Kurdish Studies
December 2022
Volume: 10, No: 2, pp. 391-401
ISSN: 2051-4883 (Print) | ISSN 2051-4891 (Online)
www.KurdishStudies.net

DOI: 10.53555/ks.v10i2.3048

The Threat Of Transmission Of Aedes Aegypti Diseases From Endemic To Sub-Endemic And Non-Endemic Areas.

Darwin Suárez Ariza[1*], Dora Marcela Benítez Ramírez[2]

[1*]Universidad Pedagógica y Tecnológica de Colombia *Docente Colombia,* darwin.suarez@uptc.edu.co, *https://orcid.org/0009-0006-1964-4692*
[2]Universidad EAN *Investigadora Colombia,* dbenite57461@universidadean.edu.co, *https://orcid.org/0009-0006-2890-4919*

Abstract –
The research entitled: Study Temporal Space of the Adaptation of the Aedes Aegypti in the western province of Boyacá, allowed us to identify the threat that the vector represents for the communities of the populated areas in the geographical corridor comprised by the municipalities of Puerto Boyacá, Otanche, San Pablo de Borbur, Pauna, and Chiquinquirá. Thence, a comparison mechanism was used from the epidemiological data collected in the departmental public health bulletins, climate data from the National Institute of Hydrology, and Meteorology and Environmental Studies. With this information, a homogeneous temporal analysis was carried out with the variables of precipitation, temperature, humidity, and cases of Dengue, Zika, and Chikungunya. Therefore, a weekly time was defined, and a comparison was made between the change in climate conditions found in the study area and the case reporting of diseases recorded in the epidemiological surveillance system. When the correlation of the climatology and epidemiology variables is obtained, they are compared with the independent variable, which includes the orographic conditions of the territory, because this shows altitudinal changes in a length of 146 kilometers of a gradient of 2732 meters, located in the lowest ground level at 141 m a.s.l. in the municipality of Puerto Boyacá, an endemic area for the vector to transmit arboviral diseases, passing to sub-endemic areas and reaching the highest level of 2873 m a.s.l. m in Chiquinquirá, a non-endemic area. Thus, the above allowed identifying the risk associated with the transmission of diseases in the different altitudinal ranges.

Keywords: Threat, climate, epidemiology, vector.

I. INTRODUCTION

Epidemiological surveillance of vector-borne diseases is becoming increasingly important worldwide [1]. To determine the epidemiological risk caused by arboviral diseases transmitted by the *Aedes aegypti* mosquito, as a transmitter of arboviruses such as yellow fever, dengue chikungunya and Zika [2]. In Colombia, studies on mosquito resilience in urban areas and suitability to climate change indicate that the risk of increased disease spread in new areas considered non-endemic and sub-endemic [3]. Next, we present the first research carried out in the biological corridor of Western Boyacá (delimited by the municipalities of Puerto Boyacá, Otanche, Pauna and Chiquinquirá), with the aim of identifying the presence or absence of the vector in an altitudinal range that ranged from 145 m a.s.l. to 2556 m a.s.l.

From the delimitation of the study area, with the processing of cartographic data, it was executed through the use of geographic information system tools. Meteorological data were collected from the information provided by the IDEAM stations or through satellite information from a period of 30 years, verifying the data of minimum 70% reliability [4]. Regarding the available historical records of the occurrence of Chikungunya and Zika diseases, data were taken from the National Institute of Health of Colombia, epidemiological surveillance system -SIVIGILA-, hosted in a publicly accessible database (http://portalsivigila.ins.gov.co/sivigila/index.php). The information found in the databases was systematized, and then compared with that obtained in the field [5].

Finally, a correlation of the data obtained was carried out, in order to identify the degree of risk for *Aedes aegypti* to reach new altitudinal ranges and establish ecological niches, for the demagnetization of arboviral diseases (Zika, Chikungunya and Dengue) in the region under study.

THEORETICAL FRAMEWORK

The A. aegypti *mosquito* is found at latitudes near the equator, in areas of the tropics and subtropics, which presents a potential risk in the transmission of viral and emerging diseases, especially in Latin America, such as the dengue virus [6]. The adaptive capacity at high latitudes is related to introductions in the warm and contact periods, which

defines the temporary colonizing capacity. Due to the proliferation of outbreaks of positive cases worldwide, it is necessary to establish entomological surveillance mechanisms. Defining demographic and spatial distribution is an important exercise through the study of climatic and demographic data that allow the evaluation and management of transmission mechanisms based on the presence and absence of vectors and determine the probability of establishment, spread and proliferation [7]

II. METHODOLOGY

A. *Identification of the study area*

The research process that led to the spatiotemporal identification of the adaptation mechanism of *Aedes aegypti* in the Western Corridor of Boyacá was based on the description of the study area, through the analysis of the geographic information system and reconnaissance of the area, through field visits in which the following actions were developed.

- Consultation of cartographic information from open databases of the Agustín Codazzi Geographic Institute.
- Processing of GIS information, selecting the study area using ArcGIS software.
- Generation of base maps of the study area
- Guided tours by inhabitants of the Western Corridor sector of Boyacá, a tour that began in the municipality of Puerto Boyacá and ended in the municipality of Chiquinquirá.
- Marking of points of interest with the use of GPS of populated places.
- Processing of information collected in the field using GIS.

With the identification of the altitudinal behavior of the Interference Corridor of National Route 60 given by the municipalities of Puerto Boyacá, Otanche, San Pablo de Borbur, Puna and Chiquinquirá, the study area is delimited. It can be seen that the municipality of Puerto Boyacá is in a range of 140 to 500 m a.s.l., which constitutes a land with a low slope unlike the other municipalities.

