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Analysis of Illicit Drug Trafficking in Colombia's Maritime Spaces: A Spatial Exploratory Approach

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ABSTRACT

The illicit drug trafficking by sea constitutes a threat to international maritime security and impacts Colombia's bioceanic development. The purpose of this article is to analyze the maritime spaces in Colombia affected by these trafficking activities. Using Exploratory Spatial Data Analysis, we examined the maritime boundaries established in international treaties, the Colombian Navy's port captaincies, and maritime departments in relation to drug seizures reported by the International Center for Research and Analysis Against Maritime Drug Trafficking, led by Colombia (2016-2021). We also analyzed the correlation between maritime seizures and those made on land. The results are presented in maps, and five levels of threat of illicit drug trafficking are proposed: mitigated (53.55%), low (33.32%), medium (7.88%), high (2.84%), and critical (2.39%), with the highest concentration of the threat in the southwest in the Pacific Ocean, in the port captaincies and departments of Tumaco, Guapi, and Buenaventura.

1. Introduction.

This article addresses the greatest threat facing the Colombian state in the 21st century: illicit drug trafficking by sea (IDTS) (Córtes Castillo, 2022). The initial hypothesis refers to Transnational Criminal Organizations (TCOs) that exploit the weaknesses of the state in exercising its sovereignty to take control of maritime spaces and carry out criminal activities. This phenomenon has generated significant concern due to its consequences for international security and societal well-being. Therefore, the main objective of this research is to analyze the clusters or groupings of IDTS in Colombia using Exploratory Spatial Data Analysis (ESDA).

The geographic location of a country is crucial for its national power projection. In the case of Colombia, its geostrategic position in the American continent makes it a portal state (Gómez-Pretel & Acebedo-Navas, 2020), by connecting South America with North and Central America and having access to two (2) oceans (Atlantic and Pacific). This continental passage facilitates the exchange of people, goods, and ideas, as well as the development of economic and social roles (Álvarez Calderón & Namen Mesa, 2019).

According to the report from the International Center for Research and Analysis Against Maritime Drug Trafficking (CMCON) in 2020, 980 seizures and 715 arrests were made in the region (Brazil, Ecuador, Peru, Costa Rica, Mexico, Guatemala, the Dominican Republic, and Honduras). In Colombia, the report revealed 192 seizures, the capture of 243 individuals, and the confiscation of 113,807 kg of narcotics (CMCON, 2021).

World security has incorporated transnational actors influ-

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encing national policies to address threats such as TCOs in their modus operandi of drug trafficking (González Martínez, et al., 2018). This threat not only violates national laws and international treaties but also engenders antisocial and illegal activities such as organized crime, bribery and intimidation of public officials, violation of import and export regulations, firearm-related offenses, and acts of violence (Ruth, et al., 2015).

In recent years, Colombia's Gross Domestic Product (GDP) has reached significant figures, hovering around $233 billion. On the other hand, the Maritime Dependency Factor (MDF), which measures the extent to which a country or region depends on oceans and marine resources for its economy, trade, security, and overall well-being, based on Colombia's maritime imports and exports, accounted for 23%. This highlights the importance of the maritime spaces of the Atlantic and Pacific oceans in Colombia's economy and development (Rivera Páez, et al., 2017). However, the impact of IDTS on the GDP is significant. In the case of Colombia, the illicit economy related solely to cocaine, without considering other drugs, represented 1.88% of the GDP in 2018, doubling the economic contribution of sectors such as coffee exports, which accounted for 0.88% of the GDP (Pyszczek, 2021).

The fight against drugs in Colombia has been focused on a prohibitionist and repressive policy (Cadena Afanador & Devia Garzón, 2013). The threat of IDTS encompasses various illegal activities, including the production, transportation, and trade of drugs. This threat extends its reach into the political, economic, and social domains, wielding influence through pervasive corruption (Medina Gallego, 2012). This affects its development, as the accumulation of illicit wealth widens the gap in terms of productivity and income within the economy (Rocha García, 2014). Furthermore, this threat delays compliance with the 2030 Agenda and its 17 sustainable development goals (Echeverry Andrade, et al., 2023). Some authors refer to drug trafficking as a mutant threat, as with the fall of several Colombian drug lords, a new generation of drug trafficking is discussed. Linked to the training or professionalization of TCO members, enhancing their weaponry and modus operandi with state-of-the-art technology and strategies (Niño González, 2016).

In accordance with the Naval Development Plan 2042 of the Navy of the Republic of Colombia (ARC), Comprehensive Maritime Security (SIM) is based on Maritime Domain Awareness (MDA) and naval operations in order to protect regulatory interests national maritime regulations (ARC, 2020). In this sense, the CMCON publishes figures and geographical information on IDTS seizures made in port captaincies in the maritime spaces of Colombia. Essential input for this research when applying an ESDA approach.

The geo-statistical ESDA method has the scope to describe the spatial distribution of the IDTS threat. This approach is fundamental in quantitative methodological development and is related to digital cartographic representations and databases in Geographic Information Systems (GIS) (Buzadi & Baxendale, 2009). In this sense, research has been carried out to spatially analyze the distribution of illicit crops, especially coca leaves, and their relationship with economic, environmental, institutional, and social factors (Rincón Ruiz, et al., 2013). The repercussions of anti-drug policies, such as the aerial spraying of coca crops, have been scrutinized, particularly with a significant focus on the maritime departments of the Pacific region (Rincón Ruiz, et al., 2016). However, these studies have only examined coca and continental areas, leaving out maritime spaces and other drugs. Another study has chemically analyzed the origin of coca leaves, finding that the most common ones are from the southwest region of Colombia and mentioning that seizures have occurred in open waters. Nevertheless, their results focus on non-maritime continental areas (Mallette, et al., 2016).

