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ORIGINAL ARTICLE

Indigenous ecological calendars and seasonal vector-borne diseases in the Colombian Amazon: an intercultural and interdisciplinary approach

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ABSTRACT

Traditional ecological knowledge of indigenous groups in the southeastern Colombian Amazon coincides in identifying the two main hydrological transition periods (wet-dry: August-November; dry-wet: March-April) as those with greater susceptibility to disease in humans. Here we analyze the association between indigenous knowledge about these two periods and the incidence of two vector-borne diseases: malaria and dengue. We researched seven "ecological calendars" from three regions in the Colombian Amazon, malaria and dengue cases reported from 2007 to 2019 by the Colombian National Institute of Health, and daily temperature and precipitation data from eight meteorological stations in the region from 1990–2019 (a climatological normal). Malaria and dengue follow a seasonal pattern: malaria has a peak from August to November, corresponding with the wet-dry transition (the "season of the worms" in the indigenous calendars), and dengue has a peak in March and April, coinciding with the dry-wet transition. Previous studies have shown a positive correlation between rainfall and dengue and a negative correlation between rainfall and malaria. However, as the indigenous ecological knowledge codified in the calendars suggests, disease prediction cannot be reduced to a linear correlation with a single environmental variable. Our data show that two major aspects of the indigenous calendars (the time of *friaje* as a critical marker of the year and the hydrological transition periods as periods of greater susceptibility to diseases) are supported by meteorological data and by the available information about the incidence of malaria and dengue.

KEYWORDS: traditional ecological knowledge, malaria, dengue, climatological normal, hydrological transitions

Calendarios ecológicos indígenas y enfermedades estacionales transmitidas por vectores en la Amazonia colombiana: un enfoque intercultural e interdisciplinario

RESUMEN

Los conocimientos ecológicos tradicionales de grupos indígenas del sureste de la Amazonia colombiana coinciden en identificar dos principales periodos de transición hidrológica (seco-húmedo: agosto-noviembre; húmedo-seco: marzo-abril) como los de mayor susceptibilidad a enfermedades en humanos. Aquí analizamos la asociación entre el conocimiento indígena sobre estos dos periodos y la incidencia de dos enfermedades transmitidas por vectores: malaria y dengue. Investigamos siete calendarios ecológicos de tres regiones en la Amazonia colombiana, casos de dengue y malaria reportados de 2007 hasta 2019 por el Instituto Nacional de Salud de Colombia y datos diarios de temperatura y precipitación de ocho estaciones meteorológicas en la región, de 1990 a 2019 (una normal climatológica). Malaria y dengue siguen un patrón estacional, la malaria tiene un pico de agosto a noviembre, correspondiendo con la transición húmedo-seco (el "tiempo de gusano" según los calendarios indígenas), mientras que dengue tiene un pico de marzo a abril, coincidiendo con la transición seco-húmedo. Estudios previos mostraron una correlación positiva entre precipitación y dengue, y una correlación negativa entre precipitación y malaria. Sin embargo, como lo sugiere el conocimiento ecológico codificado en los calendarios indígenas, la predicción de enfermedades no puede reducirse a una correlación lineal con una sola variable medioambiental. Nuestros datos muestran que dos aspectos principales de los calendarios indígenas (el tiempo de friaje como un marcador crítico anual y los periodos de transición hidrológica como épocas de mayor susceptibilidad a enfermedades) están soportados por datos meteorológicos e información disponible acerca de la incidencia de malaria y dengue.

PALABRAS CLAVE: conocimiento ecológico tradicional, dengue, normal climatológica, malaria, transición hidrológica

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INTRODUCTION

Amazonian indigenous people are keen observers of natural rhythms and have accumulated extensive and sophisticated knowledge of seasonal cycles (Echeverri 2009). This knowledge has been recorded by researchers and more recently by indigenous people themselves, with the name of "ecological calendars" (van der Hammen *et al.* 2012; Rodríguez and van der Hammen 2012), "traditional calendar-maps" (Velasco Álvarez 2021), or "eco-health calendars" (SantoDomingo *et al.* 2016). These ecological calendars are used to claim and negotiate indigenous ways of life distinct from the development policies promoted by state agents (Cayón 2012; Estrada Añokazi 2018) or as an approach seeking to integrate local knowledge in the context of vector-borne disease prevention, from an eco-health framework (SantoDomingo *et al.* 2016).

Three of us (Cárdenas Carrillo, Venegas and De Vengoechea) carried out ethnographic research in the Middle Caquetá region in the southeastern Colombian Amazon in 2018-2019, resulting in the compilation of the ecological calendar of the Féenemɨna'a ethnic group (formerly known as Muinane). We also collected information from calendars of six other indigenous groups in the regions of the Middle Caquetá, Igaraparaná and Mirití-Paraná (Franky 2004; Makuritofe and Castro 2008; Andoque and Castro 2012; Henao and Farekatde (2013); Estrada Añokazi 2018; García 2018; Guhl 2018). They all coincide in relating hydrological cycles with a variety of ecological phenomena such as the phenology of wild and cultivated plant species, the reproduction of fish and terrestrial vertebrates, and insect diversity. These calendars mark "seasons" that have an incidence in regulating the annual horticultural cycle and the greater or lesser susceptibility to diseases in human beings. Although the number and name of seasons differ among different indigenous calendars, all of them identify the hydrological transition periods from the wet to the dry, and from the dry to the wet seasons in the Colombian Amazon as those with greater susceptibility to disease in human beings. The most marked event in all these calendars is the meteorological phenomenon regionally known as *friaje,* caused by cold air currents that have their origin in the Antarctic Ocean and affect part of the South American continent (Marengo 1984).

Here we analyze the association between indigenous knowledge about these two hydrological transition periods, as contained in their calendars, and the epidemiological information on the incidence of vector-borne diseases in the Colombian Amazon. Even though the major health ailments in this region are gastrointestinal, respiratory, and dermatological diseases (Suárez-Mutis *et al*. 2010), these are rarely reported in the Colombian National Public Health Surveillance System (SIVIGILA). Therefore, we opted to use data on occurrence of malaria and dengue recorded by SIVIGILA. Malaria was introduced in South America in colonial times (Carter 2003; Yalcindag *et al.* 2012) and has been prevalent in the Amazon region for centuries. Dengue was introduced in the Americas in the XVII century (Wilson and Chen 2002; Brathwaite Dick *et al.* 2012), but the first recorded outbreaks in western Amazonia are from the 1990s (Phillips *et al.* 1992). Precisely for being introduced diseases, malaria and dengue are far better reported than gastrointestinal or respiratory diseases.

Both malaria and dengue are widespread throughout the tropical and subtropical regions. Malaria is caused by parasites of the genus *Plasmodium* and is transmitted by mosquitoes of the *Anopheles* genus in the Americas (Wilson and Chen 2002; Carter 2003; Yalcidang *et al.* 2012; Achee *et al.* 2015). There were 229 million estimated cases and about 400,000 deaths worldwide in 2019 (WHO 2021). Brazil, Colombia, and Venezuela account for more than 86% of cases in South America, with approximately 90% of the patients reported from the Amazon region (WHO 2020). Malaria is one of the morbidities with the best records in SIVIGILA, even though the Amazon region shows high levels of disease underreporting (Gutiérrez 1982; Minsalud 2013; Chaparro *et al.* 2012). Dengue is caused by a virus of the Flaviviridae family and its main vectors are the mosquitoes *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) (Achee *et al.* 2015). More than 2.5 billion people are at risk of infection, and more than 160 countries have endemic transmission (WHO 2009).

The indigenous calendars do not refer to malaria and dengue by their names; instead, they mention their symptoms such as fever, chills, headache, diarrhea, vomiting, and body aches. We analyzed the relationship between the two hydrological transition periods, as they are signaled in the indigenous calendars from the Middle Caquetá, Igaraparaná, and Mirití Paraná regions, with the incidence of malaria and dengue, as reported in SIVIGILA. Data are analyzed from an interdisciplinary perspective, combining natural and social sciences.

MATERIAL AND METHODS

Ecological calendars

We researched seven ecological calendars: three from the Middle Caquetá region in Colombia: Nɨpodɨmakɨ (Makuritofe and Castro 2008); Féenemɨna'a (Cárdenas Carrillo,Venegas and De Vengoechea, unpubl. data), and Andoque (Andoque and Castro 2012; Estrada Añokazi 2018); two Murui Mɨnɨka calendars from the Igaraparaná region (Henao and Farekatde (2013); García 2018); and two calendars from the Mirití-Paraná river region: Yukuna (Guhl 2018) and Tanimuka (Franky 2004).[1] Makuritofe and Castro (2008) is a booklet

1 The Nipodimaki and Murui Minika speak two different dialects of Murui, a language and ethnic group formerly known as "Witoto" (see Agga Calderón et al. 2019; Echeverri 2022, for an explanation of the change of ethnonyms). The Féenemina'a are also known as "Muinane" (see Ancianos del pueblo Fééneminaa 2016).

written by a Nɨpodɨmakɨ elder with the help of a younger indigenous leader, profusely illustrated, accompanied by a narrative text. Henao and Farekatde (2013) is a book chapter about the notion of "climate", authored by an indigenous elder and an anthropologist, including a table and text about the ecological calendar. The other sources contain information about the indigenous calendars in tabular or narrative form as part of scholarly dissertations in anthropology. These three regions encompass a large area of about 5 million ha (Figure 1). From the seven calendars, we synthesized the biological, climatic, cultural, and disease information and correlated them with the months of the Gregorian calendar.

Meteorological data

We obtained the meteorological data for the region from the Colombian Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM 2021). We downloaded the daily precipitation data from six meteorological stations (Aguazul, Angosturas, Araracuara, Cuemaní, Monochoa, and Santa Isabel), and daily maximum and minimum temperatures from three meteorological stations (Araracuara, Tres Esquinas, and La Chorrera) for the 1990–2019 period, i.e., a 30-year climatological standard normal, which is defined as the average of climatological data computed for a period of 30 years (Trewin 2007) (Figure 1; Table 1). From the daily values, we calculated monthly accumulated precipitation and average monthly minimum and maximum temperature. The standard deviation for each month was calculated from the pluriannual averages of each station.