The identification of the Biological Corridor [8] that includes the area of the municipalities of Puerto Boyacá, Otanche, San Pablo de Borbur, Pauna and Chiquinquirá was proposed, in order to establish the altitudinal conditions [9] through which the *Aedes aegypti would transit*. In the geographical aspect, the endogenous and exogenous environmental variables related to the generation of the ecological niche conducive to the colonization and transmission of the vector are defined [10]

B. *Selection of Climatic Factor Analysis*

Prior to the selection of climatological factors, which tend to the dissemination of the vector with the transmission of arboviral diseases, previous research denotes that temperature, precipitation and relative humidity condition the epidemiological behavior of *Aedes aegypti* [11]. Based on this proven scientific basis, the decision was made to work with the factors described.

This information was obtained from the Institute of Hydrology, Meteorology and Environmental Studies – IDEAM, where the data are the result of the indicators of the statistical operation, and are presented in tables structured according to the formats established by the organization.
The request for information was made according to the following parameters:

- Consultation of the national catalogue of stations based on the indications of the methodological guide of the statistical operation of meteorological variables [12].
- Identification of the stations present in the study area of the Western Corridor of Boyacá.
- Selection of stations according to the categories presented; ordinary climatological, main climatological, special meteorological station, rainfall and pluviometric, because in these stations they provide the data of the factors to be studied.

With the data obtained, the spatiotemporal analysis of the climatological variables of interest was carried out, taking into account that the necessary information was available; that is, data reliability, series continuity, and representativeness in the area.

C. *Epidemiological conditions*

The epidemiological bulletins were consulted, in which information on prioritized diseases of interest to the department's public health is published, which is notified weekly to the National Institute of Health (INS) through the Public Health Surveillance Systems. There, the corresponding information on vector-borne diseases was obtained.

The procedure carried out to obtain the number of reported cases consisted of:

- To extract information from the historical records available from epidemiological bulletins on the occurrence of Chikungunya, Zika and Dengue diseases in the municipalities that make up the study area, which was found in publicly accessible data from the Ministry of Health of the department of Boyacá.
- To build a database with information on epidemiological weeks, in weekly temporality in spatial relation to the municipalities of Puerto Boyacá, Otanche, San Pablo de Borbur, Pauna and Chiquinquirá.
- Generate a graphical analysis of the information obtained using Excel software.

D. Checking the presence of the vector in the study area

In order to carry out an analysis to identify the presence or absence of the vector in the population centers, the sampling methodology was adjusted, which consisted of performing the actions shown in Fig. 2.

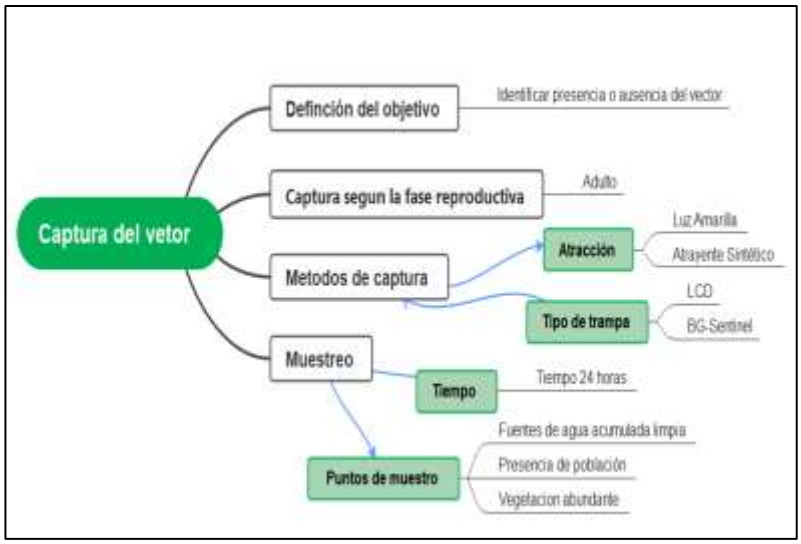

Fig. 1 Methodological procedure for vector capture. In original language: Spanish

The use of traps is justified under considerations that lead to a rapid and standardized estimation of the biological parameters of the population [13]. On the other hand, the WHO, in terms of capturing specimens in the adult reproductive phase, allows the species to be accurately identified and the effects of these on public health to be monitored [14].

As for the description of how the traps work, they are shown in Fig. 3.

