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Original Research Article

Spatial Distribution of Dengue in Honduras during 2016-2019 using a Geographic Information Systems (GIS) – Dengue Epidemic Implications for Public Health and Travel Medicine

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Abstract

Background: After serious epidemics of chikungunya (CHIKV) and Zika (ZIKV) in the Americas, dengue (DENV) have reemerged in most countries. We analyzed the incidence, incidence rates, and evolution of DENV cases in Honduras from 2015-2018 and the ongoing 2019 epidemic.

Methods: Using epidemiological weeks (EW) surveillance data on the DENV in Honduras, we estimated incidence rates (cases/100,000 population), and developed maps at national, departmental, and municipal levels.

Results: From 1 January 2016 to 21 July 2019, a total of 109,557 cases of DENV were reported, 28,603 in 2019, with an incidence rate of 312.32 cases/100,000 population this year; 0.13% laboratory-confirmed. The highest peak was reached on the EW 28°, 2019 (5,299 cases; 57.89 cases/100,000 population). The department with the highest number of cases and incidence rate was Cortes (8,404 cases, 479.68 cases/100,000 population in 2019).

Discussion: The pattern and evolution of DENV epidemic in 2019 in Honduras has been similar to that which occurred for in 2015. As previously reported, this epidemic involved the north and central areas of the country predominantly, reaching municipality incidences there >1,000 cases/100,000 population (or 1%). Studies using geographical information systems linked with clinical disease characteristics are necessary to obtain accurate epidemiological data for public health systems. Such information is also useful for assessment of risk for travelers who visit specific areas in a destination country.

Keywords

Dengue virus (DENV); geographical information systems (GIS); public health; travelers; arboviruses; infectious diseases epidemiology.

Introduction

Latin America and the Caribbean have been the epicenter of emerging epidemics of arboviral diseases since December 2013 [1]. Among the most important, chikungunya (CHIKV) [2] and Zika (ZIKV) [3] viruses infections are ranked first. Together with dengue (DENV), a flavivirus, these arboviral diseases have affected millions during the last five years, especially those in the most tropical areas near to the Equator, as is the case of countries in the north of South America and Central America [4]. Probably due to high attack rates during such epidemics, primarily due to ZIKV as another flavivirus, DENV rates, but also of CHIKV (an alphavirus) and ZIKV, felt significantly during years 2015 to 2017. In late 2018, this arboviral disease began to increase in most countries, reaching epidemic levels again in most countries in 2019.

In 2017, there were 580,640 cases of dengue in the region (254,453 in Brazil, 89,893 in Mexico and 76,093 in Peru), with 561,356 in 2018 (265,934 from Brazil, 78,621 Mexico and 44,825 Colombia) [5, 6]. Such declines in dengue have been discussed by experts, indicating that multifactorial events may have accounted for this situation, including elements of immunity, increased vector control, and even vector and virus changes or adaptations [6, 7].

Among the affected countries, Honduras is currently facing an epidemic (2019), reaching highest values of some epidemiological indicators, such as the number and proportion of severe forms of disease, as well the case fatality rates [6]. Honduras has prone conditions, such as climate [8, 9], international travel, foreign trade [10, 11], geographical susceptibility,that would be associated with the outbreak [12-16].

As reported before, in general, there are not many studies about arboviral diseases in Honduras [17-21], some explicitly exploring the potential impacts of climate change and variability on DENV, as well as the analysis of the 2015 DENV epidemics [9, 12].

Previous assessments for DENV and CHIKV in Honduras performed by our group demonstrated the importance of *A. aegypti* populations for informing public health decisions and travel advice [12]. This has also been shown in other Latin American countries [12, 14, 15, 22-24]. In addition to *A. aegypti*, the presence of *A. albopictus* was confirmed in the Mountain Park Juana Lainez at Tegucigalpa in 2013 [4, 25].

In the past decade, the near real-time availability of novel and disparate internet-based data sources has motivated the development of complementary methodologies to track the incidence and spread of disease. The Pan American Health Organization (PAHO) currently streamlines reports from ministries of health and reports weekly confirmed and suspected cases of arboviral diseases such as DENV, CHIK, and ZIKV by country [24, 26-31]. These reports provide up-to-date data about the epidemiology of arboviral diseases in affected global regions [12], However, there is no detailed information about specific places, departments or municipalities, which is necessary to make more specific recommendations to travelers as well for public health prioritization and policies [4, 27, 29, 32, 33], especially during epidemics, as is the case for Honduras in 2019.

Understanding the impact of arboviruses, in terms of clinical complications, disability, and costs to health systems, require a more significant number of investigations involving multiple medical specialties, mainly in susceptible countries such as Honduras. This information is essential to develop and prepare for possible future epidemics of new emerging arboviruses [4, 16, 22].

As part of the enhanced efforts in control and risk assessment for arboviral diseases in Latin America, the Universidad Tecnológica de Pereira, the Ministry of Health of Honduras and the Universidad Nacional Autónoma de Honduras, are working together in the analysis of epidemiological information of infectious diseases in regional and national scales [12, 34-36], including conditions such as ZIKV, DENV and CHIKV [9, 12, 24, 27-29, 32]. In this setting, this study aimed to estimate incidence rates of DENV in 2016-2019 for Honduras and its departments and municipalities and to develop GIS-based epidemiological maps for this arboviral disease, mainly focusing in 2019 epidemic.

Methods

Honduras is a Central American country constituted by 18 departments (main administrative level) and 298 municipalities (second administrative level). The Honduran territory presents climatic, geographic, and epidemiological conditions suitable for the transmission of many vector-borne diseases [4]. *Aedes aegypti*, the primary vector of DENV, CHIKV and ZIKV, is widely distributed over all the territories [12, 37], constituting large areas where environmental factors such as temperature, humidity, precipitation, latitude, and altitude, as well as social, cultural, economic and political factors are suitable for sustained vector-transmission [4, 12].

For this observational, retrospective and cross-sectional study, the epidemiological data were collected from the national surveillance system, obtaining the number of cases for each department and each municipality of the country by year for the period 2016-2019 (detailed by weeks). Data and analysis of DENV for 2015 have been previously reported by our group [12]. Data were constituted from clinically confirmed cases (suspected cases by clinical criteria definition) and laboratory-confirmed by RT-PCR, which have been revised in terms of data quality. Data analyzed for this study came from 298 primary municipal notification units,

collected at the 18 department notification units, and consolidated in Tegucigalpa (Francisco Morazán department, Capital District, CD) [12]. Determination of DENV infection included syndromic and laboratory surveillance.

Using official reference population data (National Institute of Statistics, INE), estimates of the annual incidence rates for all the departments and municipalities of the country were calculated (cases/100,000 population) to provide estimates of DENV incidence by department and municipalities [4, 12].

Besides, national GIS-based maps, by departments and municipalities with the distribution of DENV were generated. Microsoft Access® was used to design the spatial databases to import incidence rates by departments, municipalities, and disease to the GIS software. The Client GIS software Open source used was Kosmo Desktop 3.0 RC1®. The shapefiles of departments (.shp) were linked to data table database through spatial join operation, in order to produce digital maps of annual incidence rates by departments and municipalities [4, 12, 27, 30].

Results

From 1 January 2016 to 21 July 2019, a total of 109,557 cases of DENV were reported, 44,834 of them in 2016 (40.9%), then decreasing to 5,217 in 2017 (4.8%) and increasing up to 28,603 in the ongoing 2019 (26.1%), for incidence rates varying from 522.75 cases/100,000 pop in 2016, to 312.32 cases/100,000 pop till the epidemiological week (EW) 28 of 2019 (Figure 1A).

The highest peak was reached on the EW 28°, 2019 (5,299 cases; 57.89 cases/100,000 pop) (Figure 1B). The closest comparison in figures is with 2015 cases, where the highest number occurred during EW 25 with 1,789 cases (Figure 1B). The last four EW of 2019, 25 to 28, have

been higher than any previous EW since 2015 (Figure 1C), reaching rates per week above 20 cases100,000 population, after EW 25 of 2019 (Figure 1C). Looking at the four last EW, these comprise 55% of the cases reported in 2019 (15,725) (Figure 1B).

Years 2015 to 2018 showed that most cases were concentrated during mid-year months (Figure 2A), a seasonality probably related to climate change and variability, as reported before by our group [9]. The median number of cases per EW during 2015-2018 reached two peaks, during EW 20 (507 cases) and EW 25 (485 cases), with an interquartile range (IQR) of 197-1000 and 206-1014, respectively (Figure 2B). The current epidemic (2019), reached 2.5 times higher number of cases for the EW 25 compared to previous years (2015-2018) and 7.6 times for the EW 28 (Figure 2C).

All the 18 departments of Honduras reported cases during the study period (Table 1). In 2019, rates ranged from 7.82 cases/100,000 pop (Gracias a Dios) to 479.68 cases/100,000 pop (Cortés), followed by Yoro (357.71 cases/100,000 pop), Santa Barbara (274.00 cases/100,000 pop), and Olancho (271.53 cases/100,000 pop), till EW 26 (Table 1, Figure 3). Francisco Morazán department, where the capital city is located, have reported 1,924 cases (116.59 cases/100,000 pop) till EW 26 (Table 1, Figure 3). These five departments, which are located in the northwestern and central areas of Honduras (Figure 3), have reported more than 80.9% of the DENV cases of the country (Table 1). Cortes department is currently concentrating 44.3% of the reported cases (8,404) (Table 1) till EW 26.

When comparing Cortés and Francisco Morazán incidence over time, apparent differences were evident. At Francisco Morazán a high number of cases was reported during the first 17 EWs of 2018 reaching up to 11.4 cases/100,000 pop (186 cases) during that week, for a total of 1170 cases in the four first months (Figure 4). In contrast, there was a low incidence in Cortes during

that period (below 5 cases/100,000 or <60 cases per week) during the same period. Thereafter, there was a low reported number of cases in Francisco Morazán (<5 cases/100,000 pop) until EW 22 of 2019, and a significant increase in Cortes, which reached a higher incidence compared to Francisco Morazán, since EW 31 of 2018 (1.28 cases/100,000 pop versus 1.23) and then staying always significantly above in subsequent EW. The higher rates ratio from that EW and beyond, begun to increase from 1.04 times higher (EW 31 of 2018) reaching its maximum difference at EW 4 of 2019 (9.67 times higher) and EW 13 of 2019 (9.24 times higher), and after that staying above 2.3 times higher (Figure 4).

The peak during the EW 23° with 50.3 cases/100,000 (793 cases that week) reached 5,453 cases that week (for a total of 17% of the cases reported in Honduras during 2016-2017) (Figure 1). Until EW 26° more than 54% of the cases of the 2019 epidemic were reported from these two departments, documenting a concentrated occurrence in the most populated departments of Honduras containing the capital (Tegucigalpa, Francisco Morazán) and second-largest city of the country (San Pedro Sula, Cortés) (Table 1, Figures 3 and 4).

From the total number of municipalities (298) of Honduras, 59.7% of them reported cases of DENV in 2019 (Table 2, Supplemental Table 1). From those municipalities that have no reported DENV in 2019 (120), there are 18 (15%) that reported cases in 2018, but also 34 (28.3%) that reported cases in 2017, and 58 (48.3%) that reported cases in 2016 (Table 2, Supplemental Table 1).