The occurrence of *friaje* periods was assessed by calculating the number of cold outlier days per month. A cold outlier is a temperature datum below Q1-1.5*(Q3-Q1), where Q1 is the middle value between the lowest datum and the median (Q2) of the data set and Q3 is the middle value between the median and the highest datum of the 30-year temperature data set. In addition to the three meteorological stations in the immediate study region (Araracuara, Tres Esquinas, and La Chorrera), we also used the data from the meteorological station of Leticia (Colombia) to determine the *friaje* periods, as the phenomenon occurs on the continental scale (Ricarte *et al.* 2015).

Malaria and dengue cases

We retrieved information about malaria and dengue cases reported from 2007 to 2019 from the routine surveillance statistics of the National Public Health Surveillance System

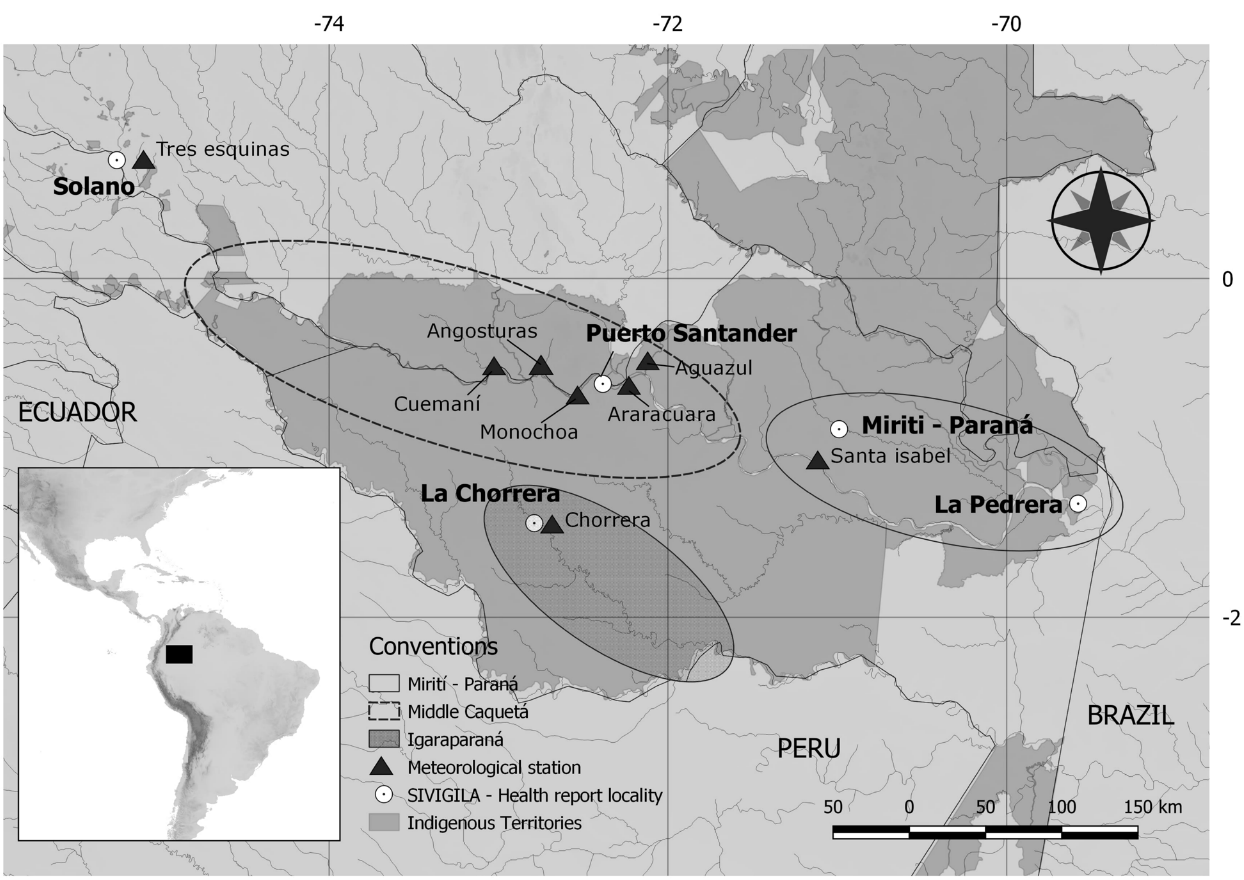

Figure 1. Map of the Colombian Amazon showing the three regions from where indigenous ecological calendars were obtained, health report localities and meteorological stations.

Table 1. Correspondence among regions, indigenous groups, and localities from which malaria and dengue occurrence data and meteorological data were obtained for the analysis of indigenous ecological calendars in the Colombian Amazon.

Region	Indigenous group	Malaria/dengue data		Meteorological station		
		Locality	Coordinates	Name	Altitude (m.a.s.l)	Coordinates
Middle Caquetá	Nɨpodɨmakɨ, Féenemɨna'a, Andoque	Puerto Santander	0°37'18"S 72°23'1"W	Aguazul*	129	0°33'35.6"S, 72°12'52.2"W
				Angosturas*	134	0°35'27.4"S, 72°16'19.4"W
				Araracuara*†	150	0°36'58.9"S, 72°14'17.5"W
				Cuemaní*	137	0°31'12"S, 73°12'24"W
				Monochoa*	133	0°42'0"S, 72°15'18"W
		Solano	0°41'56"N 75°15'12"W	Tres esquinas†	219	0°44'15"N 75°14'10"W
Igaraparaná	Murui Mɨnɨka	La Chorrera	1°26'40"S 72°72'22"W.	La Chorrera†	160	1°26'40.6"S 72°47'22.5"W
Mirití-Paraná	Yukuna, Tanimuka	Mirití- Paraná	1°12'58"S 69°53'20"W	Santa Isabel*	118	1°6'0"S 71°7'12"W
		La Pedrera	1°19'50"S 69°34'47"W			

Sources: IDEAM (2021); SIVIGILA (2020). *: precipitation data; †: temperature data.

of Colombia, which has health records available online since 2007 (SIVIGILA 2020). We selected the health report from five localities: the municipality of Solano in the department of Caquetá (west of the study area), and four municipalities in the department of Amazonas (Puerto Santander, in the middle Caquetá region, Mirití and La Pedrera, in the Mirití-Paraná region, and La Chorrera, in the south of the study area (Table 1). These municipalities are the territorial units corresponding to the three regions from where the ecological calendars come from and related to the meteorological stations from which climatic data were retrieved (Figure 1; Table 1).

We used Spearman's nonparametric correlation in the software Past v4.3 (Hammer *et al.* 2021) to determine the association between monthly average precipitation and the monthly cumulative number of malaria cases from all localities.

RESULTS

Indigenous calendars

The indigenous calendars we consulted identify the time of *friaje* as a central event in the annual calendar. Indigenous groups mark this event, which lasts only a few days, as the beginning of the annual ecological cycle. This annual cycle can be divided into four major periods, defined by the hydrological cycle: 1) the wet-dry transition, immediately after the *friaje*, between August and November; 2) the dry season, between December and February; 3) the dry-wet transition, between March and April, and 4) the wet season, between May and July (Figure 2a), corresponding to the Amazonian hydrological cycle of the climatic northern hemisphere (Gutiérrez 1982). The different indigenous ecological calendars give names to the seasons according to major ecological variables (e.g., hydrological conditions, phenology of plant species, fauna, etc.) (Table 2).

Wet-dry transition: season of the worms

The wet-dry transition period, which lasts up to four months, is characterized by a succession of "false" dry periods interspersed with periods of rain; they are called "false" because

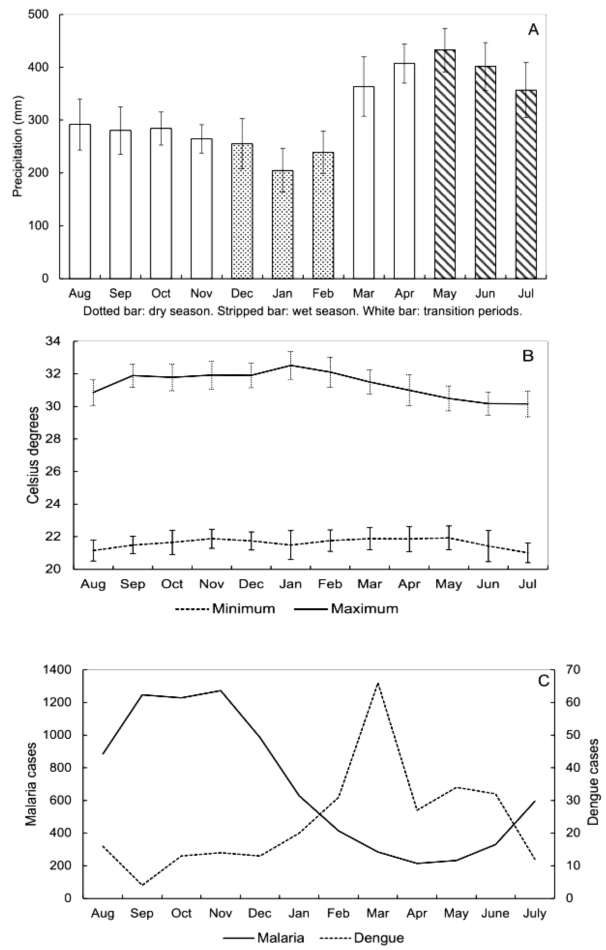

Figure 2. A – Monthly average precipitation from six meteorological stations in the Colombian Amazon, from January 1990 to December 2019. The bars indicate the standard deviations from the pluriannual averages (raw data in Supplementary Material, Table S1). Data from IDEAM (2021). B – Monthly average of daily maximum and minimum temperatures from meteorological stations in La Chorrera (Amazonas), Tres Esquinas and Araracuara (Caquetá) in the Colombian Amazon, from January 1990 to December 2019 (raw data available in Supplementary Material, Table S2). Data from IDEAM (2021). C – Monthly cumulative cases of malaria and dengue reported in the localities of La Chorrera, La Pedrera, Mirití-Paraná, Puerto Santander and Solano in the Colombian Amazon, in 2007-2019 (raw data available in Supplementary Material, Tables S3 and S4). Data from SIVIGILA (2020).

