INTRODUCTION

Using the information on the malaria situation officially shared by the member countries with the Pan-American Health Organization (PAHO) every year, the malaria project of Communicable Disease (CD) Prevention and Control Unit of the Health Surveillance and Disease Prevention and Control (HSD) Area, elaborates a report on the situation of the disease in the Americas. This document is used by various authorities in the member countries, academic institutions, collaborating agencies and the global community, as the official reference for the malaria situation in the Region.

This report, prepared in 2009, presents information about the disease in 2008. The document provides a means for analysing the achievement in the region to date with respect to the goal of the Roll Back Malaria Initiative, aimed at reducing the burden of disease by at least 50% between 2000 and 2010.

In an effort to provide a more detailed understanding of the disease characteristics in the Region, the report has been prepared in a new format, including in-depth analysis of some parameters and more visual aids. The document includes a section with an overview of the disease situation in the Region and specific sections that analyse the information available for each of the endemic countries. It also presents information on cases detected in non-endemic countries, where surveillance is essential to prevent reintroduction and/or reestablishment of disease transmission.

In addition to country level information (central level),there has been an emphasis on analysing the data available at locality level, which, depending on the country, corresponds to municipalities, cantons or districts (called administrative level 2 – ADM2- in this report). This allows the reader to analyse the distribution of the disease and to understand its implications for control efforts.

The development of this report is part of an initiative by PAHO Health Surveillance and Disease Prevention & Control Unit to systematize the management of information of communicable diseases in the Region. This is intended to improve the quality and timeliness of the regionally-reported data and to help the countries with tabulation and notification. Above all, it is hoped that the report encourages the use and analysis of information within country programs.

This document is in confirmation with the process led by the World Health Organization (WHO) Global Malaria Program to systemize and optimize the information management at national level and globally. Therefore, efforts were made in 2008 to coordinate the collection of information from the countries and avoid duplication of effort.

At a time when several countries of the Region have accomplished significant reductions in the burden of malaria such that some countries are raising interest in elimination of the disease, this document presents useful information to support the processes and changes that the reorientation of programs produce.

It is necessary to recognize the limitations of this report before reading it. It should be noted that some information may lead to misinterpretations due to data limitations and due to the efforts of analysing information from all the countries in the same format. This report also intends to be didactic and to promote a better use of information.

The review of the data presented here allows analysing the accomplishments and/or challenges of the Region of the Americas for achieving its Roll Back Malaria Initiative goal for 2010 as well as the UN Millennium Development Goal for 2015, which has been established as a 75% reduction in malaria incidence over that reported in 2000.

METHODOLOGY, SCOPE AND LIMITATIONS OF THE REPORT

The information presented here was provided to the Pan-American Health Organization by the Member States in response to a request for information sent to the health authorities of the countries by PAHO headquarters in Washington D.C.

The information was reported in tables designed by WHO Global Malaria Program for collection of standardized information from every endemic country. The format used by WHO corresponds to the table structure used in the Global Malaria database, an initiative which seeks to automate information management of malaria and to promote the monitoring of epidemiological and operational indicators of the programs, in coordination with the Regional offices globally.

As this is an effort of parameter unification globally, some tables included variables that are not managed by control programs of the Region of the Americas and on the other hand some parameters that PAHO has been monitoring along with the countries throughout the years were missing. For this reason, the request for information to the countries included a supplementary form with these variables.

The information sent by the countries was processed with MS Excel®, Tableau® and ArcGIS®. After developing a preliminary version of graphs and texts including the analysis for each country, these were sent to the health authorities for review, correction and addition of missing information. After the necessary adjustments, the document was appropriately formatted to its final version.

In contrast with the Global Malaria Report 2008 prepared by WHO that deals with estimates of disease burden, this document makes a descriptive analysis of the 2008 situation exclusively using the data supplied by the Health Ministries. The estimates calculated by WHO with the 2006 information (report presented in 2008) were based on a formula that adjusted the number of cases reported by the countries with factors to correct for the effect of underreporting and limited access to services.

