recognized in their diversification of routes, their mobility strategies, and their efforts to anticipate enforcement tactics. We found that DTOs in Latin America are territorial in nature, and that their transformations of spaces associated with their territories reflect spatial thinking on three scales. On a small scale, their thinking implies the three-dimensional comprehension of an object so as to hide drugs inside it; on an intermediate scale, it entails the recognition of the environment and location associated with the storage of transportation of drugs to avoid their seizure; and on a large scale, it involves the planning of national and transnational routes. Finally, we noted that distribution infrastructure can entail the adaptation of previously existing structures or the construction of new ones specifically for the transportation of illegal drugs.

Distribution infrastructure was described as spaces for the storage, transport, or receipt of drugs, and it was characterized by its relationship with land, maritime, or airborne modes of transportation. All cases highlighted the importance of transnational exporting, which brings with it the need to cross borders. The most creative spatial variations, narco-shipyards and narco-tunnels, are created specifically to facilitate transnational travel. In these cases, we demonstrated the application of spatial thinking to strategic insertions in the territory, along with the implementation of highly specialized professional and technical skills, reflecting a capacity for innovation, updated use of technologies, the application of traditional local knowledge, and resilient, innovative, and adaptive behavior by DTOs.

In the third main part of this article, three cross-cutting activities common to the different IDT stages were identified and eight types of support spaces associated with these activities were analyzed. Narco-camps, places of violence, and burial spaces are directly related to the use of violence at the different IDT stages; warehouses and caches, surveillance and control sites, and drug retail sites are associated with DTOs’ tactical and logistical actions; and finally, money-laundering assets and leaders’ homes are part of the DTOs’ real-estate activity. For each of these typologies, particular conclusions can be drawn regarding their function and general conclusions can be stated regarding their degree of conspicuity or exposure.

Figure 7. Reconstruction of Chapo Guzmán’s house in Sierra de Durango.
All this evidence demonstrates that spatial characteristics significantly influence DTOs’ actions and that DTO leaders carefully take space into account, intervening and building with strategically considered attention to accommodating their needs and interests. Consequently, space and spatial thinking are important components in the functioning of the illicit drug economy, as well as of other criminal activities. We also observed the organic nature of spatiality in the illicit drug market, meaning that it changes in both scale and characterization with market changes and depending on the particular activity. The analysis of the spatial behavior of IDT contributes in tangible ways to a better understanding of the changes in this illegal economy and thus provides possible strategies to combat it, tools for decision makers who face the challenge of drug trafficking, and insights to inform future studies on the topic.

The main finding of the research is the consideration that space becomes relevant to the study of illegal economic activities given their highlighted tactical nature and the spatial thought involved. Methodologies used to explain economic clusters, innovation ecosystems and even competitiveness, also work to explain how DTOs choose their sites, build their infrastructure, and conduct and develop all their specific activities in space. In consequence, it is possible to sustain that DTOs do not take space for granted but have rather developed sophisticated and tactical spatial thought to produce, hide, protect and deliver their products, themselves and all the support activities needed for IDT.

Spaces studied in this article show that each stage for IDT requires specific elements from natural context such as geographical advantages, natural resources, location; and social resources such as labor, protection and knowledge. These spaces also show externalities of IDT such as pollution, destruction of natural resources, health issues or violence among others. The strong relationship between space and IDT in each stage should be considered in order to design public policies against it, identifying social and spatial outcomes that challenge natural and social initiatives.

Acknowledgements
Special thanks to research assistants: Sioly Rodriguez and Omar Campos for their contribution and for the figures drawn; to Catalina Mahecha, Ana María Arjona and Nathalia Coronado at the Center for Studies on Security and Drugs (CESED), Universidad de los Andes; and to the Vicepresidency of Research for Technology Transfer, Tecnológico de Monterrey.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Center for Studies on Security and Drugs (CESED) of the Universidad de los Andes.

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