Table 2. Synthesis of indigenous ecological calendars from the middle Caquetá, Igarapaná, and Miriti regions, southeastern Colombian Amazon.

Hydrological period	Month	Indigenous seasons	MIDDLE CAQUETÁ			IGARAPARANÁ		MIRITÍ	
			Nɨpodɨmakɨ	Féenemɨna'a	Andoque	Murui-Mɨnɨka		Yukuna	Tanimuka
			Makuritofe and Castro (2008)	(unpubl.data)	Estrada Añokazi (2018)	Henao and Farekatde (2013)	García Rodríguez (2018)	Guhl Samudio (2018)	Franky (2004)
Wet-Dry	Aug	Season of the worms	Season of the worms	Season of worms and cicadas. False *caimo*	Worm season	Season of worms and of tobacco *Nokɨjaino*	Pineapple	Rain of the toads	Cicada season
	Sep		Beetle season	False inga False forest grape	Blossoming of palms. *Caimo*			Cicadas	
	Oct	Dry season	Palm flowering	False pineapple	Pineapple	*Caimo*, pineapple, inga and forest grape	*Caimo*	Toads	Time of the toad; Ñamato time
	Nov		*Emayo*	Blossoming summer	Unripe peach palm	*Yamao*	*Emaio* tree season	Pineapple season	Forest fruits
Dry season	Dec		Yellow *umarí*	Yellow *umarí*	Dry season	Harvest peach palm Yellow *umarí*	Peach palm, inga and forest grape, *cucuy* and green *umarí*		Season of planted fruits
	Jan		Forest grape Peach palm	Peach palm, inga and green *umarí*	Peach palm, *umarí* and forest grape	Peach palm and green *umarí*		Peach palm	Peach palm
	Feb								
Dry - Wet	Mar	Wet season	*Cucuy*	Shrimp, *cucuy* and inga *friajes*	Dry season rains	Yellow *umarí*	Yellow *umarí*	*Chirarika* (ritual) Many rains	*Yuruparí* season
	Apr		Green *umarí*	Chile tree *friaje*	Rains of red *umarí*				
Wet season	May		Tobacco	*Káanifikumu friaje*	Rains of green *umarí*	Green *umarí*	Green *umarí*		Forest fruits
	Jun		Wet season	Pineapple *friaje*. Season of the cicadas	Flowering of palms	Miriti palm	Miriti palm	Wet season	Wet season
	Jul	*Friaje*	*Friaje*	Elder's back and miriti *friaje*	Mirití palm *friaje*			*Friaje*	

Identification of species: aguacatillo, *Persea caerulea* (Ruiz & Pav.) Mez; chicle tree, *Couma macrocarpa* Barb.Rodr.; cucuy, *Macoubea guianensis* Aubl.; emaio, emayo (unident.); forest grape, *Pourouma cecropiifolia* Mart.; inga, *Inga edulis* Mart.; miriti palm, *Mauritia flexuosa* L.f.; peach palm, *Bactris gasipaes* Kunth; pineapple, *Ananas comosus* (L.) Merr.; caimo, *Pouteria caimito* Radlk.; umarí, *Poraqueiba sericea* Tul.

their duration is shorter than the main, more extended dry season (García 2018). The first false dry season is called "season of the worms", among the indigenous groups of the People of the Center[2] (Makuritofe and Castro 2008; Andoque and Castro 2012), or "season of the cicadas" for the groups living in the Mirití-Paraná River basin (Yukuna, Matapí, Letuama, and Tanimuka) (Franky 2004; Guhl 2018).

The season of the worms[3] (or cicadas) is characterized by a higher incidence of physical and spiritual diseases, the latter manifested in psychic or moral disorders such as laziness, rage, envy, jealousy, madness, and so forth (García 2016). As these diseases affect not only individuals but also the whole group, some of the actions carried out by People of the Center groups consist of ritual dances and dialogues, seeking to neutralize and avert the agents that cause them (García 2016).

The season of the worms comes with a short harvest of fruit trees such as *caimo* (*Pouteria caimito*), inga (*Inga edulis*), annatto (*Bixa orellana* L.), cashew (*Anacardium occidentale* L.), pineapple (*Ananas comosus*), and forest grape (*Pourouma cecropiifolia*). During this season, the livelihood depends mostly on cultivated crops since worms destroy wild fruits (Andoque and Castro 2012; Guhl 2018).

The different indigenous calendars agree that this time is over when the sun shines, and the *caimo* fruits mature, an event that gives its name to the dry season of the *caimo* fruits, preceding the false dry season of inga. Makuritofe and Castro (2008) state that once *caimo* fruits turn yellow, the owner of this fruit, the *jipikoreiño* bird, sings: *pi'chɨɨ, pi'chɨɨ, pi'chɨɨ*,

2 The People of the Center include the Murui (also called "Witoto", which comprises the Nipodimaki and the Murui-Minika), Féenemina'a (also called Muinane), Andoque, and Nonuya ethnic groups living in the Colombian Middle Caquetá region.

3 The different calendars describe the reproductive phases of butterflies in detail. The Andoque consider worms and butterflies as the same animal, as Gómez (2011) mentions when referring to the origin of worms and butterflies: "the worms began to eat the leaves, they pupate back and finally burst into butterflies." Esteban Ortiz, a Féenemina'a man, says: "There are clouds of butterflies flying in the fallows, and fifteen days later the trees are all eaten. People walk through the forest, and that is like excrement raining from the branches" (Cárdenas Carrillo, Venegas and De Vengoechea, unpubl. data). Indigenous people consider worms as a potential danger due to their ability to cause itchiness, sting, poison, or cause allergies, and because their smell is sometimes unpleasant and is directly associated with disease.

making the first fruits full of worms, while those that ripen at the end of the season are healthy.

In the transition period, diseases related to viruses, bacteria, protozoa, or, in general, microscopic organisms, occur, associated with the contamination accumulated during the time of *friaje* (immediately before the season of the worms), as stated by Makuritofe and Castro (2008): "During the friaje (*ro'yiɨmuy*) pests or diseases are released on mother earth, it is the garbage or invisible waste that comes into the air, one does not get sick at the moment, but later at another time."

There are caterpillars of Lepidoptera (butterflies and moths) associated with the season of the worms as well as other taxonomic groups with vermiform organisms. During this period, mammals and fish are infected with vermiform organisms (Makuritofe and Castro 2008). That is why this season is also called the time of fish epidemy, which manifests as fever, vomiting, diarrhea, and stomach parasites. These gastrointestinal diseases could be related to fish or mammals infected with nematodes or flatworms, also with waterborne pathogens.

The second sub-period (October-November) of the wet-dry transition is distinguished by a succession of false dry seasons, interspersed with periods of rain. It corresponds, in all indigenous groups, with the ripening of fruits of different species: the beginning of flowering of the peach palm (*Bactris gasipaes*), the *emaio* tree (not identified), the forest grape (*P. cecropiifolia*), and inga (*I. edulis*).

Dry season

The dry season (December–February) is mainly marked by the ripening of the fruits of the yellow *umarí* tree (*Poraqueiba sericea*) and most importantly, the ripening of the peach palm (*B. gasipaes*). In this season, the river reaches its lowest levels. At the beginning of the dry season, new horticultural plots are slashed, which will be burnt at the end of this season. The burning of the horticultural plots is associated with a higher prevalence of respiratory symptoms and allergies. Within the nosology of the People of the Center, fire is considered both a manifestation of disease and as a purifying element to treat it. Arachnids, worms, butterflies, wasps, and different insects associated with the appearance of itching on the skin are struck down with fire.

Dry-wet transition

The second transition period is in March and April, immediately after the dry season. It is marked by the ripening of the fruits of the *cucuy* tree (*Macoubea guianensis*) and the green *umarí* tree (another variety of *P. sericea*). For the Yukuna and Tanimuka, this is the time to celebrate the *yuruparí* or men's initiation ritual. It is also marked as a time of illness. This transition period corresponds to the beginning of the wet season; the rains increase, and the first flood of the year occurs (Makuritofe and Castro 2008), which lasts until the end of June.

The rainfall drains flowers, dead branches, and other debris from the earth that contribute to the accumulation of litter and tree debris while strengthening the fish. Several health problems are manifested during this time such as flu, headache, skin diseases, fungi related diseases, and diarrhea (Makuritofe and Castro 2008). The floods restrict passage on the mainland and bring animals closer to where human beings settle.

During this time, fishing is reduced because, with the increase in the river's water level, the fish disperse into creeks, streams, and flooded areas. This is the time of reproduction for terrestrial fauna. Large mammals, such as tapir, jaguar, deer, anteater, and birds, such as macaws and parrots, begin to be born approximately between April and May. Indigenous peoples believe that animals in this season are filled with worms and that, therefore, humans must prepare them properly before consumption to prevent diseases. Similarly, there is an increase in mosquitoes, since insects lay eggs in stagnant waters in April.

Wet Season

During the wet season (May–July), as precipitation increases, several wild plants fruitify, river levels rise, and it is the breeding season for fish. During this season, several milder *friaje* events can occur (named "false" in the calendars) that conclude with the major *friaje,* named after the miriti palm (*Mauritia flexuosa*) between July and August.

Friaje

The time of friaje coincides with the southern hemisphere's winter season (July-August). During the *friaje* season, the feeling of cold increases and moderate rainfall is accompanied by gusts of wind. These winds cause large drops in temperature in short and irregular periods that go from May to September and are more noticeable in June and July. According to the temperature data for the three stations with temperature data (Araracuara, Tres Esquinas, and La Chorrera), plus Leticia, for the period 1990-2019, there were 111 cold outlier days in July, 47 in August, 28 in June, 11 in September, nine in May, eight in February, six in April, three in March, two in October, and two in November. This corresponds with the marking of several *friaje* events of variable intensity in the indigenous calendars. The *friaje* announces the arrival of the wet-dry transition period and marks the end and new beginning of the ecological annual cycle, corresponding with the months of July and August (Table 2).

The *friaje* season is very important in ecological and cosmological terms. In mythical history, it marks a turning point between a time when diseases, evil and plagues affected humanity and crops, and a time when the cold weather harmonizes the atmosphere, animals are differentiated from humanity, and the celebration of ritual festivals begins. The *friaje* is a time of purification of nature and humanity. Part of the ecological management carried out by the indigenous connoisseurs is to request that the *friaje* arrives every year, as it is an indicator of good ecological functioning.