Therefore, this article is innovative and up-to-date as it does not focus on cultivation areas but analyzes maritime seizures from 2016 to 2021 and correlates them with seizures of cocaine, marijuana, and heroin made in the departments of Colombia, with the aim of identifying the most impacted maritime spaces and departments by the modus operandi of IDTS. Thus, recent recommendations that integrate the spatial component for analyzing drug seizures and estimating distribution patterns are considered (Echeverry Andrade, et al., 2023B).

The article is structured in seven sections. (I) The introduction establishes the hypothesis and objective of the study, presenting alarming figures about IDTS, Colombia's actions, and scientific component research. (II) The methodology describes the study area, data sources, and applied ESDA. (III) The results, in tables, graphs, and maps, estimate the IDTS threat in Colombia's maritime spaces. (IV) The discussions analyze the findings in relation to the hypothesis and study objective. Finally, (V) the conclusions highlight the usefulness of the results for maritime security institutions and provide recommendations for future research."

2. Maritime security in the fight against IDTS, maritime boundaries, and spatial analysis.

Below, the theoretical and conceptual elements of the scientific component that contribute to addressing the proposed objective of analyzing the clusters or groupings of IDTS in Colombia through the use of Analysis ESDA are presented.

2.1. Maritime Security and Illicit Drug Trafficking.

Maritime security is understood as the combination of preventive and responsive measures to protect the maritime domain against intentional threats and illicit acts, including IDTS (Fransas, et al., 2012). These maritime threats are transnational issues that require a collaborative approach through integrated policies and maritime cooperation (Acosta Sánchez, 2019).

In Colombia, the public policy 3990 "Colombia Potencia Bioceánica 2030," 2020, addresses five challenges in terms of maritime security: (I) lack of coordination and governance, (II) difficulties in sovereignty and security, (III) limited knowledge generation, (IV) inadequate planning instruments, and (V) underdevelopment of maritime activities. This maritime policy seeks to strengthen maritime security in Colombia for sustainable development.

2.2. The Delimitation of Colombia's Maritime Spaces

Colombia has faced difficulties in the field of maritime security, particularly in the fight against drug trafficking. These challenges arise from the country's lack of connection and access to the oceans, the result of a series of historical events that have led to the loss of national territory (Chávez Perdomo, 2016). The loss of Panama in 1903 prevented the development of a transoceanic canal between the Atlantic and the Pacific (Buitrago Paipa, 2016). In 1928, Nicaragua gained control of the Mosquitia coastline. In 1952, the Monjes Islets were handed over to Venezuela without objection (Garcia Torres, et al., 2021). Subsequently, during the emergence of drug cartels (1975-2000), Colombia acquired naval technology, but Colombian cartels established links with Mexican cartels and illegal armed groups, posing risks to international maritime security (Cortés Castillo, 2020).

Recently, the decision of the International Court of Justice (ICJ) in 2012 changed the delimitation of territorial waters with Nicaragua, resulting in another territorial loss for Colombia (Grautoff & Ghotme, 2016). The ICJ's second ruling in favor of Nicaragua in 2022 obliges Colombia to cease all activities in the waters granted to Nicaragua. However, after the third and most recent ICJ ruling on July 13, 2023, Nicaragua lost its ambitious aspirations to extend its continental shelf beyond 200 nautical miles from its coastline.

Currently, according to the Agustín Codazzi Geographic Institute (IGAC), Colombia has a total area of 2,070,408 Km^2, divided into 1,141,748 Km^2 of continental area and 928,660 Km^2 of maritime area. It has a coastal extension of 49,777 square kilometers, composed of twelve (12) departments, with a population of 5,148,240 inhabitants. It is the only South American country with coasts on two oceans. This strategic position is considered a significant advantage for Colombia's development (Osorio, et al., 2016).

According to Article 101 of the Political Constitution of Colombia, maritime boundaries are established in international treaties ratified by the Colombian presidency (11 treaties with 9 countries). This historical overview of the codification of Colombia's maritime spaces is essential for the present research, as it allows for the geographical modeling of Colombia's maritime boundaries to be analyzed with the ESDA approach.

2.3. Exploratory Spatial Data Analysis (ESDA).

ESDA includes Local Indicators of Spatial Association (LISA), which identify patterns in the spatial distribution of a variable and provide a statistical criterion to determine which patterns are significant. This enables the characterization of spatial clusters (Loaiza Quintero & Hincapié Vélez, 2016). LISA indicators like the Univariate Moran's Index and the Local Multivariate Geary's Index are statistical tools used to analyze the spatial association of variables in a geographical context. The Univariate Moran's Index assesses the spatial autocorrelation of an individual variable, while the Local Multivariate Geary's Index analyzes the similarity of values among nearby observations in terms of multiple variables (Anselin, 2018).

Another ESDA method that has been employed is Kernel Density. This technique involves computing the density in the vicinity of seizure events and smoothing it over each vector to create a map. The resulting map exhibits more intense coloring in close proximity to other vectors, facilitating the identification of clusters of criminal activities. This tool proves useful in the context of public management (Marín-Mamani, et al., 2023).