The estimates produced by WHO using the 2006 data led to figures that were considered in this Region as an over estimation of the disease burden. However, the suitability of this concern of the Global report should be highlighted, as the limitations in coverage of notification and limited access to services continue to be a critical problem in malarious areas. This aspect of control programs could not be approached in detail in this report, and this is a major limitation of this document. The issue of access to diagnosis and treatment is a major concern the malaria control programs should consider and the information that the countries of the Americas provide only allow a partial analysis of the problem.

The Global Malaria Report 2009 that WHO published with 2008 data presents information about the Region of the Americas, giving emphasis on reported data than estimates, which coincides with the information presented here.

The mapping of the distribution of malaria cases was done using case information at local level according to the political-administrative division of the countries (administrative level 2 –ADM2 in this

report). In some countries this level corresponds to municipalities, in others to cantons or districts. It was suggested that this information should be dealt with by place of origin of the cases to have a better understanding of dispersion of transmission and a more reliable approximation to incidence rates. Nevertheless, the information provided by some of the countries was by place of diagnosis, which should be taken into consideration when reading this document to take appropriate precautions when interpreting the figures presented here, especially, the annual parasite index (API, annual number of cases per 1000 inhabitants at risk) which are presented in maps at administrative level 2 (ADM2).

It should be emphasised that the images and cartography used in the preparation of maps do not imply the expression of any opinion whatsoever on the part of the Organization concerning the legal status of any country, territory, city or area, its author

In the section for each country, the paper specially emphasizes the analysis of the situation at AMD2 level. The objective is to provide more means to the reader about the magnitude, dispersion and determinants of the disease in each country. In this respect, it is necessary to explain again that the information by place of diagnosis and not by place of infection limits this type of analysis in some countries.

The time series were created based on the information about cases and deaths provided by countries to PAHO in previous years and in some cases it was updated in accordance to what is requested in communications sent to the Ministries. These time series begin in 2000, taking into account that this year represents the baseline for the goals set by the Roll Back Malaria Initiative for 2010 as well as the targets relating to this disease in the Millennium Development Goals for 2015.

Regarding the population at risk of malaria it is worth mentioning that the data correspond to estimates made by the countries with different methodologies between countries and even in different years in the same country. For this reason, variations may be observed that sometimes may not have a clear relationship with the changes in the epidemiological situation. Due to this difficulty with the populations considered at risk, the report does not give much emphasis on the analysis of this data. For the same reason, the malaria annual parasite index (API) at national level was calculated for all the countries using the country's total population reported in the document 'Health Situation in the Americas: Basic Indicators – 2008' published by PAHO, as denominator.

In the maps and figures for ADM2 level, the population provided by the countries to PAHO/WHO was used as a denominator for API calculation. In most cases, it is the total population of these administrative units. In this section of the analysis, appropriate precautions should be taken when interpreting the situation of those countries that provided the information by place of diagnosis instead of place of case origin.

Information on malaria cases according to age, urban or rural origin, ethnicity, pregnancy and access to diagnosis in the first 72 hours from onset of symptoms, was requested from the countries on an additional table elaborated by PAHO to complement the information requested by

WHO. The information systems of several countries don't collect these variables and therefore the corresponding figures may have no information. In some countries that are implementing individual patient record databases but which did not have 100% coverage for 2008, some of these parameters were obtained from the databases and extrapolated to the total registered cases by the program. The values thus obtained were considered representative of the situation at national level, given that the information available in the databases corresponds to almost the total amount of malaria burden of the country.

The analysis of intervention programs gives particular emphasis on diagnostic and therapeutic actions as well as on the coverage of indoor residual spraying and use of insecticide treated nets.

With regard to diagnosis and treatment, a four parameter analysis is proposed: i) the program management over the diagnosis of febrile people and the 2008 positivity rate compared to previous years, ii) the timeliness of diagnosis, iii) introduction of the use of rapid diagnostic tests and its comparison to microscopy, iv) the implementation of the use of Artemisinin-based combination therapy (ACT) in relation to the behaviour of *P. falciparum* cases in the Amazon countries and (v) the use of antimalarials in comparison to reported cases. The last point allows a discussion of treatment practices on clinical presumption.

