# REPORT ON THE SITUATION OF MALARIA IN THE AMERICAS

2014

Pan American Health Organization

World Health Organization
REGIONAL OFFICE FOR THE Americas

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# Contents

# Abbreviations

| | |
|---|---|
| **ABER** | Annual Blood Examination Rate |
| **ACT** | Artemisinin-based Combination Therapy |
| **ADM1** | First-level administrative division (i.e. state, province, department, etc.) |
| **ADM2** | Second-level administrative division (i.e. district, municipality, canton, etc.) |
| **ADM3** | Third-level administrative division (i.e. commune) |
| **AIM** | Action and Investment to Defeat Malaria |
| **AMI** | Amazon Malaria Initiative |
| **API** | Annual Parasite Index |
| **CDC** | Centers for Disease Control and Prevention |
| **CHA/VT** | Communicable Diseases and Health Analysis Departmentt |
| **CHAI** | Clinton Health Access Initiative |
| **EMMIE** | Elimination of Malaria in Mesoamerica and the Island of Hispaniola |
| **Gates Foundation** | Bill & Melinda Gates Foundation |
| **G6PD** | Glucose-6-phosphate-dehydrogenase |
| **Global Fund** | The Global Fund to Fight AIDS, Tuberculosis and Malaria |
| **GTS** | Global Technical Strategy for Malaria 2016-2030 |
| **HRP-2** | Histidine-Rich Protein II |
| **IDSP** | Integrated Disease Surveillance Program |
| **IRSv** | Indoor Residual Spraying |
| **ITN** | Insecticide-Treated Net |
| **LLIN** | Long-Lasting Insecticide Treated Net |
| **MDA** | Mass Drug Administration |
| **MDG** | Millennium Development Goal |
| **MDG 6C** | Millennium Development Goal Target 6C |
| **ORAS** | Andean Organization for Health (acronym in Spanish) |
| **PAHO** | Pan American Health Organization |
| **PAMAFRO** | Project for Malaria Control in Andean Border Areas (acronym in Spanish) |
| **PCR** | Polymerase Chain Reaction |
| **RACCN** | North Caribbean Coast Autonomous Region (acronym in Spanish) |
| **RACCS** | South Caribbean Coast Autonomous Region (acronym in Spanish) |
| **RAVREDA** | Amazon Network for the Surveillance of Antimalarial Drug Resistance (acronym in Spanish) |
| **RBM** | Roll Back Malaria |

| | |
|---|---|
| **RDT** | Rapid Diagnostic Test |
| **SENEPA** | National Service for Eradication of Malaria (acronym in Spanish) |
| **SNEM** | National Service for Control of Arthropod Vector-borne Diseases (acronym in Spanish) |
| **SPR** | Slide Positivity Rate |
| **T3** | Test-Treat-Track |
| **UN** | United Nations |
| **USAID** | United States Agency for International Development |
| **USP** | United States Pharmacopeia |
| **WHA** | World Health Assembly |
| **WHO** | World Health Organization |
| **WOCBA** | Women of Child-Bearing Age |

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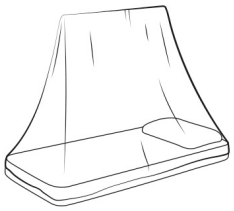
# 2014 Key Facts of the Americas

**21** countries are endemic for malaria

**389,390** cases

**87** deaths

**92.5%** of all cases occurred in the Amazon sub-region



Approximately **790,000** insecticide-treated nets were distributed, protecting an estimated **6.4** million people

**69%** of all cases in the Americas were *Plasmodium vivax* infections,

**24%** were *Plasmodium falciparum*

**108** million people are at risk for malaria in the Americas, **5.7** million of these are at high risk*

**60%** of all cases occurred in men

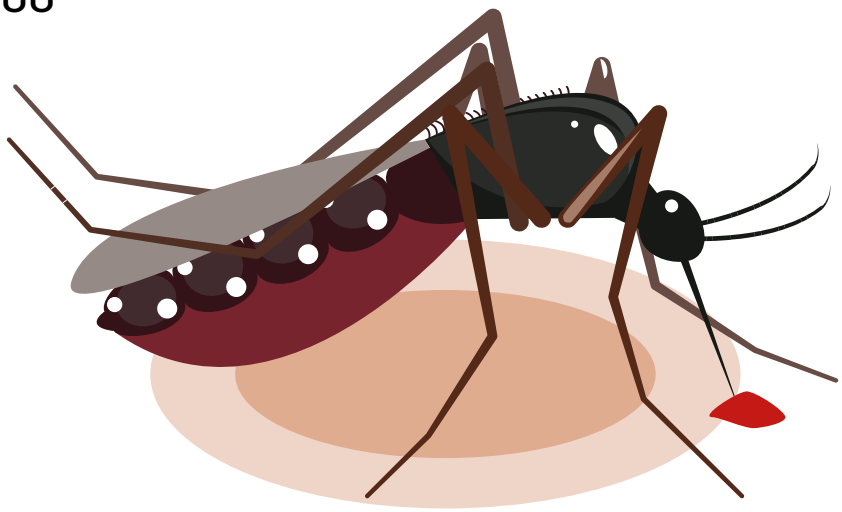
US$**20** million of funding for malaria in the countries of the Americas came from external sources

**6.7** million were tested by microscopic examination

*High risk areas are those with an annual parasite index of 10 or more cases per 1,000 inhabitants.

# 2000-2014 Key Facts of the Americas

**67%**
decline in cases
since 2000



**79%**
decline in deaths
since 2000

**6.5** million cases and
**3,500** deaths averted based on rates from 2000

**14** endemic countries have reduced malaria incidence by more than **75%**, achieving Target 6C of the MDGs 'to have halted and begun to reverse the incidence of malaria'

**2** countries with **0** local cases of malaria in 2014

# FOREWORD

In 1954, the countries in the Americas made the trail-blazing decision to adopt malaria eradication as a program with the Pan American Sanitary Bureau as the coordinating unit. It was a year later when the Global Program for Malaria Eradication was created and became the coordinating unit for malaria in the world. Throughout its more than a century-long effort in reducing malaria transmission, the disease has remained at the forefront of Pan American Health Organization (PAHO) member states' concerns. In September 2016, health ministers from across the Region of the Americas adopted a new plan for malaria elimination over the next four years, urging countries to intensify the fight against the disease.

The current state of malaria in the Americas has changed dramatically from the mid-fifties. The disease has been eliminated in many countries but was quick to have resurgence or increase in territories which failed to recognize the fragility of their achievements, where the improvements on social determinants remained a challenge and which continued to have receptivity for malaria. Due to reinforced global and regional malaria, commitments since the year 2000, the number of cases due to malaria has more than halved while the progress made in preventing deaths has been even more phenomenal. For the first time in over three decades, we are now able to imagine a world without malaria, with 18 countries of the Americas expressing official commitment to malaria elimination. One country is currently in the process of becoming certified for malaria elimination and at least four more are expected to follow within the next several years.

Despite these advances, some countries continue to face significant public health challenges. In particular, some health systems still need strengthening to accurately assess the current situation. Another area of critical concern is the potential emergence of resistance to anti-malarial medicines used in the Guiana Shield. Populations living in situations of vulnerability such as indigenous groups live in precarious conditions and are at a higher risk of having malaria. Information about the risk of malaria among pregnant women also remains inadequate in many countries of the Americas and is a key priority for PAHO.

Funding for malaria efforts in the Americas comes mostly from domestic sources, which demonstrate strong country ownership of programs. Nevertheless, the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and the United States Agency for International Development (USAID) have also continued to be among the most important sources of external support for countries with malaria in the Americas. However, as malaria has declined, funding has again dwindled, which potentially jeopardizes continued progress towards elimination.

The aim of this document is to provide an overview of the current malaria situation. PAHO's Regional Malaria Program of the Neglected, Tropical and Vector Borne Diseases Unit of the Communicable Diseases and Health Analysis Department (CHA/VT) has produced this report with officially-reported information provided by the Member states between 2000 and 2014. The report includes a general overview of the current malaria situation at the regional, sub-regional, and country levels for those that are endemic to malaria. It documents the achievements since 2000 as well as the challenges that remain.

We hope that the results presented may not only inform on the malaria situation, but inspire positive action towards achieving malaria elimination. As we move towards achieving the Sustainable Development Goals, 18 countries have declared malaria elimination as a goal either partially or throughout the entire country; others aim to further reduce malaria by 90%. The World Health Organization's Global Technical Strategy 2016-2030 has called for efforts towards the acceleration of malaria elimination and PAHO's Plan of Action for Malaria Elimination 2016-2020 in the Americas will further this goal.

The Region of the Americas has come a long way in its efforts to curb the burden of malaria since 2000 and this could not be achieved without the persistent efforts of countries along with contributions made by various entities and organizations. To achieve elimination, however, even more resources will be needed as the present-day challenges are some of the most complex and socially sensitive.

PAHO looks forward to an enduring partnership of the member states and various stakeholders in addressing the key challenges and critical gaps which have been documented in this report, towards achieving the ultimate and shared goal of a malaria free world.

**Dr. Marcos Espinal**

**Director, Department of Communicable Diseases and Health Analysis**

# SECTION I: REGION OF THE AMERICAS

In the decade of 1990–2000 (a decade prior to our analysis time period), malaria began to decrease in some countries with a few peaking during this time (1). Some epidemics were exacerbated by funding challenges and the El Niño Southern Oscillation effect.

In the Americas, the number of malaria cases declined by 67% between 2000 and 2014 and malaria-related deaths have declined by 79% (Figure 1). There are currently 21 malaria-endemic countries and territories (hereafter referred to as countries) in the Americas: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, and Venezuela. A goal of 75% reduction of malaria morbidity was set at the 58th World Health Assembly (WHA) using an assumed baseline year of 2000 (2) as outlined by Goal 6 of the Millennium Development Goals (MDG) (3). This goal, established in 2005, has been achieved in 14 of the 21 endemic countries. At the end of 2014, all malaria-endemic countries in the Americas have reduced malaria morbidity compared to 2000 except for Haiti and Venezuela (Figure 2). There are currently 13 countries in the Americas in the control phase. Belize, Dominican Republic, Ecuador, El Salvador, and Mexico are in the pre-elimination phase, while Argentina, Costa Rica, and Paraguay are in the elimination phase. In 2014, Argentina officially requested certification of malaria-free status from the World Health Organization (WHO). Despite these achievements, there are still an estimated 108 million people at risk for malaria, of which at least 5.7 million were classified as being at high risk[1] (Table 1).

**Figure 1. Number of cases and deaths due to malaria in the Region of the Americas, 2000–2014**

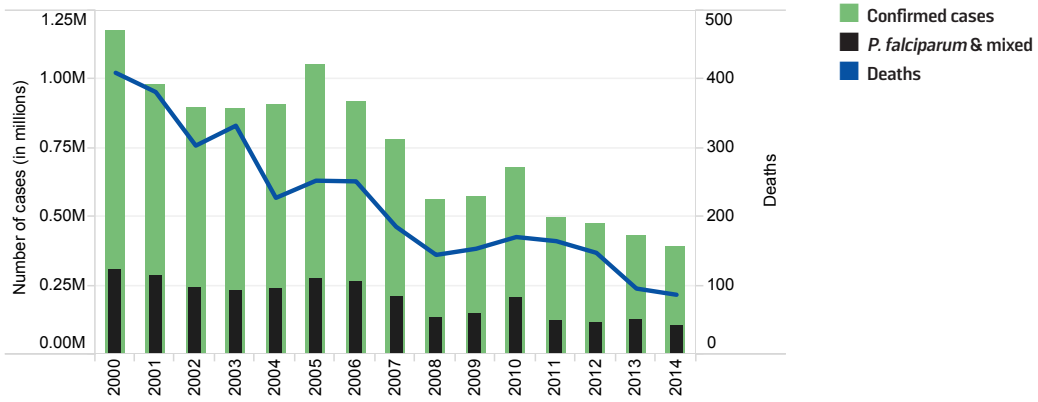
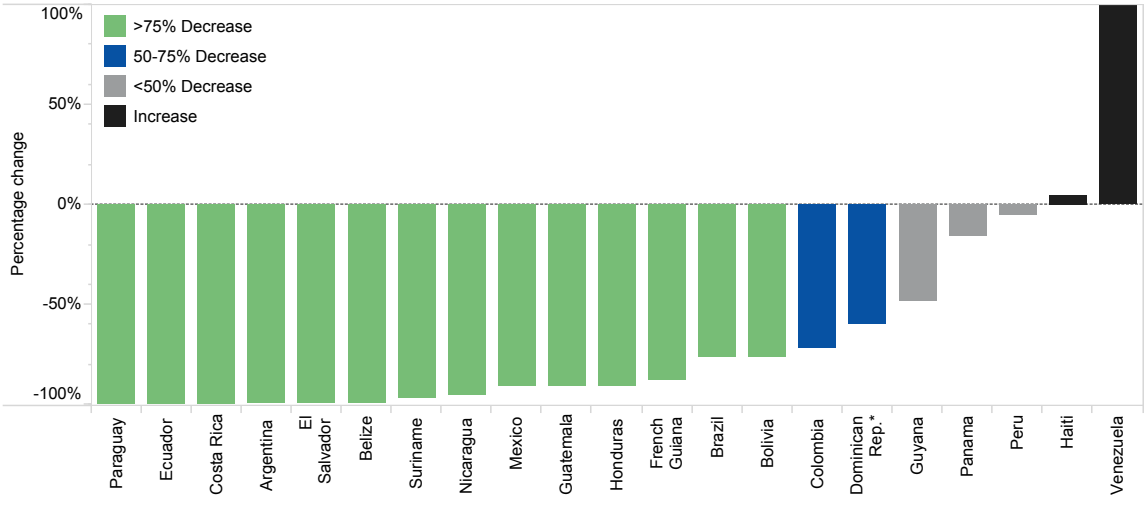



**Figure 2. Change in malaria cases by country in the Region of the Americas, 2000–2014**




*Dominican Republic

[1] High risk areas are those with an annual parasite index of 10 or more cases per 1,000 inhabitants.

## Table 1. Malaria in countries in the control phase in the Region of the Americas, 2000, 2012-2014

| Country | Year | Total population at risk | Blood samples examined | Confirmed cases | *P. falciparum* & mixed infections | Annual Parasite Index (x1000) |
|---|---|---|---|---|---|---|
| Bolivia | 2000 | 3,569,495 | 143,990 | 31,469 | 2,536 | 8.82 |
| | 2012 | 5,212,078 | 121,944 | 7,415 | 348 | 1.42 |
| | 2013 | 0 | 133,260 | 7,342 | 994 | ... |
| | 2014 | 0 | 124,900 | 7,401 | 341 | ... |
| Brazil | 2000 | 31,597,300 | 2,562,576 | 613,241 | 131,616 | 19.41 |
| | 2012 | 44,212,156 | 2,325,775 | 242,758 | 35,379 | 5.49 |
| | 2013 | 41,992,553 | 1,873,518 | 178,546 | 31,482 | 4.25 |
| | 2014 | 35,965,912 | 1,658,976 | 143,145 | 23,409 | 3.98 |
| Colombia | 2000 | 18,835,155 | 478,820 | 144,432 | 51,730 | 7.67 |
| | 2012 | 9,603,584 | 346,599 | 60,179 | 15,721 | 6.27 |
| | 2013 | 9,691,401 | 284,332 | 51,722 | 18,174 | 5.34 |
| | 2014 | 10,596,997 | 325,713 | 40,768 | 20,504 | 3.85 |
| Dominican Rep.* | 2000 | 6,568,000 | 427,297 | 1,233 | 1,226 | 0.19 |
| | 2012 | 6,787,117 | 415,808 | 952 | 950 | 0.14 |
| | 2013 | 6,577,495 | 431,683 | 579 | 576 | 0.09 |
| | 2014 | 0 | 362,304 | 496 | 491 | ... |
| French Guiana | 2000 | 167,000 | 48,162 | 3,708 | 3,051 | 22.20 |
| | 2012 | 199,040 | 13,638 | 900 | 264 | 4.52 |
| | 2013 | 199,199 | 22,327 | 877 | 307 | 4.40 |
| | 2014 | 125,004 | 14,651 | 448 | 148 | 3.58 |
| Guatemala | 2000 | 2,912,000 | 246,642 | 53,311 | 1,474 | 18.31 |
| | 2012 | 6,057,530 | 186,645 | 5,346 | 68 | 0.88 |
| | 2013 | 6,541,912 | 153,731 | 6,214 | 152 | 0.95 |
| | 2014 | 9,565,826 | 264,269 | 4,931 | 92 | 0.52 |
| Guyana | 2000 | 615,000 | 209,197 | 24,018 | 12,324 | 39.05 |
| | 2012 | 698,795 | 196,622 | 31,601 | 20,293 | 45.22 |
| | 2013 | 0 | 205,903 | 31,479 | 17,425 | ... |
| | 2014 | 747,884 | 142,843 | 12,353 | 5,139 | 16.52 |
| Haiti | 2000 | ... | 21,190 | 16,897 | 16,897 | ... |
| | 2012 | 10,312,000 | 167,726 | 27,866 | 25,423 | 2.70 |
| | 2013 | 10,388,424 | 172,624 | 20,957 | 20,378 | 2.02 |
| | 2014 | 10,466,500 | 134,766 | 17,696 | 17,696 | 1.69 |
| Honduras | 2000 | 6,080,000 | 175,577 | 35,125 | 1,446 | 5.78 |
| | 2012 | 5,478,118 | 155,165 | 6,439 | 583 | 1.18 |
| | 2013 | 5,270,455 | 144,436 | 5,428 | 1,159 | 1.03 |
| | 2014 | 5,598,244 | 151,420 | 3,380 | 567 | 0.60 |
| Nicaragua | 2000 | 4,980,000 | 509,443 | 23,878 | 1,369 | 4.79 |
| | 2012 | 3,198,774 | 536,278 | 1,235 | 236 | 0.39 |
| | 2013 | 0 | 517,141 | 1,194 | 220 | ... |
| | 2014 | 0 | 605,357 | 1,163 | 163 | ... |
| Panama | 2000 | 2,756,554 | 149,702 | 1,036 | 45 | 0.38 |
| | 2012 | 2,402,289 | 107,711 | 844 | 1 | 0.35 |
| | 2013 | 3,724,171 | 93,624 | 705 | 6 | 0.19 |
| | 2014 | 183,428 | 80,701 | 874 | 8 | 4.76 |
| Peru | 2000 | 14,724,000 | 1,483,816 | 68,321 | 20,618 | 4.64 |
| | 2012 | 4,499,236 | 758,723 | 31,436 | 3,501 | 6.99 |
| | 2013 | 4,499,236 | 863,790 | 43,139 | 6,843 | 9.59 |
| | 2014 | 11,778,357 | 864,413 | 64,676 | 6,988 | 5.49 |
| Suriname | 2000 | 62,177 | 63,377 | 11,361 | 10,648 | 211.20 |
| | 2012 | 80,000 | 17,464 | 569 | 126 | 7.11 |
| | 2013 | 80,000 | 13,693 | 729 | 343 | 9.11 |
| | 2014 | 23,000 | 17,608 | 401 | 165 | 17.43 |
| Venezuela | 2000 | 8,747,000 | 261,866 | 29,736 | 5,491 | 3.40 |
| | 2012 | 5,689,293 | 410,663 | 52,803 | 13,302 | 9.28 |
| | 2013 | 5,939,612 | 476,764 | 78,643 | 27,659 | 13.24 |
| | 2014 | 5,916,153 | 522,617 | 90,708 | 27,843 | 15.33 |