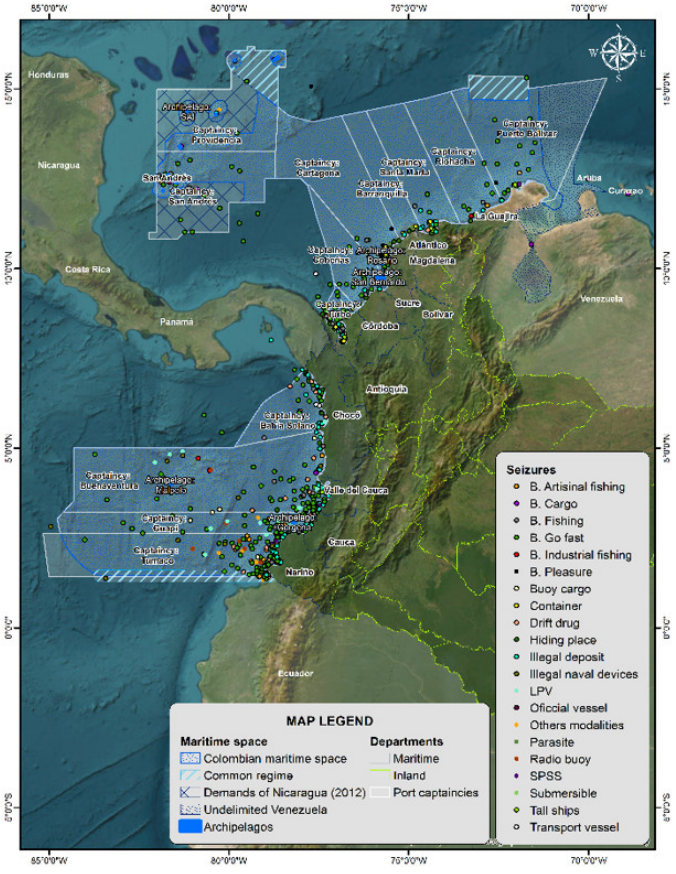
3. Methodology.

With the purpose of analyzing the Colombian maritime spaces affected by the TIDS, this research implements a methodology focused on the ESDA.

3.1. Study Area.

In the Pacific Ocean, there are 4 Port Captaincies (Tumaco, Guapi, Buenaventura, and Bahía Solano) and 4 maritime departments (Nariño, Cauca, Valle del Cauca, and Chocó). In the Atlantic Ocean, there are 9 Port Captaincies (Turbo, Cobeñas, San Andrés, Providencia, Cartagena, Barranquilla, Santa Marta, Riohacha, and Puerto Bolívar) and 8 maritime departments (Antioquia, Córdoba, Sucre, Bolívar, Magdalena, Atlántico, San Andrés – Providencia, and La Guajira). International treaties concluded with Costa Rica, Haiti, Honduras, Panama, and the USA are related to delimitation and sovereignty and have been defined as Colombian maritime territory (Figure 1).

Figure 1: Study Area and Seizures (2016-2021).



Source: Authors.

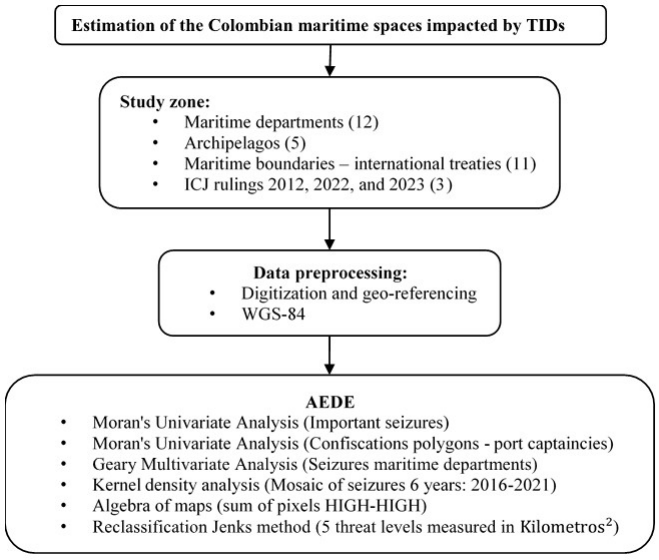
The ICJ rulings of November 19, 2012 were included (Colombia loses approximately 75,000Km2 of territorial sea in favor of Nicaragua); April 21, 2022 (Colombia must cease its patrolling operations and fishing activities in Nicaraguan waters), and July 13, 2023 (Nicaragua's claim to a continental shelf beyond 200 nautical miles cannot limit the exclusive economic zone and continental shelf rights recognized to Colombia by international law).

The lack of delimitation with Venezuela was also mapped, as well as the common regimes established in international treaties with the Dominican Republic (Liévano Jiménez. Law 38 of 1978: Zone for scientific research and common fishing exploitation), Ecuador (Liévano Lucio. Law 32 of 1975: fishing and research zone 10 miles wide from the 12 nautical miles of the coast), and Jamaica (Douglas Robertson. Law 90 of 1993: Joint administrative zone for the exploitation of hydrocarbon deposits and natural gas). Figure 2 presents the methodological scheme developed during the investigation.

3.2. Data sources and preprocessing.

The data sources used consist of graphical and alphanumeric information. The alphanumeric information was integrated with the graphical point and polygon data and subsequently transformed into the geodetic reference system used for precise representation and global positioning, World Geodetic System 1984 (WGS 84) (Romera & Pérez-Acebo, 2019). These processes were carried out using ArcMap 10.5 software.

Figure 2: Methodological scheme.



Source: Authors.

3.2.1. Territorial data.

The base cartography of the political-administrative division of departments was obtained from the Agustín Codazzi Geographic Institute (IGAC, 2023). This information did not include the archipelagos of Colombia; therefore, the Rosario and San Bernardo archipelagos were digitized using the Environmental Atlas of the Archipelagos of Our Lady of the Rosario and San Bernardo (Romero & Niño, 2014). The archipelagos of Malpelo, Gorgona, and the keys and islets of San Andrés, Santa Catalina, and Providencia were digitized in Google Earth Engine (GEE) based on satellite images (Perilla & Mas, 2020).

3.2.2. Maritime data.

Utilizing alphanumeric coordinates (latitude, longitude) as control points derived from the 11 maritime delimitation treaties negotiated by Colombia with nine countries, the maritime spaces were demarcated (Agüero, et al., 2022). The diplomatic acts of the judgments issued by the ICJ on November 19, 2012, and April 21, 2022, both in favor of Nicaragua, were also georeferenced (Wang & Xu, 2023). Finally, the port captaincies were georeferenced based on the jurisdiction map of the General Directorate of the Sea (DIMAR).