Temperature and precipitation data

Precipitation data was available for 87% of the 10,957 days of the 1990-2019 period (Supplementary Material, Table S1). Average monthly accumulated rainfall across stations showed a unimodal pattern, with a peak in May (the beginning of the wet season in the indigenous calendars) and lowest values in January (a month before the dry-wet transition) (Figure 2a).

Temperature data was available for 94% of the 10,957 days of the 1990-2019 period (Supplementary Material, Table S2). Average minimum and maximum daily temperatures were 21.9 and 31.7 °C in La Chorrera; 20.7 and 31.0 °C in Tres Esquinas; and 22.3 and 31.3 °C in Araracuara. The average minimum and maximum for the coldest month (July) were 21.1 ± 1.5 °C and 30.5 ± 1.8 °C, respectively (Figure 2b; Supplementary Material, Table S2). The overall minimum daily temperature was 12.8 °C, and the maximum temperature was 39.4 °C. The lowest average temperatures in Tres Esquinas and Araracuara were recorded in July, and in La Chorrera in August (Supplementary Material, Table S2), coinciding with the *friaje* events, as stated in the indigenous calendars (Table 2).

Cases of malaria and dengue

SIVIGILA recorded 8,316 cases of malaria in the period 2007–2019 for the five surveyed localities (Table 3). La Pedrera presented the largest number of cases, with more than 1,000 accumulated cases during September, October, and November. The records for malaria were assumed to be relatively complete because, to have access to the treatment, people need to go to a health center to get tested. However, it is also likely that many cases go unreported, mainly from communities more distant from health centers. Puerto Santander has no cases reported in 2007, 2008, 2011, and 2012; Solano has no cases reported in 2008, 2013, and 2015; and Pedrera has no cases reported in weeks 51 and 52 of 2018 (Table 3; Supplementary Material, Table S3). We found a negative correlation between monthly average precipitation and the cumulative number of malaria cases from all localies (r_s = -0.65, P = 0.02).

Dengue was found to be grossly underreported in the Colombian Amazon (Table 4). In 2010 there were only four registered cases in the four surveyed localities (Supplementary Material, Table S4), although during that year, the overall number of dengue cases in Colombia was 146,670, with 217 deaths caused by severe dengue (Castrillón *et al*. 2015). Raw dengue data from SIVIGILA shows that, in the surveyed period, prominent peaks of dengue occurred in Colombia in 2010, 2013, 2014, 2016 and 2019 (SIVIGILA 2020). These countrywide peaks are reflected in 2013 and 2014 in the four surveyed localities (Supplementary Material, Table S4), but not in the other peak years, suggesting underrepresentation.

The available data indicate that dengue and malaria are seasonal diseases, with malaria peaks from September to November, during the wet-dry transition, while dengue peaks in March, at the beginning of the dry-wet transition (Figure 2a,c).

DISCUSSION

We have presented a tight synthesis of indigenous knowledge about seasonal changes, which combines complex

Table 3. Cumulative monthly malaria cases (2007-2019) in La Chorrera (Amazonas), La Pedrera (Amazonas), Mirití-Paraná (Amazonas), Puerto Santander (Amazonas) and Solano (Caquetá) in the Colombian Amazon. Source: SIVIGILA (2020). Raw data in Supplementary Material, Table S3.

Locality	Monthly malaria cases 2017-2019												
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
La Chorrera	25	49	62	39	26	22	11	12	16	11	22	36	331
La Pedrera	632	1077	1040	1062	873	511	323	214	166	163	256	447	6764
Mirití Parana	71	53	51	71	28	30	10	4	8	17	8	24	375
Puerto Santander	101	55	71	96	54	43	40	37	19	25	29	68	638
Solano	55	13	5	5	4	22	30	18	5	16	15	20	208
Total	884	1247	1229	1273	985	628	414	285	214	232	330	595	8316

Table 4. Cumulative monthly cases of dengue (2007-2019) in La Chorrera (Amazonas), La Pedrera (Amazonas), Puerto Santander (Amazonas), and Solano (Caquetá) in the Colombian Amazon. Source: SIVIGILA (2020). Raw data in Supplementary Material, Table S4.

Locality	Monthly dengue cases 2007-2019												
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Total
La Chorrera	1		1										2
La Pedrera	1			6	7	4	5	33	5	1	3	1	66
Puerto Santander	1		1	1					1				4
Solano	13	4	11	7	6	16	26	33	21	33	29	11	210
Total	16	4	13	14	13	20	31	66	27	34	32	12	282

physical, biological, and ecological variables and relates them with occurrence of human and non-human health conditions. From all the information presented, we discuss the most remarkable interaction points between the evaluated meteorological and health data and the chronology of the indigenous calendars.

Even though the variation in average temperatures along the year is relatively slight compared to higher latitudinal climatic regions, all the indigenous calendars we consulted identify the time of *friaje* as a key event, which defines the "beginning" of the year. The *friaje* takes place in July and August, and its time of occurrence and degree of intensity are indicative of the overall health of animals, plants, ecosystems, and human beings. As stated by Echeverri (2009, 19), "For indigenous peoples, the *friaje* is the time of the 'menstruation' of the earth." As the duration of the *friaje* is just a few days (less than a week), its effect normally does not reflect on monthly temperature averages. Nonetheless, data of maximum and minimum temperatures recorded for the region in 30 years indicate that July and August have the lowest average temperature and the largest number of cold outlier days.

The effects of these brief periods of cold temperatures on animal reproduction, plant phenology, and human health are difficult to fathom. Although it has been reported that daily variations in temperature can influence the transmission process of malaria (Paaijmans *et. al*. 2010), we do not intend to establish any relationship between temperature and malaria or dengue. We limit ourselves to pointing out the coincidence between the rise in malaria cases (but not dengue cases) and this important season in the indigenous calendars.

Indigenous ecological calendars divide the year (beginning in August) into numerous "seasons", but we can group them into four major periods: the wet season, the dry season, and two transition periods. All calendars adamantly state that the transition periods are those when susceptibility to diseases in human beings increases. Although malaria or dengue are never named in indigenous calendars, and the array of ailments that may affect indigenous populations obviously is more extensive than malaria and dengue, these two diseases do affect indigenous communities in the Colombian Amazon (Méndez *et al.* 2006; Recht *et al.* 2017; Poveda 2020). Even though there may be an important degree of underreporting for dengue (and to a lesser degree for malaria), the data available for 2007-2019 shows that these two diseases have a clear seasonal pattern. The peak of malaria corresponds with the wet-dry transition, or the "season of the worms" in indigenous calendars, and the peak of dengue coincides with the dry-wet transition. Apart from malaria and dengue, the indigenous calendars refer to the occurrence of respiratory, gastrointestinal, and dermatological diseases.

Studies in other areas have determined a significant positive correlation between rainfall and the occurrence of dengue (Hoek *et al.* 1997; Hii *et al*. 2012; Silva *et al.* 2016). This is coherent with the coincidence of the dengue peak in the dry-wet transition in our study area, but does not explain why dengue cases tend to diminish during the wet season, which may be related to substantial underreporting. For malaria, a negative correlation with rainfall has been reported (Hoek *et al.* 1997; Mason *et al.* 2005; Briët *et al.* 2008; Bomblies 2011), which was confirmed by our data, which also shows a significant negative correlation between precipitation and reports of malaria.

Our data show that two structural postulates of the indigenous ecological calendars are supported by meteorological and epidemiological data: the time of *friaje* as a key marker of the year and the two hydrological transition periods as epochs of greater susceptibility to diseases. This is indicative of the potential richness of this traditional ecological knowledge, which so far has been neglected or regarded as a mere ethnographic curiosity.

CONCLUSIONS

Our study shows a close relationship between the observations recorded by indigenous experts in their ecological calendars and meteorological data and the seasonal occurrence pattern of two vector-borne diseases. Beyond simple coincidences, these similarities signal the convergence of two languages: that of the scientific method and the interpretation of the world based on empirical observation of the indigenous people and their way of life that responds appropriately to the natural rhythms of their environment. Accurate and complete epidemiological information and the potential of indigenous ecological knowledge, as we have shown here, can be a powerful tool for an interdisciplinary and intercultural approach to healthcare of the populations in this region.

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SUPPLEMENTARY MATERIAL (only available in the electronic version)

Jiménez *et al*. Indigenous ecological calendars and seasonal vector-borne diseases in the Colombian Amazon: an intercultural and interdisciplinary approach

Table S1. Monthly precipitation data (in mm) for the Angosturas, Aguazul, Araracuara, Cuemaní, Monochoa and Santa Isabel meteorological stations in the Colombian Amazon, from 1 January 1990 through 31 December 2019. Empty cells: no data available. Values in *italics* did not have measured rainfall for all days in the month and had the monthly precipitation estimated using simple arithmetic average of rainfall in other stations with complete data (Sattari et al 2016). Source: compiled from raw daily data in IDEAM (2021). CUE = Cuemani; ANG = Angosturas; MON = Monochoa; ARA = Araracuara; AGU = Aguazul; SAN = Santa Isabel.