''...'' Indicates unavailable data
*Dominican Republic

There was a decrease in the number of confirmed cases reported since 2000, from 1,181,095 cases to 389,390 cases in 2014. Brazil (36.8%), Venezuela (23.3%), and Peru (16.6%) together accounted for 76.7% of malaria cases in the Americas in 2014 (Figure 3). Deaths related to malaria also declined from 410 in 2000 to 87 deaths in 2014 (Figure 1), with Brazil accounting for 41% of these deaths. However, reporting discrepancies exist for mortality data, especially those from earlier years during the 2000–2014 period. Pan American Health Organization's (PAHO) Regional Health Observatory is a data repository that monitors priority health topics including mortality. There are notable discrepancies between malaria deaths from this repository and data reported by countries for this report, which are analyzed in later chapters. Eleven countries reported no deaths related to malaria in 2014. It is estimated that 6.5 million cases and 3,500 deaths were averted during 2001–2014 assuming the rates from 2000 remained constant. For this report the endemic countries have been divided into four sub-regions: Amazon, Hispaniola, Mesoamerica, and the Southern Cone. In 2014, the Amazon sub-region accounted for 92.5% of all cases in the Americas, followed by Hispaniola (4.7%), Mesoamerica (2.8%), and the Southern Cone (<0.1%). Further analysis on sub-regions is detailed in later chapters.

The annual parasite index (API) is used to further measure epidemiological risk of malaria across countries. Figure 3 shows the API of reported cases per 1000 people at risk per year for the endemic countries. For 2014, Guyana, Suriname, and Venezuela had an API of more than 15 cases/1000 people at risk. However, it should be noted that a large migratory population of illegal miners in these countries is not included in the total population at risk of malaria, leading to artificially high APIs. Furthermore, when analyzing number of cases and APIs at the smallest administrative unit reported[2], areas of focalized transmission can be identified. For example, the Sifontes municipality in the province of Bolivar, Venezuela, has had the largest amount of cases each year for 2012–2014 as well as a consistently high API. In 2014, Sifontes's API was 849 cases/1000 people. In Peru, the province of Loreto has a high endemicity, with the municipalities of Tigre, Pastaza, and Andoas reporting both high APIs and number of cases (Figures 4 and 5). Similarly, the municipalities of Mancio Lima and Rodrigo Alves located in the province of Acre, Brazil, have also reported high numbers of cases and high APIs.

### Table 2. Malaria in countries in the elimination and pre-elimination phase in the Region of the Americas, 2012–2014

| Country | Year | Confirmed cases | Cases Investigated | Imported | Autochthonous *P. falciparum* | Imported – *P. falciparum* | Imported – *P. vivax* | Active Foci |
|---|---|---|---|---|---|---|---|---|
| Argentina | 2012 | 4 | 4 | 4 | 0 | 0 | 4 | 0 |
| | 2013 | 4 | 4 | 4 | 0 | 0 | 4 | 0 |
| | 2014 | 4 | 4 | 4 | 0 | 0 | 4 | 0 |
| Belize | 2012 | 37 | 1 | 1 | 0 | 1 | 0 | ... |
| | 2013 | 26 | 26 | 4 | 0 | 0 | 4 | 4 |
| | 2014 | 19 | 19 | 0 | 0 | 0 | 0 | 8 |
| Costa Rica | 2012 | 8 | 8 | 1 | 0 | 0 | 1 | 1 |
| | 2013 | 6 | 6 | 4 | 0 | 1 | 3 | 0 |
| | 2014 | 6 | 6 | 5 | 0 | 3 | 2 | 0 |
| Ecuador | 2012 | 558 | 204 | 14 | 68 | 12 | 2 | 14 |
| | 2013 | 378 | 100 | 10 | 160 | 1 | 9 | 3 |
| | 2014 | 241 | ... | ... | ... | ... | ... | ... |
| El Salvador | 2012 | 21 | 21 | 7 | 0 | 3 | 4 | 10 |
| | 2013 | 7 | 7 | 1 | 0 | 0 | 1 | 2 |
| | 2014 | 8 | 8 | 2 | 0 | 0 | 2 | 2 |
| Mexico | 2012 | 842 | 842 | 9 | 0 | 9 | 0 | 71 |
| | 2013 | 499 | 499 | 4 | 0 | 4 | 0 | 61 |
| | 2014 | 664 | 664 | 8 | 0 | 6 | 2 | 56 |
| Paraguay | 2012 | 15 | 15 | 15 | 0 | 11 | 4 | 0 |
| | 2013 | 11 | 11 | 11 | 0 | 7 | 3 | 0 |
| | 2014 | 8 | 8 | 8 | 0 | 7 | 1 | 0 |

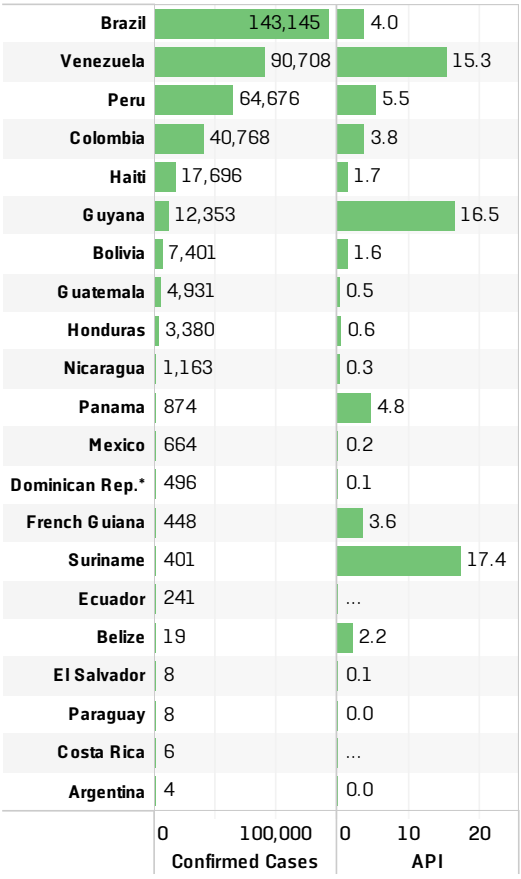
'...'' Indicates unavailable data.

[2] Most countries reported at the ADM2 level, except for Bolivia, Peru, and Haiti reporting at ADM3 level. Guyana, Suriname, and Peru reported ADM1 level data. Foci information was provided for Argentina, Belize, Costa Rica, El Salvador, and Paraguay. Ecuador did not report 2014 data.

Cases increased in Bolivia, Mexico, Panama, Peru, and Venezuela in 2014 when compared to 2013 (Table 1). In Peru, cases have increased each year since 2011 and reached a 49.9% increase in 2014 compared to the previous year. If this trend continues, Peru could report more cases in 2015 than those reported in 2000 (Figure 2). Venezuela had a 15.3% increase in cases between 2013 and 2014. Cases have increased due to worsening economic conditions, increased mining activities, and decreased vector-control interventions. Overall, Venezuela reported more cases in 2014 than in any year in the previous 50 years. In other countries, only a small increase in malaria was seen (<200 cases total). In Mexico, this increase has been related to the change in human migratory routes onwards to USA from Central and South America.

*Plasmodium vivax* is the main species in the Americas, causing 69% of malaria cases in 2014 (Figure 8). Cases in Haiti and the Dominican Republic are almost exclusively caused by *P. falciparum* (Figure 9). On the other hand, Argentina, Belize, El Salvador, Mexico, and Panama report exclusively *P. vivax* cases while Guatemala reports <1% of cases due to *P. falciparum*. Some countries have seemingly high proportions of certain species due to the small amount of cases such as Paraguay and Costa Rica where the majority of their *P. falciparum* cases were imported. Colombia had an increase of *P. falciparum* cases in 2014, which caused half of all malaria cases in that country; this is a 34% increase from 2013. *Plasmodium malariae* is also prevalent in the Americas, though accounts for less than 0.1% of all cases. Most cases are reported from the Amazon sub-region, particularly from Brazil, Colombia, French Guiana, Guyana, Peru, Suriname, and Venezuela. Costa Rica has also reported autochthonous *P. malariae* cases in the last few years. Species information was unavailable for 4% of all confirmed cases in 2014 largely from Brazil and Peru.

## Figure 3. Number of cases and Annual Parasite Index (API) by country, 2014



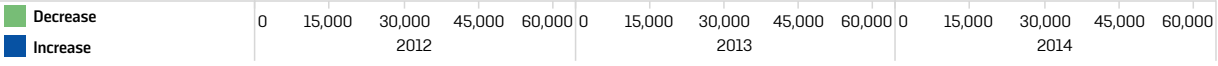

"..." indicates unavailable data.
*Dominican Republic

Throughout the Americas, men are more at risk for malaria than women (Figure 7). This trend has been consistent throughout the years and malaria mostly affects males between the ages of 15-24 years. Females are most affected during the ages of 5-14; however, the amount of cases in this age group is still less than their male counterparts. Approximately 60% of all cases occurred in men in 2014. Adjusting for age, Guyana had an incidence of 2,324 cases per 100,000 men in 2014, which is 2.9-fold higher than that in women. Venezuela also reported a 2.5-fold higher incidence in men compared to women in 2014. In the Americas, malaria is associated with occupational activities occurring outdoors such as mining and agricultural work, which predominately employs young males, a condition prevalent in both the aforementioned countries. However, an estimated 9% of all cases in 2014 occurred in children under 5 years of age, suggesting that malaria transmission occurs within households. Haiti, Peru, and Panama had particularly high incidence of malaria in children <5 years. IRS and ITN use in these countries can protect young children as a method of vector control for malaria within households.

Malaria risk is dependent on interactions with epidemiologic factors- host, vector, parasite, and environment. The Americas, as the rest of the world, has a diverse set of challenges involving interactions between these factors. The most important challenges currently being faced in the Americas have evolved from those of the past and are related to social determinants, occupation, geography, and various other issues. Social determinants mostly stemming from race, ethnicity, and cultural distinctions are a major issue in key malaria-endemic areas of the Americas such as Panama, Nicaragua, Honduras, Colombia, Guyana, and throughout the Amazon. Many of these distinct groups of people are impoverished, lack access to healthcare, and face cultural barriers inhibiting proper treatment. Another current challenge is malaria's association with occupation, particularly in mining, logging, and agriculture. Miners in all countries making up the Guiana Shield are at risk of malaria with limited intervention or control methods available to them. Finally, additional problems such as Haiti's weak surveillance system and the surge of cases in Venezuela due to a challenging political situation add to the prevailing malaria concerns in the Americas.

## Figure 4. Municipalities with the highest number of malaria cases in the Region of the Americas, 2012-2014

| Municipality | Country | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Sifontes | Venezuela | 31,396 | 46,610 | 52,509 |
| Cruzeiro do Sul | Brazil | 16,055 | 20,043 | 17,210 |
| San Juan Bautista | Peru | ... | 7,414 | 10,616 |
| Manaus | Brazil | 9,768 | 7,295 | 7,443 |
| Labrea | Brazil | 4,068 | 4,651 | 7,412 |
| Andoas | Peru | ... | 1,029 | 6,842 |
| Porto Velho | Brazil | 15,570 | 9,134 | 6,639 |
| Mancio Lima | Brazil | 5,205 | 7,281 | 6,207 |
| Atures | Venezuela | 2,269 | 4,377 | 5,897 |
| Cedeno | Venezuela | 3,604 | 5,057 | 5,289 |
| Eirunepe | Brazil | 9,269 | 8,483 | 5,288 |
| Gran Sabana | Venezuela | 2,985 | 5,195 | 5,224 |
| Tigre | Peru | ... | 2,511 | 5,194 |
| Raul Leoni | Venezuela | 1,363 | 2,844 | 5,130 |
| Quibdo | Colombia | 1,703 | 4,232 | 5,008 |
| Rodrigues Alves | Brazil | 3,701 | 3,524 | 4,774 |
| Sao Gabriel* | Brazil | 4,049 | 5,524 | 4,533 |
| Itaituba | Brazil | 14,179 | 9,004 | 3,940 |
| Barcelos | Brazil | 2,432 | 2,423 | 3,863 |
| Pastaza | Peru | ... | 2,821 | 3,677 |