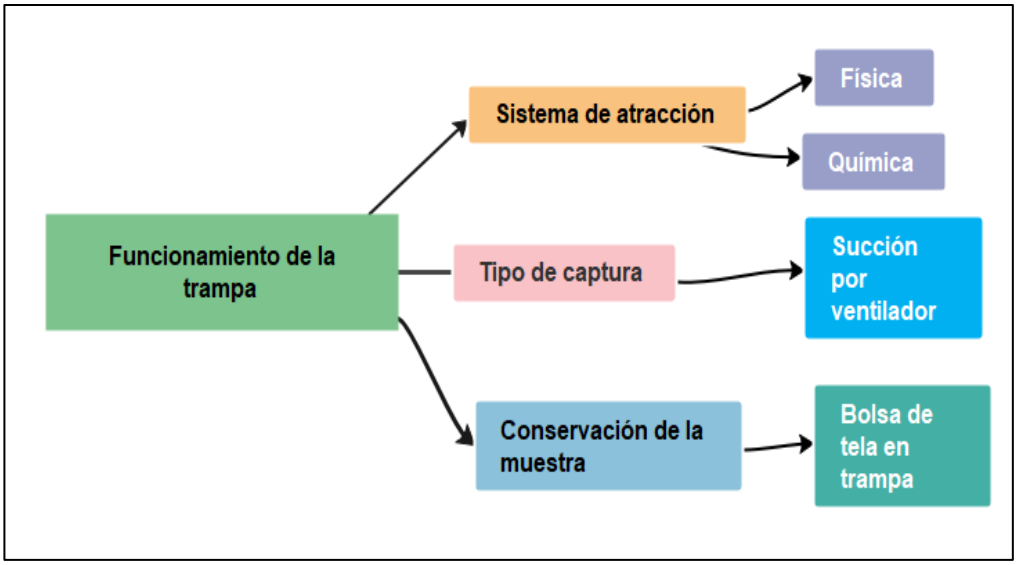

Fig. 3. Description of how the trap works. In original language: Spanish

III. RESULTS

A. Location of the corridor

Spatially, the study area was identified with geographic information analysis (GIS) using ArcGIS software. Fig 4 describes the Geographic Corridor of Western Boyacá, made up of the municipalities of Puerto Boyacá, Otanche, San Pablo de Borbur, Pauna and Chiquinquirá, with an approximate area of 9,158.77 hectares.

The description of the orographic and relief conditions of the corridor of the study area shows changes in geomorphological structures between the valley of the Magdalena River and the eastern mountain range. Fig. 5 corresponds to the elevation profile, which allows the identification of habitats for the vector in terms of altitudinal behavior, with a gradient of 2732 meters, over a length of 146 kilometers. The lowest level of the terrain is 141 m a.s.l. in the municipality of Puerto Boyacá and the highest level is 2873 m a.s.l. in the municipality of Chiquinquirá; This gradient, with a wide altitudinal range, prepares the territory for the location and habitat of the *Aedes aegypti vector,* which, according to the WHO, develops between zero meters and 1800 m a.s.l. [15] This analysis was carried out using ArcGIS and Google Earth Pro software

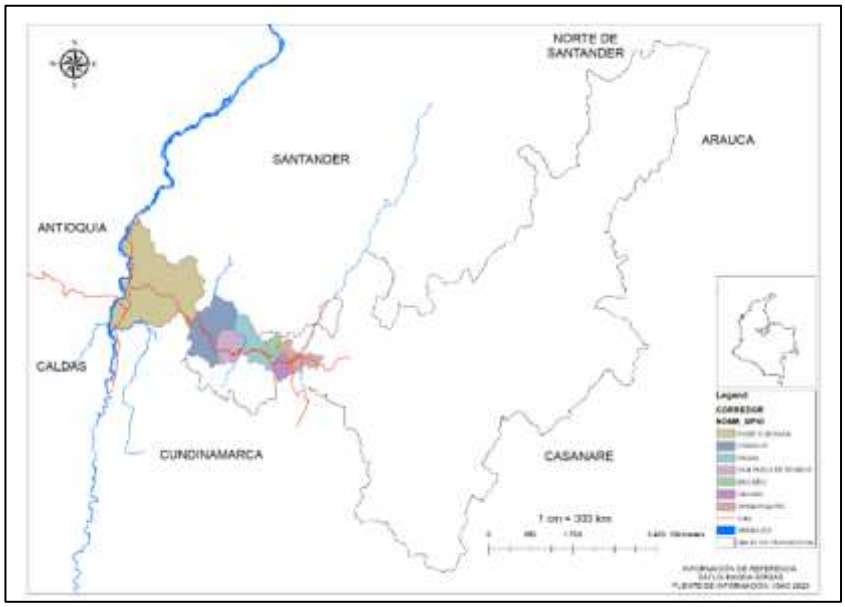

Fig. 4: Geographic identification of the study area. In original language: Spanish

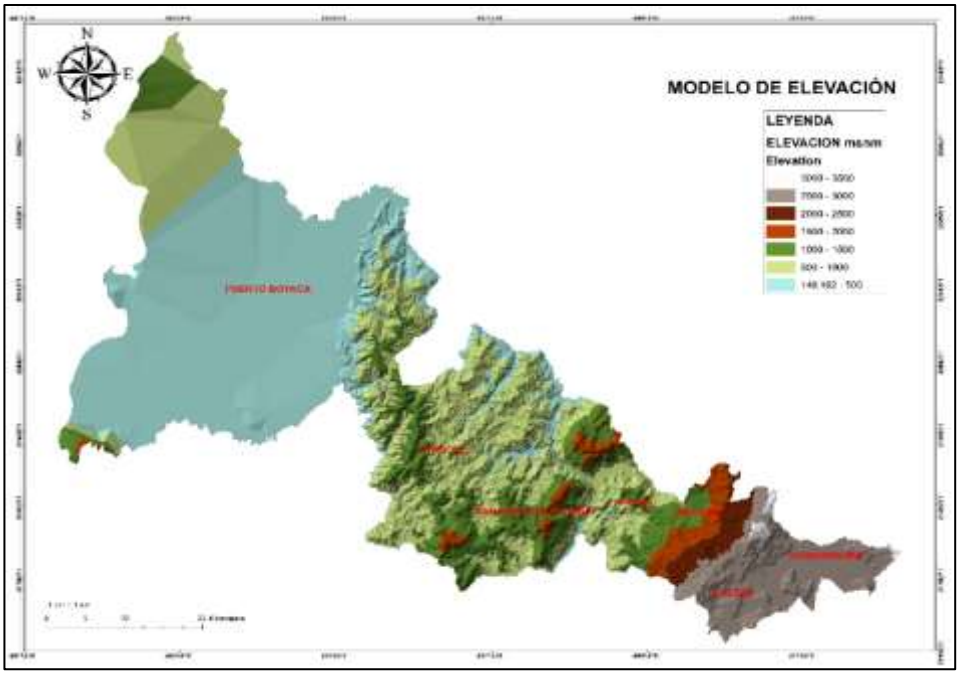

Fig. 5. Elevation profile. In original language: Spanish

B. **Climate analysis**

The selection of stations corresponded to the classification of Ordinary Climatological (CO) and Principal Climatological (CP). Called Furatena 23125140 station, 23115010 Puerto Boyacá station and Buenavista station 23125100 because they have data on the three parameters to analyze. Temperature, precipitation, and relative humidity. Recommended data for 30 years, for the purpose of conducting climate studies,