Rates ranged from 0 to 1,468.26 cases/100,000 pop (Choloma, Cortes department), followed by Santa Barbara (Santa Barbara department, 1,255.04 cases/100,000 pop) and Santa Lucia (Intibucá department, 1,155.54 cases/100,000 pop.) (Table 2, Figure 5). Tegucigalpa, at the

Capital District, reported 1,813 cases till EW 26 of 2019 for a rate of 43.93 cases/100,000 pop. (Figure 5).

From the total number of cases till EW 28, 26.89% of them (7,691) were classified as severe dengue (Figure 6), which is a proportion higher than previous years (201-2018) (Figure 6). From the severe dengue cases, 92% (7,054) occurred in Cortés (3,666), San Pedro Sula (2,690), Santa Bárbara (508) and Yoro (190) (Figure 5). Till EW 28, 97 suspected deaths have been reported, with 52 laboratory-confirmed, yielding a case fatality rate (CFR%) of 0.128% (1.82 deaths/1,000 cases). Of these confirmed deaths, 39 (75%) were in patients less than fifteen years old (21 [54%] between five and nine years old). From the laboratory investigation, DENV-1 and DENV-2 serotypes have been identified, with a predominance of DENV-2.

Discussion

After CHIKV and ZIKV epidemics in Brazil and other countries in Latin America [3, 27], dengue is reemerging in many countries, such as Brazil, Colombia, Bolivia, Nicaragua, and Honduras, among other [6]. As showed in our analysis, Honduras is suffering a significant DENV epidemic in most of its territory. As occurred with DENV, CHIKV, and ZIKV in previous years [4, 12], Francisco Morazán and Cortés, the most populated departments, were the most affected. DENV has followed the path of areas in Honduras, namely urban areas, previously affected by CHIKV, ZIKV, and DENV in the past. Those areas with high incidence rates of these infections also exhibited the highest risk for DENV reemergence [4, 12]. Although more than 28,000 cases were reported in the country, only 0.13% of cases (those who died) have been laboratory-confirmed by RT-PCR. This is directly related to the financial limitations that preclude assessment of all patients by laboratory confirmation and to a lack of readily available

diagnostic facilities. Nevertheless, the current epidemics, is becoming the worst in 50 years in Honduras, with 26 out of 32 public hospitals that are near to collapse as a result.

Social and eco-epidemiological conditions in Honduras have make the whole country susceptible to spread of arboviral diseases such as DENV, CHIKV, and ZIKV [9, 12]; therefore, analyses such as the one presented herein are relevant for understanding future emerging arboviral diseases in the region and the country, but may be anticipated based on previous analyses for DENV, CHIKV, and ZIKV in Honduras [4, 12]. Other relevant viral diseases to consider in the immediate future should include Mayaro (MAYV) [38], Oropouche (OROV), Venezuelan Equine Encephalitis (VEEV), West Nile virus (WNV), among others [1, 22, 38, 39]. In the case of MAYV, some authors have recently suggested that the exported cases observed in European and North American countries where the competent mosquito vectors exist indicate an appreciable global risk in addition to the regional implications [38]. With the rapid increasing trends of globalization, a high potential for this arbovirus emerging in urban centers in the tropics that have competent mosquito vectors is a threat that should be considered. Recent social and geopolitical movements such as the migration of large numbers of people from Central America through Mexico toward the United States of America present the potential for spread of DENV cases related to this epidemic in Honduras, as well as also other arboviruses, into other regions and countries.

During the 2019 DENV epidemic in Honduras, one prominent aspect to be recognized is the high proportion of severe DENV forms, more than 25%, which is 20-times higher than in any other country in the Americas, making Honduras currently the territory with the highest proportion, but also the highest number of severe DENV cases, even above Brazil [6]. Up to EW26, Honduras reported over 6,000 severe DENV cases, and Brazil only 710 (out of 1,127,244 cases till EW 23, 0.06%) [6]. Then, it is reasonable, even given the limitations of more

data, to consider if this is related or not to an effect of prior ZIKV infection on DENV incidence and severity. The epidemiological effect of prior ZIKV infection on dengue incidence and severity, as well as the impact on immune correlates, based on new-generation ELISA assays, should be considered. The impact of prior ZIKV/other arbovirus infection on DENV immune response concerning different infections and the duration of antibodies concerning the interval between, for possible protection, is a matter of discussion [40]. In expectation of a high proportion of severe cases, the proportion of deaths or the CFR% is also higher than in any other country in the Americas (0.128%), including Brazil (0.032%) [6]. Also, in 2018 and especially in 2019, environmental conditions, including global warming, in the Americas, as well as in other regions of the world, were conducive for DENV transmission [8, 9, 41-44]. The World Health Organization (WHO) have identified Ten Threats to Global Health in 2019, including air pollution and climate change; noncommunicable diseases; global influenza pandemic; fragile and vulnerable settings; antimicrobial resistance; Ebola and other high-threat pathogens; weak primary health care; vaccine hesitancy, dengue and HIV [45].

In this setting, public health tools for detailed analyses, such as the use of GIS-epidemiological maps [12, 30, 32], are of high relevance for any affected country [4]. In the case of Central American territories, there is an evident lack of studies developing such maps for arboviral and other infectious diseases. In Honduras, previous assessments using GIS mapped DENV and CHIKV during 2015 and ZIKV in 2016, found a similar spatial distribution as has been found for DENV in 2019. In 2019, according to the Ministry of Health of Honduras, 129 cases of CHIKV and 117 cases of ZIKV have been reported. Although Honduras has been especially affected by DENV, CHIKV, and ZIKV, there is a significant lack of scientific and public health studies dealing with these arboviruses and their sequelae [4, 6, 46]. The limited evidence shows that can lead to acute and chronic complications, even fatal outcomes [47, 48].

Further studies are essential to understand the epidemiological and medical characteristics of this and other emerging and reemerging arboviruses in Honduras. Although this may not provide all the answers, such information is particularly useful for public health evidenced-based decisions [4, 49]. Developed maps would provide baseline epidemiological information for the assessment of the differentiated risk related to acquiring such diseases in certain areas (departments and municipalities) of Honduras and will be key for preparedness. Similar recommendations have previously been made for DENV, CHIKV, and ZIKV in previous epidemics [4, 9, 12].

Use of GIS-based epidemiological maps is beneficial to develop preventative/control strategies and public health policies for joint control of these vector-borne diseases in Honduras [12, 27-29, 32, 33], as well as other countries in Central and South America. These tools, such as GIS-based maps can also be developed and used for making public health decisions about other emerging diseases in Honduras [4, 6].

These maps can also provide relevant information concerning the risk to individuals traveling to specific regions of the world [12, 27-29, 32, 33, 50]. A correlated and crucial role is using the data to help prevent further spread of viruses such as DENV, CHIKV, and ZIKV from other countries (imported cases) to Honduras and other countries in Latin America. According to the Secretary of Tourism of Honduras (*Instituto Hondureño de Turismo*), in 2014, the country received 1.133 million international tourists (51.3% from Europe and 23.2% from Asia-Pacific region); 107,710 visited the archaeological site of Copán, and 20,118 the fortress of Santa Barbara, both located in arboviral endemic areas) [4]. According to the World Tourism

Organization (https://data.worldbank.org/indicator/ST.INT.ARVL), the number of international arrivals to Honduras in 2017 was 851,000 [6].

Touristic areas, such as Roatan in the department of Islas de la Bahía (Bay Islands), are highly visited destination during all seasons. This area has a considerable occurrence of DENV (24.62 cases/100,000, and previously of CHIKV and ZIKV [4, 12], highlighting the need for increased measures to prevent arbovirus infection in these areas. A recent study specifically at Roatán found by molecular diagnosis the co-circulation of ZIKV, DENV, and CHIKV [19]. The use of daytime anti-mosquito measures, such as repellents and impregnated clothing, should be highlighted for visitors to affected territories.

Roatan is constantly receiving international cruise ships, with the consequent epidemiological implications, as described [4, 12]. Now, in the department of Colon (with 202.16 cases/100,000 pop of DENV in 2019), which includes Trujillo (152.65 cases/100,000 pop of DENV in 2019) with its port Puerto Castilla, there is sizeable industrial development and an international hub for cruise ships. This area should also be a focus of concern for travel medicine and public health for DENV, ZIKV, and other arboviral diseases in Honduras [4]. Acquisition of ZIKV and CHIKV has been reported in a young woman who returned to Madrid, Spain, after visiting Tegucigalpa and Choluteca [20].

Other eco-epidemiological assessments should be performed in Honduras for these arboviral diseases. With warm temperatures during the whole year, but especially in the summer months, susceptible individuals, and high density of mosquito vectors, many municipalities are suitable for transmission of DENV as well as for other arboviruses [4, 12].

Limitations

Less than 1% of cases of DENV infection were laboratory confirmed. However, we consider the PAHO case definition in surveillance to be as accurate as possible in obtaining the epidemiological data [33]. This situation is similar to other countries and published reports about GIS-mapping of DENV and other arboviral diseases in the Americas [27-30, 32]. However, indeed, in Honduras, as in other areas of the tropical Americas, ZIKV and CHIKV also circulate with DENV, and there is overlap in their clinical features, maybe also with other arboviruses not yet detected, such as MAYV [39]. All three viruses have similar clinical presentations, and coinfections may be more common than previously known [10, 11, 39, 51-54], even with other endemic pathogens such as *Leptospira* [55]. Also, there is probably under-reporting of cases in certain areas as compared with more accurate reporting in individual municipalities.

Conclusions

GIS-based maps provide relevant information to assess the risk to individuals traveling to specific destinations in endemic-epidemic areas allowing detailed prevention advice [4, 6, 33]. Such maps allow integration of prevention and control strategies, as well as public health policies, for control of this vector-borne disease in this and other countries of the region [56]. Simultaneous or sequential arboviral infections occur and should be assessed and mapped as a subject of surveillance [52-54]. Preparedness in this setting should also consider the potential arrival of MAYV [22, 38], Oropouche, and yellow fever viruses in *Aedes* infested areas [57]. Finally, considering the reemergence of DENV in other countries, these assessments would be useful in other territories with ongoing epidemics.

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Data availability

Raw data is available and will be provided on request.