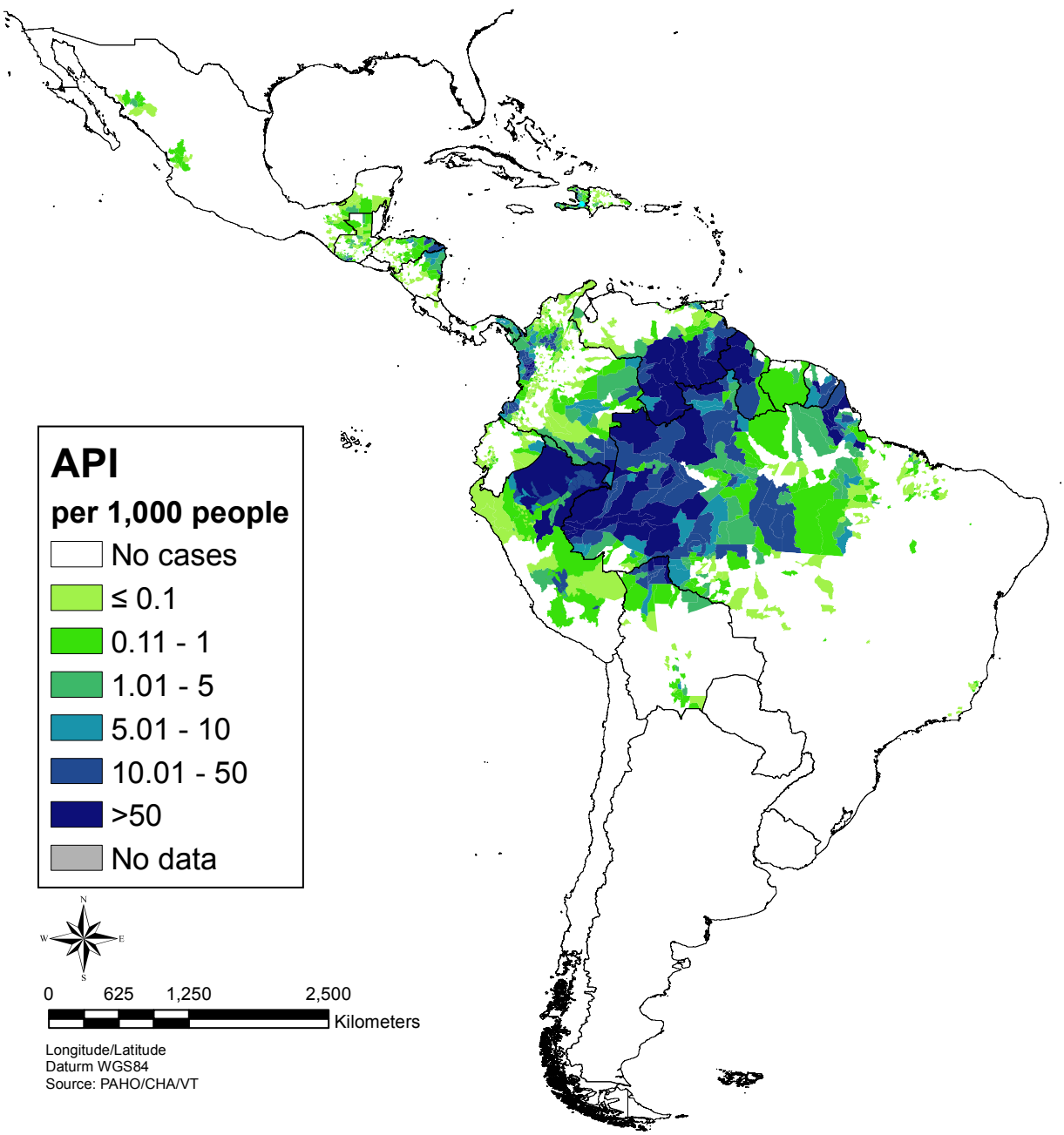

*Sao Gabriel da Cachoeira

## Figure 5. Municipalities with the highest API in the Region of the Americas, 2012-2014

| Municipality | Country | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Alto Nanay | Peru | 636.4 | 560.7 | 850.8 |
| Sifontes | Venezuela | 731.1 | 777.2 | 848.7 |
| Tigre | Peru | ... | 303.1 | 621.6 |
| Pastaza | Peru | ... | 437.3 | 573.5 |
| Andoas | Peru | ... | 87.4 | 566.8 |
| Soplin | Peru | 660.8 | 269.4 | 430.9 |
| Mancio Lima | Brazil | 327.6 | 422.7 | 341.9 |
| Trompeteros | Peru | ... | 122.8 | 264.8 |
| Rodrigues Alves | Brazil | 242.5 | 190.6 | 263.6 |
| Novita | Colombia | 49.4 | 84.2 | 237.5 |
| Alto Tapiche | Peru | 98.4 | ... | 209.3 |
| Manapiare | Venezuela | 33.9 | 95.6 | 198.0 |
| Napo | Peru | 42.0 | 52.8 | 197.0 |
| Yaquerana | Peru | 208.9 | 215.2 | 196.0 |
| Cruzeiro do Sul | Brazil | 201.1 | 230.4 | 195.2 |
| Urarinas | Peru | ... | 26.5 | 194.5 |
| Serra do Navio | Brazil | 111.6 | 75.6 | 185.8 |
| Tado | Colombia | 83.6 | 97.2 | 184.3 |
| Yavari | Peru | ... | 150.7 | 174.5 |
| Putumayo | Peru | 12.5 | 9.1 | 174.4 |

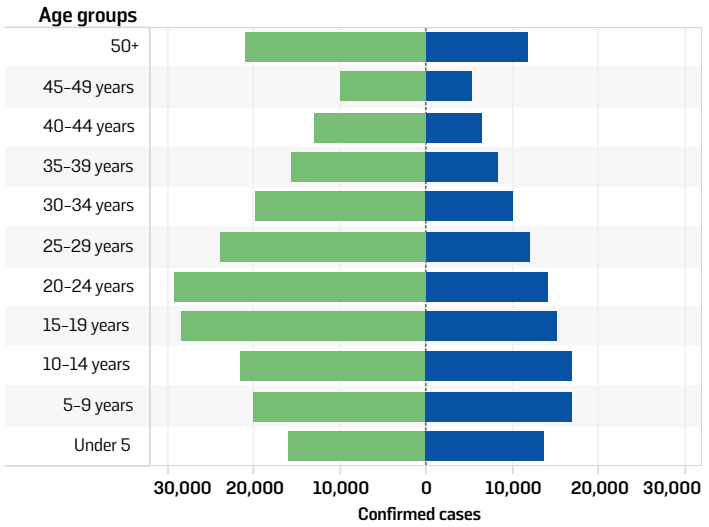

"..." indicates unavailable data.

Figure 6. Malaria by Annual Parasite Index (API) in the Region of the Americas, 2014



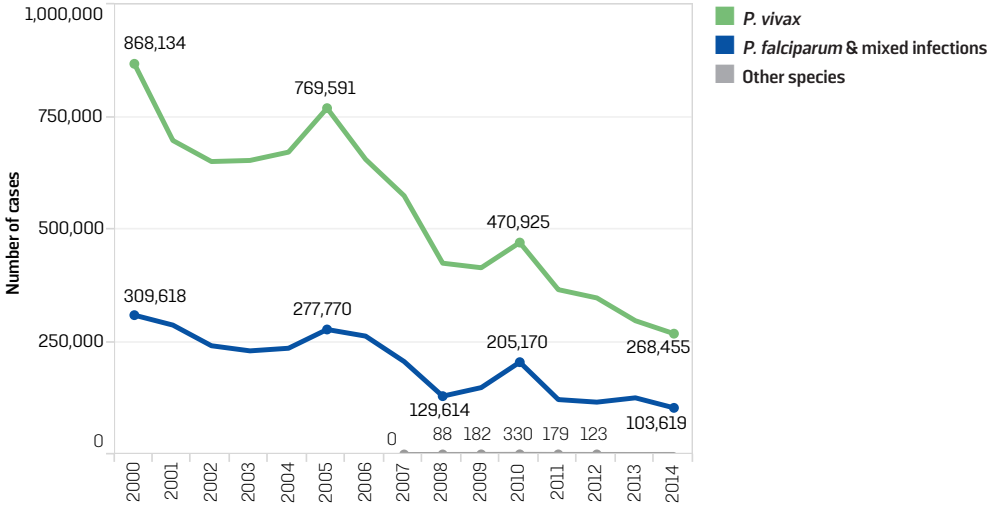

*Bolivia and Haiti reported API at the ADM3 level. Guyana and Suriname reported API at the ADM1 level. All other countries reported at the ADM2 level, except Ecuador who did not report 2014 data and instead ADM2 level data from 2013 is shown. Peru reported ADM3 data for Amazonas, Ayacucho, Cusco, Junin, Loreto, and San Martin while reporting ADM1 data for the rest of the provinces.

## Figure 7. Malaria cases by age and sex in the Region of the Americas, 2014

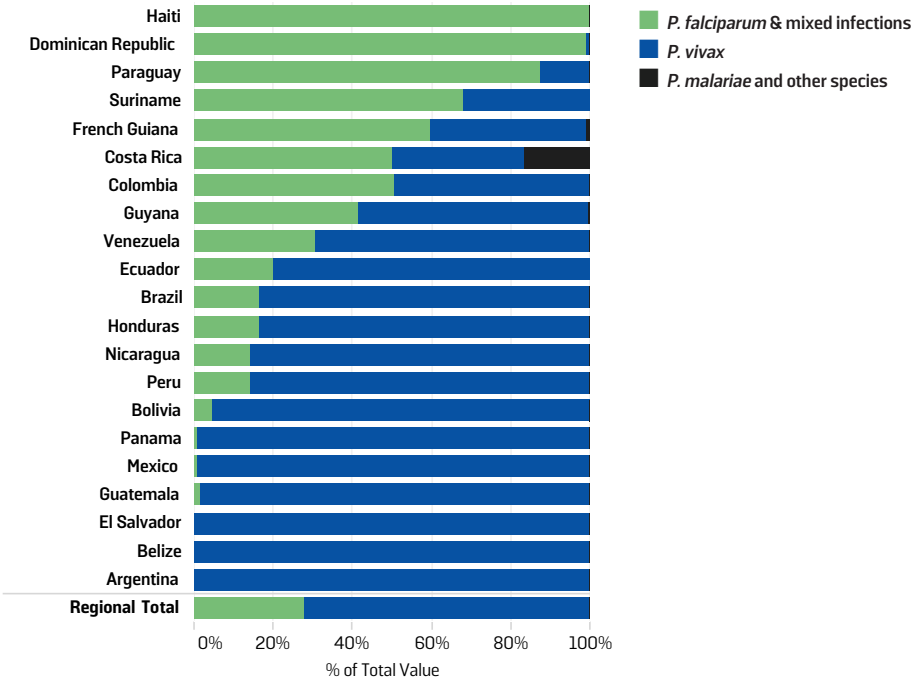



*Ecuador, French Guiana, and Haiti did not provide gender and age data for 2014 cases. Cases not reported within the presented age groups were excluded as they could not be categorized into the dimensions of the graph. Cases of unknown gender (46) were also excluded.

## Figure 8. Number of cases by species, 2000–2014



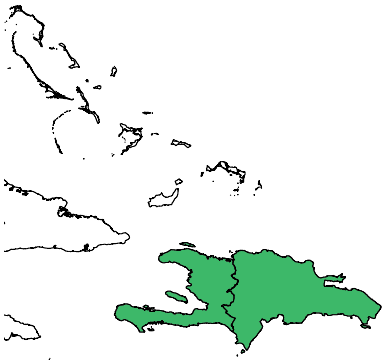

## Figure 9. Proportion of malaria cases by species, 2014



# SUB-REGIONS

## Amazon

Bolivia
Brazil
Colombia
Ecuador
French Guiana
Guyana
Peru
Suriname
Venezuela



## Hispaniola

Dominican Republic
Haiti

## Mesoamerica

Belize
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

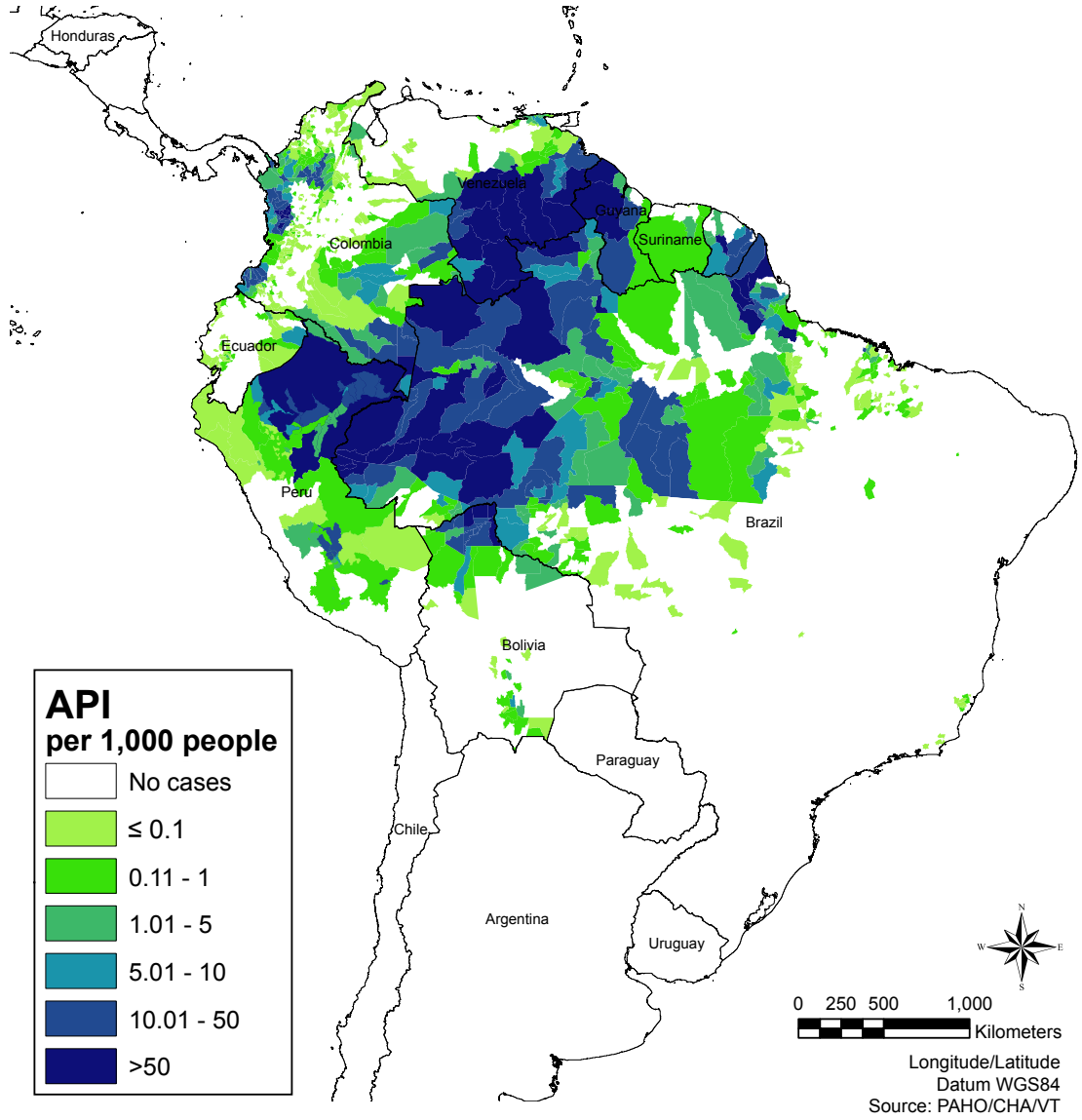
## Southern Cone

Argentina
Paraguay

## Non-Endemic

Anguila
Antigua and Barbuda
Aruba
Bahamas
Barbados
Bermuda
Bonaire
British Virgin Islands
Canada
Cayman Islands
Chile
Cuba
Curacao
Dominica
Grenada
Guadeloupe
Jamaica
Martinique
Montserrat
Puerto Rico
Saba
Saint Barthelemy
Saint Kitts and Nevis
Saint Lucia
Saint Martin
Saint Vincent and the Grenadines
Sint Eustatius
Sint Maarten
Trinidad and Tobago
Turks and Caicos
Uruguay
United States of America
United States Virgin Islands

## Figure 1. Malaria by Annual Parasite Index (API) in the Amazon sub-region, 2014




*Bolivia and Haiti reported API at the ADM3 level. Guyana and Suriname reported API at the ADM1 level. All other countries reported at the ADM2 level, except Ecuador who did not report 2014 data and instead ADM2 level data from 2013 is shown. Peru reported ADM3 data for Amazonas, Ayacucho, Cusco, Junin, Loreto, and San Martin while reporting ADM1 data for the rest of the provinces.

# SECTION II: SUB-REGIONS

## AMAZON

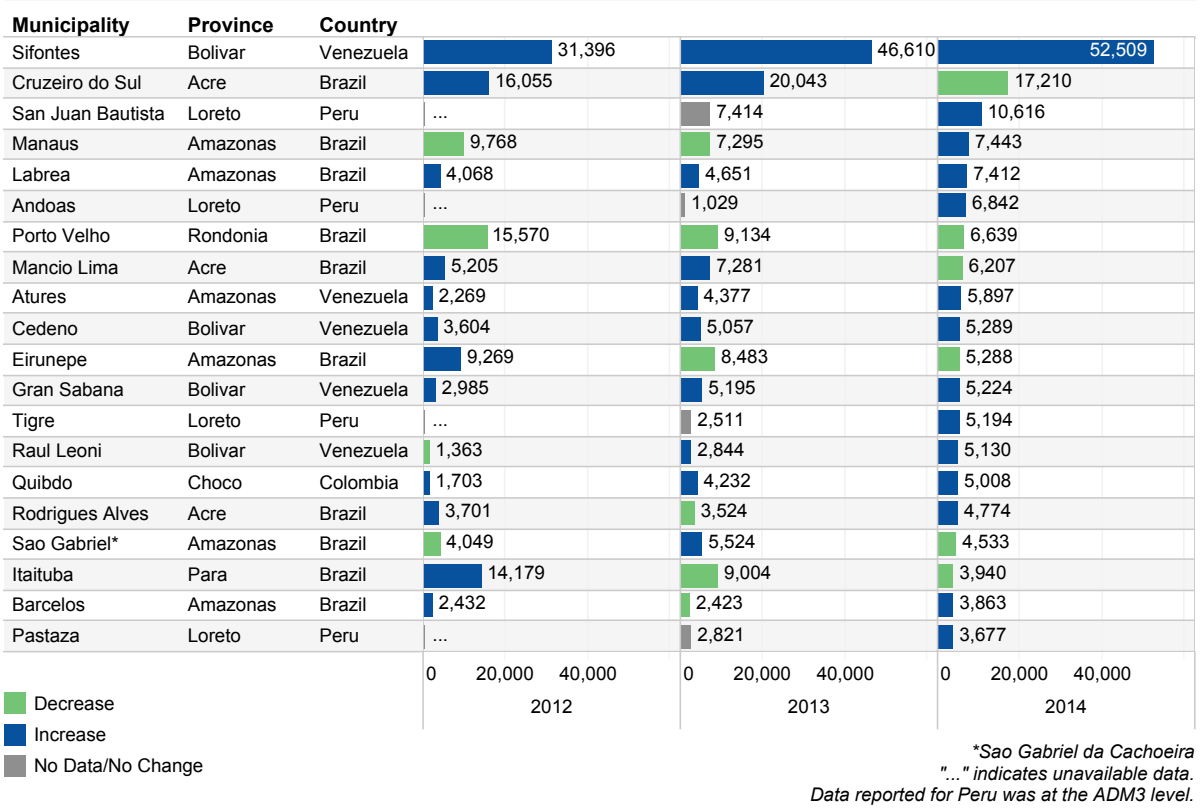
The Amazon sub-region has the highest burden of malaria in the Americas. Spanning over 5.5 million square kilometers, the Amazon rainforest encompasses 9 countries including Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela (Figure 1). Combined, these countries reported 92.5% of all cases in the Americas. The municipalities with the highest malaria burden in this sub-region are all from the Amazon rainforest except for some in Colombia and Ecuador (Figure 2).