However, the analysis of these parameters was limited for some countries with missing information and sometimes by the inconsistency of the data provided. For example, the comparison between the numbers of treatments distributed vs. the number of cases with parasitological diagnosis was limited because, in many cases, the countries reported the value corresponding to the number of diagnosed cases as the number of treatments distributed instead of reporting values for medications consumed.

The time of access to diagnosis, which gives a very objective orientation about the timeliness and coverage of the system, should be one of the most carefully monitored variables, but it is a parameter that is only used by a minority of the countries in the Region.

In relation to rapid diagnostic tests, there were also some analytic limitations due to lack of information. In some countries, this variable is not yet considered in the individual notification system and there is no information on inventories of tests used and examinations performed. The failure to supply this information provides food for thought on the need to properly organize the management of this relatively new tool that the malaria programs offer for the control of the disease.

The information about indoor residual spraying (IRS) coverage was in some cases provided as the number of households sprayed and in some others as the number of people protected. Therefore, for those countries that provided information by household, the number was multiplied by five (assuming the mean number of people per household to be 5), as an estimate of the number of people protected.

The analysis at Regional level made a comparison of the coverage of IRS and the use of long lasting insecticide impregnated nets (LLIN) between the countries. To

obtain the parameters that allow a comparison between the countries, a ratio was calculated between the coverage of the intervention and the number of cases in 2008. For IRS, the number of people protected by residual spraying in 2008 was divided by the number of cases and this ratio was multiplied by 10, giving the total number of people protected per 10 cases of malaria in 2008.

Concerning LLINs, assuming a lifetime of at least three years, the coverage for 2008 can be estimated as the aggregate number of nets distributed between 2005 and 2008. This amount was divided by number of cases in 2008 and multiplied by 10 to get an estimate of the number of nets distributed per 10 cases of malaria in 2008.

These approaches to intervention coverage allowed for an objective comparison of the scope of preventive actions in relation to the magnitude of the disease in each country. This was preferred instead of working with at-risk population as denominator, due to the lack of standardization in the method by which the countries determine their population at risk.

GENERAL DESCRIPTION OF THE MALARIA SITUATION IN THE REGION

In 2008, 560,221 malaria cases were reported in the Americas, 30% less than the number reported to the Pan-American Health Organization by the Member States in 2007. Since 2005, a significant decrease of disease transmission, that disables and compromises the quality of life of an important portion of the continent's population, has been seen in the Region.

Having certified the interruption of transmission in some countries in the 60´s, there has been an endemic transmission of malaria in 21 countries of the Region: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, French Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Suriname and Venezuela. The disease trend in recent years suggests that some countries (Argentina, Mexico, El Salvador, and Paraguay) have a great potential for a continued reduction that may lead to disease elimination in the coming years.

The malaria situation in the Region can be analysed by grouping countries in four sub-regions which share eco-epidemiological characteristics and social determinants.

The countries that share the Amazon forest form the sub-region with the same name, where the highest numbers of cases occur, and 89% of the continent's total disease burden in 2008. Among the Amazon countries, Brazil has the highest proportion of disease cases, with 315,553 cases in 2008 and 56% of the total cases in the Americas (Figures 2 and 3). Mexico and the Central American countries form the sub-region with lower transmission levels, with a prevalence of over 96% of *P. vivax* malaria and *P. falciparum* strains sensitive to chloroquine. Colombia, with a large territory under environmental and social situations conducive to malaria transmission, has been for several years the country with second-highest number of malaria cases in the continent and represents an important link between both sub-regions. The Island of Hispaniola (Haiti and Dominican Republic) is a third important setting` in the Region, the only territory of the Caribbean Islands with malaria transmission. With 100% of cases due to *P. falciparum* (Figure 2), malaria represents a serious public health problem, and a potential risk for tourism and for case dissemination to countries that have been free from malaria transmission. Argentina and Paraguay, in the south of the continent, would fall into another group, characterized by a very low *P. vivax* malaria transmission in focalized areas.