3.2.3. Seizure and Arrest Data at the National Level.

The departmental alphanumeric data on seizures of cocaine, marijuana, and heroin were obtained from the Colombia Drug Observatory (ODC) and joined with the departmental layer using the "NameDepartment" attribute (MINJUSTICIA, 2023). Finally, the six (6) annual reports (2016-2021) published by CMCON were compiled (CMCON, 2016); (CMCON, 2017); (CMCON, 2018); (CMCON, 2019); (CMCON, 2020); (CMCON, 2021). The seizures of IDTS recorded in the reports were georeferenced as vector points using their coordinates (latitude, longitude). Simultaneously, the points were linked by their spatial location to the polygonal layer of port captaincies. This generated two inputs for seizures: point data and polygonal data based on the specific port captaincy where the seizure occurred. The CMCON reports also included the number of detainees classified by their nationality. This data was collected and used to create a global map that displays the detainees by country.

3.3. Exploratory Spatial Data Analysis (ESDA).

In this article, the ESDA technique was employed to visualize spatial distribution, detect the presence of outliers, and verify the existence of clusters related to IDTS (Correa-Quezada, et al., 2018).

3.3.1. Local indicators of spatial association (LISA).

The Local Univariate Moran Index was applied to measure the spatial autocorrelation of IDTS seizure events at both the point level and the port captaincy level. This index can range from -1 to 1, revealing positive or negative spatial autocorrelation, with a value of 0 indicating the absence of spatial autocorrelation. Specific combinations of high and low values lead to the typification of spatial clusters. The following cluster types can be observed: HIGH-HIGH: high values surrounded by other high values (Quadrant I); LOW-LOW: low values surrounded by other low values (Quadrant III); HIGH-LOW: high values surrounded by low values (Quadrant IV); LOW-HIGH: low values surrounded by high values (Quadrant II) (Pellegrini, 2017).

The Geary index was applied to evaluate the spatial autocorrelation of illicit crop hectares with the variables of cocaine,

marijuana, and heroin seizures in the departments of Colombia (Alcântara, et al., 2020).

3.3.2. Cluster map.

Cluster maps represent how each study variable can differentiate from neighboring units based on the type of spatial autocorrelation it possesses (González-Loza, et al., 2020). These maps are composed of a system called RGB (Red, Green, Blue), which is the most common and widely used color-coding system (León, et al., 2020). In the cluster map of the Local Moran's I index for point seizures, the RGB patterns corresponding to red pixels (RGB: 255, 0, 0) were extracted, representing pixels with the highest values of spatial correlation (HIGH-HIGH).

3.3.3. Kernel Density Analysis and Seizure Mosaic.

To calculate the Kernel Density a model was built in ArcMap 10.5 software. The output parameters were set to pixels of 1 square kilometer (Km∧2). The geodesic method was chosen since maritime spaces cover large distances where the Earth's curvature plays a role (Cruz Islas, 2019).

3.3.4. Map Algebra for Threat Identification.

Map algebra is a process that involves combining different layers of information using their respective weights and in the same spatial systems, resulting in a synthesis map (Caldas Santos, et al., 2020). In this study, map algebra was used to sum the pixels extracted from the Local Moran I cluster map representing HIGH-HIGH values with the Kernel Density. Subsequently, a reclassification was applied using the Jenks method, which fulfills two (2) conditions: grouping data into homogeneous sets and maximizing class differences between them. Five (5) threat levels were established: mitigated, low, medium, high, and critical (Cadena & Garrocho, 2020). With a pixel size of 1 square kilometer, the reclassification provides the total count of pixels in each threat level.

4. Results.

Out of the 1242 seizures reported by CMCON in the six reports, 586 were successfully georeferenced, indicating a georeferencing success rate of 47.18% (Table 1).

Table 1: Georeferenced seizures in Colombian maritime spaces during the period 2016-2021.

Seizures	2016	2017	2018	2019	2020	2021	Total
CMCON	150	199	215	230	192	256	1242
Georeferenced	91	107	95	99	86	108	586
%	60,67	53,77	44,19	43,04	44,79	42,19	47,18

Source: Authors.

When crossing the 586 georeferenced seizures with the jurisdiction of the port captaincies, there was an overlap of 562 seizures. In the Atlantic Ocean, an estimated 209 (35.67%) seizures were observed, with Antioquia being the most affected maritime department under the responsibility of the Port Captaincy of Turbo (51 seizures, 8.70%). In the Pacific Ocean, an estimated 353 seizures (60.24%) were observed, with Nariño being the most affected maritime department under the responsibility of the Port Captaincy of Tumaco (121 seizures, 20.65%). Outside of Colombian maritime spaces, 24 seizures (4.10%) were estimated (Table 2).

Table 2: Georeferenced seizures according to port captaincy during the period (2016-2021).

Ocean	Department	P. C.	Georeferenced	Percentage	Total
Atlantic 35.67%	Antioquia	Turbo	51	8,70	209
	Bolívar	Cartagena	38	6,48	
	San Andrés	San Andrés	24	4,10	
	Magdalena	Santa Marta	24	4,10	
	Sucre	Cobeñas	22	3,75	
	Guajira	P. Bolívar	22	3,75	
	Guajira	Riohacha	11	1,88	
	Atlántico	Barranquilla	10	1,71	
	San Andrés	Providencia	7	1,19	
Pacific 60.24%	Nariño	Tumaco	121	20,65	353
	Valle	Buenaventura	114	19,45	
	Cauca	Guapi	76	12,97	
	Choco	Bahia Solano	42	7,17	
Regional	Outside the jurisdiction		24	4,10	

Note. P. C.: Port Captaincy.
Source: Authors.