Colombia reports many cases from the Choco province, which shares a border with Panama. Another highly endemic area in Colombia is the municipality of Tumaco in Nariño province near the Ecuadorian border. For 2014, only partial data was available for Ecuador including number of confirmed cases, species information, and number of slides examined. Though sub-national data for 2014 was not reported, the province of Esmeraldas in Ecuador, located along the Colombian border was the most endemic area in 2013 and reported the most cases (141) in the country for that year. While the majority of cases in Colombia and Ecuador are reported from the Pacific coast area, these countries also report cases from the Amazon rainforest. In stark contrast, the rest of the countries in the Amazon sub-region reports almost no cases along their coastal areas.

The Amazon rainforest is sparsely populated, which is an advantage for the fight against malaria. However, for those who live and work in the rainforest, malaria is a very serious threat for which treatment is not easily accessible. Small-scale gold mining draws many people, particularly Brazilians known as *garimpeiros*, to the Guiana Shield (an area rich in minerals). Due to the interest in mining, there is a lot of cross-border movement in this area. Some countries such as French Guiana have very strict laws prohibiting foreigners to work within their borders, which influences access to healthcare for those involved in illegal mining.

The illegal population faces complex challenges in accessing healthcare for many other reasons, too. One of these is their remote location and lack of transportation to even the nearest health centers, making accessing treatment difficult. Another challenge is the fear of

**Figure 2. Municipalities (ADM2) with the highest number of malaria cases in the Amazon sub-region, 2012-2014**




**Sao Gabriel da Cachoeira*
*"..." indicates unavailable data.*
*Data reported for Peru was at the ADM3 level.*

identification of illegal status at health facilities and possible deportation. Another issue is the language barrier faced by many patients in the Guiana Shield. There are various cultures in this area including a Dutch-speaking population in Suriname, French population in French Guiana, English population in Guyana, Portuguese-speaking *garimpeiros* from Brazil, Spanish-speaking population in Venezuela and Colombia, as well as various indigenous tribes and ethnicities with their own proper languages. The inability for health personnel and patients to communicate leads to improper treatment and possibly life-threatening consequences.

Suriname has had success in reducing the number of malaria cases as a result of two consecutive projects supported by the Global Fund. Currently, the country's biggest malaria challenge is managing the importation of malaria cases from French Guiana. Suriname's ministry of health has provided treatment to miners through trained individuals working in mining areas; however, Suriname cannot eliminate malaria alone and trans-border cooperation is pivotal in order to achieve real progress. While Suriname benefitted from resources provided by the Global Fund to carry out their projects, Guyana is the only other country in the Guiana Shield currently eligible to receive funding from this source.

Due to the probable non-adherence to and self-treatment with antimalarials in the Guiana Shield, the risk of developing artemisinin resistance is high. Studies conducted within the framework of the AMI/RAVREDA project have not found decreased sensitivity to artemisinin in Suriname and Guyana. French Guiana and Brazil have similar ongoing studies.

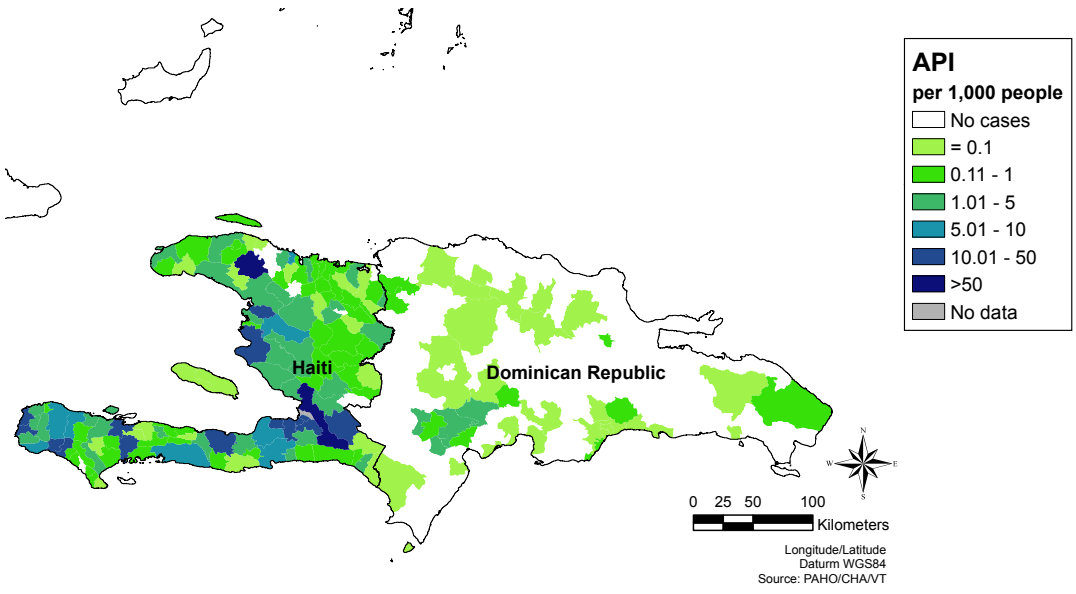
Outside the Guiana Shield, other highly endemic areas of the Amazon sub-region are in Peru and Bolivia. Approximately 43.8% of all cases in Bolivia were reported from Guayaramerin, a municipality along the Brazilian border and where many people work in the Amazon rainforest to harvest *castaña* (chestnut). Access to healthcare in this border area has been particularly challenging due to movement of people across borders. In Peru, there has been an increase in malaria cases in the province of Loreto, the largest and most sparsely-populated province in the country, a majority of which is covered by the Amazon rainforest. People living in conditions amenable for malaria transmission along with inadequate coverage with preventive interventions in the last few years after the end of a Global Fund financed project (PAMAFRO) have been the reasons for continued transmission in this province.

## HISPANIOLA

Except for a few sporadic outbreaks in the past, malaria has been mostly eliminated in the Caribbean. However, the island of Hispaniola is still endemic (Figures 3 and 4). Infections are almost exclusively caused by *P. falciparum*. Although surveillance in Haiti is inadequate, data from the Dominican Republic, which has adequate malaria surveillance, indicates no local transmission of *P. vivax*. In 2014, there were 5 imported *P. vivax* cases in the Dominican Republic (all from Venezuela). Less than 0.01% of all cases were caused by this species in 2000-2014.

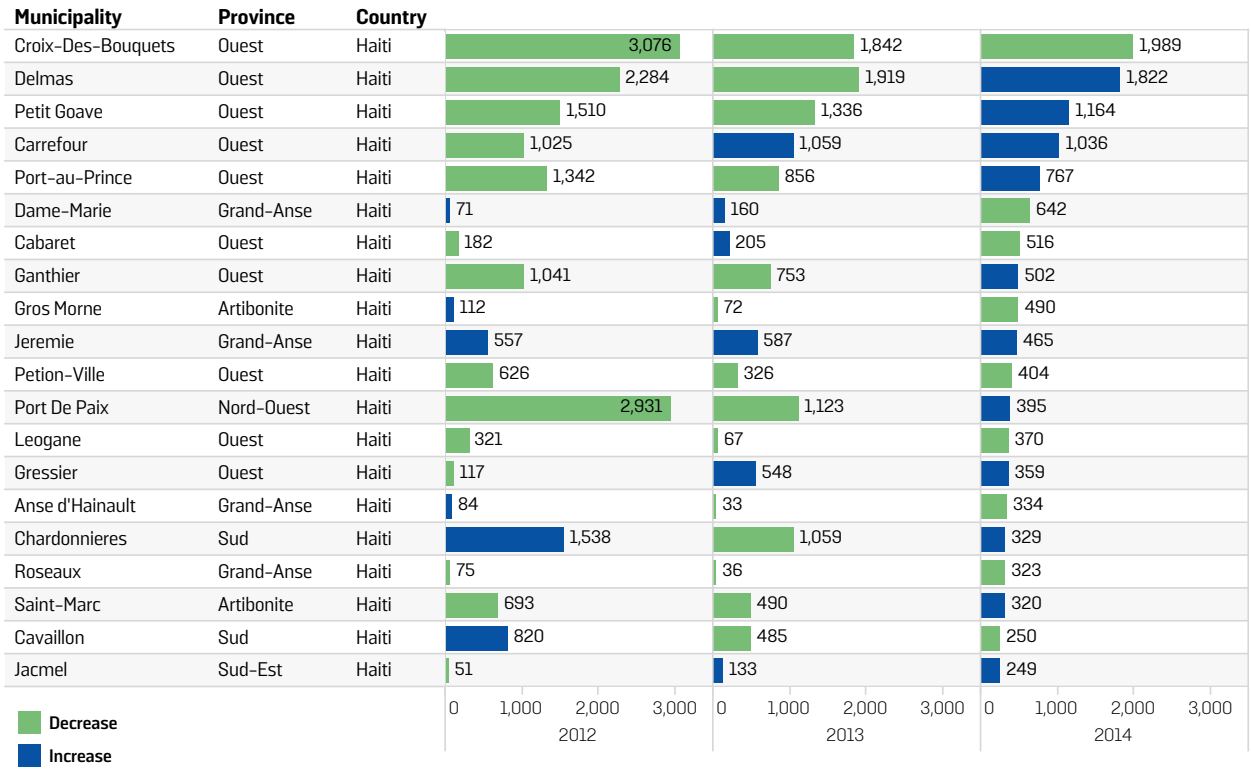
Haiti suffered a devastating earthquake in January of 2010, and a combination of the subsequent chaotic

Figure 3. Malaria by Annual Parasite Index (API) at the municipality level in the Hispaniola sub-region, 2014




*Haiti reported API at the ADM3 level, Dominican Republic reported API at the ADM2 level.

## Figure 4. Municipalities with the highest number of malaria cases in the Hispaniola sub-region, 2012-2014




environment and lack of infrastructure influenced malaria transmission, among the country's other problems. Duplication of data for those tested for malaria multiple times and by multiple organizations after the earthquake is a probable cause for the increase in malaria by 69.9% from 2009 to 2010 in Haiti. In the Dominican Republic, malaria increased largely in areas along major migratory routes and in the capital after the earthquake (33.8% increase from 2009 to 2010). Owing to inadequate quality of surveillance, it is not possible to ascertain true malaria trends in Haiti. On the other hand, the Dominican Republic will likely achieve a 50-75% decline by 2015.

However, in recent years surveillance in Haiti has improved and information is more reliable. A prime reason for this has been the increase in testing of all suspected malaria cases with the introduction of RDTs, although it has led to replacement of microscopy in many areas rather than complementing the existing diagnostic network. In border areas, especially in the northeast, malaria seems to have declined significantly. In Monte Cristi province of Dominican Republic, malaria has decreased by 99% since 2010 and only 1 confirmed case was reported in 2014 from the whole province. One of the adjacent municipalities in Haiti, Ferrier in Nord-est province, reported that of 280 people tested with RDTs, 0 were confirmed positive in 2014. Fort Liberte, in the west of Ferrier, reported 2 positive cases (772 tested with 263 by RDTs). Due to the increase in urbanization in the north of the country after the 2010 earthquake, breeding places for *An. albimanus* have decreased while those for the *Aedes* and *Culex* species have increased (4). These data suggest that the northern area of Haiti has very low transmission. Data from 2015 is still required before conclusions about malaria trends can be drawn. On the other hand, the southern province of Grand Anse in Haiti is highly endemic and preliminary reports in 2015 indicated that the area had an outbreak of malaria.

Both Haiti and the Dominican Republic use chloroquine and primaquine as the first line treatment for *P. falciparum* and *P. vivax*. Primaquine is used as radical treatment and is administered in a 45-mg single dose for *P. falciparum* and as a 14-day regimen of 15 mg for *P. vivax*. Resistance studies conducted in Hispaniola in the past have demonstrated susceptibility of the parasite to chloroquine treatment (5).

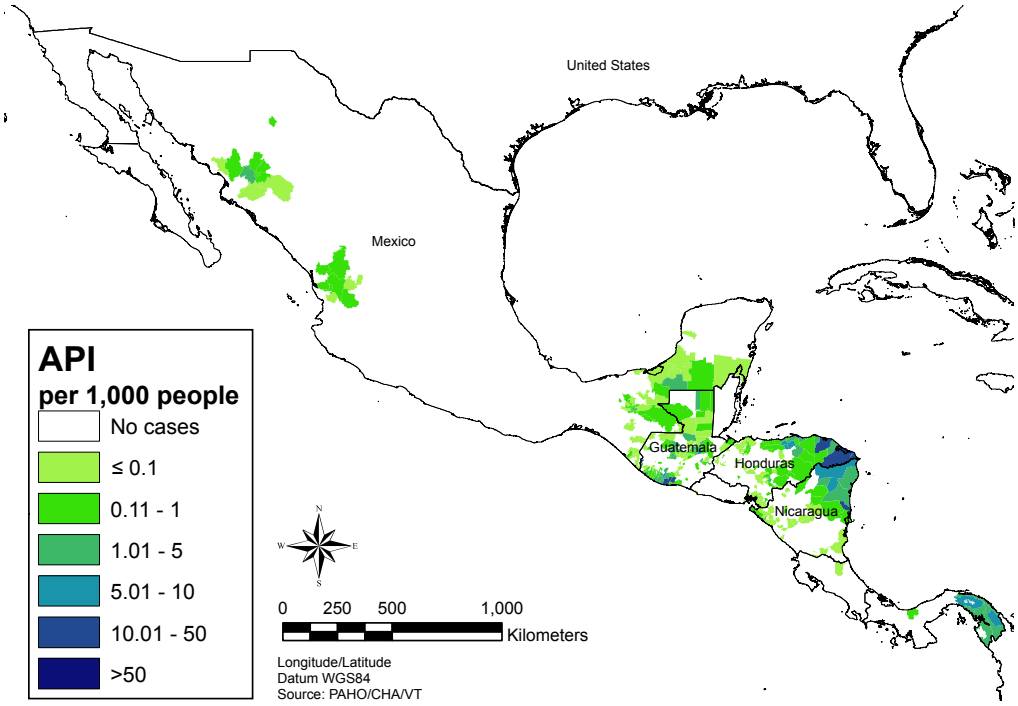
Each country uses vector control by promoting ITN usage; on the other hand, IRS is presently only used in the Dominican Republic. Both countries have also increased their use of RDTs to diagnose cases and

enhanced surveillance. The Dominican Republic has specifically targeted problem areas and populations to monitor using their surveillance system.

The Dominican Republic reports many imported cases from Haiti, especially along the border and in migrating populations. The countries recognize that cooperation between the two governments will be pivotal in decreasing incidence and have included plans to align elimination efforts in their respective strategic plans. Initiatives such as EMMIE and the Malaria Zero project focus on elimination of malaria on the whole island. Malaria Zero is funded by the Bill and Melinda Gates Foundation (Gates Foundation) and aims to eliminate malaria by 2020.

Inadequate funding has been a major problem in Hispaniola, but more so for Haiti. Most of the funding for malaria control in Haiti has come from external donors such as the Global Fund, USAID, PAHO/WHO, CDC, BMGF, CHAI, etc. In contrast, most funding for malaria in the Dominican Republic comes from the government with support also provided by the Global Fund.