MAIN FOCI OF TRANSMISSION

AMAZONIA

The high burden of malaria cases in Brazil is a strong determinant of the malaria situation in the group of countries in the Amazon basin and in the Americas in general. In Brazil, malaria decreased significantly in 2008, with a downward trend since 2005. The numbers of cases have also decreased in Ecuador, Colombia, Peru, Venezuela and Bolivia in 2008. In all the Amazon countries, except for Colombia and Ecuador, malaria burden is determined especially by the social and environmental processes in Amazon basin. In contrast, , the disease burden in Colombia and Ecuador is maximally caused by

transmission in communities living along the Pacific Coast and, particularly, in Colombia in the Uraba Region close to the Panama border (Figure 1).

The primary malaria vector in the Amazon sub-region is the Anopheles darlingi, and its vectorial capacity, along with the way in which people occupy the space and use the forest, determine the intensity of disease transmission. The settlement and development processes in many of the Brazilian municipalities represent the main transmission foci; an important burden of the municipalities is in big cities like Manaus, in the Amazonas, in the North of the country, and Porto Velho in the State of Rondonia (Figure 5). In the west of Brazil near the border of the State of Acre with the departments of Loreto and Ucayali in Peru, there is another significant focus of transmission especially on the Brazilian side. In this area, three municipalities of Jurua Valley had the highest disease burden in the country in 2006, and they have experienced a significant decline over the past two years.

In the Departments of Beni and Pando in the northern part of Bolivia, the highest concentration of malaria cases in the country is found (Figure 5), with foci relating to Brazil nut harvesting. In the same region, in the State of Rondonia (Brazil), there has historically been a malaria transmission focus that involves several municipalities, but especially the Municipality of Porto Velho. This is a development area with hydroelectric projects which, if not properly managed, may boost up malaria transmission.

The area of the State of Pará and Amapá, in northeast of Brazil, includes several foci of malaria related to settlement projects, mining activities and forest harvesting. These transmission foci in the Northeast of Brazil, in the regional map, seem to merge with transmission areas in French Guiana and in Suriname (Figure 5), closely related to gold mining activities in the area. Several foci of malaria in the three countries are associated with movement of people due to mining activities. Gold mining is also related topmost cases in Guyana and in the Eastern region of Venezuela, where the municipality of Domingo Sifontes has 43% of the total malaria cases in the country in 2008 (Figure 5).

In the past three years, Suriname and Guyana have experienced a significant decline in the number of cases, but in 2008 there was no significant change compared to 2007. In 2008, Guyana had the highest incidence among the countries in the Region (API of 15 cases per 1000 inhabitants, Figure 7). It is worth mentioning that total country populations used by PAHO for the calculation of key public health indicators in the Region, from the document 'Health Situation in the America: Basic Indicators 2008' were used for API calculation.

Colombia and Venezuela have transmission foci in the Region of Orinoquia, an ecosystem shared by both countries. Several communities of Venezuela, including indigenous populations of the Amazonas, represent the second area of importance, following the previously described situation close to the Guyana border. In Colombia, the department of Guaviare in the centre of the country, as well as the municipality of Cumaribo, have been important foci in recent years and are related to population movements, driven by illegal activities.

In the North-western region of South America, the Andes separate the Amazon and the Orinoquia regions from other ecosystems that are essential for malaria transmission in Colombia. Most important malaria foci are formed in the Urabá and the Pacific Regions of the country (Figures 4 and 5). The Urabá and Low Cauca are areas in which armed conflicts and forced displacements in the past few years have contributed in maintaining an endemic, particularly of *P. vivax* malaria. In 2008, intensive control efforts in the Department of Antioquia have yielded key impact results in the area. The Pacific Coast in the south of Colombia and in the north of Ecuador has similar ecological characteristics, but Colombia has a much higher burden of disease. In the Departments of Chocó, Cauca, Valle and Nariño in Colombia, there is a rainforest where communities reside in situations with low access to health care, and have problems of public order and displacement. The predominance of people with African origin in this region of Colombia is associated with a high proportion of *P. falciparum* malaria. During recent years, malaria has significantly diminished in the Departments of Nariño and Valle in Colombia and in the Province of Esmeraldas in Ecuador. The introduction of ACT, among other factors, has played an important role in these areas which have high *P. falciparum* prevalence.