Year -month	CUE	ANG	MON	ARA	AGU	SAN
1990-01	414	*444*	376	276	203	656
1990-02	308		165	193	207	158
1990-03	520		454	248	386	505
1990-04	699	256	430	319	292	279
1990-05	596	159	493	473	234	330
1990-06	668	536	354	370	506	599
1990-07	768	253	258	273	328	201
1990-08	733	347	395	271	507	340
1990-09	935	280	191	201	162	202
1990-10	334	312	253	167	189	247
1990-11	486	58	229	272	325	237
1990-12	412	194	*192*	*215*	293	260
1991-01	0		37	*94*	129	183
1991-02	300	172	299	274	284	344
1991-03	525		247	294	234	279
1991-04	706		482	639	440	354
1991-05	737		419	*458*	477	455
1991-06	705		424	244	415	329
1991-07	1288		386	*511*	376	374
1991-08	521		184	233	237	150
1991-09	592		*232*	181	186	264
1991-10	997		400	220	308	209
1991-11	463		*250*	220	348	334
1991-12	84		95	132	58	214
1992-01	143		99	*96*	91	118
1992-02	244		223	265	231	*202*
1992-03	642		294	261	315	441
1992-04	745		409	399	396	*572*
1992-05	586		322	224	326	302
1992-06	736	*534*	504	*461*	497	484
1992-07	998	215	244	217	316	277
1992-08	432	346	232	138	227	395
1992-09	266	345	*252*	276	276	248
1992-10	410	249	173	175	245	230
1992-11	581	*177*	244	335	226	402
1992-12	477		312	434	311	445
1993-01	233	249	193	338	256	241
1993-02	497	188	202	151	50	230
1993-03	677	333	278	370	489	425
1993-04	483	538	443	437	404	625
1993-05	392	324	306	375	379	403
1993-06	140	503	347	423	363	343
1993-07	372	402	355	*401*	437	261
1993-08	692	476	353	297	*179*	275
1993-09	610	476	321	268	454	258
1993-10	636	424	409	469	303	342
1993-11	434	301	279	274	170	240
1993-12	150	371	222	281	259	232
1994-01	90	163	141	125	97	225
1994-02	297	269	392	*224*	396	318
1994-03	452	401	284	233	178	638
1994-04	710	609	342	372	446	448

Table S1. Continued

Year -month	CUE	ANG	MON	ARA	AGU	SAN
1994-05	620	484	584	601	498	548
1994-06	343	498	393	517	515	474
1994-07		333	361	236	360	276
1994-08		291	408	267	277	299
1994-09		297	244	*270*	390	250
1994-10	155	165	330	412	218	325
1994-11	287	365	264	226	414	393
1994-12	195	182	111	164	275	326
1995-01	235	283	212	170	205	285
1995-02	54	52	55	128	123	206
1995-03	216	*256*	241	*187*	294	334
1995-04	156	419	524	392	582	342
1995-05	296	394	241	334	295	462
1995-06	423	337	431	437	528	322
1995-07	415	319	258	280	293	290
1995-08	128	173	127	163	255	89
1995-09	461	245	321	237	298	296
1995-10	380	294	353	379	363	239
1995-11	196	231	186	162	159	182
1995-12	193	192	113	54	131	271
1996-01	187	205	105	110	230	426
1996-02	199	349	289	335	300	434
1996-03	234	341	171	284	467	319
1996-04	374	292	349	287	393	404
1996-05	364	372	380	382	316	390
1996-06	499	545	435	350	536	380
1996-07	330	470	368	238	320	242
1996-08	217	266	288	329	360	*188*
1996-09	380	265	346	347	382	340
1996-10	210	180	289	280	252	415
1996-11	291	229	248	228	286	317
1996-12	659	324	216	*325*	341	332
1997-01		105	125	101	23	147
1997-02	438	584	446	400	461	555
1997-03		373	152		309	401
1997-04	264	416	373	276	344	467
1997-05	493	791	671	604	728	458
1997-06	443	437	327	247	190	371
1997-07		431	304	280	323	352
1997-08		337	215	248	322	288
1997-09	*484*	267	220	291	211	301
1997-10	277	378	243	250	196	227
1997-11	271	278	206	235	316	166
1997-12	531	419	221	129	285	277
1998-01	250	256	156	*172*	242	245
1998-02	481	363	285		354	529
1998-03	381	551	295	310	350	328
1998-04	513	600	494	554	477	376
1998-05	361	574	530	451	392	384
1998-06	378	447	295	306	419	405
1998-07	524	430	368	403	473	331
1998-08	321	452	377	323	383	217
1998-09	120	272	220	*236*	266	476
1998-10	307	561	257		237	267
1998-11	245	295	266	245	222	309
1998-12	176	281	214	170	164	251
1999-01	345	328	168	194	231	356
1999-02	336	310	330	403	370	239
1999-03	325	316	276	189	316	303
1999-04	651	507	464	461	394	517

Table S1. Continued

Year -month	CUE	ANG	MON	ARA	AGU	SAN
1999-05	499	662	551	500	352	383
1999-06	195	587	371	245	364	640
1999-07	351	403	296	300	227	163
1999-08	339	285	273	*250*	316	209
1999-09	292	439	270	*238*	273	84
1999-10	232	501	263	360	250	152
1999-11	172	273	198	175	247	162
1999-12	98	259	203	233	249	168
2000-01	195	111	*95*	93	79	124
2000-02	104	105	180	170	139	288
2000-03	621	613	332	*325*	459	280
2000-04	576	676	442	*423*	330	372
2000-05	440	671	298	302	328	461
2000-06		419	518	412	420	407
2000-07	452	547	407	343	320	364
2000-08	478	487	306	321	402	264
2000-09	246	583	331	353	366	332
2000-10	251	446	270	304	409	278
2000-11	138	411	223	305	289	172
2000-12	175	576	280	266	203	217
2001-01	236	244	152	183	203	258
2001-02	56	110	67	84	113	338
2001-03	562	477	321	466	435	443
2001-04	476		373	*378*	380	423
2001-05	435	434	*435*	432	528	334
2001-06	255	360	375	*314*	333	425
2001-07	457	737	451	343	400	165
2001-08	200	440	242	266	259	254
2001-09	422	301	254	231	202	178
2001-10	170	335	292	287	304	182
2001-11	232	413	246	199	159	258
2001-12	269	491	344	254	464	232
2002-01	143	211	165	106	183	260
2002-02	216	392	58	201	277	293
2002-03	283	525	384	374	276	*487*
2002-04	326	514	400	314	422	525
2002-05	*417*	514	342	418	700	673
2002-06	439	526	485		397	195
2002-07	369	550	318		358	330
2002-08	250	725	277		395	262
2002-09	177	286	296		308	146
2002-10	168	436				433
2002-11	417	429				319
2002-12	115	316				261
2003-01	55	300				128
2003-02	185	280				259
2003-03	203	463				244
2003-04	364	518				556
2003-05	455	584				444
2003-06	200	419				534
2003-07	241	540				322
2003-08	145	317				341
2003-09	108	238				307
2003-10		255				221
2003-11		412				203
2003-12		345				236
2004-01		61				86
2004-02		97				148
2004-03		654				556
2004-04		294				234
2004-05		386			*326*	412
2004-06	592	453			523	467
2004-07	270	554			275	306
2004-08	294	347			202	277

Table S1. Continued

Year -month	CUE	ANG	MON	ARA	AGU	SAN
2004-09	318	345			96	252
2004-10	242	329			258	363
2004-11	327	335			336	*223*
2004-12	*137*	463	138	137	243	*197*
2005-01		196	*45*	*148*	198	174
2005-02	65	266	180		325	487
2005-03	252	*533*	158		319	493
2005-04	333	675	592		419	355
2005-05	*308*	460	*398*		378	312
2005-06		494	179	330	392	250
2005-07	*224*	342	386	202	311	241
2005-08	241	301		244	424	219
2005-09		381		133	332	124
2005-10	152	372		147	376	278
2005-11	84	362		*294*	263	298
2005-12	91	226	206	226	115	223
2006-01	72	313	246	215	338	
2006-02	75	88	44	110	102	198
2006-03	72	658	516	404	609	512
2006-04	223		284	378	409	339
2006-05			276	216	419	308
2006-06		512	255	237	181	211
2006-07	311	355	347		376	289
2006-08	147	406	331		343	267
2006-09	109	364	186	128	132	*203*
2006-10		204	201	313	190	301
2006-11		500	338		433	340
2006-12	306	422	173	251	307	559
2007-01	370	235	185	169	379	319
2007-02	149	162	126	151	113	98
2007-03	192	545	492	297	388	660
2007-04	296	462	281	202	330	554
2007-05	250	552	494	371	265	286
2007-06	397	544	522	466	529	534
2007-07	244	436	397	710	352	289
2007-08	191	369	390	263	257	198
2007-09	213	313	387	184	221	260
2007-10	110	335	235	132	152	317
2007-11	247	253	246	260	120	271
2007-12	175	420	354	288	334	341
2008-01	103	154	183	145	145	312
2008-02	199	111	115	27	339	*357*
2008-03	183	235	262	147	120	*384*
2008-04	242	307	273	164	110	309
2008-05	298	390	328	344		392
2008-06	392	496	207	321		197
2008-07	157	447	511	455		303
2008-08	96	509	220	352		88
2008-09	309	468	229	262		233
2008-10	211	623	247	271		282
2008-11	206		*248*	204		301
2008-12	65	275	131	110	168	329
2009-01	247	448	264	*287*	362	557
2009-02	295	512	242	184	457	309
2009-03	163	327	602	251	318	387
2009-04	400	722	971	703	465	552
2009-05	221	787	508	492	507	313
2009-06	215	652	351	398	489	222
2009-07	256	641	456	374	346	395
2009-08	142	629	400	287	444	161
2009-09	138	430	247	166	157	230
2009-10	252	293	275	188	114	219
2009-11	130	274	114	150	156	242
2009-12	201	188	283	145	*236*	415