**Figure 5. Malaria by Annual Parasite Index (API) in the Mesoamerica sub-region, 2014**




## MESOAMERICA

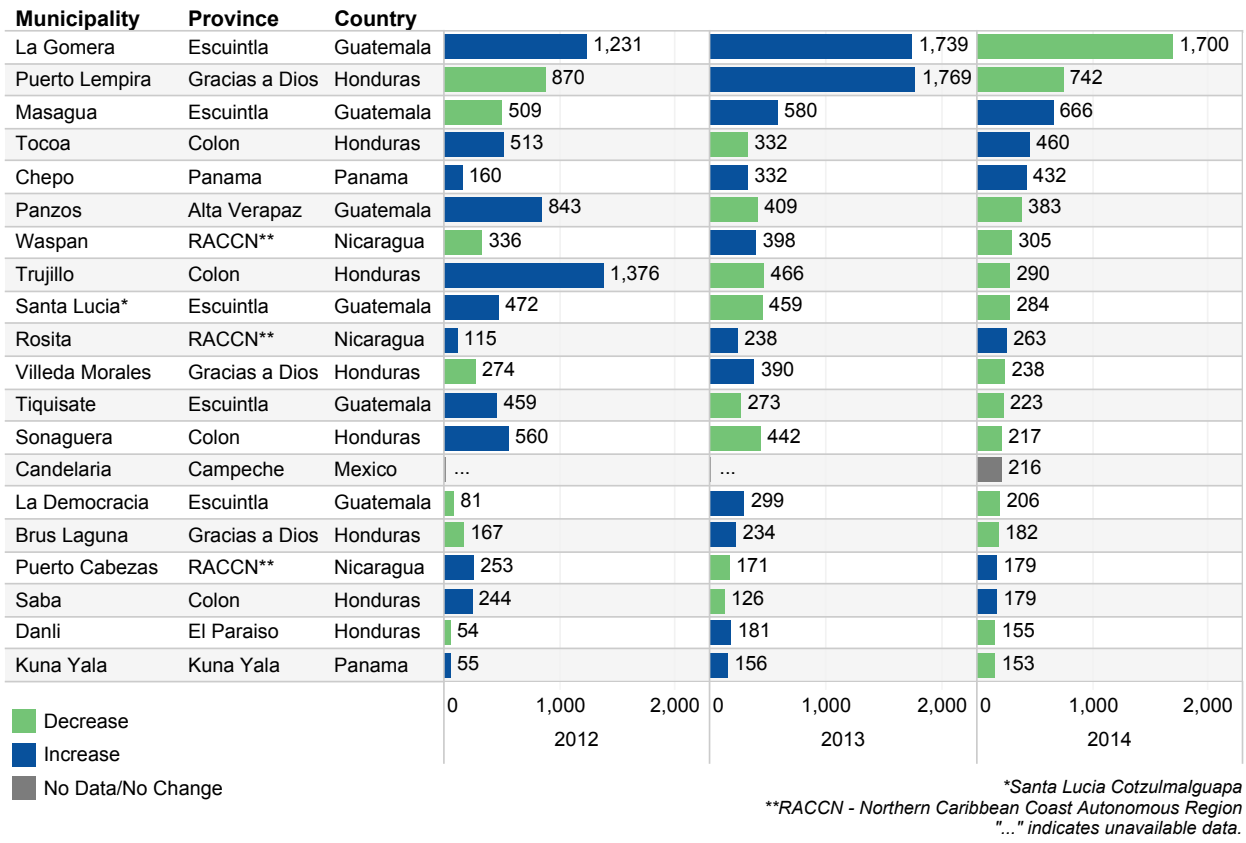
The countries of Mesoamerica have had a significant decrease in malaria cases. Since 2000, there has been a 91.2% reduction in malaria cases in the entire sub-region. Of the 8 countries that form the Mesoamerican sub-region, Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama, the last is the only country that has not achieved WHA target for the MDG 6C of 75% reduction of cases compared to 2000 (Figure 5).

Costa Rica is currently in the elimination phase, while Belize, El Salvador, and Mexico are all in the pre-elimination phase. Costa Rica, Belize, and El Salvador all reported less than 20 autochthonous malaria cases in 2014.

Malaria transmission is concentrated in the province of Escuintla in Guatemala, the shared Moskitia area of Honduras and Nicaragua, and Chepo municipality and the Guna Yala *comarca* in Panama (Figure 6). Escuintla is characterized as an impoverished province with a mobile population arriving from the highlands and northeast areas of the country to work in the sugarcane plantations. The municipalities of particular concern in this province are La Gomera and Masagua.

In Honduras and Nicaragua, many ethnic groups live in the Moskitia area, a tropical rainforest that flanks both countries. Malaria has been a challenge in this area due to difficulties in accessing healthcare as well as poverty. Though the majority of cases in the Moskitia are caused by *P. vivax*, this area reports the most cases caused by *P. falciparum* in Mesoamerica. Combined, the provinces of Gracias a Dios in Honduras and Northern Caribbean Coast Autonomous Region (RACCN) in Nicaragua reported 64.4% of *P. falciparum* cases in the sub-region. In Panama, the administrative regions (or *comarcas*) of Madungandi (near the municipality of Chepo) and Guna Yala have substantial indigenous and ethnic populations. In these *comarcas,* there is limited access to healthcare, along with cultural and language barriers affecting a patient's ability to be adequately treated.

**Figure 6. Municipalities (ADM2) with the highest number of malaria cases in the Mesoamerica sub-region, 2012-2014**




**Santa Lucia Cotzulmalguapa*
***RACCN - Northern Caribbean Coast Autonomous Region*
*"..." indicates unavailable data.*

The majority of the cases in Mesoamerica are caused by *P. vivax*; in 2014, this species caused 92.4% of cases in the sub-region. The remaining 7.6% of cases were caused by *P. falciparum* and mixed infections mostly in the provinces of Gracias a Dios and Colon in Honduras and RACCN in Nicaragua. First line treatment for both *P. falciparum* and *P. vivax* in the entire sub-region is chloroquine and primaquine except for Panama who, like Colombia, uses the combination drug artemether-lumefantrine to treat *P. falciparum* cases. In Guatemala, a 15-mg dose of primaquine for 3 days is used to treat *P. falciparum*. Studies and molecular surveillance show that the parasite continues to be sensitive to chloroquine in the sub-region. Treatment for *P. vivax* in the sub-region is a 3-day dose of chloroquine and a 14-day dose of primaquine except in Nicaragua, Panama, and Costa Rica where 0.5 mg/kg per day is given for 7 days. Different treatment policies across countries, especially along the Honduras and Nicaragua border, lead to incomplete adherence and treatment.

In the sub-region, ethnic and mobile populations are especially at higher risk of having malaria. Central American countries are a major transit area for mobile populations from all over the world towards the north to Mexico, U.S., and Canada. Mobile populations are susceptible to malaria due to the nature of their migratory lifestyle. Health clinics set up in sites along migratory routes in Mexico and aimed at such migratory populations have tried to improve healthcare access.

## SOUTHERN CONE

Argentina and Paraguay are the only remaining malaria-endemic countries in the Southern Cone. Both countries, however, are currently in the elimination phase and have reported a small number of cases in the past few years. In 2014, Argentina reported 4 cases and Paraguay reported 8, all of which were imported cases. No autochthonous cases have been reported in the past three years in Argentina; the country has applied for certification of malaria-free status to the WHO in 2014. Paraguay has not reported any autochthonous cases since 2012 and is expected to request certification by the WHO soon.

While no autochthonous cases have been reported, the major issue has been the importation of cases from neighboring countries. Argentina has reported many imported cases from Bolivia and Brazil, particularly in the provinces of Salta and Misiones. Salta attributes the malaria problem to impoverished Bolivians crossing into Argentina for work. In Misiones, malaria problems stem from ecological conditions, poverty, and proximity to malaria-endemic areas of Brazil. In Paraguay, people returning from Africa have been an important source of imported cases other than Brazil.

Argentina's intervention plan includes high-quality surveillance and vector control to prevent malaria transmission especially in border areas. In the past, Argentina has even assisted in indoor residual spraying of Bolivian homes in adjoining border areas as a binational effort to reduce transmission across borders.

In Paraguay, the National Service for Eradication of Malaria (SENEPA is its acronym in Spanish) has been a long-standing malaria service created in the 1950s by the government. In 2008, SENEPA began implementing the national malaria plan that focused on epidemiological surveillance, free testing and treatment for malaria patients, and vector control. The goals of the malaria plan were achieved quickly and a plan dedicated to elimination was created with the goal to eliminate the disease by 2015. The plan includes objectives for reporting all cases, treating all patients, quality-assured diagnosis, linking Geographical Information Systems (GIS) to surveillance information, and community capacitation for prevention and treatment.

Progress has thus far come a long way for both Argentina and Paraguay; efforts in the latter were recognized as the "Malaria Champion of the Americas" for the year 2012. Their continued efforts are a remarkable model for other countries in the Region which will find themselves in a similar position in the next few years.

## NON ENDEMIC COUNTRIES

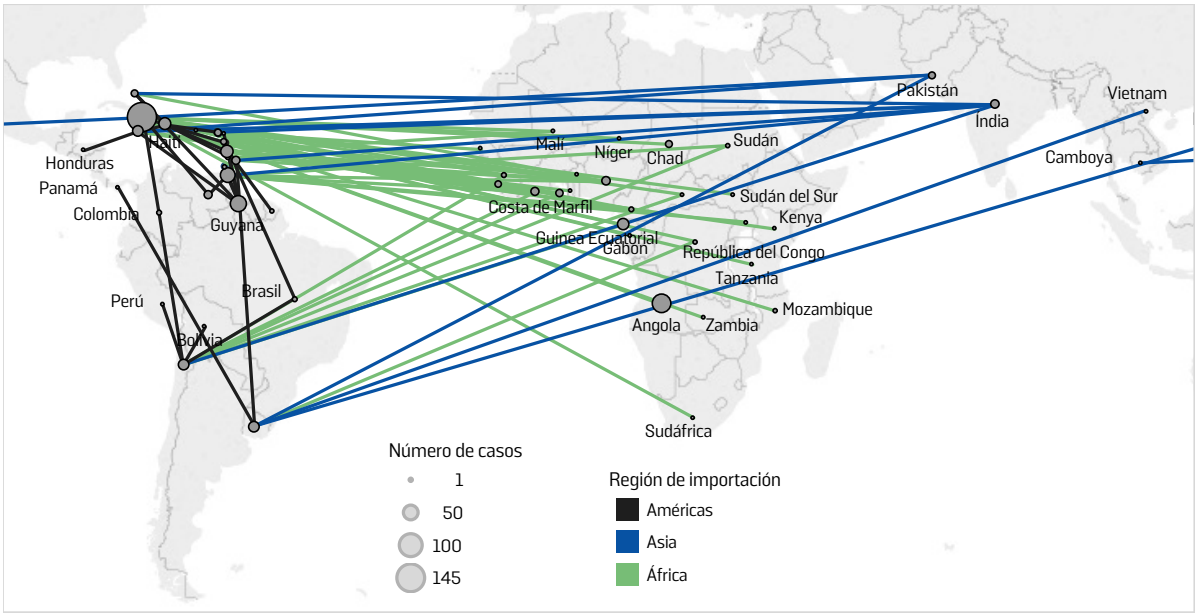
There are 30 member states and territories in the Region of the Americas that are considered non-endemic for

### Table 1. Malaria cases in non-endemic countries in the Region of the Americas, 2010-2014

| Country | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| United States of America | 1,691 | 1,925 | 1,687 | 1,742 | 1,727 |
| Canada | 514 | 517 | 477 | 488 | 447 |
| Cuba | ... | 28 | 32 | 48 | 37 |
| Trinidad & Tobago | 23 | 10 | 19 | 13 | 12 |
| Martinique | 7 | 13 | 2 | 9 | 5 |
| Barbados | 2 | 10 | 9 | 5 | 2 |
| Uruguay | ... | 2 | 7 | 13 | 2 |
| Guadeloupe | 8 | 1 | 2 | 2 | 1 |
| Saint Lucia | ... | 1 | 2 | 1 | 1 |
| British Virgin Islands | 0 | ... | ... | 0 | 0 |
| Grenada | 0 | 0 | 1 | 2 | 0 |
| Anguilla | ... | 0 | 0 | 0 | ... |
| Antigua & Barbuda | 1 | 1 | 0 | 0 | ... |
| Aruba | ... | ... | ... | ... | ... |
| Bahamas | 1 | 6 | 2 | 2 | ... |
| Bermuda | ... | ... | ... | ... | ... |
| Bonaire | ... | ... | ... | ... | ... |
| Cayman Islands | 1 | 1 | 3 | ... | ... |
| Chile | 3 | 5 | 10 | 6 | ... |
| Curaçao | ... | ... | ... | ... | ... |
| Dominica | 1 | 1 | 0 | ... | ... |
| Jamaica | 12 | 9 | 5 | 6 | ... |
| Monteserrat | 0 | 0 | 0 | 0 | ... |
| Puerto Rico | 5 | 2 | 1 | 1 | ... |
| Saba | ... | ... | ... | ... | ... |
| Saint Barthelemy | ... | ... | 1 | ... | ... |
| Saint Kitts & Nevis | 1 | 1 | 0 | 0 | ... |
| Saint Martin | 1 | 7 | 1 | ... | ... |
| Saint Vincent* | 2 | 0 | 0 | ... | ... |
| Sint Eustatius | ... | ... | ... | ... | ... |
| Sint Maarten | ... | ... | ... | ... | ... |
| Turks & Caicos Islands | ... | ... | ... | ... | ... |
| US Virgin Islands | 0 | 0 | 0 | 0 | ... |
| Grand Total | 2,273 | 2,540 | 2,261 | 2,338 | 2,234 |

*Saint Vincent & the Grenadines
"..." indicates unavailable data.

Figure 7. Malaria cases imported in the Region of the Americas, 2011 - 2014




malaria. In 2014, nine of these countries reported a total of 1,932 malaria cases most of which were reported from the United States of America (USA) (Table 1). Canada reported about 20% of the cases imported in the Americas between 2010 and 2014. Though 8 countries have officially been certified as malaria-free and another 9 have been listed on the supplementary list (indicating countries where malaria never existed or disappeared without specific measures), thousands of cases continue to be imported from endemic countries every year (6).

Malaria is imported from all endemic countries of the world, though the majority of cases come from those who have traveled from African countries (Figure 7). Non-endemic countries who submitted information about origin of case during 2011-2014 (excluding the USA), reported a total of 1,326 cases, with 58.7% coming from Africa, 31.1% from the Americas, 7.9% from Asia, and 2.2% had an unidentified origin (Table 2). During 2011-2014, cases imported to non-endemic countries in the Americas mostly originated from Angola (19.2% of total reported), followed by Guyana (14.3%); Haiti (7.6%) and Venezuela (3.49%) were other important endemic countries from the Americas from which cases were imported. Consequently, the majority of cases in this period were due to *P. falciparum* infections in all countries except for Trinidad and Tobago and Grenada where *P. vivax* infection importation predominated. It is noteworthy to mention that species could not be identified in some cases reported from Chile (n=7), Saint Lucia (n=2), Martinique (n=1), and Barbados (n=1). It is of utmost importance that non-endemic countries maintain their diagnostic capacities as part of surveillance to prevent reestablishment of transmission. Among non-endemic countries, malaria surveillance in Cuba is fairly robust as evidenced by the information reported.

Of the non-endemic countries in the Caribbean sub-region, Cuba reported the most imported cases each year throughout 2011-2014. Many of the cases were imported by traveling medical personnel as well as military returning from United Nations (UN) peace-keeping deployments. This is also the case in Uruguay. Furthermore, this is also evident in age and gender information of imported cases; of all the cases for which age and gender information was available (805) during 2011-2014, a majority were in men (70.7%) and those in the 15-49 year age group (men: 56.7%, women: 20.6%).

During 2006-2009, Jamaica had an outbreak of malaria, which resulted in a peak of 43 cases during epidemiological week 50 of 2006 (7). The outbreak began due to an influx of imported malaria cases believed to have been introduced by Haitian refugees in the years prior. Jamaica reported 15 autochthonous cases in 2009, but has not reported any thereafter. The Bahamas also had an outbreak in 2006, identifying 19 cases within a 2-month period (8). The Bahamas was eventually listed on the supplementary list in 2012. Jamaica, on the other hand, was certified as malaria-free in 1966 and is an example of a successful outbreak intervention and emergency response during reintroduction of malaria.

The malaria challenges in non-endemic countries are based on travel and the potential to be unprepared for outbreaks. Many of the non-endemic countries are islands, which implies that it is easier to screen for malaria in immigrants when compared to those countries where immigration can happen via land, the latter being harder to check. With the ever-increasing mobility of humans by air, sea, and land, non-endemic countries will always be at risk of malaria importation. Non-endemic countries all have the *Anopheles* vector; it is therefore imperative to have functioning surveillance and emergency response systems to prevent reestablishment of malaria transmission by intervening in a timely manner.