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Table 1. DENV incidence rates (cases/100,000pop) by departments, Honduras, 2016-2019.*

	Cases				Population				Rates**			
Department	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**
Cortés	4,677	900	2,436	**8,404**	1,653,699	1,686,094	1,718,881	1,751,997	282.82	53.38	141.72	**479.68**
Yoro	849	241	524	**2,225**	596,138	604,844	613,473	622,006	142.42	39.84	85.42	**357.71**
Santa Bárbara	456	124	308	**1,268**	441,939	448,942	455,891	462,774	103.18	27.62	67.56	**274.00**
Olancho	1,207	370	387	**1,550**	545,835	554,282	562,626	570,845	221.13	66.75	68.78	**271.53**
Colón	456	203	275	688	324,950	330,105	335,233	340,323	140.33	61.50	82.03	**202.16**
Atlántida	1,027	269	288	928	457,031	464,288	471,575	478,876	224.71	57.94	61.07	**193.79**
La Paz	224	62	116	338	209,783	213,499	217,204	220,892	106.78	29.04	53.41	**153.02**
Francisco Morazán	9,996	2,286	2,555	**1,924**	1,577,178	1,601,291	1,625,663	1,650,245	633.79	142.76	157.17	**116.59**
Copán	479	98	90	424	388,810	394,890	400,947	406,965	123.20	24.82	22.45	**104.19**
Comayagua	669	112	289	423	521,748	531,676	541,711	551,837	128.22	21.07	53.35	76.65
Intibucá	188	14	10	104	246,258	250,959	255,658	260,344	76.34	5.58	3.91	63.95
Ocotepeque	152	25	12	146	154,251	157,018	159,816	162,638	98.54	15.92	7.51	56.08
Choluteca	1,391	129	237	206	453,360	458,871	464,372	469,848	306.82	28.11	51.04	43.84
Valle	196	132	104	71	180,772	182,996	185,227	187,460	108.42	72.13	56.15	37.87
Lempira	208	35	97	129	339,310	345,489	351,652	357,783	61.30	10.13	27.58	36.06
El Paraíso	630	159	168	134	465,864	473,277	480,700	488,119	135.23	33.60	34.95	27.45
Islas de la Bahía	147	54	46	18	67,704	69,493	71,296	73,112	217.12	77.71	64.52	24.62
Gracias a Dios	9	4	0	8	96,384	98,337	100,304	102,281	9.34	4.07	0.00	7.82
Total	22,961	5,217	7,942	18,988	8,721,014	8,866,351	9,012,229	9,158,345	263.28	58.84	88.12	207.33

*Till EW26-2019. **Cases per 100,000 pop.

Table 2. DENV incidence rates (cases/100,000pop) in the top 20 municipalities, including additionally San Pedro Sula and Tegucigalpa, Honduras, 2016-2019.*

		Cases				Population				Rates**			
Department	**Municipality**	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**
Cortés	Choloma	1,124	294	885	**3,948**	249,217	255,625	262,186	268,889	451.01	115.01	337.55	**1,468.26**
Santa Bárbara	Santa Barbara	168	20	213	585	44,182	45,002	45,812	46,612	380.25	44.44	464.94	**1,255.04**
Intibucá	Santa Lucia	0	0	0	64	5,382	5,434	5,486	5,539	0.00	0.00	0.00	**1,155.54**
Olancho	Juticalpa	689	279	280	**1,354**	132,484	135,076	137,648	140,194	520.06	206.55	203.42	**965.81**
Santa Bárbara	San Pedro Zacapa	9	0	0	94	10,790	10,868	10,940	11,008	83.41	0.00	0.00	853.90
Santa Bárbara	Ceguaca	16	6	3	44	5,249	5,353	5,456	5,558	304.83	112.09	54.99	791.63
Santa Bárbara	Petoa	18	9	15	98	12,501	12,617	12,728	12,832	143.98	71.33	117.85	763.69
Yoro	Yoro	248	63	87	631	91,751	93,489	95,205	96,897	270.30	67.39	91.38	651.20
La Paz	La Paz	147	48	111	324	47,452	48,640	49,828	51,015	309.79	98.68	222.77	635.11
Ocotepeque	Sinuapa	50	7	2	61	9,371	9,601	9,837	10,077	533.58	72.91	20.33	605.31
Yoro	El Progreso	291	99	318	**1,099**	193,567	195,247	196,884	198,474	150.34	50.71	161.52	**553.73**
Yoro	Santa Rita	14	14	22	110	20,710	20,841	20,968	21,091	67.60	67.18	104.92	521.56
Cortés	Santa Cruz de Yojoa	7	10	10	435	86,590	88,054	89,569	91,134	8.08	11.36	11.16	477.32
Colón	Tocoa	191	97	150	488	96,360	98,602	100,841	103,073	198.21	98.38	148.75	473.45
Santa Bárbara	San Jose de Colinas	64	13	17	93	19,266	19,407	19,538	19,660	332.20	66.99	87.01	473.04
Copán	Santa Rosa de Copan	304	72	82	320	65,233	66,629	68,016	69,392	466.02	108.06	120.56	461.15
Santa Bárbara	Naranjito	31	1	1	57	12,447	12,637	12,827	13,016	249.06	7.91	7.80	437.92
Cortés	San Francisco de Yojoa	3	7	1	102	23,097	23,499	23,906	24,320	12.99	29.79	4.18	419.41
Cortés	Puerto Cortes	592	125	233	557	127,968	129,961	131,981	134,023	462.62	96.18	176.54	415.60
Cortés	Pimienta	3	8	67	88	19,899	20,394	20,905	21,432	15.08	39.23	320.50	410.60
Copán	San Pedro Sula	2,655	385	821	**2,550**	754,061	765,999	777,877	789,645	352.09	50.26	105.54	**322.93**
Francisco Morazán	Tegucigalpa DC	9,872	2,275	2,535	**1,813**	1,207,635	1,225,043	1,242,397	1,259,646	817.47	185.71	204.04	**143.93**

*Till EW26-2019. **Cases per 100,000 pop.

Figure 1. Dengue in Honduras, 2015-2019*. Number of cases and incidence rates (cases/100,000 pop.) (A), temporal distribution of case number by epidemiological weeks (EW) (B), and the comparison of EW of incidence rates (cases/100,000 pop) per years (C). *Till EW28.

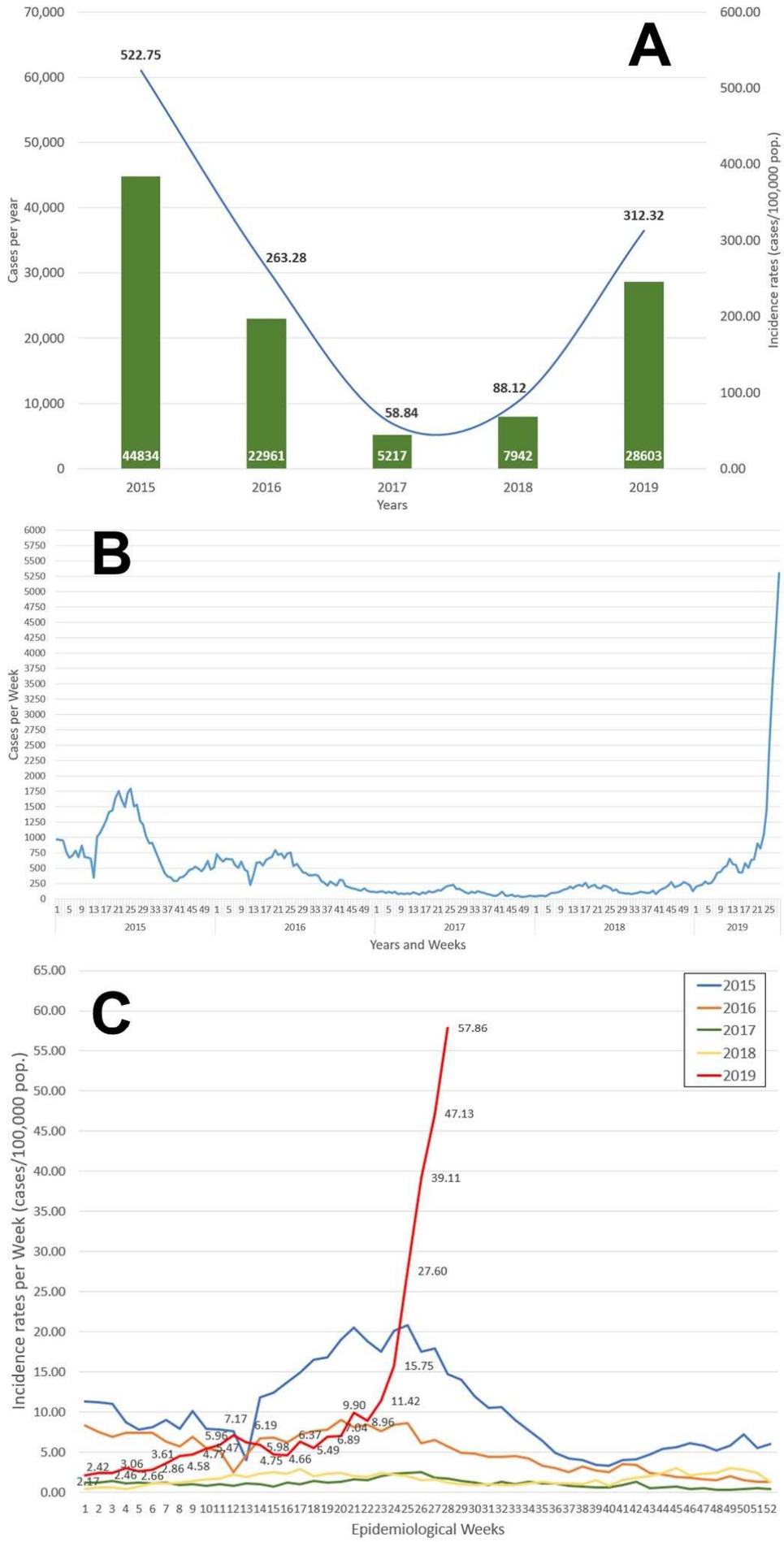


Figure 2. Seasonality of Dengue in Honduras, 2015-2019*. Percentage distribution of cases (%) per weeks (A), projection of median, quartile 1 and 3 of cases during 2015-2018, per week (B), and comparison with 2019 weekly cases. *Till EW28.