Table S1. Continued

Year -month	CUE	ANG	MON	ARA	AGU	SAN
2010-01	89	201	83	51		290
2010-02	176	197	194	151		294
2010-03	300	581	501	473	*639*	482
2010-04	314	501	414	539	506	383
2010-05	322	569	434	290	315	444
2010-06	205	476	605	426	391	456
2010-07	289	456	184	211	59	292
2010-08	187	338	214	139	170	348
2010-09	298	470	224	251	339	372
2010-10	133	265	329	196	165	191
2010-11		290	275	234	299	
2010-12	159	361	261	227	202	459
2011-01	9	111	100	91		379
2011-02	112	325	132	123		450
2011-03	334	389	235	178	365	546
2011-04	421	304	*111*	263	*388*	256
2011-05	244	429	425	407	513	729
2011-06	226	459	534	368	480	536
2011-07	156	299	363	240	235	251
2011-08	162	262	188	235	360	244
2011-09	*303*	334	262	222	411	327
2011-10	189	263	210	238	140	
2011-11	242	322	*191*	177	222	334
2011-12	227	274	*301*	334	341	436
2012-01	71	277	150	130	317	348
2012-02	158	320	*236*	308	279	403
2012-03	289	481	414		340	459
2012-04	276	247	*519*	360	310	179
2012-05	332	691	*486*	356	482	429
2012-06	139	485	308	330	337	*210*
2012-07	*346*	422	*491*	344	421	*291*
2012-08	148	266	339	268	226	162
2012-09	137	347	144	172	318	391
2012-10	163	464	251	316	335	175
2012-11	133	267	192	120	222	362
2012-12	195	586	399	245	224	212
2013-01	138	219	178	159	215	275
2013-02	171	331	353	297	271	470
2013-03	220	431	390	*270*	260	395
2013-04	299	578	405	406	425	223
2013-05	268	447	560	349	562	369
2013-06	346	639	546	*473*	479	216
2013-07		277	236	269	244	229
2013-08		366	279	211	338	282
2013-09		307	416	299	358	173
2013-10	280	235	*277*	342	287	219
2013-11	226	300	*233*	261	375	*207*
2013-12	265	233	*230*	229	255	216
2014-01	82	163	*131*	132	267	299
2014-02	165		192	119	204	*357*
2014-03	387		253	162	210	*232*
2014-04	383		*578*	308	*284*	*364*
2014-05	255		469		511	483
2014-06	376		547		540	469
2014-07	308		338	267	382	311
2014-08	238		373	311	319	346
2014-09	117		160	110	147	232
2014-10			309	339	238	*433*
2014-11	364		253	194	353	*217*
2014-12	98		220	228	198	251
2015-01	286		361	328	451	389
2015-02	261		283	150	211	287
2015-03	257		375	235	282	242
2015-04	220		604	365	451	*501*

Table S1. Continued

Year -month	CUE	ANG	MON	ARA	AGU	SAN
2015-05	400		741	389	606	575
2015-06	531		494	419	511	350
2015-07	407		428	273	543	337
2015-08	235		358	310	228	*223*
2015-09	217		202	164	307	111
2015-10	435		493	499	297	192
2015-11	179			*180*	168	294
2015-12	345			*131*	252	229
2016-01	27			23	77	56
2016-02				185	263	
2016-03	265			*401*	409	
2016-04	450			329	234	
2016-05	429			447	624	*390*
2016-06			472	407	636	342
2016-07			353	411	308	312
2016-08			361	253	294	165
2016-09	344		*336*	292	361	212
2016-10			159	157	172	191
2016-11			281	189	258	
2016-12			283	207	206	
2017-01			328	244	*350*	
2017-02			225	128	*216*	
2017-03			455	354	*455*	401
2017-04			265	203	339	251
2017-05	482		420	323	292	*348*
2017-06			398	155	196	*211*
2017-07			420	357		408
2017-08			215	240	141	*431*
2017-09	380		315	201	423	217
2017-10	225		*363*	214	357	303
2017-11	403		*325*	284	251	309
2017-12	137		*135*	154	153	*230*
2018-01			256	241	*268*	249
2018-02				62	*42*	104
2018-03				*386*	*331*	342
2018-04	524			394	*332*	572
2018-05	667			484	286	481
2018-06				228	308	*291*
2018-07	397			322	356	*269*
2018-08	240		237	164		398
2018-09			288	265		135
2018-10	196		*363*	291		
2018-11	225			293		
2018-12	264		238	283		
2019-01	426		181	306		
2019-02			239	252		
2019-03	273		343	466		
2019-04	218		156	293		357
2019-05	497			323		
2019-06	303		475	446		
2019-07	285		482	344		
2019-08	274		381	186		
2019-09	292		*234*	329		
2019-10	325		172	*230*		
2019-11	245		320	298		
2019-12	308			270		
Sum	**97974**	**100549**	**96235**	**87974**	**97855**	**107261**
Months w/data	**311**	**266**	**314**	**317**	**312**	**336**

Table S2. Monthly average maximum and minimum temperatures in Celsius degrees from La Chorrera (Amazonas), Araracuara (Amazonas) and Tres Esquinas (Caquetá) in the Colombian Amazon, from January 1990 to December 2019. Source: compiled from raw daily data in IDEAM (2021). Empty cells = no data available.

Year-Month	N days with data	La Chorrera		Tres Esquinas		Araracuara	
		min.	max	min.	max	min.	max
1990-01	31				33.4	22.5	31.3
1990-02	28				31.8	21.5	31.5
1990-03	31			21.9	30.3		
1990-04	30			22.1	29.1		
1990-05	31			21.7	29.9		
1990-06	30			21.6	28.1		
1990-07	31			20.7	27.8	20.9	30.2
1990-08	31			20.5	29.7	21.7	31.0
1990-09	30			19.4	30.3	21.5	31.8
1990-10	31			19.8	30.5	22.6	31.8
1990-11	30	21.3	32.4	20.8	29.7	22.7	30.6
1990-12	31			16.4	30.3	21.2	31.1
1991-01	30	19.9			33.1	20.2	32.2
1991-02	28			22.0	33.2	21.4	31.7
1991-03	31			23.5	31.5	21.8	30.6
1991-04	30			21.2	31.1	21.3	30.5
1991-05	31	22.7	33.5	19.7	30.6	22.7	29.8
1991-06	30	22.0	32.6			22.3	29.3
1991-07	31	21.9	31.1			21.9	28.1
1991-08	31	20.9	29.6			21.5	29.2
1991-09	30	21.2	31.9			21.9	30.5
1991-10	31	21.1	31.7			21.7	30.7
1991-11	30					22.5	30.5
1991-12	31	21.5	32.0			22.4	32.1
1992-01	31	21.5	32.7			22.6	32.6
1992-02	29	21.9	33.0			22.2	32.9
1992-03	31	22.3	31.5			21.6	30.8
1992-04	30	21.3	31.2			21.1	31.4
1992-05	31	21.5	31.3			20.4	31.0
1992-06	30	21.3	30.5			19.9	29.9
1992-07	31	20.4	29.7			21.0	28.6
1992-08	31	20.3	30.4			21.8	29.5
1992-09	30	21.4	31.3			22.0	30.6
1992-10	31	20.7	31.6			21.7	31.1
1992-11	30	21.7	31.7			22.3	31.0
1992-12	31	21.7	30.9			22.3	30.7
1993-01	31	21.8	31.0			22.2	30.8
1993-02	28	21.9	31.3			22.0	30.8
1993-03	31	21.7	30.6			22.3	30.6
1993-04	30	22.5	30.1			23.0	30.5
1993-05	31	22.0	30.7			22.5	30.5
1993-06	30	21.3	29.6			22.2	29.6
1993-07	31	20.9	29.6			21.7	30.1
1993-08	31	21.1	30.2			21.4	30.0
1993-09	30	21.4	30.9		31.3	21.7	31.1
1993-10	31	21.7	31.0	20.8	29.7	22.4	31.0
1993-11	30	22.3	31.2	20.1	31.4	22.3	31.0
1993-12	31			20.5	31.8	22.2	31.5
1994-01	31			20.2	32.6	22.3	32.1
1994-02	28			21.8	31.3	22.5	31.3
1994-03	31			21.7	28.8	22.6	31.1
1994-04	30			22.0	29.1	22.7	31.2
1994-05	31			21.7	29.0	22.8	30.2
1994-06	30					21.7	29.8
1994-07	31			20.6	28.1	21.3	29.4
1994-08	31	22.0	31.4	20.2	28.2	21.6	30.2
1994-09	30	21.6	30.9	20.9	30.1	21.8	31.3
1994-10	31	22.0	31.2	20.8	30.2	22.0	31.9
1994-11	30	22.1	31.7	21.4	30.5	22.4	31.7
1994-12	31			20.9	30.9	22.5	31.4
1995-01	31			20.0	31.2	21.5	32.2
1995-02	28			19.7	33.7	22.9	34.2
1995-03	31			20.1	30.8	22.7	31.7
1995-04	30	22.2	30.9	20.0	29.6	23.1	30.8
1995-05	31	22.1	31.2	20.3	29.4	22.9	30.7
1995-06	30	22.2	31.2	19.6	29.1	22.4	29.5
1995-07	31			20.4	29.5	21.8	30.6
1995-08	31	21.1	31.8	20.4	30.5	21.8	31.7
1995-09	30	21.1	31.5	20.9	30.1	22.1	31.9
1995-10	31	21.3	30.9	19.8	30.9	22.4	31.6
1995-11	30	21.0	32.5	19.8	31.6	22.4	32.1
1995-12	31	18.9	31.5	19.9	32.6	22.5	32.4
1996-01	31			19.3	32.9	22.0	32.1
1996-02	29			19.7	30.3	22.3	31.7
1996-03	31		31.5	20.3	29.9	22.9	31.8
1996-04	30		31.9	19.5	30.1	22.2	31.0
1996-05	31		31.4	20.1	29.8	22.8	30.4
1996-06	30			19.5	29.3	22.1	29.3
1996-07	31			19.5	28.8	21.0	29.8
1996-08	31			19.6	29.7	21.7	31.1
1996-09	30		31.0	20.2	30.4	22.3	31.5
1996-10	31		31.7	20.2	31.2	22.3	31.9
1996-11	30	22.1	31.7	20.6	31.3	22.7	32.1
1996-12	31	21.5	32.2	19.7	30.7	21.9	31.4
1997-01	31	21.3	32.7	21.5	33.4	22.0	33.1
1997-02	28	21.7	30.3	19.7	31.2	22.3	30.6
1997-03	31	21.3	31.3	20.3	31.3	22.5	31.9
1997-04	30	20.9	32.1	20.5	30.8	22.8	31.3
1997-05	31	21.3	31.8	21.3	29.8	22.6	29.6
1997-06	30	20.7	31.1	21.8	30.1	22.1	30.4
1997-07	31		32.9	20.9	28.7	21.7	29.8
1997-08	31			19.9	30.8	21.8	30.9
1997-09	30		34.1	21.5	31.4	22.5	31.9
1997-10	31		31.1	21.9	32.3	22.9	33.1
1997-11	30		29.7	21.5	31.2	22.8	31.5
1997-12	31	22.9	33.8	21.6	31.6	22.8	32.1
1998-01	31			21.7	31.1	23.5	32.0
1998-02	28			20.7	32.3		
1998-03	31			21.9	30.6	23.8	32.2
1998-04	30			20.7	30.8	23.9	31.4
1998-05	31	21.1		21.8	30.2	23.0	30.3
1998-06	30	20.0		21.1	28.1	22.5	29.2
1998-07	31	20.0	36.1	21.4	29.0	22.2	30.4
1998-08	31	21.1		21.3	30.4	21.7	32.0
1998-09	30	20.2		21.5	31.1	22.0	31.2
1998-10	31	19.5		21.6	32.1		
1998-11	30			22.0	32.1	22.7	32.4
1998-12	31			21.0	32.5	22.3	32.8
1999-01	31	20.0	34.9	20.3	31.3	22.5	32.2
1999-02	28			20.7	30.3	22.4	31.3
1999-03	31	20.5	34.1	21.1	30.8	22.1	32.6
1999-04	30		33.0	21.3	28.2	22.4	30.0
1999-05	31		34.1	20.0	28.6	22.3	30.3
1999-06	30		34.4		29.2	22.1	30.2
1999-07	31				28.2	21.2	30.4
1999-08	30	20.7	30.9	18.0	29.8	21.8	29.3
1999-09	30	21.6	33.7	21.6	31.2	22.1	32.2
1999-10	31	21.2	33.2	21.1	30.8	21.7	32.3
1999-11	30	21.2	35.7	22.3	33.0	22.3	31.9
1999-12	31			21.6	32.2	22.3	32.6