Table 3 presents the figures of detainees at the national level. The data is illustrated in Figure 3.

Table 3: Nationality of detainees in Colombian maritime spaces (2016-2021).

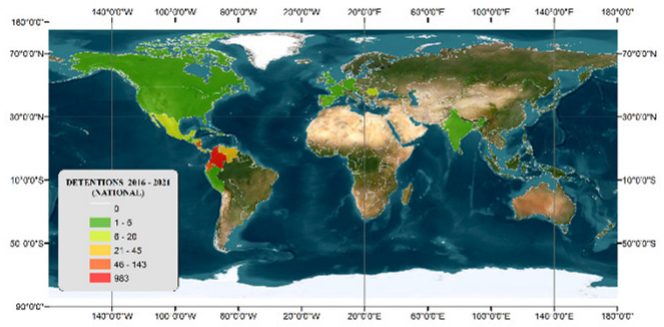
Origin	2016	2017	2018	2019	2020	2021	Total	%
Colombia	120	193	167	173	171	159	983	70,47
Ecuador	39	45	16	17	16	10	143	10,25
Nicaragua	7	2	0	10	14	19	52	3,73
Venezuela	7	4	7	17	2	8	45	3,23
Costa Rica	5	0	3	0	22	12	42	3,01
Panama	0	6	0	0	13	17	36	2,58
Romania	20	0	0	0	0	0	20	1,43
Mexico	0	7	7	0	2	0	16	1,15
Honduras	0	4	0	0	2	0	6	0,36
France	5	0	0	0	0	0	5	0,36
Guatemala	2	1	1	0	0	0	4	0,29
Dominican R.	0	0	0	0	0	4	4	0,29
Jamaica	0	0	0	0	0	3	3	0,22
Peru	0	0	0	0	2	1	3	0,22
Australia	2	0	0	0	0	0	2	0,14
Spain	1	0	1	0	0	0	2	0,14
Kiribati Islands	0	0	2	0	0	0	2	0,14
Germany	0	0	1	0	0	0	1	0,07
Canada	0	1	0	0	0	0	1	0,07
Cuba	0	0	1	0	0	0	1	0,07
United States	0	0	1	0	0	0	1	0,07
India	0	0	0	1	0	0	1	0,07
England	0	1	0	0	0	0	1	0,07
Montenegro	0	0	0	0	0	1	1	0,07
Unknown	0	0	0	14	0	7	21	1,51
Total Year	208	264	207	232	244	234	1.375	100,00

Source: Authors.

According to the detention records in Colombian maritime spaces during the period 2016-2021, it has been determined that the five nationalities with the highest number of detainees are: Colombians, with 983 detainees (70.47%); Ecuadorians, with 143 detainees (10.25%); Nicaraguans, with 52 detainees (3.73%); Venezuelans, with 45 detainees (3.23%); and Costa Ricans, with 42 detainees (3.01%). These five nationalities be-

long to countries that share maritime borders with Colombia.

Figure 3: Detentions in Colombian maritime spaces according to their nationality (2016-2021).

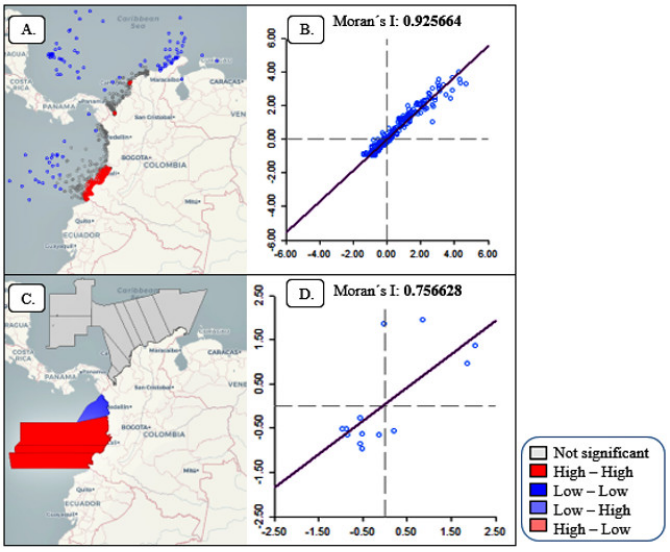


Source: Authors.

4.1. Univariate Analysis: Illicit Maritime Seizures.

In Figure 4, univariate Moran analyses revealed a high positive correlation of the seizure variable.

Figure 4: Cluster and Moran's I: A, B. Pinpoint Seizures; C, D. Port Captaincy Seizures.



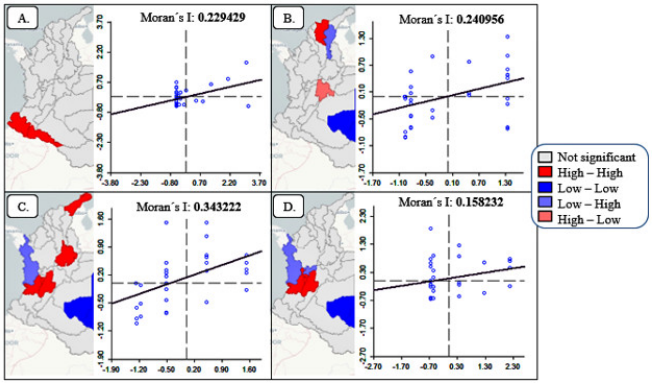
Source: Authors.

In Figure 4B, the pinpoint seizures achieved a Moran's I index (I. Moran) of 0.925664. In Figure 4D, seizures under the jurisdiction of Port Captaincies attained a Moran's I of 0.756628. Both Figure 4A and Figure 4C identified a "High-High" cluster (shown in red and the first quadrant) in the southwest of Colombia within the Port Captaincies of Guapi, Nariño, and Valle del Cauca. This indicates a dense concentration of seizures in these areas. Figure 4A also identified two (2) "High-High" clusters in the northwest of Colombia within the Port Captaincies of Turbo and Cartagena. Additionally, there were 291 pinpoint seizures with no significant correlation (represented in gray) and 100 seizures with a "Low-Low" correlation (shown in blue and the third quadrant).