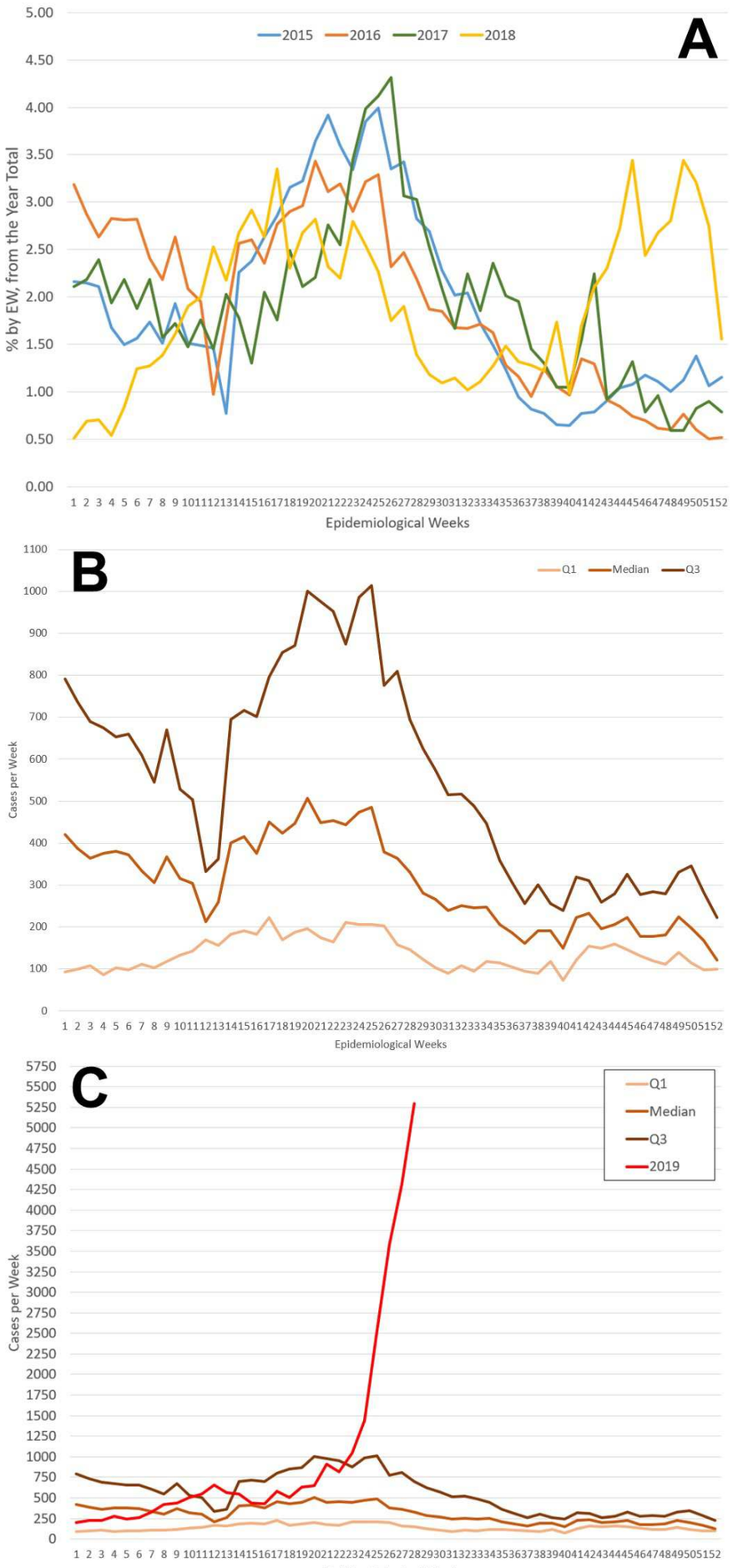


Figure 3. Geographic distribution by GIS-based map of the calculated incidence rates for Dengue in Honduras, 2016-2019 by departments. *Till EW26.

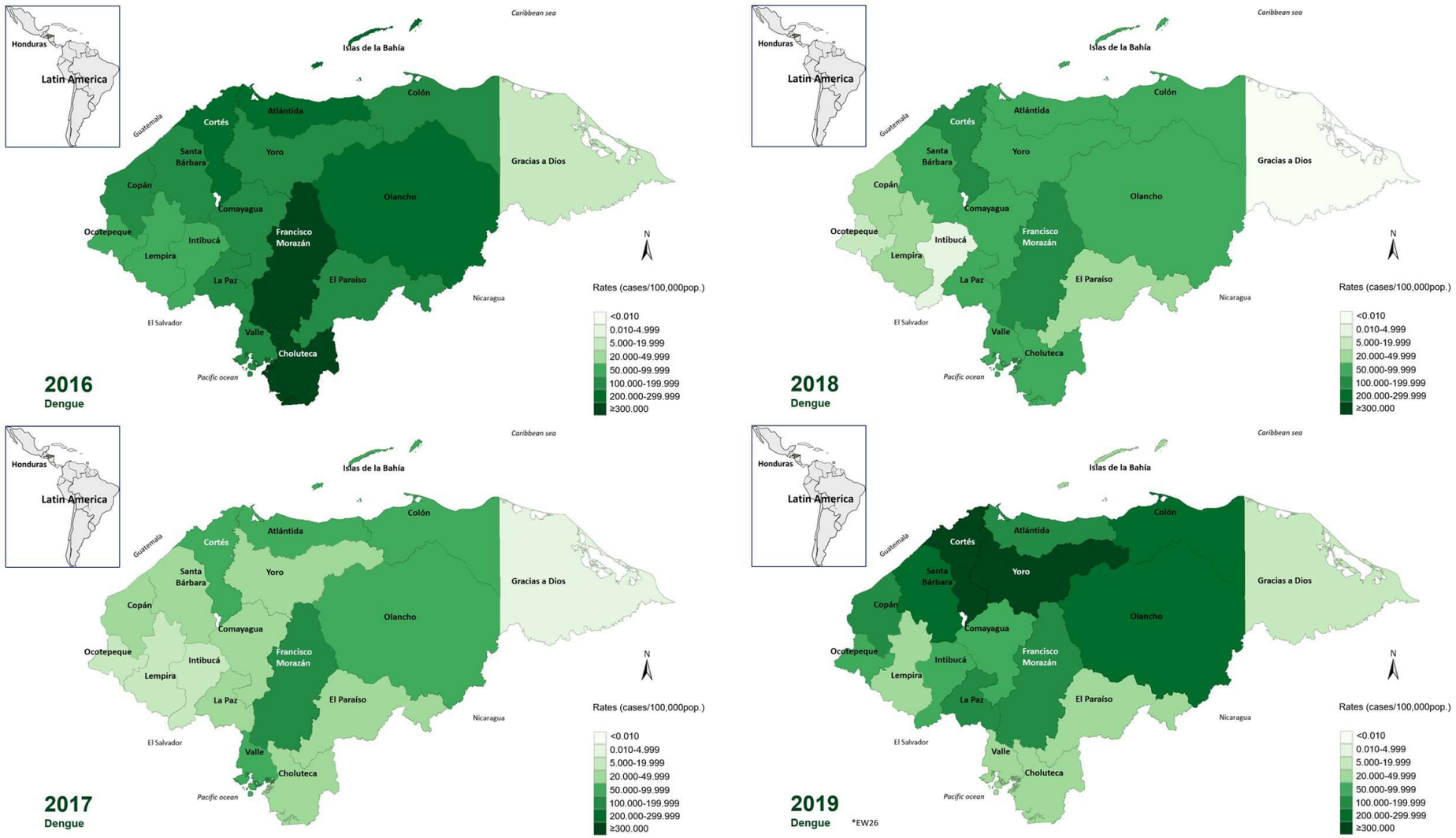


Figure 4. Temporal distribution of the calculated incidence rates per week for Dengue in Cortés and Francisco Morazán departments, Honduras, 2018-2019. *Till EW26.

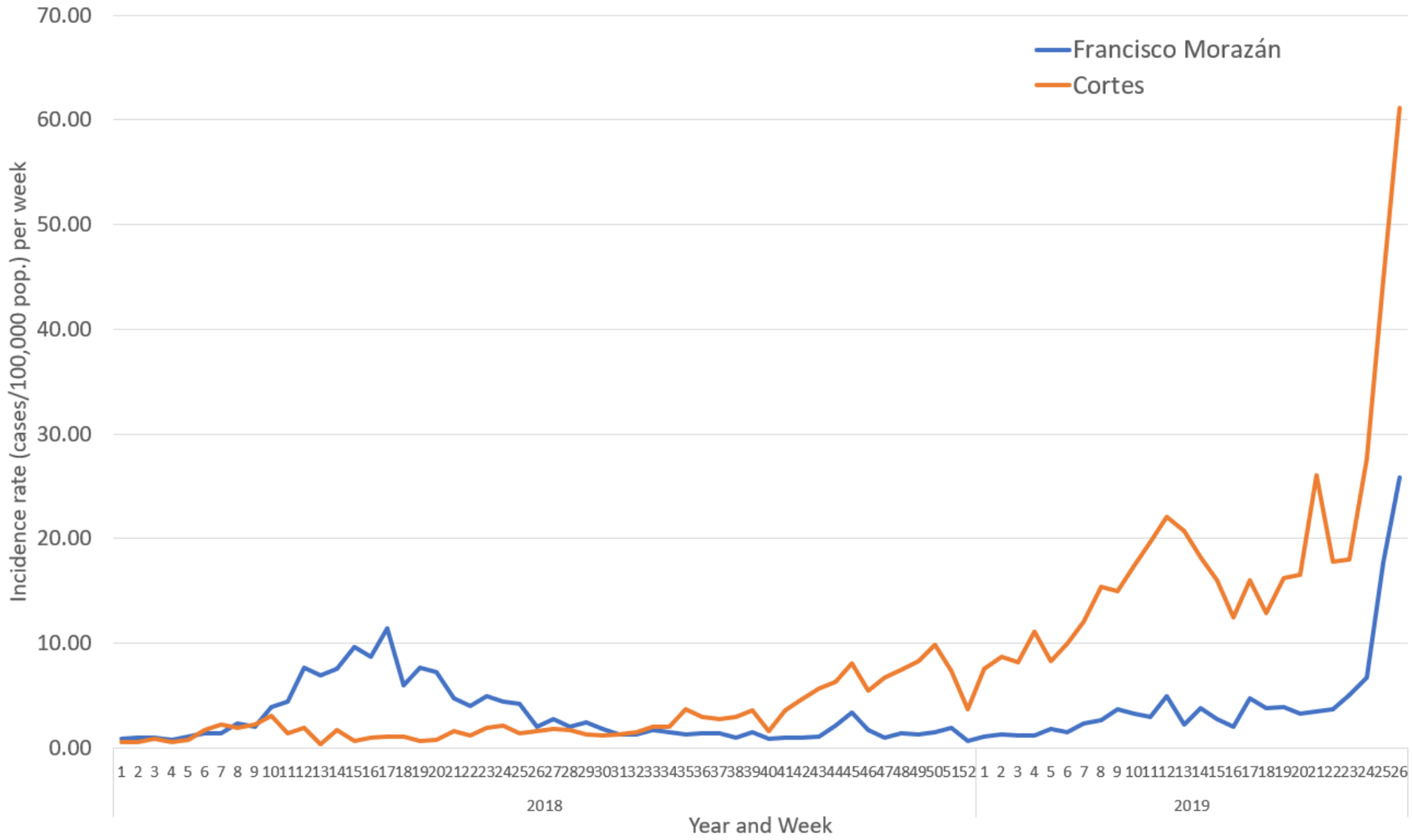


Figure 5. Geographic distribution by GIS-based map of the calculated incidence rates for Dengue in Honduras, 2016-2019 by municipalities. *Till EW26.