Table S2. Continued

Year-Month	N days with data	La Chorrera		Tres Esquinas		Araracuara	
		min.	max	min.	max	min.	max
2000-01	31			20.4	33.2	21.2	33.4
2000-02	29			20.6	32.2	21.8	32.8
2000-03	31			21.3	30.6	22.4	32.1
2000-04	30			20.8	29.3	22.4	30.7
2000-05	31	21.9	30.5	21.8	29.5	22.7	29.7
2000-06	30	22.2	31.0	21.4	29.7	22.2	30.1
2000-07	31	21.3	30.8	20.8	28.3	21.4	29.3
2000-08	31	21.5	33.3	20.9	29.5	21.9	31.3
2000-09	30	21.5	33.7	21.4	30.4	21.8	31.4
2000-10	31	19.7	33.4	21.2	30.8	22.0	31.7
2000-11	30	22.1	34.2	21.6	32.1	22.5	32.3
2000-12	31	21.6	33.7	21.0	31.0	22.2	32.0
2001-01	31	22.0		20.6	31.2	22.2	31.0
2001-02	28	21.9		20.9	32.7	22.4	32.3
2001-03	31	21.7		21.0	30.6	22.6	31.7
2001-04	30	22.2		21.7	30.4	22.1	31.1
2001-05	31	22.3	26.9	22.1	30.6	21.8	30.1
2001-06	30	20.7	26.6	20.7	28.5	19.8	28.7
2001-07	31	21.3	27.8	21.1	29.3	20.6	29.8
2001-08	31	21.1	26.6	20.9	29.2	20.8	30.9
2001-09	30	21.4		20.9	31.3	21.2	31.1
2001-10	31	21.7	26.2	21.6	31.8	21.8	32.0
2001-11	30	22.1		20.6	31.7	21.7	32.4
2001-12	31	22.4	33.7	21.0	31.0	22.1	31.9
2002-01	31		36.1	21.1	33.5	21.1	32.6
2002-02	28	22.3	31.5	19.9	32.5	22.3	31.4
2002-03	31	22.0	33.0	21.1	31.2	22.0	30.7
2002-04	30	22.2	31.6	21.0	30.0	22.3	30.8
2002-05	31	22.3	31.3	22.0	30.1	22.6	29.9
2002-06	30	21.5	30.0	20.3	29.3		
2002-07	31			19.5	29.9		
2002-08	30			19.8	30.4		
2002-09	30			19.8	30.9		
2002-12	29				32.4		
2003-01	31	22.1	33.0		33.5		
2003-02	28	22.5	32.4		30.8		
2003-03	30	21.9	32.8		30.1		
2003-04	30	22.0	32.0		29.9		
2003-05	30	22.1	31.5		28.4		
2003-06	23	21.2	31.5				
2003-07	31	20.9	30.5	14.4	29.3		
2003-08	28	20.5	32.0	21.6	30.5		
2003-09	29	21.1	32.9	20.3	30.7		
2003-10	31	21.7	32.7	21.0	31.8		
2003-11	29	21.6	32.8	19.5	32.4		
2003-12	30	21.7	31.6	21.4	31.5		
2004-01	26	19.0	35.9	20.9	34.1		
2004-02	29	21.5	32.7	21.1	33.5		
2004-03	31	21.8	32.6	21.5	31.6		
2004-04	30	21.4	32.1	20.6	31.5		
2004-05	31	22.0	31.2	21.5	29.4		
2004-06	30	20.9	30.2	21.0	29.2		
2004-07	31			19.9	30.0		
2004-08	31			20.3	29.7		
2004-09	30			20.9	31.0		
2004-10	31			21.7	32.0		
2004-11	30			22.2	31.5		
2004-12	31			21.8	32.2		
2005-01	31			21.5	33.5		
2005-02	28			21.8	32.3		
2005-03	26	22.9	32.2				
2005-04	29	23.2	31.9		31.1		
2005-05	29	22.5	32.7	22.6	30.9		
2005-06	30	22.4	30.8	21.0	29.4		31.6

Table S2. Continued

Year-Month	N days with data	La Chorrera		Tres Esquinas		Araracuara	
		min.	max	min.	max	min.	max
2005-07	31	21.2	31.4	21.2	30.0		
2005-08	31	21.5	32.0	19.2	31.0		
2005-09	30			18.2	31.5		
2005-10	31	21.7	33.4	18.9	31.9		
2005-11	30	22.2	32.8	20.4	32.5		
2005-12	31	22.1	32.0	21.0	33.0		
2006-01	30			19.7	32.3		
2006-02	21	21.7	33.0				
2006-03	27	19.6	32.4				
2006-04	30	18.9	31.5	19.7	32.6		
2006-05	31	21.5	29.6	19.3	30.7		
2006-06	30	22.3	29.9	19.3	30.8		
2006-07	31			18.8	30.1		
2006-08	31			19.7	31.6		
2006-10	31			18.6	32.9		
2006-11	30			21.1	32.0		
2006-12	31			21.5	32.1		
2007-01	31	23.0	32.5	19.9	33.0		
2007-02	28	21.5	34.4				
2007-03	30	22.3	30.6				
2007-04	30	22.4	24.9	21.5	30.6		
2007-05	31	22.2	26.1	21.5	29.9		
2007-06	30	22.0		20.9	28.7		
2007-07	31	21.4		20.9	31.2		
2007-08	31	21.3	32.1	19.0	31.0		
2007-09	30	21.4	33.5	19.8	31.3		
2007-10	30	22.0	33.4		31.1		
2007-11	30	22.4	32.0	20.3	31.7		
2007-12	30	21.3	31.9				
2008-01	31	21.7	31.4	20.5	32.8		
2008-02	28	21.9	32.3	21.4	32.7		
2008-03	31	21.4	34.0	21.0	31.4		31.3
2008-04	30			20.9	31.5		32.2
2008-05	31			21.1	29.9		30.3
2008-06	30	20.3	34.3	20.6	28.4		30.3
2008-07	31	19.8		20.7	29.5		31.3
2008-08	31	20.4		21.4	31.2		31.8
2008-09	30	20.9		21.0	30.5		
2008-10	31	20.7		21.0	30.9		
2008-11	30	20.6		21.1	31.1		
2008-12	31	21.3		21.1	32.2		
2009-01	30	21.2		21.3	31.0		
2009-02	28	21.5		19.8	31.4		
2009-03	31			19.6	30.3		
2009-04	30			20.3	30.0		
2009-05	31			19.7	30.0		
2009-06	30			19.0	29.6		
2009-07	30			19.5	29.4		
2009-08	30			19.9	29.7		
2009-09	30			20.5	32.1		
2009-10	31			20.6	30.9		
2009-11	30			20.0	32.1		
2009-12	30			20.4	33.1		
2010-01	31			20.4	33.5		
2010-02	28	24.1	32.9	20.7	32.2		
2010-03	31	23.5	33.5	21.0	32.4		
2010-04	30	22.9	32.4	20.7	31.1		
2010-05	31	22.9	31.9	21.9	34.0		
2010-06	30	21.9	33.1	21.5	31.5		
2010-07	31	21.4	33.1	20.3	31.1		
2010-08	31	19.7	33.4	21.1	31.3	23.1	
2010-09	30	22.4	33.7	20.9	33.9		
2010-10	31	22.6	33.1	20.8	32.1		
2010-11	30	22.9	32.4	19.9	31.9		

Table S2. Continued

Year-Month	N days with data	La Chorrera		Tres Esquinas		Araracuara	
		min.	max	min.	max	min.	max
2010-12	31	22.5	31.9	20.1	31.3		
2011-01	31	22.2	32.4	20.1	33.8		
2011-02	28	22.0	32.2	20.3	31.6		
2011-03	31	21.8	31.8	20.5	32.6		
2011-04	30	22.3	31.7			23.6	
2011-05	31	21.9	30.6			23.6	
2011-06	30	21.9	30.6			23.0	
2011-07	31	21.4	30.9			22.7	
2011-08	31	21.3	32.3			23.0	
2011-09	30	22.1	33.2			23.4	
2011-10	31	22.6	32.6			24.3	
2011-11	30	22.3	32.3			24.1	
2011-12	31	22.6	31.7			23.7	
2012-01	31	22.8	31.4			23.4	
2012-02	29	22.1	30.7			23.3	
2012-03	31	22.7	30.9				
2012-04	19	23.2	31.6				
2012-05	31	22.5	30.7				
2012-06	30	22.4	30.9				
2012-07	31	22.1	30.5				
2012-08	31	21.6	32.1				
2012-09	30	22.3	32.7				
2012-10	31	22.6	32.9				
2012-11	30	22.7	33.2				
2013-01	31	22.1	32.1				
2013-02	28	22.6	31.4				
2013-03	31		31.8				
2013-04	30	23.1	33.7				
2013-05	26	22.6	32.7				
2013-06	30	22.3	33.0				
2013-07	31	21.8	30.8				
2013-08	31	21.5	30.7				
2013-09	30	22.0	33.1				
2013-10	31	22.3	32.2				
2013-11	30	22.7	31.5				
2013-12	31	21.5	32.3				
2014-01	31	22.0	32.0	21.3	32.3		
2014-02	28	22.0	32.0	21.3	33.5		
2014-03	31	22.4	31.3				
2014-04	25	22.2	32.3				
2014-05	31	22.4	32.2				
2014-10	5	22.4	32.8				
2014-11	30	22.6	32.3				
2014-12	31	22.4	32.2				
2015-07	31					22.5	30.9
2015-08	31					22.6	31.6
2015-09	30			21.6	32.9	22.4	34.0
2015-10	31			22.1	32.2	23.2	33.1
2015-11	30				32.7		
2015-12	31			23.7	31.9	23.1	31.6
2016-01	31					23.5	34.2
2016-02	29					23.9	32.6
2016-03	29					23.9	31.5
2016-04	27					23.6	31.7
2016-05	30					23.5	31.3
2016-06	30	22.0	30.4			22.7	30.6
2016-07	31	22.6	30.4			22.1	30.3
2016-08	31					22.2	31.9
2016-09	30					22.6	32.5
2016-10	31					23.1	33.3
2016-11	30					23.5	32.9
2016-12	31					23.1	31.6