In 2008, malaria occurred in Ecuador in very small magnitude foci compared to the situation persisting in several municipalities in Colombia and Brazil (Figure 5). The decline of malaria during the last year in the North of Ecuador, where the burden was historically the highest, has increased importance of the foci in the south of the country in the provinces of Guayas and El Oro. In the latter, most cases are concentrated in a district bordering Peru where the population lives in a peri-urban environment in fringe areas together with An. Albimanus breeding grounds and also has activities related to pisciculture.

In Peru populations in the Departments of Piura and Tumbes in the north of the country are the second most important focus for malaria, following the Amazonian departments (Figure 5). In several localities of this area transmission has been related to An. Albimanus breeding sites in paddy fields, based on which several innovative projects have been developed for malaria prevention by adopting intermittent irrigation strategies. In contrast to the situation in the Amazonian departments, *P. falciparum* strains in these foci along the Pacific Coast are still sensitive to sulfadoxine-pyrimethamine. This led the malaria program in 2001 to adopt different treatment regimens in the two regions (different combinations with artemisinin derivatives

MESOAMERICA

In this sub-region, Honduras and Guatemala have the highest disease burden (Figures 2, 3 and 4). Nevertheless, between 2000 and 2008 malaria has significantly decreased in both countries, as well as in the rest of the sub-region. In 2008, 20,823 cases were reported in Mexico and the 7 Central American countries combined. In all the countries there were autochthonous cases in 2008, but the disease burden was much lower compared to previous years. In El Salvador malaria reached very low levels (32 cases in 2008) (Figures 2 and 3).

No local cases of *P. falciparum* were detected in Belize, Costa Rica, El Salvador, Mexico, and Panama (Figures 2 and 3). In 2008 *P. falciparum* malaria comprised less

than 10% of the total cases in Honduras and Nicaragua, where malaria is highly localized in the North Atlantic Autonomous Region (NAAR); this level is similar to that of Bolivia and Ecuador in the Amazon basin. Guatemala, with over 7,000 malaria cases, reported only 50 *P. falciparum* malaria cases (0.7%, Figure 3).

Panama reported a reduction of 42% in the number of cases compared to 2007 and a decline of 100% in autochthonous *P. falciparum* cases. The high endemicity in the Colombian Regions of Urabá and Chocó, where multidrug-resistant *P. falciparum* strains circulate, the geographic proximity (Figure 4), and the flow of people between the regions of Urabá and the Colombian Pacific Coast to receptive areas in Panama and the other countries, constitute one of the aspects demanding greater surveillance and further cooperation among countries.

In Honduras the transmission is especially related to population movements in the Department of Gracias a Dios with consequent ecological and social effects arising from occupation of an area that is ecologically favourable to *An. albimanus*.

Guatemala experienced a significant reduction since 2005 which continued to in 2008, with a decrease of more than 50% of cases compared to the previous year. The decrease is related to the actions financed by the GFATM to fight AIDS, Tuberculosis and Malaria (GFATM) in the northern departments of the country. Nevertheless, important transmission foci persist in several municipalities all over the country as well as along the Pacific coast due to population migration related to working in the agricultural fields, and the proliferation of breeding grounds due to environmental modification.

In 2008, Mexico maintained the low transmission level gradually reached during the past years. In 2008, no *P. falciparum* cases were registered and malaria transmission was especially localized in the states of Chiapas and Oaxaca, with less number of cases in other states.