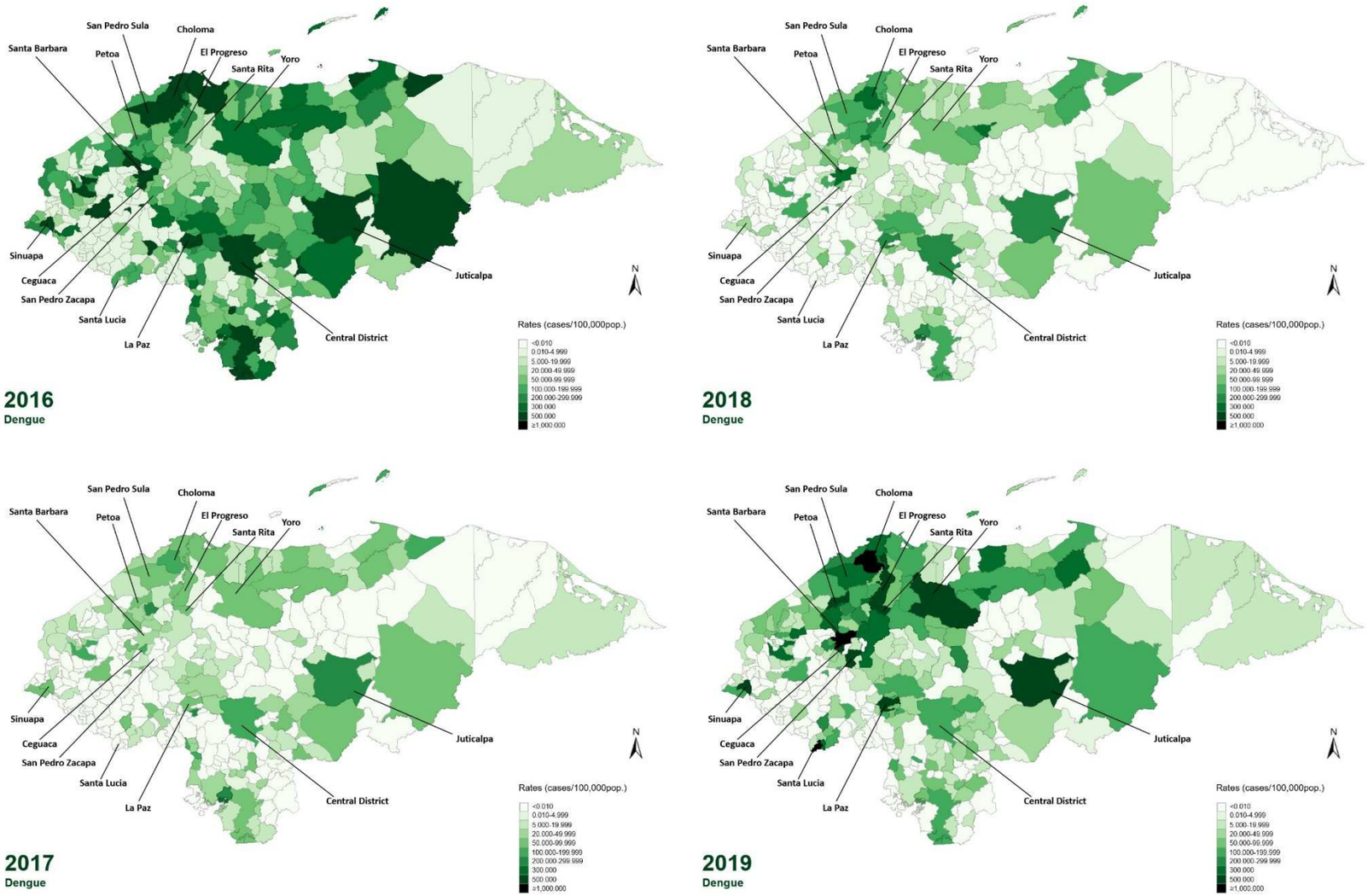
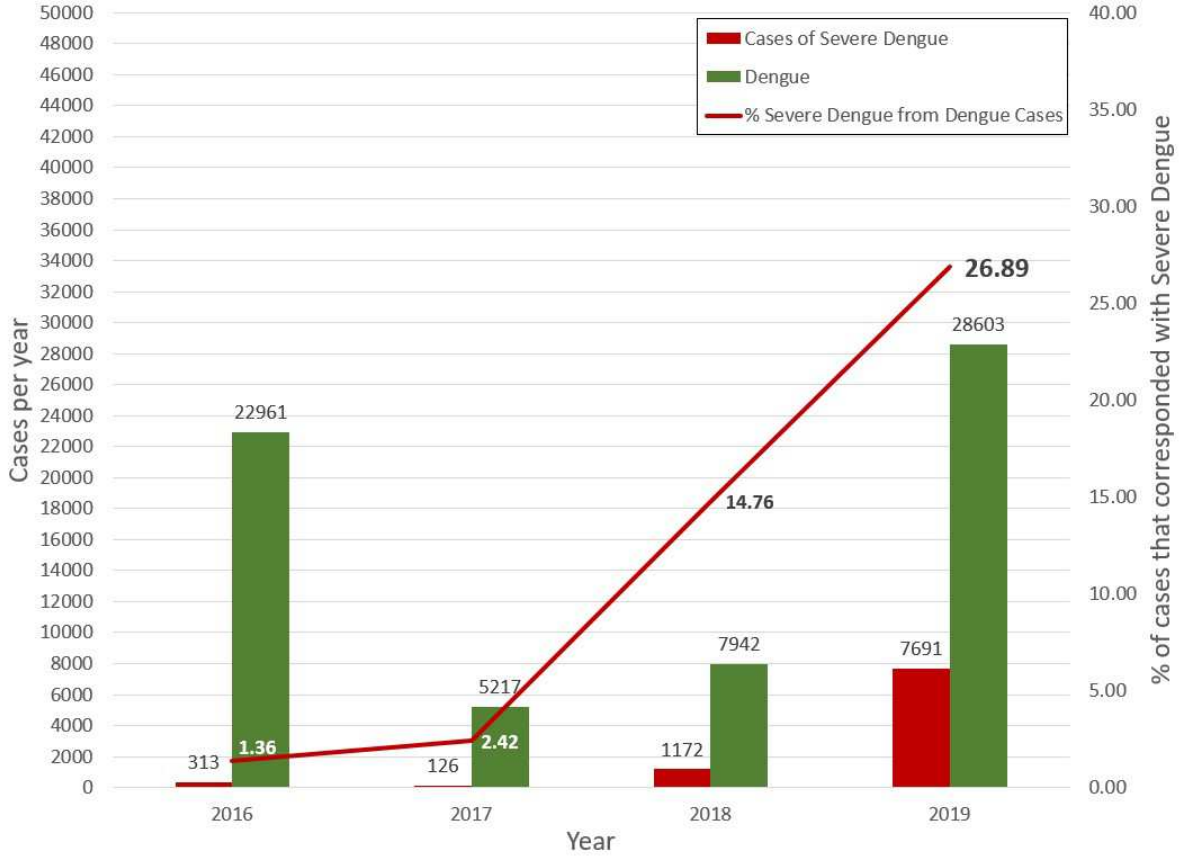


Figure 6. Number and proportion of severe dengue, Honduras, 2016-2019*. *Till EW28.



Supplementary Table 1. DENV incidence rates (cases/100,000pop) by municipalities, Honduras, 2016-2019.*

		Cases				Population				Rates**			
Department	**Municipality**	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**	**2016**	**2017**	**2018**	**2019**
Cortés	Choloma	1,124	294	885	3,948	249,217	255,625	262,186	268,889	451.01	115.01	337.55	1,468.26
Santa Bárbara	Santa Barbara	168	20	213	585	44,182	45,002	45,812	46,612	380.25	44.44	464.94	1,255.04
Intibucá	Santa Lucia	0	0	0	64	5,382	5,434	5,486	5,539	0.00	0.00	0.00	1,155.54
Olancho	Juticalpa	689	279	280	1,354	132,484	135,076	137,648	140,194	520.06	206.55	203.42	965.81
Santa Bárbara	San Pedro Zacapa	9	0	0	94	10,790	10,868	10,940	11,008	83.41	0.00	0.00	853.90
Santa Bárbara	Ceguaca	16	6	3	44	5,249	5,353	5,456	5,558	304.83	112.09	54.99	791.63
Santa Bárbara	Petoa	18	9	15	98	12,501	12,617	12,728	12,832	143.98	71.33	117.85	763.69
Yoro	Yoro	248	63	87	631	91,751	93,489	95,205	96,897	270.30	67.39	91.38	651.20
La Paz	La Paz	147	48	111	324	47,452	48,640	49,828	51,015	309.79	98.68	222.77	635.11
Ocotepeque	Sinuapa	50	7	2	61	9,371	9,601	9,837	10,077	533.58	72.91	20.33	605.31
Yoro	El Progreso	291	99	318	1,099	193,567	195,247	196,884	198,474	150.34	50.71	161.52	553.73
Yoro	Santa Rita	14	14	22	110	20,710	20,841	20,968	21,091	67.60	67.18	104.92	521.56
Cortés	Santa Cruz de Yojoa	7	10	10	435	86,590	88,054	89,569	91,134	8.08	11.36	11.16	477.32
Colón	Tocoa	191	97	150	488	96,360	98,602	100,841	103,073	198.21	98.38	148.75	473.45
Santa Bárbara	San Jose de Colinas	64	13	17	93	19,266	19,407	19,538	19,660	332.20	66.99	87.01	473.04
Copán	Santa Rosa de Copan	304	72	82	320	65,233	66,629	68,016	69,392	466.02	108.06	120.56	461.15
Santa Bárbara	Naranjito	31	1	1	57	12,447	12,637	12,827	13,016	249.06	7.91	7.80	437.92
Cortés	San Francisco de Yojoa	3	7	1	102	23,097	23,499	23,906	24,320	12.99	29.79	4.18	419.41
Cortés	Puerto Cortes	592	125	233	557	127,968	129,961	131,981	134,023	462.62	96.18	176.54	415.60
Cortés	Pimienta	3	8	67	88	19,899	20,394	20,905	21,432	15.08	39.23	320.50	410.60
Santa Bárbara	Trinidad	18	8	10	71	20,074	20,307	20,534	20,754	89.67	39.39	48.70	342.10
Atlántida	La Ceiba	608	164	161	729	207,733	211,327	214,917	218,495	292.68	77.60	74.91	333.65
Intibucá	Magdalena	1	0	0	15	4,455	4,489	4,524	4,559	22.45	0.00	0.00	328.99
Copán	San Pedro Sula	2,655	385	821	2,550	754,061	765,999	777,877	789,645	352.09	50.26	105.54	322.93

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Yoro	Arenal	7	0	21	19	5,983	5,995	6,009	6,023	117.01	0.00	349.47	315.47
Comayagua	Taulabe	10	1	3	80	24,930	25,158	25,382	25,601	40.11	3.97	11.82	312.49
Francisco Morazán	San Ignacio	10	1	0	26	9,036	9,119	9,204	9,291	110.66	10.97	0.00	279.85
Santa Bárbara	La Arada	2	8	16	30	10,220	10,433	10,648	10,865	19.57	76.68	150.26	276.12
Cortés	San Antonio de Cortes	10	1	0	62	22,386	22,498	22,619	22,748	44.67	4.44	0.00	272.55
Cortés	Omoa	45	22	36	133	48,495	49,749	51,046	52,387	92.79	44.22	70.52	253.88
Lempira	San Francisco	0	6	6	23	9,205	9,260	9,311	9,358	0.00	64.80	64.44	245.78
Santa Bárbara	Concepcion del Norte	9	27	9	22	9,303	9,405	9,503	9,598	96.74	287.08	94.70	229.22
Santa Bárbara	Gualala	0	0	0	11	5,361	5,416	5,469	5,519	0.00	0.00	0.00	199.31
Santa Bárbara	San Vicente Centenario	1	0	0	7	3,598	3,629	3,657	3,682	27.79	0.00	0.00	190.10
Intibucá	La Esperanza	70	10	9	27	12,955	13,413	13,875	14,341	540.34	74.56	64.87	188.27
Cortés	San Manuel	123	33	179	122	58,927	61,159	63,486	65,912	208.73	53.96	281.95	185.10
Cortés	Villanueva	70	12	187	315	161,609	165,602	169,609	173,640	43.31	7.25	110.25	181.41
Lempira	Gracias	206	29	88	97	51,635	53,018	54,404	55,793	398.96	54.70	161.75	173.86
Yoro	Victoria	0	0	0	60	34,848	35,475	36,095	36,707	0.00	0.00	0.00	163.46
Atlántida	Tela	338	67	98	168	100,650	102,018	103,392	104,766	335.82	65.67	94.79	160.36
Santa Bárbara	Quimistan	19	7	6	92	52,884	54,638	56,418	58,221	35.93	12.81	10.63	158.02
Comayagua	Comayagua	446	76	192	259	155,948	159,904	163,914	167,971	285.99	47.53	117.13	154.19
Colón	Trujillo	137	61	79	102	63,622	64,688	65,754	66,818	215.33	94.30	120.15	152.65
Yoro	Olanchito	267	62	54	177	110,437	112,444	114,442	116,427	241.77	55.14	47.19	152.03
Colón	Saba	9	2	17	48	30,949	31,402	31,843	32,271	29.08	6.37	53.39	148.74
Valle	Aramecina	18	7	0	11	7,384	7,460	7,536	7,611	243.76	93.83	0.00	144.53
Francisco Morazán	Tegucigalpa DC	9,872	2,275	2,535	1,813	1,207,635	1,225,043	1,242,397	1,259,646	817.47	185.71	204.04	143.93
Islas de la Bahía	Utila	2	0	0	6	4,277	4,400	4,526	4,656	46.76	0.00	0.00	128.87
Francisco Morazán	Alubaren	1	0	0	7	5,566	5,576	5,588	5,601	17.97	0.00	0.00	124.97
Ocotepeque	Ocotepeque	48	13	2	32	24,337	24,770	25,207	25,647	197.23	52.48	7.93	124.77