The temperature and precipitation conditions are shown in Fig. 6, which describes a bimodal behavior with two periods of increased rainfall and inversely decreased temperature. The Furatena station, which is located to the south of the Corridor, at an altitude of 1250 m above sea level, shows an increase in temperature in the months of December to February and a decrease in rainfall. In the months of March to June, rainfall increases, with its highest peak in April; In the months of June to August, there is the second period of decreased rainfall; and from September to November, rainfall increases again

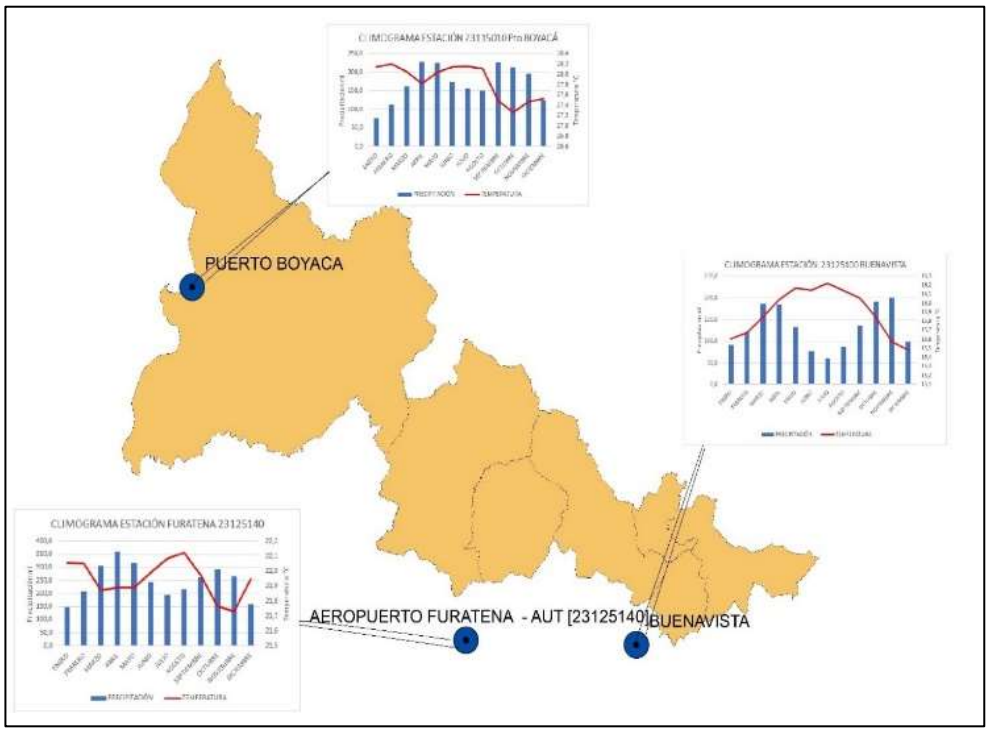

Fig. 6: general climatic conditions in the Western Corridor of Boyacá

The climate conditions according to the data analysis carried out in the present study for the Puerto Boyacá station, with an altitude of 350 m a.s.l., show a bimodal rainy period; the first, in the months of March to May; the second, from September to November, with a range of maximum and minimum temperature variation of 0.9 °C.

The Buenavista station, located to the south-west of the Corridor at an altitude of 2200 m a.s.l., has the peaks of precipitation in the months of March and November. It is imperative to highlight the existence of a wide range between the maximum precipitation values with respect to the multi-year monthly minimum, which oscillates around 60.8 ml. Given this condition, the bimodal rainfall regime is more remarkable . The temperature gradient between maximum and minimum is 0.7 °C.

Relative humidity conditions allow us to know how humid or dry the air is, a determining factor for an insect to find the conditions of habitability and development of its life cycle [16]. The humidity behavior in the air was evaluated by creating multitemporal maps, using ArcMap software, with the relative humidity data of the three stations that construct Fig. 7.

Average humidity ranges are between 75% to 90%. In the months of January to February, the humidity decreases over the valley of the Magdalena River and the Minero River; Like the months of May to June, from September to December, the humidity increases in much of the corridor remaining above 80%.