4.2. Illicit Seizures in Maritime Departments.

Figure 5 shows the results of the univariate Moran's I analysis at the departmental level for the four (4) variables: illicit cultivation hectares, cocaine seizures, marijuana seizures, and heroin seizures. The obtained Moran's I values were 0.229429, 0.240956, 0.343222, and 0.158232, respectively, indicating low positive spatial autocorrelation.

Figure 5: Cluster and Moran's I: A. Illicit Cultivation (Ha); B. Cocaine Seizures (Kg); C. Marijuana Seizures (Kg); D. Heroin Seizures (Kg).



Note: Statistically significant values equal to or below the 5% probability level. The interpretation of the results focuses on maritime departments, omitting the interpretation of inland departments for this study.
Source: Authors.

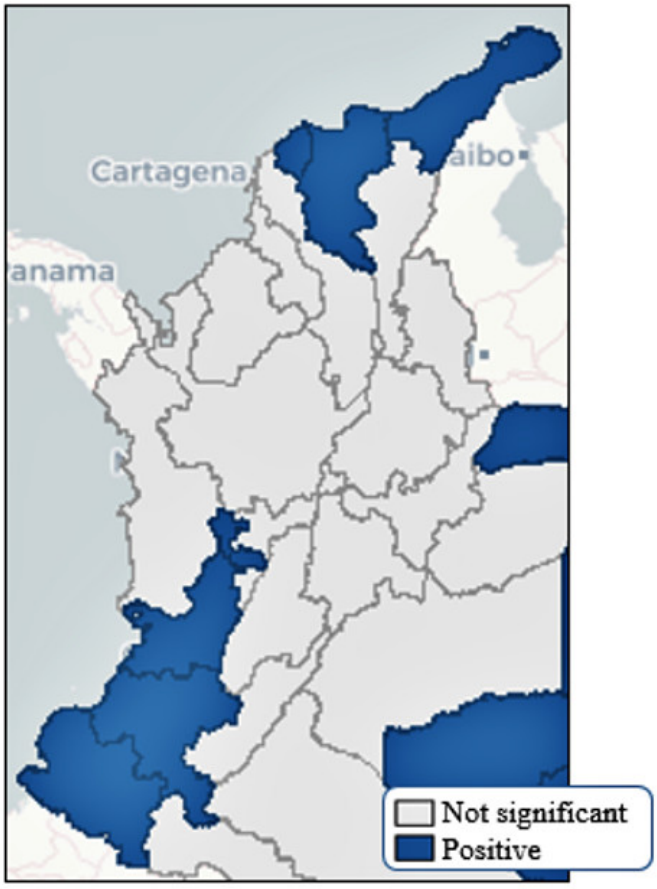
The "High-High" (red) classification for illicit cultivation hectares is mainly concentrated in the southern maritime department of Nariño (Figure 5A). "High-High" cocaine seizures are concentrated in the northern maritime department of Magdalena (Figure 5B). "High-High" marijuana seizures are concentrated in the southwest in the maritime department of Valle del Cauca and the north in the maritime department of La Guajira (Figure 5C). Finally, "High-High" heroin seizures are observed in the southwest, specifically in the maritime department of Valle del Cauca (Figure 5D).

4.3. Multivariate Geary Analysis: Illicit Cultivation and Seizures in Maritime Departments.

Figure 6 displays the results of the multivariate local Geary analysis applied to the maritime departments of Colombia, considering the variables of illicit cultivation, cocaine seizures, marijuana seizures, and heroin seizures.

The results reveal a positive correlation in 6 maritime departments grouped into two (2) blue clusters: north and southwest. The northern cluster, composed of the departments of La Guajira, Magdalena, and Atlántico, shows a significant positive correlation. The southwest cluster, comprising the departments of Cauca, Nariño, and Valle del Cauca, also exhibits a significant positive correlation. These two clusters are characterized by their access to the sea and high values of illicit cultivation and seizures.

Figure 6: Cluster of Multivariate Geary Correlation (Illicit Cultivation, Cocaine Seizures, Marijuana Seizures, Heroin Seizures).



Note: Statistically significant values equal to or below the 5% probability level. The interpretation of the results focuses on maritime departments, omitting the interpretation of inland departments for this study.
Source: Authors.

4.4. Colombian maritime spaces affected by IDTS.

Visually, when evaluating the clusters of seizures maritime and departments (Figures 4 and 6), a relationship between seizures occurring at sea and those on land (maritime departments) becomes evident. These departments and their respective Port Captaincies are the most impacted by illicit drug trafficking in Colombia.

The results indicate that 53.55% of Colombia's maritime spaces are either mitigated or located far from the coast, making patrolling challenging. Low-threat areas represent 33.32% of the maritime spaces. Medium, high, and critical threats account for 7.88%, 2.84%, and 2.39%, respectively (Figure 7).

Regarding the Colombian archipelagos, in Figure 7, it is evident that the Gorgona archipelago, located in the port captaincy of Guapi in the Pacific Ocean, is in a critical threat zone. The Rosario and San Bernardo archipelagos, situated in the port captaincy of Cartagena and Cobeñas, are in zones of high and medium threat, respectively. As for the Archipelago of San Andrés, located in the Caribbean (Atlantic Ocean), its main island is in a medium-threat zone, while the rest of the islets and cays are in a low-threat zone. Finally, the Malpelo archipelago, located in the Pacific Ocean, is in a low-threat zone.

Table 4: Classification of Threat Areas.