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Olancho	Catacamas	426	76	103	161	124,599	126,982	129,328	131,635	341.90	59.85	79.64	122.31
Santa Bárbara	Chinda	5	2	0	6	4,886	4,947	5,006	5,064	102.33	40.43	0.00	118.49
Francisco Morazán	San Juan de Flores	29	5	4	20	16,457	16,857	17,268	17,692	176.21	29.66	23.16	113.05
Comayagua	San Sebastian	2	0	1	4	3,631	3,629	3,629	3,632	55.08	0.00	27.55	110.12
Copán	Trinidad de Copan	0	0	0	8	7,122	7,215	7,310	7,407	0.00	0.00	0.00	108.00
Intibucá	Colomoncagua	13	2	0	20	18,613	18,737	18,856	18,968	69.84	10.67	0.00	105.44
Choluteca	Choluteca	994	105	227	172	159,739	162,125	164,452	166,712	622.27	64.76	138.03	103.17
Yoro	Jocon	5	2	19	10	9,687	9,710	9,728	9,741	51.61	20.60	195.31	102.66
Yoro	Morazan	2	0	0	47	43,163	44,188	45,243	46,327	4.63	0.00	0.00	101.45
Comayagua	Lejamani	3	0	2	6	5,831	5,883	5,935	5,988	51.44	0.00	33.70	100.20
Colón	Sonaguera	20	7	9	46	44,574	45,073	45,573	46,072	44.87	15.53	19.75	99.84
Choluteca	Morolica	14	0	0	5	5,007	5,012	5,017	5,022	279.58	0.00	0.00	99.57
Copán	El Paraiso	1	3	0	20	20,053	20,104	20,154	20,201	4.99	14.92	0.00	99.01
Cortés	La Lima	44	3	1	80	76,823	78,596	80,404	82,241	57.27	3.82	1.24	97.28
Copán	San Jeronimo	0	0	0	5	5,097	5,120	5,141	5,160	0.00	0.00	0.00	96.90
Yoro	Yorito	5	0	0	21	20,372	20,926	21,487	22,054	24.54	0.00	0.00	95.22
Valle	San Lorenzo	119	103	94	44	43,977	44,917	45,862	46,810	270.60	229.31	204.96	94.00
Francisco Morazán	La Venta	0	0	0	6	6,353	6,421	6,494	6,571	0.00	0.00	0.00	91.31
La Paz	Cane	24	0	0	4	4,003	4,150	4,300	4,453	599.61	0.00	0.00	89.83
Yoro	El Negrito	9	1	3	40	47,104	47,663	48,198	48,710	19.11	2.10	6.22	82.12
Olancho	San Esteban	10	0	0	22	26,488	26,781	27,063	27,334	37.75	0.00	0.00	80.49
Copán	Florida	19	1	1	24	29,134	29,400	29,661	29,914	65.22	3.40	3.37	80.23
Atlántida	San Francisco	8	2	4	12	15,277	15,531	15,790	16,051	52.37	12.88	25.33	74.76
Choluteca	Pespire	9	1	6	17	24,024	24,063	24,099	24,131	37.46	4.16	24.90	70.45
Comayagua	Humuya	2	3	1	1	1,378	1,399	1,419	1,439	145.10	214.48	70.48	69.50
Santa Bárbara	San Luis	28	3	2	17	25,033	25,166	25,292	25,411	111.85	11.92	7.91	66.90

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Comayagua	Ajuterique	10	3	12	7	11,579	11,655	11,732	11,810	86.36	25.74	102.28	59.27
Santa Bárbara	Macuelizo	23	11	10	22	36,058	36,607	37,146	37,674	63.79	30.05	26.92	58.40
Yoro	Sulaco	1	0	0	11	18,517	18,866	19,212	19,555	5.40	0.00	0.00	56.25
Valle	Langue	10	0	0	12	21,275	21,387	21,494	21,597	47.00	0.00	0.00	55.56
El Paraíso	Liure	12	4	1	6	10,808	10,852	10,893	10,930	111.03	36.86	9.18	54.89
Intibucá	Concepcion	8	1	0	6	10,379	10,557	10,741	10,930	77.08	9.47	0.00	54.89
Francisco Morazán	Marale	2	0	1	5	9,183	9,199	9,217	9,237	21.78	0.00	10.85	54.13
El Paraíso	Guinope	1	1	0	5	8,949	9,107	9,266	9,427	11.17	10.98	0.00	53.04
Copán	La Jigua	0	0	0	5	9,579	9,677	9,772	9,864	0.00	0.00	0.00	50.69
El Paraíso	Moroceli	20	9	1	9	17,458	17,764	18,071	18,377	114.56	50.66	5.53	48.97
Copán	San Nicolas	0	1	0	4	7,932	8,068	8,206	8,347	0.00	12.39	0.00	47.92
Cortés	Potrerillos	1	0	16	12	24,626	24,958	25,292	25,626	4.06	0.00	63.26	46.83
El Paraíso	Danli	502	113	150	97	206,922	210,742	214,566	218,391	242.60	53.62	69.91	44.42
Choluteca	Apacilagua	2	0	0	4	9,084	9,093	9,101	9,108	22.02	0.00	0.00	43.92
Santa Bárbara	Ilama	25	4	4	4	9,137	9,160	9,183	9,204	273.62	43.67	43.56	43.46
Comayagua	El Rosario	20	7	8	14	30,687	31,339	31,998	32,661	65.17	22.34	25.00	42.86
Francisco Morazán	Maraita	0	0	0	3	6,867	6,927	6,990	7,056	0.00	0.00	0.00	42.52
Ocotepeque	San Marcos	44	4	8	9	21,068	21,448	21,831	22,214	208.85	18.65	36.65	40.51
La Paz	Aguanqueterique	7	0	1	2	4,846	4,888	4,933	4,978	144.44	0.00	20.27	40.18
Francisco Morazán	Talanga	11	1	3	15	36,285	36,733	37,184	37,639	30.32	2.72	8.07	39.85
La Paz	San Pedro de Tutule	0	0	0	3	7,290	7,421	7,556	7,695	0.00	0.00	0.00	38.99
Copán	San Antonio	0	4	0	4	10,064	10,185	10,310	10,436	0.00	39.27	0.00	38.33
Atlántida	Jutiapa	24	9	12	14	35,690	36,207	36,726	37,244	67.25	24.86	32.67	37.59
Copán	Corquin	1	0	0	7	17,542	17,940	18,340	18,742	5.70	0.00	0.00	37.35
Copán	Santa Rita	30	3	1	11	31,072	31,455	31,829	32,194	96.55	9.54	3.14	34.17
Intibucá	Camasca	4	0	0	2	6,924	6,977	7,031	7,086	57.77	0.00	0.00	28.23

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Copán	San Jose	6	1	0	2	7,152	7,218	7,286	7,356	83.89	13.85	0.00	27.19
Comayagua	Lamani	5	0	0	2	7,176	7,239	7,306	7,376	69.68	0.00	0.00	27.12
Comayagua	Villa de San Antonio	39	8	22	7	24,824	25,234	25,651	26,072	157.11	31.70	85.77	26.85
Comayagua	San Jer≤nimo	28	2	9	6	22,064	22,441	22,818	23,194	126.90	8.91	39.44	25.87
Olancho	Manto	0	0	0	3	11,697	11,748	11,793	11,834	0.00	0.00	0.00	25.35
Santa Bárbara	San Francisco de Ojuera	0	1	0	2	7,441	7,595	7,747	7,899	0.00	13.17	0.00	25.32
Francisco Morazán	San Antonio de Oriente	2	1	0	4	15,446	15,598	15,753	15,911	12.95	6.41	0.00	25.14
Olancho	Salama	5	0	0	2	7,778	7,859	7,940	8,021	64.29	0.00	0.00	24.93
Santa Bárbara	Santa Rita	0	0	0	1	4,020	4,036	4,052	4,068	0.00	0.00	0.00	24.58
Francisco Morazán	Nueva Armenia	3	2	0	1	3,782	3,880	3,981	4,086	79.32	51.55	0.00	24.47
Comayagua	Siguatepeque	83	6	18	26	101,316	103,506	105,732	107,995	81.92	5.80	17.02	24.08
Francisco Morazán	Vallecillo	2	0	0	2	8,430	8,542	8,658	8,778	23.73	0.00	0.00	22.78
Intibucá	Yamaranguila	3	0	0	5	21,946	22,258	22,568	22,875	13.67	0.00	0.00	21.86
Islas de la Bahía	Roatan	131	48	36	11	46,133	47,608	49,079	50,545	283.96	100.82	73.35	21.76
El Paraíso	Alauca	8	7	1	2	9,354	9,433	9,510	9,583	85.52	74.21	10.52	20.87
Lempira	La Union	0	0	0	3	13,463	13,791	14,124	14,459	0.00	0.00	0.00	20.75
Lempira	San Andres	0	0	0	3	13,807	14,028	14,246	14,460	0.00	0.00	0.00	20.75
El Paraíso	Potrerillos	0	0	0	1	4,553	4,663	4,774	4,887	0.00	0.00	0.00	20.46
Francisco Morazán	Valle de Angeles	0	0	3	4	17,922	18,476	19,050	19,644	0.00	0.00	15.75	20.36
Copán	San Juan de Opoa	13	0	0	2	9,750	9,788	9,824	9,858	133.33	0.00	0.00	20.29
Francisco Morazán	El Porvenir	13	0	3	5	22,611	23,655	24,805	26,070	57.49	0.00	12.09	19.18
Lempira	Las Flores	0	0	0	2	10,005	10,172	10,336	10,499	0.00	0.00	0.00	19.05
Comayagua	Las Lajas	2	0	2	3	15,038	15,284	15,533	15,785	13.30	0.00	12.88	19.01
Intibucá	Jesus de Otoro	79	1	1	6	30,073	30,663	31,245	31,819	262.69	3.26	3.20	18.86
Santa Bárbara	San Marcos	0	0	0	3	15,709	15,857	15,998	16,132	0.00	0.00	0.00	18.60