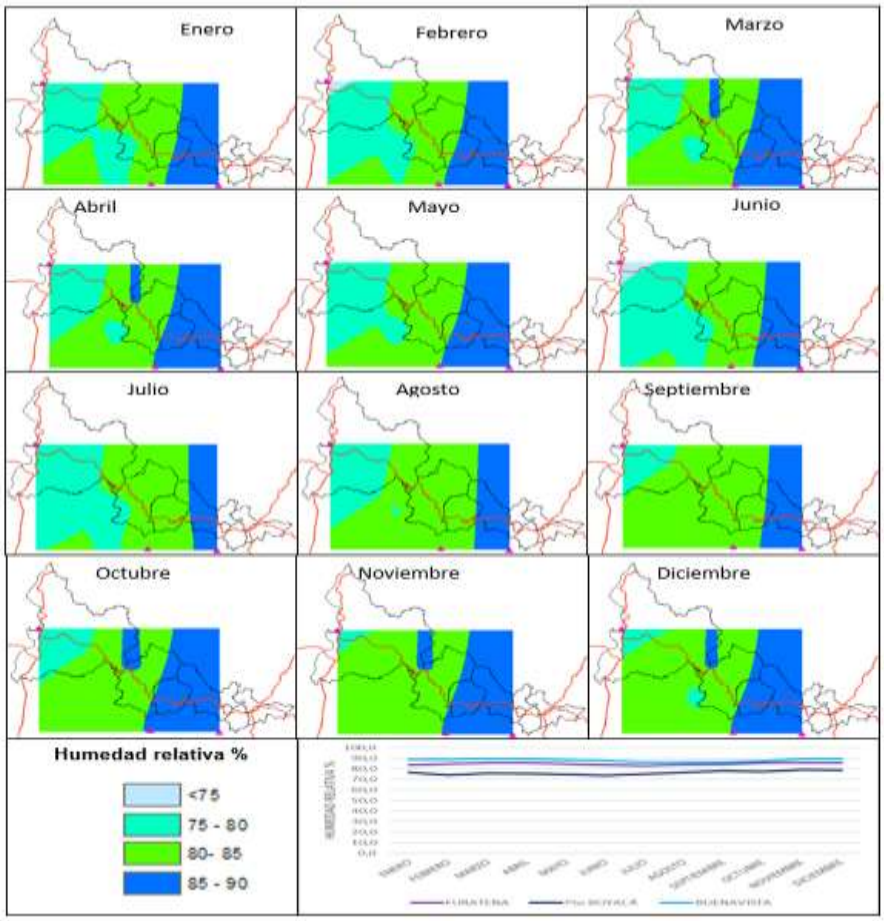

Fig. 7: Monthly multi-year behavior of relative humidity. In original language: Spanish

C. Epidemiological data

The epidemiological analysis was carried out taking into account the information contained in the epidemiological bulletins existing in the open access database of the Ministry of Health of the department of Boyacá, extracting the information of the reported cases of the diseases: Dengue, Zika, Chikungunya, for each of the municipalities object of this study. with a temporary order from 2013 to 2020.

The behavior of reported cases of dengue, zika, and chikungunya is shown in Fig. 8. In general, it is found that for the municipality of Puerto Boyacá the number of cases of diseases transmitted by the Aedes Aegypti is higher.

An atypical case occurred in 2019, which presents a high incidence of Dengue cases. The reported value was 383 cases for the corridor, this result is in accordance with the epidemiological alert issued by the Ministry of Health for the year 2019, which describes the importance of territorial entities adopting the instruments aimed at organizing primary care services and support for monitoring the associated contingency of the epidemic related to the presence of the El Niño phenomenon throughout the national territory. This health entity reported that 951 municipalities in the country were at risk for being below 2200 m a.s.l. [17] In Latin America, epidemiological week 49 to 52 of 2019 reported 3,139,335 cases of dengue (incidence of 321.58 cases per 100,000 inhabitants), including 1,538 deaths. Of the total reported cases, 1,367,353 (43.6%) were laboratory-confirmed and 28,169 (0.9%) were classified as severe dengue. The case fatality rate was 0.049% [18].

In 2014, the municipality of Puerto Boyacá had the highest number of Chikungunya cases, and in 2015 it led with the presence of Zika. The second municipality with a permanent record during the entire period of study of Dengue cases is Otanche, which in 2015 presents a significant increase in the number of cases, in contrast the municipality of Chiquinquirá reports the lowest number of cases of arboviral diseases.

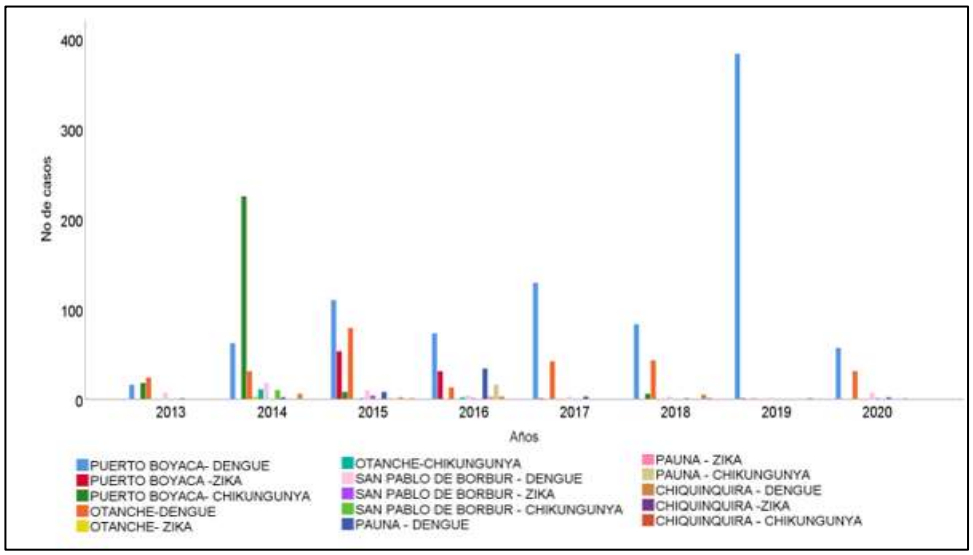

Fig. 8: reported cases of the diseases: Dengue, Zika, Chikungunya, for each of the municipalities. In original language: Spanish

D. Vector identification

The *Aedes aegypti* test in the Western Corridor of Boyacá was carried out as a general epidemiological surveillance mechanism, without determining the virology of the VDEN, VCHIK, VZIK and VFA agents. To verify the presence or absence of the vector, sampling was carried out in the main population centers. The objective of the sampling was to verify the postulate in the distribution of the vector, which is transported all over the world, in tropical, subtropical and sometimes temperate regions, through global trade and commodity courier activities [19], since mosquitoes have an enormous vectorial capacity. innate effectiveness in transmitting viruses [20].