Threat Level	Km^2	*% Maritime spaces*
Mitigated	497.156	53,55%
Low	309.325	33,32%
Medium	73.191	7,88%
High	26.369	2,84%
Critical	22.225	2,39%
Total	928.266	100,00%

Note: The calculated area does not include the maritime departments impacted by illicit drug trafficking.
Source: Authors.

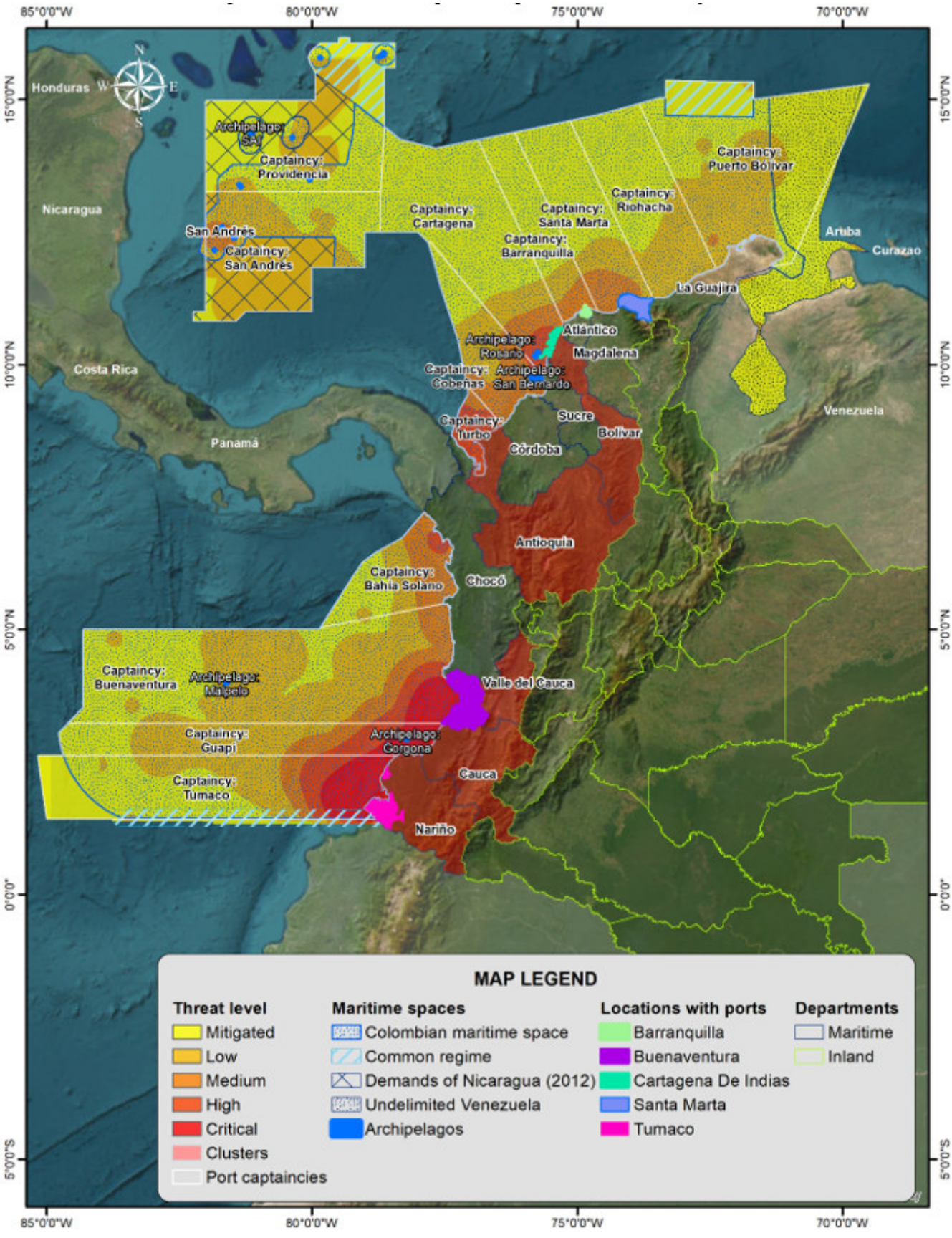
5. Discussions.

After analyzing and estimating Colombian maritime spaces affected by drug trafficking through the application of ESDA, the main discussions are presented. The univariate Moran analysis revealed a high positive correlation of seizures both in terms of point location and according to the jurisdictions of port captaincies. This indicates a spatial concentration of drug trafficking, especially in the Pacific Ocean, in the jurisdictions of the Port Captaincies of Guapi, Tumaco, and Buenaventura. In this context, the UNODC's October 2022 Monitoring of Territories Affected by Illicit Crops reports that the concentration and persistence of illicit crops can be explained by a functional geographical relationship with drug trafficking, as they are located in border departments or those with access to the sea. Such as the departments of Cauca, Valle del Cauca, and Nariño, which have more than a thousand hectares of cultivated illicit crops (UNODC, 2022).

The cluster identified in the Port Captaincy of Turbo is related to the most frequent routes used by criminal organizations heading towards Central America from this municipality located in the maritime department of Antioquia (Cujabante Villamil, et al., 2022). Similarly, in the case of the Port Captaincy of Cartagena in the maritime department of Bolívar, these routes are frequently used by TCO and have connections to North America, the Caribbean, and Europe (Uribe Cáceres, 2016). The Geary multivariate analyses showed the existence of two significant positive correlation clusters: one in the north (La Guajira, Magdalena, and Atlántico) and another in the southwest (Cauca, Nariño, Valle del Cauca, and Risaralda). These analyses, combined through map algebra, allowed for a graphical representation of both the maritime departments and the affected maritime zones (Buzadi & Baxendale, 2009).