## Table 2. Imported cases in non-endemic countries of the Americas by country / Region of origin, 2011 - 2014

| | Country /Territory | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country/Region from which malaria was imported** | **Antigua & Barbuda** | **Bahamas** | **Barbados** | **Canada** | **Chile** | **Cuba** | **Grenada** | **Guadeloupe** | **Jamaica** | **Martinique** | **Puerto Rico** | **Saint Barthelemy** | **Saint Lucia** | **Saint Martin** | **Trinidad & Tobago** | **U.S.A.*** | **Uruguay** | **Total** |
| **Argentina** | | | | | | | | | | | | | | | | 1 | | 1 |
| **Bahamas** | | | | | | | | | | | | | | | | 1 | | 1 |
| **Belize** | | | | | | | | | | | | | | | | 3 | | 3 |
| **Bolivia** | | | | | 1 | | | | | | | | | | | 1 | | 2 |
| **Brazil** | | | | | 3 | | | 1 | | | | | | | | 16 | | 20 |
| **Colombia** | | | | | 3 | 1 | | | | | | | | | | 7 | | 11 |
| **Costa Rica** | | | | | | | | | | | | | | | | 3 | | 3 |
| **Dominican Republic** | | | | | | | | | | | | | | | | 14 | | 14 |
| **Ecuador** | | | | | | | | | | | | | | | | 2 | | 2 |
| **El Salvador** | | | | | | | | | | | | | | | | 3 | | 3 |
| **French Guiana** | | | | | | | | 1 | | 3 | | | | | | 1 | | 5 |
| **Guatemala** | | | | 1 | | | | | | | | | | | | 18 | | 19 |
| **Guyana** | 1 | 1 | 5 | | | | 2 | | 5 | 4 | | | 3 | | 22 | 89 | 1 | 133 |
| **Haiti** | | 1 | 1 | 1 | | 3 | | 2 | 5 | 6 | 0 | 0 | | 6 | | 134 | | 159 |
| **Honduras** | | | | | | | | | 1 | | | | | | | 42 | | 43 |
| **Jamaica** | | | | | | | | | | | | | | | | 3 | | 3 |
| **Mexico** | | | | | | | | | | | | | | | | 4 | | 4 |
| **Nicaragua** | | | | | | | | | | | | | | | | 4 | | 4 |
| **Panama** | | | | | | | | | | | | | | | | 3 | 1 | 4 |
| **Peru** | | | | 1 | 2 | | | | | | | | | | | 36 | | 39 |
| **Suriname** | | | | | | | | | | | | | | | | 1 | | 1 |
| **Trinidad & Tobago** | | | | | | | | | | | | | | | 1 | | | 1 |
| **Venezuela** | | | | | | 9 | | | | | | | | | 2 | 2 | | 13 |
| **Caribbean, unsp.** | | | | | | | | | | | | | | | | 2 | | 2 |
| **Central America, unsp.** | | | | | | | | | | | | | | | | 7 | | 7 |
| **South America, unsp.** | | | | | | | | | | | | | | | | 2 | | 2 |
| **Total** | 1 | 2 | 6 | 3 | 9 | 13 | 2 | 4 | 11 | 14 | 0 | 0 | 3 | 6 | 25 | 399 | 2 | 500 |
| | | | | | | | | | | | | | | | | | | |
| **Africa** | | 6 | 8 | 126 | 18 | 249 | 2 | 4 | 12 | 24 | 2 | 2 | 2 | | 18 | 9,998 | 24 | 10,495 |
| **Asia** | | 6 | 4 | 8 | 2 | 14 | | | 4 | | | | | 4 | 6 | 1,782 | 10 | 1,840 |
| **Oceania** | 0 | | | 2 | | | | | | | | | | | | 58 | | 60 |
| **Unknown** | 0 | 2 | 2 | 752 | 4 | | | | 2 | 6 | | | | | | 1,396 | | 2,164 |
| **Total** | 0 | 14 | 14 | 888 | 24 | 263 | 2 | 4 | 18 | 30 | 2 | 2 | 2 | 4 | 24 | 13,234 | 34 | 14,559 |

*United States of America

# SECTION III: CROSS-CUTTING ISSUES

## Policies, Strategies, Goals and Targets for Malaria

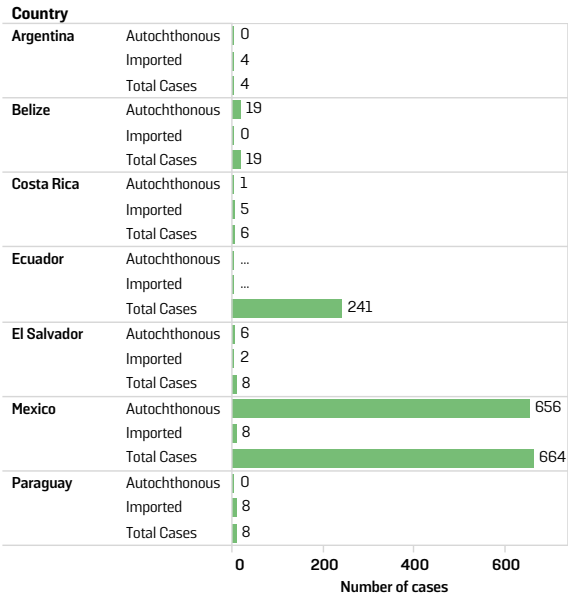
Many of the global goals and targets set for malaria since 2000 have influenced the targets for the Region. Table 1 summarizes some of the major global declarations concerning malaria during 2000–2015.

**Table 1. Global plans regarding malaria control and elimination, 2000–2015**

- United Nations Millennium Declaration
- World Health Assembly WHA58.2
- Global Malaria Action Plan for a malaria-free world (updated goals for 2011 and beyond)

The United Nations Millennium Declaration made malaria a priority in 2000 by establishing it as one of the 8 goals. Target 6C is "Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases." Following the MDGs, further targets for MDG 6C were created during the 58th WHA in 2005. Resolution WHA58.2 called for a 75% reduction of morbidity and mortality due to malaria by 2015. In 2011, Resolution CD 51.R9 was passed at the 51st Session for the Directing Council which led to the 'Strategy and Plan for Malaria' for the 2011–2015, period which aligned with MDG and Roll Back Malaria (RBM) targets (9).

**Figure 1. Number of cases by origin of infection in countries approaching elimination, 2014**




*Ecuador did not report origin of infections for 2014.

Currently, 14 of the 21 endemic countries in the Americas have committed to malaria elimination in their national strategic plans and enlisted initiatives. At the 68th WHA, the WHO adopted its new malaria strategy: the Global Technical Strategy for Malaria 2016–2030 (GTS)(10). The new strategy focuses on acceleration of elimination with a target of certifying 35 new countries as malaria-free by 2030. The Action and Investment to Defeat Malaria (AIM)(11) is a tool that can enable stakeholders to gain support for malaria initiatives and further complements the GTS. PAHO/WHO has updated the Regional Strategy and Plan of Action that expands the GTS and tailors goals specifically for the Americas for the 2016–2020 period. The combination of the aforementioned documents will serve in guiding elimination efforts in the Americas.

Policies differ based on a country's program phase (control or elimination) and focus on the areas of diagnosis, treatment, vector control, and surveillance. For those countries in the pre-elimination and elimination phases of malaria, it is important to have in place a program for assurance of diagnostic quality of microscopy of laboratories. Currently, all 8 countries in the Americas (Argentina, Belize, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, and Paraguay) that are in the pre-elimination and elimination phases do so. Furthermore, national reference laboratories should be internationally certified; 4 countries in the pre-elimination and elimination phases were reported certified in 2014 including Argentina, Costa Rica, El Salvador, and Mexico. In treatment policies, strict supervision of treatment with primaquine is currently implemented by 11 of the 19 endemic countries in the Americas where *P. vivax* is endemic. Routine admission of patients with uncomplicated *P. falciparum* malaria in hospitals is a recommended policy for pre-elimination and elimination phases and was put in place in all but Belize, Dominican Republic, and Ecuador. Monitoring of therapeutic efficacy is currently being undertaken in 12 countries in Americas while another five do not have enough cases in a year to carry out *in-vivo* drug efficacy trials. In vector control, the use of larval control is currently a policy in 13 countries of the Americas, most of which are in the Mesoamerican sub-region. All countries except Suriname recommend use of IRS while bed nets are distributed for free in all countries except

Argentina and Paraguay, both of which have not reported autochthonous cases in the past two years. Monitoring of insecticide resistance in malaria vectors was reported as a policy in all but three countries in the Americas; however, implementation is still lacking in some of these. Malaria is a notifiable disease in public sector all countries in the pre-elimination and elimination phase in the Americas and four of these require that the private sector also notify cases. Additionally, as a policy, all confirmed cases of these countries are to be investigated.

## Elimination

As of 2014, three countries were in the malaria elimination phase: Argentina, Costa Rica, and Paraguay. Additionally, Belize, Dominican Republic, Ecuador, El Salvador, and Mexico were in the pre-elimination phase. The classification criteria for program phase encompasses epidemiological factors, case management policies, and surveillance(12). Specifically, in Argentina and Paraguay all cases were imported (Figure 1). In Costa Rica, all cases except 1 recrudescence case were imported and in El Salvador 2 of 8 cases were imported. This indicates that transmission in these countries is very low or has been interrupted.

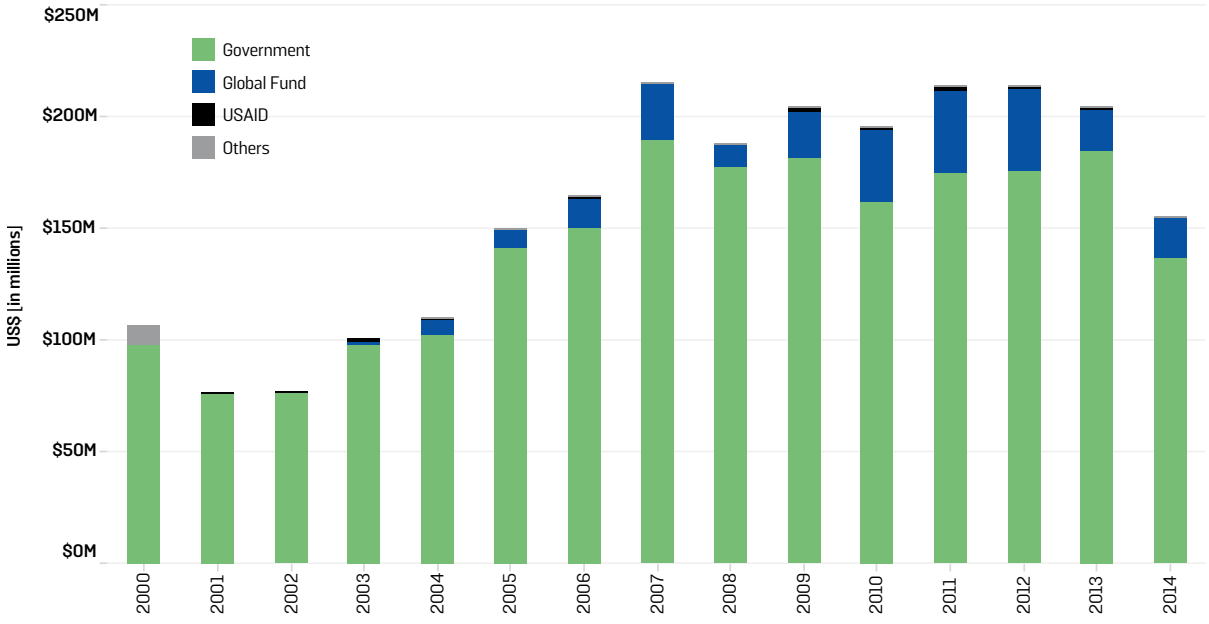
Eighteen of the 21 countries in the Americas have committed to eliminate malaria in the whole country or a part thereof. A number of malaria projects in the Americas focus on malaria elimination. The Malaria Elimination in Mesoamerica and the Hispaniola Island (EMMIE) Initiative is funded by the Global Fund and provides support for Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, and Panama, while Mexico also supports the initiative. Malaria Zero is a project funded by the Gates Foundation and aims to eliminate malaria on the Island of Hispaniola. Another project, the Mesoamerican Initiative on Malaria in Vulnerable Populations supported by the Mexican Agency for International Cooperation and Development also aims for malaria elimination in some countries.

These initiatives, along with the availability of domestic resources, financial support from key partners, and technical collaboration from international agencies, provide an important platform for realizing malaria elimination goals.

## Funding for Malaria

The majority of funding for malaria in the Americas comes from governmental sources. At least US$20 million came from external funding sources in 2014; the Global Fund alone provided US$17.6 million and has supported the Americas since 2003 (Figure 2). Fifteen out the 21 endemic countries received funding from the Global Fund in 2014 either through individual grants or as part of multi-country initiatives. Of those countries that were eligible to receive funding from the Global Fund, all except El Salvador and Paraguay received grants; however, these two countries are in the

**Figure 2. Funding for malaria in the Region of the Americas, 2000-2014**



process of applying for Global Fund grants. Additionally, the Global Fund supports projects involving multiple countries in the Americas such as PAMAFRO and the EMMIE initiative. PAMAFRO, implemented from 2005 to 2010 by the Andean Organization for Health (ORAS), focused on prevention of malaria in the border areas of Colombia, Ecuador, Peru, and Venezuela. The EMMIE initiative utilizes a cash-on-delivery mechanism and aims to accelerate efforts towards malaria elimination by 2020. Overall, support from the Global Fund has increased steadily since the establishment of the organization in 2002. Though funding decreased by half from US$36 million in 2011-2012 to US$18 million in 2013-2014, the Global Fund still contributes greatly to the malaria budget. The USAID-financed Amazon Malaria Initiative (AMI) has supported the Americas since 2002. The initiative, implemented by PAHO, distributed nearly US$1 million in 2014 to 11 countries. Though funding is often little compared to the entire country's malaria budget, funds are applied towards antimalarial sensitivity surveillance, improving the quality of diagnosis and treatment, improving quality of pharmaceuticals and supply chain management, strengthening vector surveillance and management, improving epidemiologic surveillance, and facilitating south-south cooperation.

Countries that did not report having received any external funding were Argentina, French Guiana, Mexico, and Venezuela. Excluding Venezuela, all countries have decreased their cases substantially since 2000. Malaria funding in Venezuela is of particular concern because the amount of cases has reached record-high levels, but the amount of reported governmental funding will not be able to support the resources desperately needed for control and intervention. The country is currently ineligible to receive funds from the Global Fund, nor receives funding from USAID. There is no external funding for Venezuela, but support is an apparent need.

Other external sources of funding in the Americas are the Gates Foundation (Malaria Zero project), the Clinton Health Access Initiative (CHAI), and other non-governmental organizations. Private companies also provide funds, often times voluntarily through social responsibility programs. Estimates on private sector funding are not available for this report.

Overall, total domestic funding in countries of the Americas decreased between 2013 and 2014 by 26% despite having increased in 2011 and 2012. Colombia had a US$11.6 million decrease in 2014 compared to the previous year, while Panama had a US$3.8 million increase the same year. Ecuador, French Guiana, and Peru did not report information on the amount of domestic funding for malaria in 2014, although resources were provided. As countries begin to gradually enter the elimination phase, adequate funding will have to be maintained to achieve these goals as well as prevent reestablishment of malaria transmission. At present, funding information is only collected at the national level and may not include funds for malaria at subnational levels, funds related to patient care and or salaries of medical personnel in hospitals and health centers. Countries may also not include funding from other governmental sources such as military or social security hospitals in their reports. Other in-kind contributions may also not be reported by countries as donations may be difficult to translate into monetary values. All these issues add to the underreporting of resources for malaria, especially domestically.

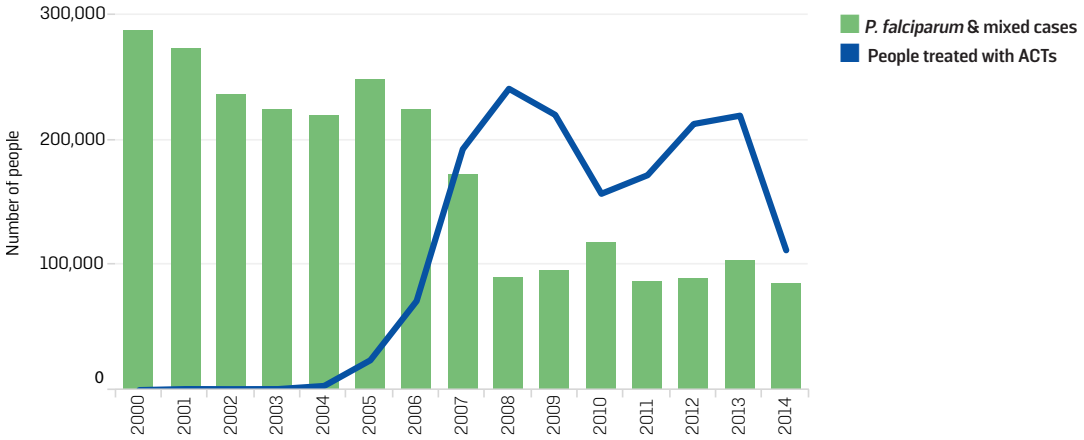
### Diagnosis and Treatment

Malaria microscopy is the gold standard for diagnosis of *Plasmodium* infections and is the most widely used diagnostic tool in the Americas. During 2014, 6.7 million blood slides examinations were done, lower than in previous years due to the overall reduction of cases. The use of RDTs has increased in the Americas over the last few years and in 2014 reached its highest amount reported. A total of 354,119 RDTs were examined during 2014 from nine countries. In most of these countries, RDTs are performed by community health workers in rural areas where people have limited access to health facilities. Haiti, however, uses RDTs nationwide, having been introduced in 2012. Evidence suggests RDTs have replaced rather than complemented microscopy in Haiti.

In 2014, about a quarter of the total reported cases in the Americas were caused by *P. falciparum* and mixed infections. Compared to data from 2000, *P. falciparum* decreased by 66.5%. Most *P. falciparum* cases are reported from the Amazon sub-region and account for 82% of cases reported in the entire Americas in 2014. As artemisinin-based combination therapies (ACTs) were introduced in the Amazon sub-region, an initial decrease could be seen in the number of *P. falciparum* cases (Figure 3), indicating the beneficial effects of introduction of ACTs.