The results of the methodology for capturing adult mosquitoes by means of traps, as shown in Fig. 9 corresponding to the identification of nearby points with human presence, abundant vegetation and sources of stagnant clean water, characteristics of the habitat of the vector [21].

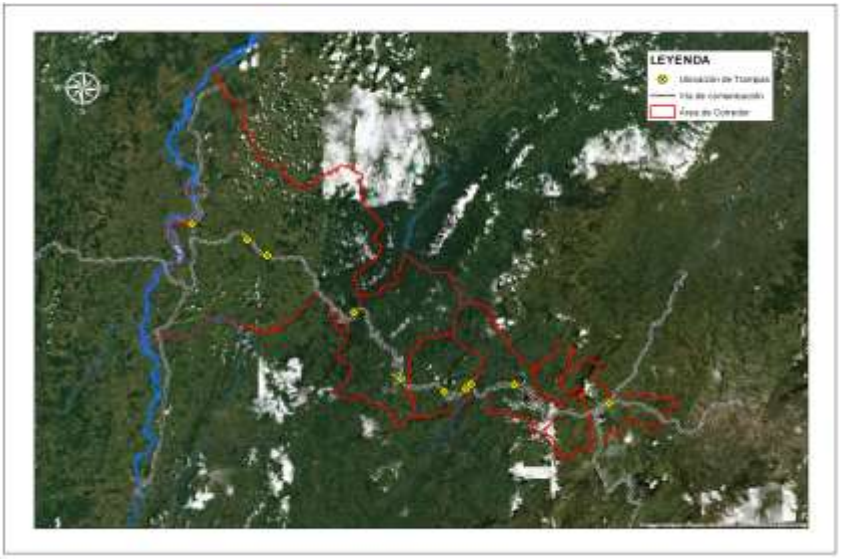

Fig. 9: Sampling points for vector identification.

Sampling at the indicated points was carried out by placing CDC light traps, which were imported from the United States. The operation of this type of trap consists of a reverse ventilation system, which sucks the mosquitoes from the top and throws them into the collection container at the bottom (entomological cloth bag for live samples); In addition, with white light on its top as a source of attraction for insects, powered by a power system supplied by a 12-volt battery.

The other traps used were BG Sentinel. these capture mechanisms use BG-Lure as an attractant, which have a combination of attractive visual and olfactory cues.

The identification analysis was performed with the electron stereoscopy technique of the entomology laboratory, defining the general taxonomic characteristics. of the morphotype of the vector found in the study area.

- Kingdom: Animal
- Phylum: *arthropoda.*
- Class: Insect
- Order: *Diptera*
- Family: Culicidea
- Genus: *aedes*
- Species: *A. aegypti*

Fig. 10 Vector morphotype.

Once the presence of the vector has been verified in the points selected for the location of the traps along the Western Corridor of Boyacá, it is concluded that the captures made in all the municipalities using the BG-Sentitinel trap and the attractant, are effective for the collection of individuals, given the conditions of selectivity in attracting *Aedes aegypti* [20] On the other hand, in the points identified as urban areas, the collection of mosquitoes was higher for all cases than the PTAPs.

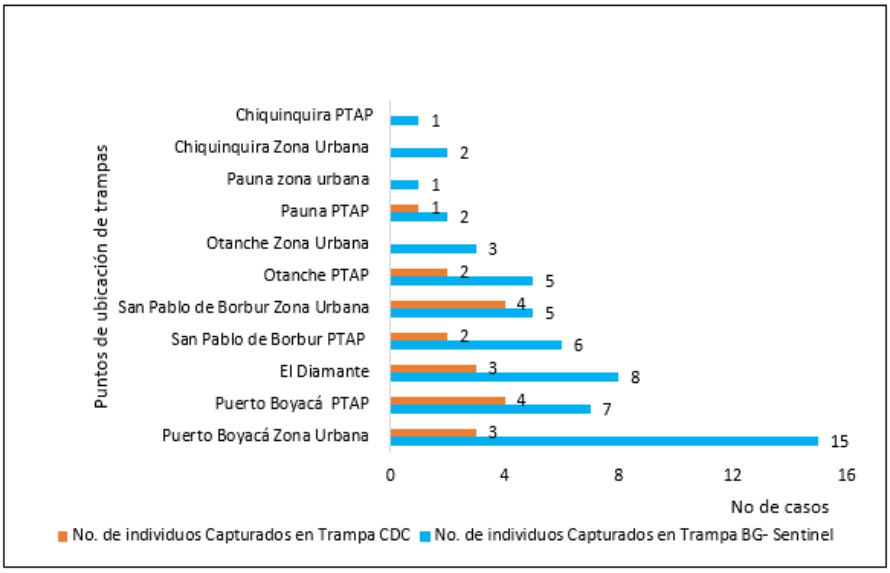

Fig. 11. Verification of the vector in the Western Corridor of Boyacá.

In general, Table 1 summarizes the total number of cases presented for each of the diseases in which the greatest presence of dengue is observed in all municipalities.

The lowest number of reported cases corresponds to Zika, for Chikungunya intermediate case of reports, with 2014 being the most significant year for this corridor with 225 cases.