		Cases				Population				Rates**			
Department	Municipality	2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Ocotepeque	Concepcion	2	0	0	1	5,344	5,439	5,536	5,632	37.43	0.00	0.00	17.75
Intibucá	San Antonio	4	0	0	1	5,614	5,658	5,703	5,748	71.25	0.00	0.00	17.40
Olancho	Gualaco	1	0	0	4	22,552	22,769	22,975	23,171	4.43	0.00	0.00	17.26
Islas de la Bahía	Guanaja	14	6	10	1	5,595	5,663	5,739	5,823	250.21	105.96	174.25	17.17
El Paraíso	San Antonio de Flores	2	0	0	1	5,729	5,783	5,835	5,885	34.91	0.00	0.00	16.99
Gracias a Dios	Ahuas	0	0	0	1	6,417	6,428	6,440	6,454	0.00	0.00	0.00	15.49
Santa Bárbara	Las Vegas	12	0	1	4	24,679	25,075	25,459	25,834	48.62	0.00	3.93	15.48
Copán	Dulce Nombre	5	1	0	1	6,116	6,273	6,431	6,591	81.76	15.94	0.00	15.17
Colón	Balfate	0	0	0	2	13,273	13,326	13,375	13,421	0.00	0.00	0.00	14.90
El Paraíso	Teupasenti	31	14	2	7	44,442	45,417	46,399	47,386	69.75	30.83	4.31	14.77
Comayagua	Minas de Oro	2	0	0	2	13,445	13,548	13,649	13,748	14.88	0.00	0.00	14.55
Choluteca	Concepcion de Maria	0	0	0	4	27,469	27,687	27,905	28,121	0.00	0.00	0.00	14.22
Ocotepeque	San Fernando	0	0	0	1	7,126	7,184	7,240	7,295	0.00	0.00	0.00	13.71
Copán	Nueva Arcadia	0	0	0	6	42,590	43,346	44,100	44,851	0.00	0.00	0.00	13.38
Francisco Morazán	Orica	6	0	3	2	14,398	14,604	14,816	15,034	41.67	0.00	20.25	13.30
Francisco Morazán	Santa Lucia	2	0	0	2	13,463	14,065	14,701	15,374	14.86	0.00	0.00	13.01
El Paraíso	Yuscaran	3	2	2	2	14,974	15,271	15,572	15,875	20.03	13.10	12.84	12.60
Comayagua	San Jose de Comayagua	1	0	1	1	7,882	7,909	7,936	7,962	12.69	0.00	12.60	12.56
La Paz	Marcala	12	7	1	4	30,504	31,148	31,791	32,429	39.34	22.47	3.15	12.33
Atlántida	Arizona	7	4	2	3	24,345	24,578	24,819	25,067	28.75	16.27	8.06	11.97
Francisco Morazán	Tatumbla	0	0	1	1	7,799	8,018	8,247	8,484	0.00	0.00	12.13	11.79
Santa Bárbara	Proteccion	0	0	0	2	17,013	17,220	17,421	17,615	0.00	0.00	0.00	11.35
Gracias a Dios	Juan Francisco Bulnes	0	0	0	1	8,539	8,694	8,852	9,011	0.00	0.00	0.00	11.10
Santa Bárbara	El Nispero	6	3	0	1	8,580	8,745	8,910	9,077	69.93	34.31	0.00	11.02
El Paraíso	Soledad	0	0	0	1	9,352	9,352	9,353	9,354	0.00	0.00	0.00	10.69

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Atlántida	Esparta	23	2	6	2	19,125	19,364	19,603	19,841	120.26	10.33	30.61	10.08
Olancho	Dulce Nombre de Culmi	3	4	3	3	30,836	31,118	31,387	31,643	9.73	12.85	9.56	9.48
Copán	Copan Ruinas	64	8	3	4	40,219	40,952	41,684	42,411	159.13	19.53	7.20	9.43
Olancho	San Francisco de Becerra	0	2	0	1	10,096	10,318	10,543	10,773	0.00	19.38	0.00	9.28
Comayagua	Esquias	2	3	10	2	21,262	21,514	21,764	22,012	9.41	13.94	45.95	9.09
Francisco Morazán	Villa de San Francisco	2	0	0	1	10,589	10,752	10,915	11,080	18.89	0.00	0.00	9.03
Choluteca	Namasigue	26	2	0	3	31,536	32,096	32,675	33,273	82.44	6.23	0.00	9.02
Comayagua	Ojos de Agua	7	1	1	1	10,739	10,873	11,006	11,136	65.18	9.20	9.09	8.98
Gracias a Dios	Puerto Lempira	9	4	0	5	51,702	53,131	54,554	55,973	17.41	7.53	0.00	8.93
Francisco Morazán	Sabanagrande	3	1	1	2	21,445	21,781	22,127	22,483	13.99	4.59	4.52	8.90
Francisco Morazán	Ojojona	0	0	0	1	10,872	11,017	11,167	11,319	0.00	0.00	0.00	8.83
Lempira	Talgua	2	0	0	1	10,908	11,071	11,232	11,389	18.33	0.00	0.00	8.78
Santa Bárbara	Azacualpa	0	0	0	2	21,693	22,240	22,806	23,389	0.00	0.00	0.00	8.55
Comayagua	Meambar	2	0	0	1	13,092	13,287	13,481	13,673	15.28	0.00	0.00	7.31
Gracias a Dios	Brus Laguna	0	0	0	1	13,505	13,801	14,107	14,423	0.00	0.00	0.00	6.93
Colón	Bonito Oriental	7	8	0	2	29,087	29,313	29,540	29,767	24.07	27.29	0.00	6.72
Valle	Nacaome	23	12	5	4	59,291	59,970	60,647	61,320	38.79	20.01	8.24	6.52
Francisco Morazán	Guaimaca	8	0	0	2	29,438	29,923	30,417	30,920	27.18	0.00	0.00	6.47
La Paz	Santiago de Puringla	0	0	0	1	16,782	16,978	17,168	17,351	0.00	0.00	0.00	5.76
Francisco Morazán	Santa Ana	3	0	0	1	16,661	16,889	17,123	17,361	18.01	0.00	0.00	5.76
Copán	Cucuyagua	4	0	0	1	17,042	17,379	17,717	18,055	23.47	0.00	0.00	5.54
Choluteca	Orocuina	6	2	0	1	18,578	18,676	18,775	18,873	32.30	10.71	0.00	5.30
Francisco Morazán	Curaren	3	0	0	1	20,775	20,924	21,080	21,244	14.44	0.00	0.00	4.71
El Paraíso	El Paraiso	17	7	11	2	45,638	45,920	46,199	46,473	37.25	15.24	23.81	4.30
Comayagua	La Libertad	3	2	4	1	27,652	28,275	28,906	29,541	10.85	7.07	13.84	3.39

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
El Paraíso	Las Trojes	6	0	0	1	50,047	51,011	51,979	52,950	11.99	0.00	0.00	1.89
Colón	Limon	75	28	18	0	14,770	15,112	15,446	15,771	507.79	185.28	116.54	0.00
La Paz	Mercedes de Oriente	1	2	1	0	1,124	1,138	1,151	1,165	88.95	175.79	86.85	0.00
Choluteca	San Isidro	3	1	2	0	3,765	3,793	3,821	3,849	79.67	26.36	52.34	0.00
Colón	Santa Rosa de Aguan	0	0	2	0	5,463	5,498	5,534	5,571	0.00	0.00	36.14	0.00
Valle	Goascoran	19	5	5	0	14,441	14,489	14,540	14,595	131.57	34.51	34.39	0.00
Copán	Concepci≤n	6	2	3	0	8,311	8,524	8,738	8,954	72.19	23.46	34.33	0.00
Comayagua	San Luis	2	0	3	0	11,561	11,718	11,875	12,032	17.30	0.00	25.26	0.00
Choluteca	San Antonio de Flores	27	2	1	0	5,463	5,470	5,477	5,484	494.25	36.56	18.26	0.00
Atlántida	La Masica	15	18	5	0	30,619	31,034	31,449	31,864	48.99	58.00	15.90	0.00
Lempira	La Campa	0	0	1	0	7,172	7,408	7,650	7,895	0.00	0.00	13.07	0.00
La Paz	Opatoro	0	0	1	0	7,662	7,754	7,848	7,943	0.00	0.00	12.74	0.00
Olancho	Concordia	0	0	1	0	8,418	8,498	8,577	8,655	0.00	0.00	11.66	0.00
La Paz	Santa Elena	2	1	1	0	12,904	13,139	13,364	13,580	15.50	7.61	7.48	0.00
Santa Bárbara	San Nicolas	0	0	1	0	15,112	15,360	15,604	15,843	0.00	0.00	6.41	0.00
Lempira	Erandique	0	0	1	0	15,823	16,009	16,190	16,367	0.00	0.00	6.18	0.00
Francisco Morazán	Cedros	20	0	1	0	25,539	26,003	26,496	27,018	78.31	0.00	3.77	0.00
Lempira	La Iguala	0	0	1	0	27,508	28,219	28,934	29,654	0.00	0.00	3.46	0.00
Choluteca	El Triunfo	111	7	1	0	45,741	46,490	47,247	48,010	242.67	15.06	2.12	0.00
Valle	Caridad	1	5	0	0	3,980	4,000	4,018	4,037	25.12	125.02	0.00	0.00
El Paraíso	Jacaleapa	18	2	0	0	4,126	4,186	4,248	4,311	436.27	47.78	0.00	0.00
La Paz	San Juan	3	1	0	0	2,539	2,571	2,603	2,634	118.14	38.89	0.00	0.00
La Paz	San Antonio del Norte	6	1	0	0	2,817	2,851	2,885	2,920	212.99	35.08	0.00	0.00
Copán	Veracruz	14	1	0	0	3,399	3,447	3,494	3,541	411.94	29.01	0.00	0.00
Olancho	Campamento	18	6	0	0	21,283	21,814	22,357	22,910	84.57	27.51	0.00	0.00
Choluteca	Santa Ana de Yusguare	81	4	0	0	14,717	14,813	14,914	15,021	550.37	27.00	0.00	0.00