PAHO recommends that 80% of cases, treatment should begin in less than 72 hours from the onset of symptoms (13). There is a paucity of data on this subject, though countries in the Americas have begun to report this information in the past few years. Honduras has shown a decrease in the percentage of cases receiving timely treatment due to changes from presumptive treatment to treatment of only confirmed cases, thus having a negative trend (Figure 4). Bolivia's increase in the percentage of cases receiving timely treatment may be an error of data collection since the country now reports that almost all cases are starting treatment in less than 24 hours of onset of symptoms.

## Figure 3. Number of *P. falciparum* and mixed cases and those treated with ACTs in the Amazon sub-region, 2000-2014

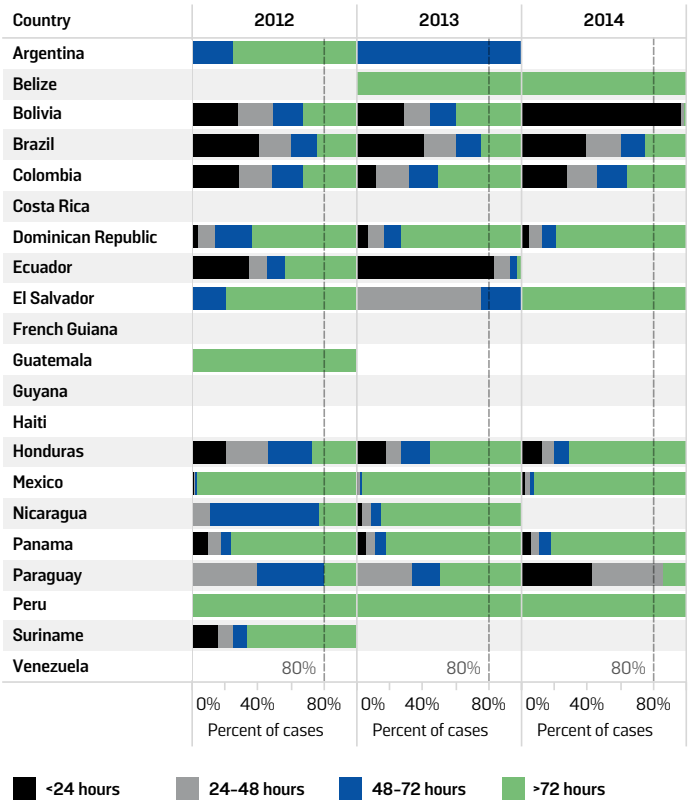



## Table 2. Microscopy and RDT use in the Region of the Americas, 2000-2014

| Year | Blood smears examined | RDTs Examined |
|---|---|---|
| 2000 | 9,793,737 | ... |
| 2001 | 9,205,342 | 0 |
| 2002 | 9,025,164 | 0 |
| 2003 | 8,414,602 | 0 |
| 2004 | 8,365,723 | 5,000 |
| 2005 | 12,660,369 | 8,500 |
| 2006 | 9,270,303 | 30,063 |
| 2007 | 9,390,226 | 57,078 |
| 2008 | 8,193,079 | 46,253 |
| 2009 | 8,124,331 | 121,048 |
| 2010 | 8,455,652 | 66,843 |
| 2011 | 7,612,545 | 105,482 |
| 2012 | 7,442,929 | 220,529 |
| 2013 | 6,977,551 | 175,765 |
| 2014 | 6,707,921 | 354,119 |

"..." Indicates unavailable data.

## Figure 4. Time between first symptom and initiation of treatment in countries of the Americas, 2012-2014



## Table 3. First line of treatment for malaria by species type in the Region of the Americas

| Country | *P. falciparum* | *P. vivax* |
|---|---|---|
| **Argentina** | AS+MQ; AL | CQ+PQ(7) |
| **Belize** | CQ+PQ(1d) | CQ+PQ(14) |
| **Bolivia** | AS+MQ+PQ | CQ+PQ(7) |
| **Brazil** | AL+PQ; AS+MQ+PQ | CQ+PQ(7); CQ+PQ(14) |
| **Colombia** | AL | CQ+PQ(14) |
| **Costa Rica** | CQ+PQ(1d) | CQ+PQ(7); CQ+PQ(14) |
| **Dom. Rep.*** | CQ+PQ(1d) | CQ+PQ(14) |
| **Ecuador** | AL+PQ | CQ+PQ(7) |
| **El Salvador** | CQ+PQ(1d) | CQ+PQ(14) |
| **French Guiana** | AL; AQ+PG | CQ+PQ |
| **Guatemala** | CQ+PQ(3d) | CQ+PQ(14) |
| **Guyana** | AL+PQ(1d) | CQ+PQ(14) |
| **Haiti** | CQ+PQ(1d) | CQ+PQ(14) |
| **Honduras** | CQ+PQ(1d) | CQ+PQ(14) |
| **Mexico** | CQ+PQ | CQ+PQ |
| **Nicaragua** | CQ+PQ(1d) | CQ+PQ(7) |
| **Panama** | AL+PQ | CQ+PQ(7); CQ+PQ(14) |
| **Paraguay** | AL+PQ | CQ+PQ(14) |
| **Peru** | AS+MQ+PQ(1d) | CQ+PQ(7) |
| **Suriname** | AL+PQ(1d) | CQ+PQ(14) |
| **Venezuela** | AS+MQ+PQ(1d) | CQ+PQ(14) |

CQ- Chloroquine PQ- Primaquine MQ- Mefloquine
AS- Artesunate AL- Artemether & Lumefantrine
PG- Proguanil AQ- Atovaquone
For *P. falciparum* - (3d): 15 mg of Primaquine per day for 3 days (adults)
(1d): 45 mg of Primaquine in 1 dose on 1st day (adults)
For *P. vivax*- (14d): 15 mg of Primaquine per day for 14 days (adults)
(7d): 30 mg of Primaquine per day for 7 days (adults)
** Artemisinin-based combination therapy (ACT) is used for imported cases of *P. falciparum* in countries using CQ as first-line treatment for this species.
*Dom. Rep. - Dominican Republic

Brazil and Colombia are approaching the 80% recommendation. The Dominican Republic has had an increase in the percent of cases starting treatment in more than 72 hours because of their continuous concern with immigrants avoiding treatment so as not to expose their illegal status. Panama has had a high percentage of cases receiving treatment in more than 72 hours because many cases occur in areas with limited access to healthcare and among populations with strong cultural barriers. Paraguay has the reported ability to manage malaria cases rapidly. Their advantage over other countries in the Americas is that they have had only a few imported cases. Once a case is detected, healthcare personnel are expected to inform SENEPA, who then provides malaria services including treatment. Active malaria surveillance entails systematic collection of blood samples for people with or without symptoms by going out into the communities. As countries approach elimination, more emphasis is laid on active surveillance wherein the time period between onset of symptoms and treatment is decreased, as thus the probability of transmission from an infected person to others decreases. This could lead to an increase in the proportion of cases detected through active surveillance specifically and in general the total number of cases reported by the country. Panama reported that 81% of cases were detected through active surveillance in 2014. This country together with Argentina, Paraguay, and Dominican Republic reported that over 70% of all microscopic examinations were done on blood smears collected through active surveillance. This proportion stands at around 50% in Belize, Bolivia and Brazil, indicating the underlying effort of the country. Few countries, including Ecuador, French Guiana, Guatemala, Haiti, Mexico, and Peru, have not reported data on active surveillance.

### Antimalarial Resistance

Currently, there are 12 endemic countries in the Americas that use ACT drugs for the treatment of uncomplicated *P. falciparum*. These include endemic countries of South America and Panama. There are a few countries that use ACTs to treat *P. falciparum* but did not report on the number of people treated in 2014 including Ecuador, French Guiana, Guyana, and Peru, though the latter has provided this information consistently in the past. The rest of the countries in the Mesoamerican and Hispaniola sub-regions treat all malaria infections with chloroquine, which continues to be efficacious based on routine surveillance information. Currently, molecular surveillance of chloroquine resistance is conducted in Honduras(14) and Nicaragua and will be extended to other countries of Mesoamerica.

Drug resistance can develop due to inadequate treatment resulting from non-compliance of medication dosages. Throughout the Americas there have been areas known to be a problem. In the Guiana Shield,

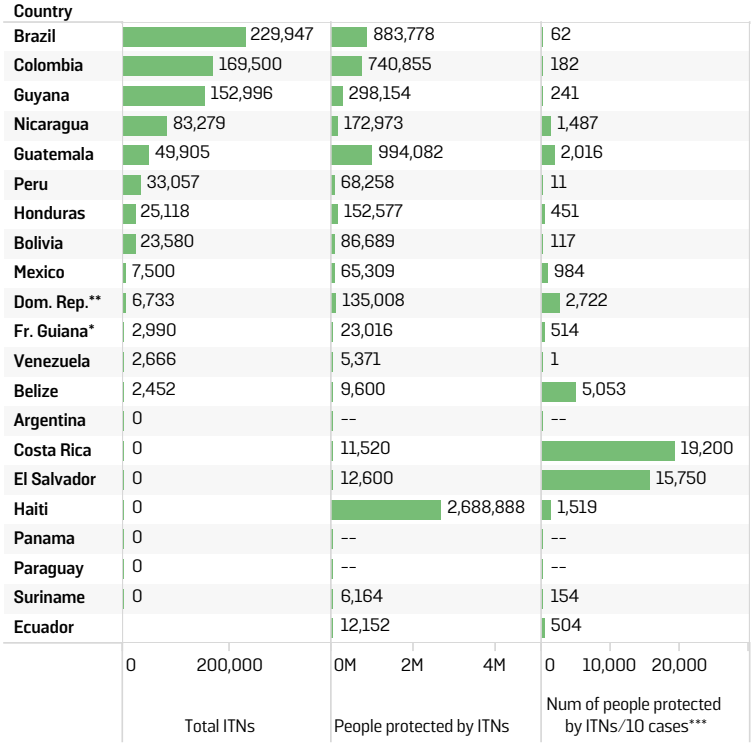
some miners often consume enough medicine to feel better and then proceed to sell the rest before completing the recommended dosage. The quality of antimalarials available in the private sector is also circumspect. Although artemisinin monotherapy is banned, it is available illegally in the interiors of countries in the Guiana Shield.

Along the border of Honduras and Nicaragua, treatment policies differ, causing problems of adherence leading to inadequate dosage. Throughout the Americas, primaquine is used to clear hypnozoites in the liver for *P. vivax* infections and is usually given in a 7-day dose of 0.5 mg/kg or 14-day dose of 0.25 mg/kg. While drug resistance has not been reported along the Honduras and Nicaraguan border, a difference in policies may contribute to apathetic attitudes towards drug adherence. Primaquine also causes adverse effects in those with glucose-6-phosphate dehydrogenase (G6PD) deficiencies. Though primaquine is used extensively throughout the Americas to treat malaria, G6PD testing is not routinely conducted. The prevalence of G6PD is low in the Americas and, although primaquine is being used, it has historically not been associated with the reported adverse events.

In 2012, Suriname detected possible signs of decreased sensitivity to artemisinin-based treatment. Therefore, several institutions were prompted to take action and studies were conducted in order to see if decreased sensitivity had emerged not just in Suriname, but the rest of the Guiana Shield. In-vivo studies were conducted in Suriname and Guyana. Another study is planned to determine resistance along the border between French Guiana and Brazil. The AMI/RAVREDA project provides technical assistance for these studies. Preliminary data from these studies show that there is no decreased sensitivity to artemisinin; nonetheless, risk factors continue to exist and require urgent attention on the part of all governments of the Guiana Shield area and partnering institutions.

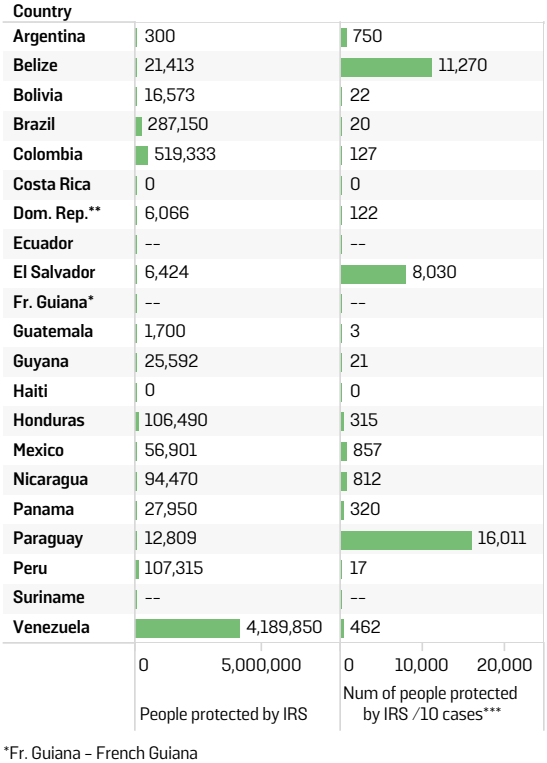
PAHO/WHO additionally provides assistance to maintain stocks of antimalarials. Countries are requested to provide quarterly stock information, which has decreased stock-outs, improved planning, and fostered south-south collaboration by exchange of medicines between countries. PAHO also keeps a regional stock of medicine for quick mobilization of antimalarial medicines in the event of emergencies or severe cases.

## Figure 5. ITN coverage in the Region of the Americas, 2014




*Fr. Guiana – French Guiana
**Dom. Rep. – Dominican Republic
***Number of people protected by ITNs per 10 malaria cases in 2014.
''--''indicates unavailable data.

## Figure 6. IRS coverage in the Region of the Americas, 2014




*Fr. Guiana – French Guiana
**Dom. Rep. – Dominican Republic
***Number of people protected by IRS per 10 malaria cases in 2014
''--''indicates unavailable data.

## Vector Control

### ITNs

In the Americas, ITNs and IRS are the primary vector control methods. All endemic countries in the Americas have policies to distribute ITNs free of charge except for Argentina and Paraguay. Though the majority of endemic countries have policies in place for ITN distribution, only 13 countries reported ITN distribution in 2014, amounting to about 790,000 total nets distributed. Brazil, Colombia, and Guyana distributed the most ITNs (Figure 5). All reported ITNs distributed in 2014 were long-lasting insecticide treated nets (LLINs). An estimated 6.4 million people were protected by ITNs in 2014, including those receiving protection from ITNs distributed in previous years. This estimate represents 5.9% of the total population at risk for malaria in the Americas. This includes protection from LLINs that have an average efficacy of 3 years. Haiti, for example distributed almost 3 million bed nets in 2012, which, if used properly, would continue to protect an estimated 2.7 million people in 2014. More than 4.5 million nets were distributed throughout the Americas in 2012, the highest number ever recorded. Even when excluding Haiti, 2012 was still the year when most bed nets were distributed. The number of people protected by ITNs per 10 cases was the highest for Costa Rica and other countries in the elimination phase that distribute them, though for countries still in the control phase, Dominican Republic, Guatemala, Haiti, and Nicaragua protect many people.

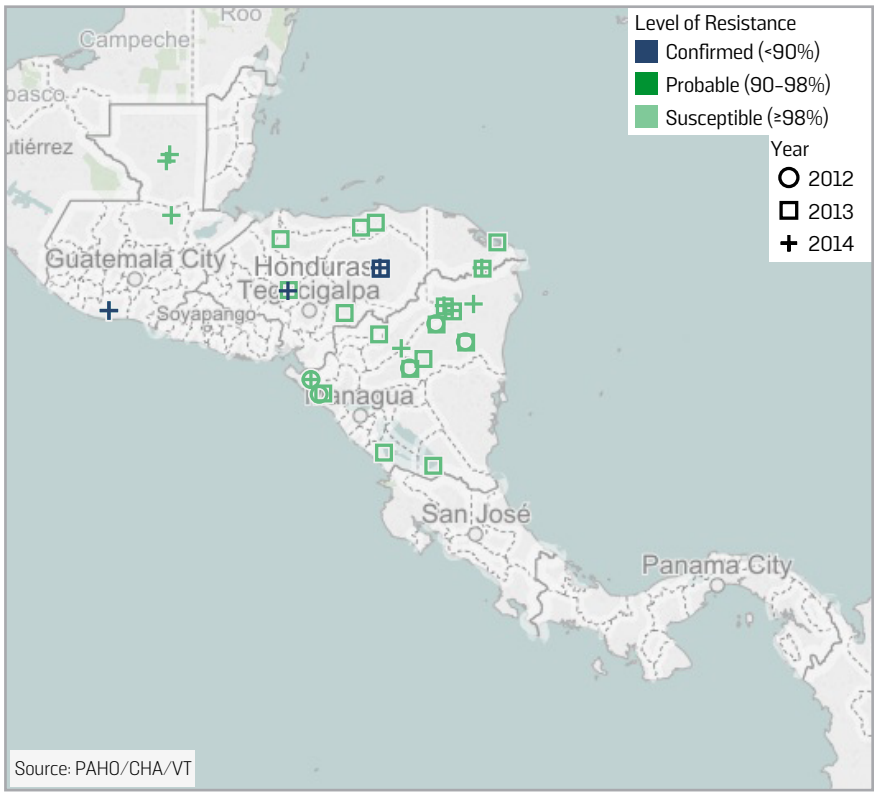
### IRS

All endemic countries use IRS except Haiti and Suriname. The use of DDT is not authorized as an official policy in any of the countries in the Americas. In 2014, 16 countries reported using IRS, protecting an estimated 5.5 million people in the Region, or 5.1% of the total population at risk for malaria in the Americas. Analysis of the number of people protected by IRS per 10 cases shows that Paraguay protects the most people followed by Belize and El Salvador (Figure 6). Among those countries in the control phase, Nicaragua, Venezuela, Honduras, and Panama protected over 300 people with IRS per 10 cases.