Dengue is the virus that presents the most frequent case dynamics for the Western Corridor of Boyacá. However, there is no correlation with the climatic variables analyzed, which can be seen in Fig. 12 where there is a wide dispersion of data. Similar studies conducted in Montería, Córdoba, Colombia, indicate that temperature did not influence the presentation of cases of any of the arboviral diseases [22]

Table I Records Of Dengue, Zika And Chikungunya Cases Throughout The Corridor Period 2013-2020. In original language: Spanish

		Enfermedad		
		Dengue	Zika	Chikungunya
		Sumatoria	Sumatoria	Sumatoria
		Media	Media	Media
Año	AÑO 2013	16	0	18
	AÑO 2014	62	0	225
	AÑO 2015	110	53	8
	AÑO 2016	73	31	0
	AÑO 2017	129	1	0
	AÑO 2018	83	0	6
	AÑO 2019	383	1	.
	AÑO 2020	57	.	0

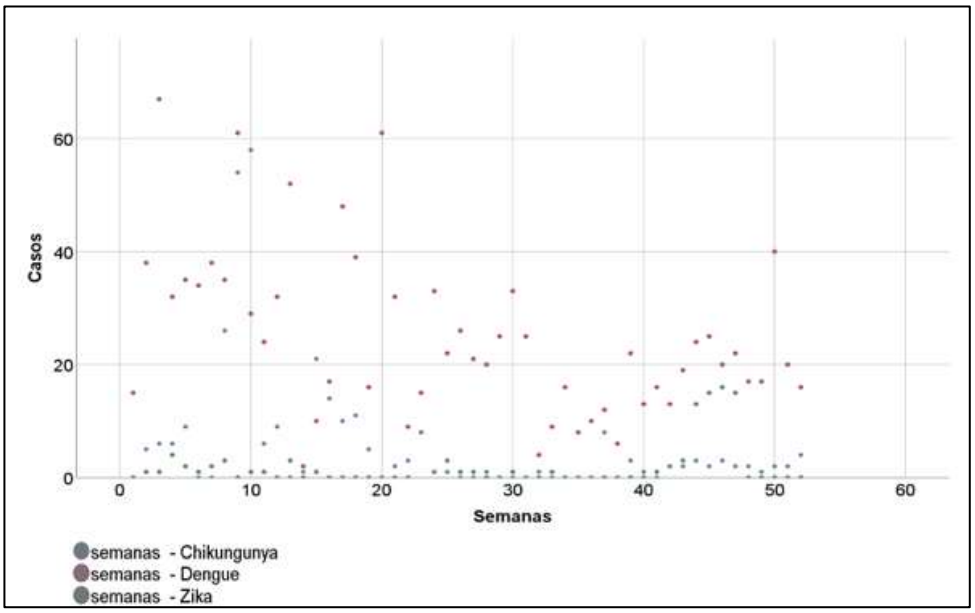

Fig. 12. Correlation of climatic factors and reported disease cases

The above are variables that allow the increase or decrease of risk indices, since it has been estimated that the *Aedes aegypti* vector can break barriers in areas considered as non-endemic to transmit diseases. To date, chemical and biological control systems have been implemented, where it has been shown that chemical control is not effective, since it produces collateral damage to human health and the environment, in addition to creating resistance in the vector and the biological mechanisms lack scientific validity. Therefore, effective and benign control methods for vector control are urgently needed. It has also been shown that educational strategies, such as tools for symptomatic recognition of diseases and domestic health control, have not been successful in reducing morbidity and mortality rates

IV CONCLUSIONS

The establishment of the altitudinal condition through the elaboration of cartography allowed the delimitation of the endemic, sub-endemic and non-endemic zones, which allow the study of the adaptation of *the Aedes aegypti* in new habitats according to the orographic conditions of the territory. Vector adaptation was found in these geomorphological zones identified in the study.

The information recorded in the epidemiological bulletins allowed us to know the behavior of the disease transmitted by the *Aedes aegypti* vector, establishing the frequency and number of cases reported to public health surveillance systems. Dengue is the virus with the highest prevalence in the population. However, it is vitally important to carry out epidemiological monitoring of Zika and Chikungunya, as the outbreaks have occurred with high transmissibility in the human population.

The study compared different methods of capturing vector specimens in the adult state. According to the analysis of information, he indicated that, due to the characteristics of field work, geographical and management conditions, the best tool to use are traps as an epidemiological surveillance system for vector identification. According to the advantages offered, it is defined that the BG-Sentinel trap is the best that, together with the attractant, allows the selective capture of the vector for subsequent entomological and virological analyses.

The study required a homogeneous temporal weekly comparison mechanism (epidemiological data-climatic data) for the variables of precipitation, temperature, humidity, cases of Dengue, Zika and Chikungunya, which generated the need to build concordant databases between the information of the IDEAM and the Secretary of Health, defining a weekly temporality for the territory. where no direct relationship was found in the report of the cases with the meteorological dynamics of the Western Corridor of Boyacá.

The study reveals that there are cases of Zika and Chikunguya in the municipalities of Puerto Boyacá and San Pablo, however, the municipality of Otanche, which is located in the middle of these two territorial entities, shows a lower number of cases, therefore, it is inferred that, given the altitudinal conditions above 1000 m a.s.l., The vector finds a more comfortable habitat in lower altitudinal ranges.

Of the climatological variables studied (temperature, precipitation and humidity) it is found that humidity has a greater incidence in the life cycle and in the transmissibility of diseases in the study area. This conclusion is in addition to the evidence of the study carried out by Barrera R.

In general, corresponding to the territory of the Western Corridor of Boyacá, changes in the altitudinal range favor the conditions of adaptability to the vector, without having a relevant impact on climatic conditions.