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Olancho	El Rosario	2	1	0	0	4,282	4,298	4,312	4,324	46.70	23.27	0.00	0.00
Santa Bárbara	Concepcion del Sur	2	1	0	0	5,514	5,517	5,517	5,515	36.27	18.13	0.00	0.00
La Paz	Santa Maria	15	2	0	0	11,250	11,404	11,561	11,720	133.34	17.54	0.00	0.00
Copán	San Agustin	0	1	0	0	5,721	5,801	5,882	5,964	0.00	17.24	0.00	0.00
Ocotepeque	Fraternidad	0	1	0	0	5,769	6,111	6,471	6,849	0.00	16.37	0.00	0.00
Atlántida	El Porvenir	4	3	0	0	23,592	24,228	24,881	25,549	16.95	12.38	0.00	0.00
Olancho	Silca	8	1	0	0	8,087	8,135	8,179	8,219	98.92	12.29	0.00	0.00
Choluteca	Marcovia	78	5	0	0	46,725	47,113	47,510	47,917	166.93	10.61	0.00	0.00
Olancho	Yocon	3	1	0	0	12,375	12,566	12,755	12,939	24.24	7.96	0.00	0.00
Colón	Santa Fe	17	0	0	0	5,390	5,376	5,362	5,346	315.41	0.00	0.00	0.00
Olancho	Santa Maria del Real	25	0	0	0	10,823	10,875	10,924	10,967	230.99	0.00	0.00	0.00
Choluteca	San Marcos de Colon	36	0	0	0	28,102	28,679	29,263	29,853	128.10	0.00	0.00	0.00
El Paraíso	Texiguat	10	0	0	0	8,817	8,841	8,863	8,880	113.41	0.00	0.00	0.00
Ocotepeque	Santa Fe	5	0	0	0	5,090	5,174	5,259	5,345	98.24	0.00	0.00	0.00
Olancho	Guayape	11	0	0	0	13,027	13,152	13,279	13,408	84.44	0.00	0.00	0.00
Copán	La Union	11	0	0	0	16,463	16,612	16,756	16,894	66.81	0.00	0.00	0.00
La Paz	San Jose	6	0	0	0	9,047	9,086	9,124	9,163	66.32	0.00	0.00	0.00
Choluteca	San Jose	3	0	0	0	4,543	4,633	4,724	4,816	66.04	0.00	0.00	0.00
Francisco Morazán	San Miguelito	1	0	0	0	1,943	1,957	1,973	1,991	51.48	0.00	0.00	0.00
Olancho	La Union	4	0	0	0	7,949	8,038	8,129	8,220	50.32	0.00	0.00	0.00
Intibucá	San Juan	6	0	0	0	14,138	14,390	14,643	14,898	42.44	0.00	0.00	0.00
Valle	Amapala	5	0	0	0	13,020	13,302	13,586	13,874	38.40	0.00	0.00	0.00
Francisco Morazán	La Libertad	1	0	0	0	2,869	2,900	2,932	2,967	34.85	0.00	0.00	0.00
Francisco Morazán	San Buenaventura	1	0	0	0	2,963	3,029	3,097	3,168	33.75	0.00	0.00	0.00
Choluteca	Duyure	1	0	0	0	3,529	3,537	3,547	3,559	28.34	0.00	0.00	0.00
Ocotepeque	Mercedes	2	0	0	0	7,423	7,491	7,558	7,623	26.94	0.00	0.00	0.00

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Copán	San Pedro	1	0	0	0	7,716	7,772	7,827	7,880	12.96	0.00	0.00	0.00
La Paz	Chinacla	1	0	0	0	8,232	8,366	8,498	8,628	12.15	0.00	0.00	0.00
Valle	San Francisco de Coray	1	0	0	0	9,859	9,910	9,964	10,021	10.14	0.00	0.00	0.00
Ocotepeque	La Labor	1	0	0	0	10,012	10,188	10,366	10,546	9.99	0.00	0.00	0.00
Olancho	Esquipulas del Norte	1	0	0	0	11,135	11,496	11,864	12,236	8.98	0.00	0.00	0.00
Olancho	San Francisco de La Paz	1	0	0	0	19,937	20,183	20,428	20,671	5.02	0.00	0.00	0.00
Francisco Morazán	Lepaterique	1	0	0	0	21,245	21,767	22,306	22,862	4.71	0.00	0.00	0.00
Colón	Iriona	0	0	0	0	21,461	21,716	21,967	22,213	0.00	0.00	0.00	0.00
Comayagua	La Trinidad	0	0	0	0	4,694	4,755	4,814	4,873	0.00	0.00	0.00	0.00
Comayagua	San Jose del Potrero	0	0	0	0	7,018	7,125	7,231	7,336	0.00	0.00	0.00	0.00
Copán	Cabana	0	0	0	0	14,725	15,082	15,441	15,803	0.00	0.00	0.00	0.00
Copán	Dolores	0	0	0	0	6,777	6,902	7,027	7,151	0.00	0.00	0.00	0.00
Choluteca	El Corpus	0	0	0	0	25,337	25,591	25,845	26,099	0.00	0.00	0.00	0.00
El Paraíso	Oropoli	0	0	0	0	6,053	6,090	6,126	6,160	0.00	0.00	0.00	0.00
El Paraíso	San Lucas	0	0	0	0	7,963	8,057	8,155	8,255	0.00	0.00	0.00	0.00
El Paraíso	San Matias	0	0	0	0	5,250	5,321	5,392	5,461	0.00	0.00	0.00	0.00
El Paraíso	Vado Ancho	0	0	0	0	4,050	4,071	4,091	4,109	0.00	0.00	0.00	0.00
El Paraíso	Yauyupe	0	0	0	0	1,378	1,394	1,410	1,426	0.00	0.00	0.00	0.00
Francisco Morazán	Reitoca	0	0	0	0	10,735	10,761	10,790	10,823	0.00	0.00	0.00	0.00
Gracias a Dios	Ram≤n Villeda Morales	0	0	0	0	5,873	5,919	5,967	6,017	0.00	0.00	0.00	0.00
Gracias a Dios	Wampusirpi	0	0	0	0	10,348	10,365	10,383	10,403	0.00	0.00	0.00	0.00
Intibucá	Dolores	0	0	0	0	5,434	5,537	5,640	5,742	0.00	0.00	0.00	0.00
Intibucá	Intibuca	0	0	0	0	60,264	61,695	63,117	64,527	0.00	0.00	0.00	0.00
Intibucá	Masaguara	0	0	0	0	16,566	16,794	17,019	17,242	0.00	0.00	0.00	0.00
Intibucá	San Isidro	0	0	0	0	4,701	4,812	4,925	5,038	0.00	0.00	0.00	0.00

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Intibucá	San Marcos de Sierra	0	0	0	0	9,123	9,285	9,447	9,608	0.00	0.00	0.00	0.00
Intibucá	San Miguelito	0	0	0	0	8,006	8,236	8,470	8,706	0.00	0.00	0.00	0.00
Intibucá	San Francisco de Opalaca	0	0	0	0	11,685	12,024	12,369	12,718	0.00	0.00	0.00	0.00
Islas de la Bahía	Jose Santos Guardiola	0	0	0	0	11,698	11,823	11,953	12,088	0.00	0.00	0.00	0.00
La Paz	Cabanas	0	0	0	0	3,492	3,579	3,666	3,754	0.00	0.00	0.00	0.00
La Paz	Guajiquiro	0	0	0	0	15,138	15,317	15,495	15,671	0.00	0.00	0.00	0.00
La Paz	Lauterique	0	0	0	0	3,040	3,060	3,081	3,103	0.00	0.00	0.00	0.00
La Paz	Santa Ana	0	0	0	0	12,304	12,486	12,669	12,851	0.00	0.00	0.00	0.00
La Paz	Yarula	0	0	0	0	9,356	9,522	9,683	9,838	0.00	0.00	0.00	0.00
Lempira	Belen	0	0	0	0	7,477	7,720	7,968	8,220	0.00	0.00	0.00	0.00
Lempira	Candelaria	0	0	0	0	6,896	6,931	6,963	6,992	0.00	0.00	0.00	0.00
Lempira	Cololaca	0	0	0	0	9,401	9,715	10,034	10,360	0.00	0.00	0.00	0.00
Lempira	Gualcince	0	0	0	0	11,697	11,826	11,952	12,073	0.00	0.00	0.00	0.00
Lempira	Guarita	0	0	0	0	8,577	8,646	8,717	8,787	0.00	0.00	0.00	0.00
Lempira	La Virtud	0	0	0	0	6,662	6,682	6,698	6,712	0.00	0.00	0.00	0.00
Lempira	Lepaera	0	0	0	0	38,445	39,004	39,554	40,092	0.00	0.00	0.00	0.00
Lempira	Mapulaca	0	0	0	0	4,338	4,360	4,380	4,399	0.00	0.00	0.00	0.00
Lempira	Piraera	0	0	0	0	14,306	14,485	14,660	14,830	0.00	0.00	0.00	0.00
Lempira	San Juan Guarita	0	0	0	0	2,693	2,710	2,728	2,747	0.00	0.00	0.00	0.00
Lempira	San Manuel Colohete	0	0	0	0	14,854	15,123	15,391	15,656	0.00	0.00	0.00	0.00
Lempira	San Rafael	0	0	0	0	13,938	14,109	14,275	14,437	0.00	0.00	0.00	0.00
Lempira	San Sebastian	0	0	0	0	11,069	11,279	11,489	11,698	0.00	0.00	0.00	0.00
Lempira	Santa Cruz	0	0	0	0	7,258	7,429	7,600	7,771	0.00	0.00	0.00	0.00
Lempira	Tambla	0	0	0	0	3,291	3,360	3,430	3,500	0.00	0.00	0.00	0.00
Lempira	Tomala	0	0	0	0	6,574	6,652	6,727	6,801	0.00	0.00	0.00	0.00

Department	Municipality	Cases				Population				Rates**			
		2016	2017	2018	2019	2016	2017	2018	2019	2016	2017	2018	2019
Lempira	Valladolid	0	0	0	0	3,774	3,802	3,831	3,860	0.00	0.00	0.00	0.00
Lempira	Virginia	0	0	0	0	2,588	2,605	2,622	2,640	0.00	0.00	0.00	0.00
Lempira	San Marcos de Caiquin	0	0	0	0	5,946	6,076	6,206	6,335	0.00	0.00	0.00	0.00
Ocotepeque	Belen Gualcho	0	0	0	0	16,276	16,568	16,861	17,153	0.00	0.00	0.00	0.00
Ocotepeque	Dolores Merendon	0	0	0	0	4,140	4,287	4,439	4,595	0.00	0.00	0.00	0.00
Ocotepeque	La Encarnacion	0	0	0	0	5,232	5,330	5,430	5,530	0.00	0.00	0.00	0.00
Ocotepeque	Lucerna	0	0	0	0	6,083	6,157	6,229	6,300	0.00	0.00	0.00	0.00
Ocotepeque	San Francisco del Valle	0	0	0	0	9,946	10,051	10,154	10,254	0.00	0.00	0.00	0.00
Ocotepeque	San Jorge	0	0	0	0	5,258	5,336	5,414	5,491	0.00	0.00	0.00	0.00
Ocotepeque	Sensenti	0	0	0	0	11,776	11,881	11,984	12,085	0.00	0.00	0.00	0.00
Olancho	Guarizama	0	0	0	0	7,896	7,942	7,990	8,038	0.00	0.00	0.00	0.00
Olancho	Guata	0	0	0	0	12,236	12,385	12,529	12,668	0.00	0.00	0.00	0.00
Olancho	Jano	0	0	0	0	4,943	5,083	5,225	5,367	0.00	0.00	0.00	0.00
Olancho	Mangulile	0	0	0	0	9,481	9,495	9,505	9,511	0.00	0.00	0.00	0.00
Olancho	Patuca	0	0	0	0	27,433	27,671	27,897	28,109	0.00	0.00	0.00	0.00
Santa Bárbara	Atima	0	0	0	0	18,752	19,132	19,510	19,885	0.00	0.00	0.00	0.00
Santa Bárbara	Nuevo Celilac	0	0	0	0	8,166	8,185	8,200	8,212	0.00	0.00	0.00	0.00
Santa Bárbara	Nueva Frontera	0	0	0	0	13,138	13,245	13,348	13,448	0.00	0.00	0.00	0.00
Valle	Alianza	0	0	0	0	7,544	7,562	7,579	7,596	0.00	0.00	0.00	0.00

*Till EW26-2019. **Cases per 100,000 pop.