## Insecticide Resistance

As many as 11 countries have reported information on insecticide surveillance for *Anopheles* mosquitoes during 2012–2014 (Figures 7–9). Routine surveillance

**Figure 7. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Mesoamerica sub-region, 2012–2014**



of insecticide resistance is not conducted in Argentina, Belize, Costa Rica, El Salvador, Guyana, and Paraguay. French Guiana and Venezuela have not submitted this information and it is unclear if routine surveillance is conducted. Almost all countries that submitted data show resistance to pyrethroids in some areas except for Belize, Haiti, and Suriname.

In Haiti, the vector remains sensitive to pyrethroids tested. However, the Dominican Republic has reported resistance to alpha-cypermethrin and deltamethrin along the border with Haiti in the northwestern provinces of Montecristi and Dajabon. The vector continues to be sensitive to pyrethroids in all other areas of the country except Azua.

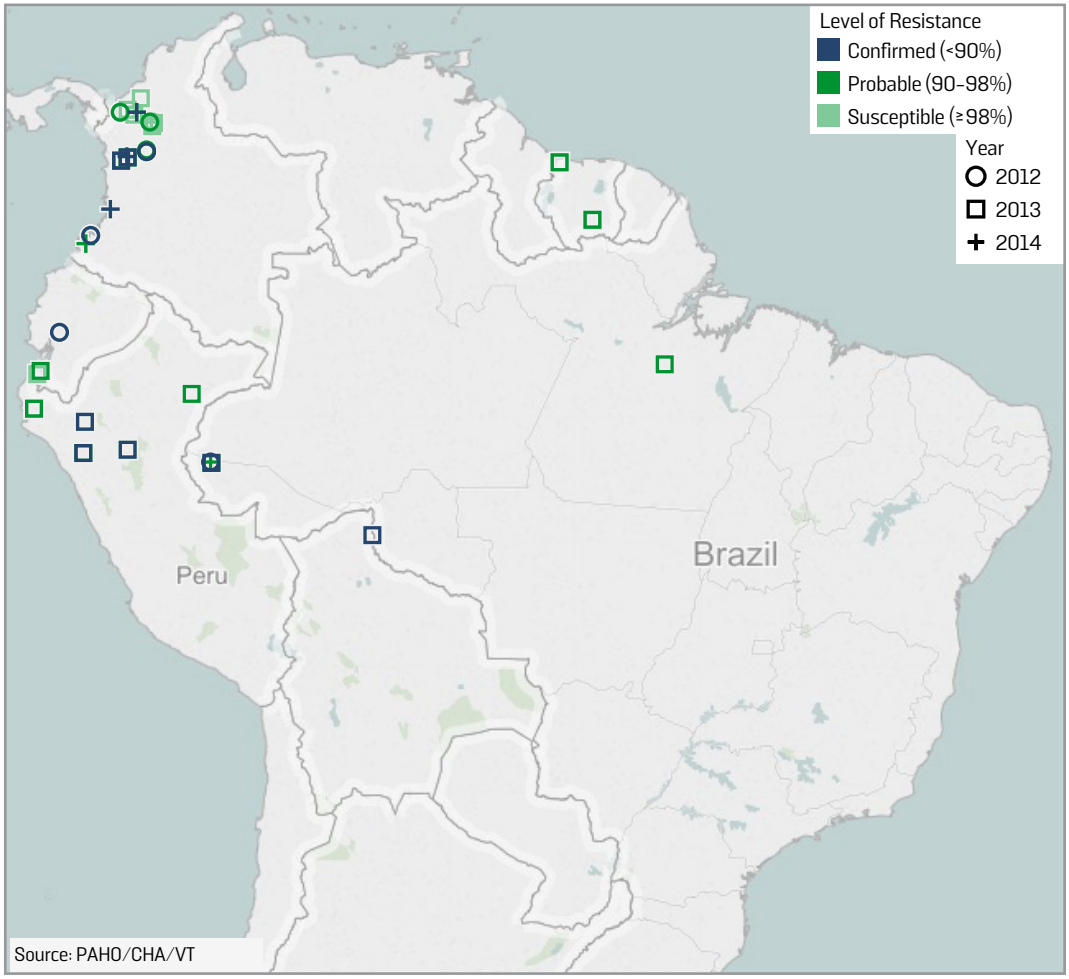
In Mesoamerica, resistance has been detected in malaria-endemic areas like Chepo in Panama, Escuintla in Guatemala, and Comayagua and Olancho in Honduras. Although resistance to deltamethrin has been reported in Nicaragua, the country uses fenitrothion to which the vectors continue to be susceptible. Many other areas of these countries have reported that the principal malaria vector is sensitive to pyrethroids.

While confirmed resistance to deltamethrin has been reported in Choco (*An. darlingi*) and other provinces on the Pacific coast (*An. albimanus*) of Colombia, *An. albimanus* largely continues to be susceptible in Antioquia and on the Atlantic coast of the country. Resistance of *An. darlingi* to pyrethroids has been reported in other high transmission areas of South America like Loreto in Peru, Guayaramerin in Bolivia, and Acre in Brazil. Information about insecticide resistance monitoring has been deficient in the past few years from most Amazon countries.

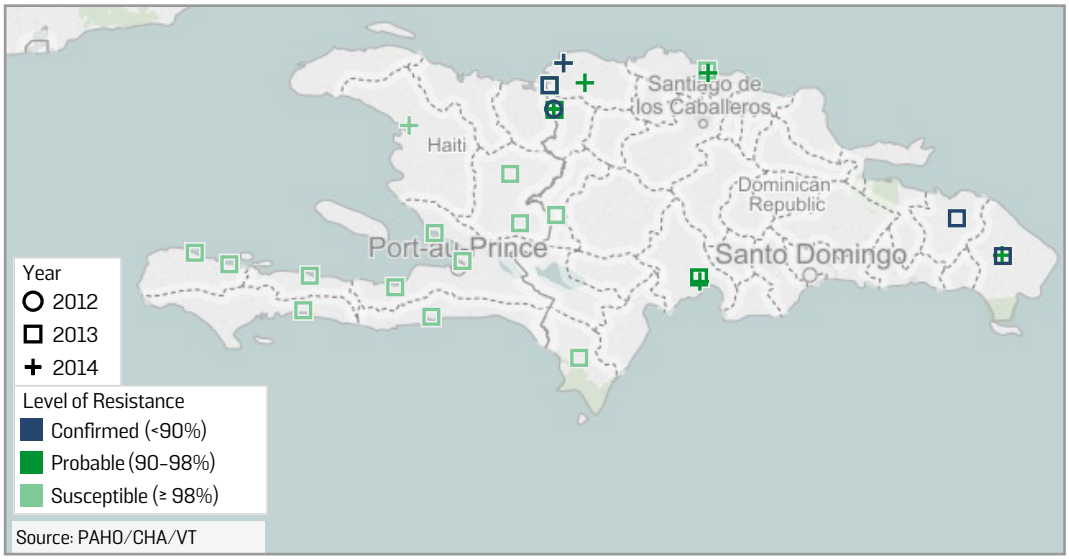
### Priority Groups

There are various subsets of people who are at higher risk of malaria or developing severe malaria. Some of these

**Figure 8. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Amazon sub-region, 2012-2014**



## Figure 9. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Hispaniola sub-region, 2012-2014




## Figure 10. Malaria in priority groups in the Region of the Americas

populations have been identified as children less than 5 years of age, pregnant women, and migrant populations among others. In the Americas, priority groups vary by country. Notable trends in the Americas can be observed in indigenous populations, people living in border areas, and mobile populations. Malaria is also an occupational risk for miners, loggers, and plantation workers.

Generally, these priority groups tend to have higher rates of poverty, live in rural areas, lack access to diagnosis and treatment, lack access to preventive methods, possess cultural barriers, and experience marginalization.

Indigenous peoples and ethnic groups are vulnerable to malaria in many Latin American countries including Miskitos in Honduras and Nicaragua, Guna Yala in Panama, Embera-Wounaans in Colombia and Panama, and Yanomamis in Venezuela just to name a few. The Economic Commission for Latin America and the Caribbean estimated an indigenous population of 45 million in Latin America in 2010(15). One of the reasons for higher rates of malaria among the ethnic groups and the indigenous population is that the areas they inhabit are associated with higher vector exposure such as the forests in the Amazons or the marshes of the Moskitia area.

Unfortunately, health information is not always collected about these populations leading to poor understanding about the risk. Cases for ethnic/indigenous populations were only reported by 8 of the 21 endemic countries in the Americas in 2014. Without adequate data, it is difficult to track disease trends and implement proper interventions as well as make a sound case for policy changes. PAHO resolution CD47.R18(16) was approved in 2006 and addressed the health needs of the indigenous peoples of the Americas calling for equity in each country. Access to prompt and quality diagnosis and treatment of malaria for this population is plagued by cultural and language barriers. Indirect costs like that for transportation further decrease accessibility; areas where these populations live are usually rural and far away from the nearest health center. Many ethnic groups and indigenous peoples also use traditional medicine adding to the complexity of the issue. WHO estimated that 80% of the indigenous population in the world uses traditional medicine as a means of primary care (17). It is therefore important to overcome these barriers and factor acceptability of Western versus traditional medicine when treating these populations.

In 2014, five countries in the Americas reported a number of cases in those living in border areas including Venezuela, Brazil, Dominican Republic, Panama, and Bolivia (Figure 10). As malaria decreases, transmission is ever more limited to border areas that are hard to access. Venezuela reported 90.3% of all confirmed cases to be among those living near the border. Both Bolivia and Brazil reported about half of their cases to be in this population and around 40% in Panama and Suriname (2012-2013 data). However, the definition and the method by which the population of those living in border areas is measured are not standard and thus the information is not comparable across countries. Other countries such as Honduras and Nicaragua, who do not specifically report the number of border cases, have a higher endemicity along their borders. Tracking cases along the border is a difficult task especially in the Guiana Shield where some miners lead discrete lifestyles due to the illegal nature of their work. In the past Mexico has also reported many cases from the border areas.

Occupational associations with high malaria transmission are of particular concern for several countries in the Americas. Some countries have reported cases in the mining, logging, and agricultural plantation workers. Throughout the Americas, miners represented 13% of all cases in 2014; however, underreporting is highly probable as many live discreet lifestyles and may try to avoid health facilities. Suriname and Brazil have reported cases in miners consistently over the past few years showing a general decline. Venezuela has reported cases in miners for the past 3 years, demonstrating an increase in cases which mirrors the trend in overall cases for the country. Colombia was the only other country to report on miners, recording more than a 1000 cases. The health information system in Guyana does not collect information on occupation and as such no cases in miners were reported by the country.

Before 2014, Brazil was the only country to report on cases in plantation workers (except for minimal cases in Belize and Paraguay). In 2014, almost 4,000 cases in plantation workers were reported (excluding Brazil) with an estimated half of those from Venezuela. Loggers are another occupational group of concern for Brazil and malaria has declined in them every year since 2009. No other country has reported information on this occupational group. Identifying possible associations with occupation can provide avenues for intervention. Afro-Colombians and Haitians are other priority groups accounting for more than 35% of all cases in Colombia and Dominican Republic respectively between 2012 and 2014.

### Malaria in Pregnancy

Incidence for malaria in pregnancy varies throughout the Americas, though the countries of the Guiana Shield report the highest rates. Brazil reported the highest number of malaria infections in pregnant women in 2014 (2,300) or 2% of total cases reported in that country. Bolivia and Suriname also reported that approximately 2% of the total cases occurred among pregnant women. Data regarding pregnancy cases are not routinely reported by French Guiana or Mexico, while Ecuador did not submit data for 2014.

Data were pooled for multiple years as only a small number of malaria in pregnancy cases were reported in some countries and/or data were missing for the most recent year (Table 4). While the incidence of malaria in pregnant women was significantly higher than that in non-pregnant women in child-bearing age in Brazil and Guyana, that was not the case in Suriname and Venezuela (Figure 10). Malaria is highly correlated with gold mining in these countries. Women at risk in the mining areas include cooks, sexual workers, and other working women; they are less likely to be pregnant, resulting in lower incidence rates of malaria in pregnancy in some of these countries. In Guyana and Brazil, areas other than mining camps are also endemic wherein pregnant women are more likely to have malaria. The relative risk was significantly higher in pregnant women in Bolivia but significantly lower in Colombia, Ecuador, and Peru. As Ecuador moves towards elimination, malaria is now restricted to some pockets of the country and malaria in pregnant women is less of a concern. On the other hand, lower risk in Colombia and Peru is mostly indicative of a weak surveillance system with regards to pregnancy status in malaria patients. In Colombia, the reported numbers vary widely, almost halving from one year to the other, although no such significant deviation in case numbers are seen overall, indicating irregular reporting. A recent hospital based study estimated the prevalence to be around 9% of all pregnant women (18).

Surveillance systems in Haiti are weak, yet the relative risk in pregnant women was significantly higher during 2011-2012. This concurs with the highest of incidence rates in children under 5 years old in that country, probably indicating that malaria transmission is happening largely indoors. On the other hand, the relative risk is significantly lower in the Dominican Republic; migrants from neighboring Haiti are at high risk of malaria and are mostly men in the economically productive age group (15-49 years old).

In Honduras specifically, the number of pregnant women with malaria increased during 2010-2013, while the total number of cases decreased. This indicates an improvement in quality of surveillance during that period. It is noteworthy to mention that neighboring Nicaragua, which has a similar epidemiology as Honduras, reported a non-significant lower risk in pregnant women. This was also the case in Panama, indicating no increased risk of malaria in pregnant females. On the other hand, the surveillance system in Guatemala is deficient in coverage and unable to collect information about women who are pregnant and have malaria; since 2010 only 4 malaria cases have been reported, although unpublished data from studies show the prevalence by PCR to be around 12% in pregnant women. In other Central American countries like El Salvador, Belize, and Costa Rica, the number of malaria cases are too low for malaria in pregnancy to be of significant concern.

To better target this population, malaria programs in the Americas should ensure that there is adequate communication with prenatal care programs so that every pregnant woman exposed in endemic areas uses protective measures like bed nets and is given malaria tests at each visit during pregnancy and after delivery. Some countries like Guatemala, Honduras, and Nicaragua have policies stipulating that every pregnant woman living in an endemic area should be tested for malaria during prenatal visits; however, implementation of this policy remains irregular.

### Table 4. Malaria in pregnancy by country in the Region of the Americas

| Country | Most recent year | | | | | Over a period of years | |
|---|---|---|---|---|---|---|---|
| | Year | Malaria Cases in Pregnancy | Malaria in Pregnancy Rate† | WOCBA Incidence± | Relative Risk | Period | Relative Risk |
| Bolivia | 2014 | 143 | 70,60 | 54,67 | 1.29* | 2010-2014 | 1.12* |
| Brazil | 2014 | 2303 | 93,07 | 53,45 | 1.74* | 2010-2014 | 1.67* |
| Colombia | 2014 | 318 | 51,71 | 70,56 | 0.73* | 2010-2014 | 0.76* |
| Dominican Republic | 2014 | 3 | 1,71 | 4,84 | 0.35 | 2012-2014 | 0.41* |
| Ecuador | 2013 | 10 | 3,77 | 1,87 | 2.02 | 2010-2013 | 0.60* |
| Guatemala | 2014 | 1 | 0,29 | 42,23 | 0.01 | 2012, 2014 | 0.01 |
| Guyana | 2014 | 151 | 1320,97 | 1097,65 | 1.20* | 2010-2014 | 1.21* |
| Haiti | 2012 | 621 | 292,21 | 205,66 | 1.42 | 2011, 2012, 2014 | 2.15* |
| Honduras | 2014 | 46 | 33,73 | 50,09 | 0.67* | 2010-2014 | 0.76* |
| Nicaragua | 2014 | 17 | 17,03 | 16,51 | 1.03 | 2011-2014 | 0.87 |
| Panama | 2014 | 5 | 8,30 | 14,28 | 0.58 | 2010-2014 | 1.04 |
| Peru | 2014 | 469 | 94,03 | 115,17 | 0.82* | 2011-2014 | 0.84* |
| Suriname | 2014 | 8 | 101,41 | 127,86 | 0.79 | 2010-2014 | 0.80 |
| Venezuela | 2014 | 333 | 68,85 | 267,12 | 0.26* | 2010-2014 | 0.24* |

† (per 100,000 pregnant women)
* indicates relative risk significance at a 95% confidence interval
± Women of child-bearing age (WOCBA) incidence per 100,000 women aged 15-45

## Figure 11. Relative risk of malaria in pregnancy by country, 2010–2014