The present work is of great relevance at the local, regional and national levels, taking into account that in the area where this study was developed, there were no similar investigations that allow to identify the conditions of adaptability of the vector with attitude, demography, basic sanitation conditions and climatological parameters

REFERENCES

1. William Wint, Peter Jones, Moritz Kraemer, Neil Alexander, Francis Schaffner. Past, present and future distribution of the yellow fever mosquito Aedes aegypti: The European paradox,
2. Science of The Total Environment. Volume 847. 2022. Available in: https://doi.org/10.1016/j.scitotenv.2022.157566.
3. Tobón, A. Pérez, J. Rojas, R. Rojas, W. Triana, O. Rúa, G. Gomez, A. Surveillance of Zika virus in field-caught Aedes aegypti and Aedes albopictus suggests important role of male mosquitoes in viral populations maintenance in Medellín, Colombia, Infection, Genetics and Evolution. 2020. https://doi.org/10.1016/j.meegid.2020.104434.
4. Portilla, C. Josephraj, J. Geographic shifts in the bioclimatic suitability for Aedes aegypti under climate change scenarios in Colombia,Heliyon, Volume 6, Issue 1. 2020. https://doi.org/10.1016/j.heliyon.2019.e03101.
5. IDEAM. Methodology of the statistical operation : methodological variables. Deputy Directorate of Methodologies. Methodological Document Meteorological Variable Statistics, 2020.
6. Carbajo, A. E., Cardo, M.V., & Vezzani, D. Past, present and future of Aedes aegypti in its South American southern distribution fringe: What do temperature and population tell us? Cited by Acta Trópica. [Online]. 2019, Vol. 177, January 2018, pp. 74-80. [Accessed 22 October 2019]. Available: https://doi.org/10.1016/j.actatropica.2017.09.029
7. Soria, A. Faraji, A. Hamik, Hamik, J. Whie, Gregory. Amsberry, S. Donahue, M. Buss, B. Pless, E. Veiga, L. Powell, J. Origins of high latitude introductions of Aedes aegypti to Nebraska and Utah during 2019, Infection, Genetics and Evolution. 2022. https://doi.org/10.1016/j.meegid.2022.105333.
8. Lorenz, C. Chiaravalloti, F. Control methods for Aedes aegypti: Have we lost the battle?. 2022. https://doi.org/10.1016/j.tmaid.2022.102428.
9. Osorio Ruiz, Catalina; Cardona Hernández, Dorotea and Duque, José Luis. Biological corridors: a recovery strategy in highly fragmented landscapes. Case study La Bolsa microbasin, municipality of Marinilla. In: Gestión y Ambiente, 2012, vol. 15 no. 1, pp. 7-18. Universidad Nacional de Colombia Medellín, Colombia. [Accessed 8 September 2019]. Available in: https://www.redalyc.org/pdf/1694/169424101002.pdf
10. IDEAM. Weather, Climate and Climate Change Scenarios Modeling Group. 2012.
11. Fangyu Ding. et al. Mapping the spatial distribution of *Aedes aegypti* and *Aedes albopictus*. In: Acta Tropica, February 2018, Vol. 178, pp. 155-162. [Accessed 8 September 2019]. Available in: https://doi.org/10.1016/j.actatropica.2017.11.020

12. Calle T. Et al. Surveillance of Zika virus in field-caught Aedes aegypti and Aedes albopictus suggests important role of male mosquitoes in viral populations maintenance in Medellín, Colombia. [Accessed July 2, 2021]. Available in: https://doi.org/10.1016/j.meegid.2020.104434
13. IDEAM. Methodological Guide for the Operation of Meteorological Variable Statistics. 2019. [Accessed online July 6, 2021]. Available in: http://www.ideam.gov.co/documents/10182/557765/Definiciones+CNE.pdf/25e1cca5-ee47-4eaf-86c0-c4f5192a9937
14. AMCA. Mosquito Control Best Practices 2017. [Accessed online, 23 August 2021]. Available in: https://cdn.ymaws.com/sites/mosquito.site-ym.com/resource/resmgr/docs/Resource_Center/Training_Certification/AMCA_Guidelines_FINAL_SPANIS.pdf
15. WHO. Vector-borne diseases. Facts and figures. 2020. [Accessed online 21 August 2021]. Available in: https://www.who.int/es/news-room/fact-sheets/detail/vector-borne-diseases
16. WHO. Characteristics of diseases transmitted by Aedes aegypti. [Accessed 2 August 2021]. Available in: https://www.paho.org/es/temas/dengue.
17. Barrera R. Competition and resistance to starvation in larvae of container-inhabiting Aedes mosquitoes. Ecol Entomol. 1996;21:117-27. http://dx.doi.org/10.1111/j.1365- 2311.1996.tb01178.x
18. MINISTRY OF HEALTH AND SOCIAL PROTECTION. Dengue contingency plan 2019. [Accessed online 11 September 2021]. Available in: https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/PP/ET/contingencia-dengue-2019-vuelta-colombia.pdf
19. PAHO. Dengue Epidemiological Update. February 7, 2020. [accessed online 22 August 2021]. Available in: https://www.paho.org/sites/default/files/2020-02/2020-feb-7-phe-actualizacion-epi-dengue.pdf
20. Powell Jr, Tabachnick WJ. History of domestication and spread of Aedes aegypti—a review. Memórias do Instituto Oswaldo Cruz Suppl 1:11-17. 2013
21. NATIONAL INSTITUTE OF HEALTH. Management for entomological surveillance and control of dengue transmission. [Accessed Online October 18, 2021]. Available in: https://www.paho.org/col/dmdocuments/Entomologia_DENGUE.pdf
22. Eiras, Ae, Pires, Sf, Staunton, Km et al. A high-risk Zika and dengue transmission center: virus detection in mosquitoes on a Brazilian university campus. Parasite vectors 11, 359 (2018). https://doi.org/10.1186/s13071-018-2883-8
23. Cassab, A., Morales, V. and Mattar, S. Climatic factors and dengue cases in Montería, Colombia. 2003-2008. In: Journal of Public Health. 13(1) 11-128. [Accessed online: 23 August 2021] Available in: https://scielosp.org/pdf/rsap/2011.v13n1/115-128/es