According to the Marine and Coastal Research Institute of Colombia (INVEMAR), Colombian maritime spaces cover approximately 988,000 Km^2. However, it also points out that

Figure 7: The threat of Illicit Drug Trafficking in Colombian Maritime Spaces.



Source: Authors.

this figure reduces to 929,000 Km^2 if the coastal zone strip extending from the shoreline to inland is excluded (INVEMAR, 2015). In this article, only the area corresponding to the maritime spaces was considered, without including the internal area of the coastline, resulting in a total surface of 928,266 Km^2. Of these, approximately 121,785 Km^2 equivalent to 13.11% of Colombian maritime spaces exhibit a medium, high, or critical presence of IDTS.

Colombia is still pending to fully comply with the ICJ decisions in 2012 and 2022 regarding its maritime spaces with Nicaragua. The delimitation established by the ICJ has had implications on the interests of other states, raising concerns about maritime borders and the potential need for future negotiations between Costa Rica, Honduras, Panama, Jamaica, and Nicaragua (Tanaka, 2013). These territorial issues in the Caribbean provide opportunities for organized criminal groups involved in drug trafficking, as these crimes often exploit changes arising from territorial disputes, thus amplifying threats (Bueger & Edmunds, 2020). In terms of maritime security, Colombia is in a better position compared to Nicaragua, thanks to its efforts in combating drug trafficking, the human and material resources available in the San Andrés archipelago, and the assistance provided by the USA (Gallego Cosme, 2013).

One of the limitations of the study was the lack of access to geographic information. Despite requesting data from DIMAR, it was not provided due to national security reasons. As an alternative, the seizures present in the CMCON maps were georeferenced, which allowed the identification of only 47.37% of the reported data. The same difficulty was encountered when attempting to obtain the boundaries established in international treaties and the maps of the Port Captaincy.

Surprisingly, the archipelagos of Colombia lack publicly accessible cartographic information, which hinders the development of maritime culture and identity in the country, and as a result, delays innovation and research in the field of maritime security and maritime spaces of Colombia. To contribute to Colombia's vision for 2030 of becoming a Sustainable Bioceanic Power, it is urgent to address the five (5) challenges posed by CONPES 3990, focusing on (I) coordination, governance, and (III) knowledge generation, involving academia.

Within this constraint, it is crucial to recognize that the study was conducted exclusively on the basis of seizure data, and although authorities make significant efforts to counter this threat, it must be assumed that many drug trafficking events that are not seized manage to cross the maritime barriers and reach the northern geographic regions.

Regarding future work, it is recommended to address proximity analysis. This analysis can evaluate the distance between drug seizures, ports, and locations of maritime companies and services. This could reveal whether there is a close relationship between the presence of port clusters and criminal activity. Route analysis can also be applied to establish whether commercial routes overlap with IDTS threat zones. Additionally, the spatial correlation between drug seizures and geographical or socio-economic characteristics of surrounding areas can be examined. For example, investigating whether seizures are related to proximity to ports or areas of higher poverty. Environmental impact studies of IDTS in threat zones can also be addressed.

Conclusions.

The main findings in the analysis to estimate the Colombian maritime spaces affected by drug trafficking through the application of ESDA provide valuable information for the authorities responsible for combating drug trafficking. The positive correlation found in the univariate and multivariate analyses, as well as the algebra of maps, support the idea that drug trafficking incidents do not occur randomly but concentrate in certain regions, making it feasible to estimate the Colombian maritime spaces affected by IDT. These findings highlight the importance of strengthening surveillance and interdiction in the port captaincies identified as critical areas, as well as those located in the northern and southwestern clusters.

Regarding the Colombian maritime spaces where a higher number of seizures occur, it can be asserted that as we move away from the coast, id est, outside the Colombian territorial sea, fewer seizure events occur. This can be attributed to the long distances that security vessels must cover. This threat can be addressed by establishing security strategies focused on areas classified as high and critical threats.

It is important to highlight that an additional concern arises due to the Undetected Illicit Traffic that manages to reach its destination and falls outside the scope of this study, which focuses solely on analyzing seizures. Therefore, it is necessary to consider this limitation when interpreting the results and understand that the actual situation could be more complex and worrisome than what the seizure data reflects.

The results about the detainees and their countries of origin reveal that Illicit Trafficking is a transnational threat that affects all involved states. The detainees come from a diverse set of countries, indicating that illegal trafficking somehow has connections and reach across multiple nations. While Colombia has the highest number of detainees, followed by Ecuador, Nicaragua, and Venezuela, it's essential to note that illicit trafficking is not limited to these regions. Detainees come from various countries, including Costa Rica, Panama, Romania, Mexico, Honduras, France, Guatemala, Dominican Republic, Jamaica, Peru, Australia, Spain, Kiribati, Germany, Canada, Cuba, India, England, Montenegro, and the USA. This diverse involvement of countries emphasizes the transnational nature of the Illicit Trafficking problem and highlights the need for global cooperation and collaboration among states to effectively address this threat.

The ruling of July 13, 2023, by the ICJ favored Colombia, protecting its national continental shelf and, consequently, the delimitation of its waters. However, it is important to recall that the ruling of November 19, 2012, by the ICJ granted Nicaragua approximately 75,000 Km^2 of the sea, which modified the delimitation of waters in the region. It is crucial to highlight that, as a responsible international actor bound by international law, Colombia must comply with and accept this decision, as it was confirmed by the ICJ in its ruling of April 21, 2022. This confirmation obliges Colombia to cease all patrol activities in

the waters granted to Nicaragua. Despite the territorial loss, Colombia can view this situation as an opportunity to establish bilateral relations with Nicaragua concerning security and strengthen the port captaincies established in San Andrés and Providencia. In doing so, Colombia could position itself as a relevant international actor and reference in the region in the fight against IDT. Cooperation and diplomacy will be essential to progress toward peaceful and mutually beneficial coexistence between both countries and the American continent.

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