HAITI AND THE DOMINICAN REPUBLIC

The Island of Hispaniola is the only territory in the Caribbean Islands with endemic malaria transmission. In 2008, Haiti reported 36,774 cases and after Brazil, Colombia and Peru was the country with the fourth highest burden of disease in the region (Figures 2 and 3), but with an annual incidence 2.5 times higher than that observed in afore-mentioned countries in 2008. The predominance of people with African origin among the affected population has historically been responsible for preponderance of *P. falciparum* malaria on the island, but fortunately the strains of the parasite are still sensitive to chloroquine. In 2008, Haiti reported a 57% increase in malaria cases compared to 2007, while the Dominican Republic, where the problem is localized in areas bordering Haiti, had a decline of 32%. The increase reported in Haiti may be related to an improvement in the information system and the care given to cases in the high risk groups in recent years.

SOUTHERN CONE

The southern-most areas of the continent with malaria transmission are the foci in Argentina and Paraguay, where the transmission is exclusively that of *P. vivax* malaria with very low incidence rates (Figure 7). After an increase in the number of cases in 2007, in 2008 Paraguay reported

the lowest incidence of cases in the last decade and also the absence of local *P. falciparum* cases. (7 cases were reported imported). The transmission is localized in 4 districts to the East of the country, but more than 20 districts reported cases. In Argentina there were only 106 cases in 2008 (Figure 2) in a residual focus in Salta province, near the border with the Department of Tarija in Bolivia (Figure 5).

POPULATIONS AT RISK OF TRANSMISSION AND ITS DETERMINANTS

Although the reduction in burden of malaria in recent years is a fact of great public health importance for the region, with a remarkable improvement in the indicators at country level, a significant proportion of population living in the Americas is still at high risk of acquiring malaria; some communities have very high incidence rates. The highest annual parasite index (API) at the administrative level corresponding to municipalities, districts or cantons (ADM2) in 2008 was registered in Brazil (Figure 8). In 2008 in the municipality of Anajas in Brazil, where transmission is associated with palm harvesting activities, the API was 452 cases per 1000 inhabitants (Figure 8). Bolivia, Brazil, Colombia, Honduras, Peru, Suriname and Venezuela reported municipalities with an API greater than or equal to 100 cases per 1000 inhabitants (Figure 8).

A combination of environmental and social factors is the determinant in these situations. In general, these are communities with living and working conditions favourable for transmission of malaria in remote areas, where it is difficult to provide health care. Although there are important differences due to the varied ecosystems from the Amazonia to the Island of Hispaniola, the common factor is the high vulnerability of these populations characterized by: difficult access to health services, little local institutional development, conditions of extreme poverty, and settlements in areas of difficult access and scattered rural or marginal urban areas.

The environmental factors are related to land occupation by people, land use and the lack of sustainable environmental management along with deterioration of ecosystems due to the indiscriminate extraction of natural resources. These areas are occupied by highly vulnerable communities living in situations with poor access to health services, which leads to further perpetuation of transmission.

In some countries there are well characterized determinants of malaria; in Bolivia the cycle of chestnut harvesting in the departments of Pando and Beni and associated social determinants clearly correlate with seasonality and geographical spread of malaria in the country. In Brazil, living conditions of communities that are involved with palm harvesting on the Marajo Island in the state of Pará, also correlates with malaria transmission in this region. In some areas of Colombia, malaria is related to illegal crop cultivation as well as with forced displacement of people. In the department of Piura in northern Peru, rice cultivation is associated with the disease. A proliferation of fish farms in the marginal areas of cities in the Brazilian Amazon has been the reason for transmission peaks in recent years. Gold mining is the main determinant of malaria in Suriname, Guyana, French Guyana, Venezuela and a large number of Brazilian municipalities, largely by engendering a

constant flow of people and parasites within and between these countries.

Major infrastructure projects in the Amazon and other rainforests of the Region have historically been determinants of malaria peaks and they continue to be risk factors currently. In 2008 steps were taken in Brazil to prevent an increase in malaria that was foreseen for future years due to the construction of hydroelectric dams on the Madera River, in the state of Rondonia, which has historically been an important focus of malaria.