Table S2. Continued

Year-Month	N days with data	La Chorrera		Tres Esquinas		Araracuara	
		min.	max	min.	max	min.	max
2017-01	31					23.0	31.3
2017-02	28					22.9	32.3
2017-03	31					23.2	32.1
2017-04	30			19.9	31.4	23.2	32.7
2017-05	31			21.3	31.5	23.3	32.1
2017-06	30			20.7	31.4	23.0	31.0
2017-07	31			20.4	31.0		
2017-08	28			21.5	32.0	22.6	
2017-09	30				32.8	22.9	
2017-10	31				31.8	23.2	
2017-11	30				32.4	23.5	
2017-12	31				32.5	23.0	
2018-01	31				32.3	22.7	
2018-02	23				34.7		
2018-05	7	20.3	30.3				
2018-06	1	20.8					
2018-07	31			21.1	29.8		
2018-08	15			20.2	31.3		
2018-09	23	22.3	33.3				
2018-10	31	22.2	32.2	22.0	31.8		
2018-11	30	21.5	31.7	22.3	31.7		
2018-12	31	21.2	31.2	22.2	31.4		
2019-01	31	21.2	31.2				
2019-02	28	22.7	32.6				
2019-03	31	22.2	32.9				
2019-04	30	22.6	32.1			22.5	
2019-05	31	22.5	30.4			22.4	
2019-06	30	22.6	30.3			21.6	31.2
2019-07	31	22.3	30.3	20.2	29.4	21.0	31.4
2019-08	31	23.1	31.5	21.3	30.4	20.7	32.2
2019-09	30	24.0	33.4	22.4	32.7	21.8	33.5
2019-10	31	23.3	31.8	21.3	31.9		
2019-11	30	22.6	30.5	22.0	32.3	22.2	33.1
2019-12	31	22.8	30.4	22.7		22.4	32.4
2020-01	30	23.4	31.0				
2020-02	29	23.4	31.4				
2020-03	31	23.1	31.2				
2020-04	30	23.4	30.5				
2020-05	31	23.2	29.5				
2020-06	30	23.2	29.9				
2020-07	31	23.1	30.4				
2020-08	21	23.5	31.8				

Table S3. Malaria cases (2007-2019) in Solano (Caquetá), La Pedrera (Amazonas), Mirití (Amazonas), La Chorrera (Amazonas) and Puerto Santander (Amazonas) in the Colombian Amazon. Source: compiled from raw data in SIVIGILA (2020). Empty cells = no data available. SOL = Solano; PED = La Pedrera; MIR = Mirití Paraná; CHO = La Chorrera; PUE = Puerto Santander.

Year-Month	SOL	PED	MIR	CHO	PUE
2007-01	4	7	2		
2007-02	3	4	3		
2007-03	2				
2007-04	1			2	
2007-05	2				
2007-06	2				
2007-07	2				
2007-08	2				
2007-09					
2007-10					
2007-11					
2007-12					
2008-01					
2008-02		1			
2008-03		2		1	
2008-04				1	
2008-05		2	1		
2008-06			1	7	
2008-07		1	2		
2008-08		1	8	1	
2008-09		14	14	14	
2008-10		23	4	5	
2008-11		49	11	4	
2008-12		39	0	2	
2009-01		7		2	0
2009-02	2	3		1	1
2009-03	5			2	
2009-04	2	1		1	
2009-05	6	2		1	
2009-06		13		1	2
2009-07		15		4	
2009-08		13		2	5
2009-09		40		0	
2009-10		107	5	1	
2009-11		61	23		
2009-12		25	1		6
2010-01	15	4		1	12
2010-02	15	1			17
2010-03	6	5			22
2010-04	1	4		1	6
2010-05	6	4			6
2010-06	10	30			4
2010-07	13	39	3		5
2010-08	12	27	1		2
2010-09	4	9			
2010-10		2	1		
2010-11	1	1	1		
2010-12		3			
2011-01		3			
2011-02		2		1	
2011-03		3			
2011-04		2			
2011-05					
2011-06		1	1	2	
2011-07	1			1	
2011-08		1		1	
2011-09				7	
2011-10		1			
2011-11		1			
2011-12		2			

Table S3. Continued

Year-Month	SOL	PED	MIR	CHO	PUE
2012-01		2		3	
2012-02		9			
2012-03		12		1	
2012-04		3			
2012-05		0			
2012-06	1	2		2	
2012-07		8		17	
2012-08		9		5	
2012-09		5		2	
2012-10	1	24		6	
2012-11		35		7	
2012-12		75	3	4	
2013-01		27	3	4	
2013-02		24		3	
2013-03		10		1	3
2013-04		7	3		
2013-05		12		4	
2013-06		24		2	
2013-07		43	1		
2013-08		48		3	
2013-09		21			
2013-10		50		28	2
2013-11		54	2	2	7
2013-12		87	1	1	3
2014-01		16	8	7	
2014-02		16		1	
2014-03		3			
2014-04		3		1	
2014-05		3	4	0	1
2014-06		2		3	1
2014-07		7		3	
2014-08		4	2	7	
2014-09		4	15	14	2
2014-10		7		10	
2014-11	1	10		4	4
2014-12	1	4		3	
2015-01		7			
2015-02		3	1		
2015-03		1		1	
2015-04		1		1	
2015-05		1			
2015-06		2		2	
2015-07		5			1
2015-08		24		3	
2015-09		51		6	2
2015-10		102		6	2
2015-11		65		14	
2015-12		41	1	12	
2016-01		36		4	
2016-02		31		2	
2016-03		16		6	1
2016-04		22		8	1
2016-05		17		4	
2016-06		43	1	2	
2016-07		155	0	3	1
2016-08		203	57		
2016-09		372	2	2	2
2016-10		248	5	1	15
2016-11		416	4	2	21
2016-12	2	335	14		15
2017-01	2	170	1		14
2017-02	1	55	1	1	14
2017-03	1	25			2
2017-04	1	36	1		4

Table S3. Continued

Year-Month	SOL	PED	MIR	CHO	PUE
2017-05		20	11	1	5
2017-06		34	2		3
2017-07	1	78	7	4	7
2017-08	1	105		1	4
2017-09	2	229	8	1	17
2017-10		131	15		15
2017-11		132	10		31
2017-12		154	1	2	16
2018-01		116			2
2018-02		110	1	1	0
2018-03		81			2
2018-04		62	1		1
2018-05	2	73			9
2018-06		57	1	1	18
2018-07	3	30	11	3	45
2018-08	33	96		1	85
2018-09	3	201	8	2	27
2018-10	4	235	20	5	35
2018-11	1	195	18	6	31
2018-12	1	99	7	2	13
2019-01	1	116	16	1	15
2019-02	9	64	4	1	8
2019-03	4	56	4		7
2019-04		25	3	1	7
2019-05		29	1	1	4
2019-06	2	48	2	0	1
2019-07	0	66	0	1	9
2019-08	7	101	3	1	5
2019-09	4	131	6	1	5
2019-10		110	1		2
2019-11	2	43	2		2
2019-12		9	0		1
Sum	**208**	**6764**	**375**	**331**	**638**

Table S4. Dengue cases (2007-2019) in Solano (Caquetá), La Pedrera (Amazonas), Mirití (Amazonas), La Chorrera (Amazonas) and Puerto Santander (Amazonas) in the Colombian Amazon. Source: compiled from raw data in SIVIGILA (2020). Empty cells = no data available. SOL = Solano; CHO = La Chorrera; PED = La Pedrera; PUE = Puerto Santander.

Year-Month	SOL	CHO	PED	PUE
2007-02	2			
2007-03	13			
2007-04	5		1	
2007-05	23			
2007-06	2			
2007-08	1			
2008-08	1			1
2010-03	1			
2010-05	1		1	
2010-09	1			
2011-07			1	
2011-10	5			
2012-01	1			
2012-04	1			
2012-06	14			
2012-07	5			
2012-08			1	
2012-11	1			
2013-01	5			
2013-02	2			

Table S4. Continued

Year-Month	SOL	CHO	PED	PUE
2013-03	6			
2013-04	6			
2013-05	3			
2013-06	7			
2013-07	4			
2013-08	7			
2013-09	3			
2013-10	4			
2013-11	1			
2013-12	3			
2014-01			3	
2014-02			5	
2014-03			33	
2014-04			3	
2014-05	1			
2014-06	1			
2014-08	2			
2014-10	1			
2014-12	1			
2015-01	8		1	
2015-02	6			
2015-03	9			
2015-04	1		1	
2015-05	4			
2015-06	4			
2015-07	2			
2015-08	1			
2015-11	1			
2015-12	1			
2016-01	2			
2016-02	14			
2016-03	3			
2016-04	5			1
2016-05	1			
2016-06			3	
2016-10	1	1		
2016-11				1
2017-03	1			
2017-04	2			
2017-06	1			
2017-08		1		
2017-12	1			
2018-11	2			
2019-02	2			
2019-04	1			
2019-08	1			
2019-10				1
2019-11	2		6	
2019-12			7	
Sum	**210**	**2**	**66**	**4**