Overall the main determinants of malaria foci in the Americas are well-known and the combination of factors previously described tends to repeat in different pockets of the Region. However, for malaria control it is essential to understand the dynamics of transmission in each focus. Understanding the specificities of transmission dynamics in each focus, the key factors determining the confluence of infected people with vectors and susceptible population, and planning the action of the services accordingly in order to disrupt the transmission chain are the keys to disease control. The explanation for perpetuation of transmission lies in routine human activities and in the ecology of each endemic area, and these factors should be prioritized by the programs in order to determine the most appropriate intervention according to the characteristics of the focus.

At present there are countries with very low endemicity that may catalyse the progress towards a pre-elimination phase. In these situations the key factor for the reorientation of the programs should be to improve the collection and use of information, so that a deep analysis of the determinants of transmission allows an understanding of transmission dynamics specific to each focus.

Malaria in gold mining areas deserves special attention among other scenarios as it represents transmission foci which are difficult to control and are potential hot-spots for dissemination of *P. falciparum* strains resistant to antimalarial drugs. In addition, the permanent flow of people involved in mining from one country to the other, leads to dissemination of various parasite strains across borders. Living conditions in the mines are extremely poor and favourable for malaria transmission. The assault on environment has all kinds of effects with regards to anopheline breeding sites, but it culminates in a situation with high exposure to mosquito bites due to the degree of unprotected households and the proximity to breeding grounds, which become unmanageable. Poor access to health care services completes the scenario. It is impossible for the health system to continuously make adjustments in the network of health care delivery based on mining activities, which repeatedly occur illegally. Absence of diagnosis and treatment for malaria leads to self-medication and to the use of non-recommended drugs. The indiscriminate use of monotherapies with artemisinin derivatives and incomplete treatments in these areas makes them breeding grounds for development of anti-malarial resistant strains and their spread through the Region. The lack of diagnosis and treatment may also result in the sale and use of counterfeit drugs and medicines of poor quality.

At country level, the API was distinctly high in Guyana and French Guiana, with 15.7 cases per 1000 inhabitants (Figure 7), especially because of the high malaria burden in mining areas and the low population density in these territories. In

2008, Haiti had the second-highest API (4.6 cases per 1000 inhabitants) followed by Suriname (Figure 7). They are followed by Colombia, which in spite of having a large population (higher than 44 million, denominator of API), has an API close to 2 cases per 1000 inhabitants; this reveals the high disease burden in Colombia compared to other countries. Brazil, Belize, Peru, Venezuela, Honduras and Bolivia follow in that order in the list of countries with a national API equal to or higher than 1 case per 1000 inhabitants in 2008.

VARIATIONS IN MALARIA MORBIDITY AND MORTALITY IN THE REGION

Regionally, in 2008 there was a marked decline in the number of cases compared to 2007 (Figures 9 and 13). Compared to the year 2000, a decrease of 53% of cases was reported in 2008 (Figure 10, 15a, 15b). The changes in the disease burden in countries between 2000 and 2008 can be seen in Figures 15a and 15b. Figure 15c shows the situation in the Region with respect to the goals of the Roll Back Malaria (50% reduction in 2010) and the Millennium Development Goals (75% reduction in 2015).

The downward trend has been since 2005, when several countries had transmission peaks (Belize, Costa Rica, Dominican Republic, Guatemala, Guyana, Haiti and Brazil, Figure 14b). In 2005, Brazil experienced an increase of more than 138,000 cases, compared to the previous year (Figures 14a and 14b); since 2005, there has been a sustained decrease in the transmission. Owing to the large number of cases, the decrease of malaria burden in Brazil is responsible for the variation at regional level (Figure 14a), but individually too the decline has been significant in most of the countries (Figure 15). Among countries with significant decline in malaria burden in 2008 compared to 2007, Paraguay (75%), Guatemala (53%), Nicaragua (44%), Panama (42%) and Ecuador (41%) are highlighted (Figure 14b). In 2008 malaria increased in Haiti and Suriname. This increase in Suriname was preceded by dramatic decrease in the number of cases in 2006 (64%) and 2007 (75%, Figure 14b). Thus, having a very low number of cases, a slight increase in absolute numbers in 2008 represents a significant increase in terms of proportion.

At the regional level, the decrease in *P. vivax* malaria (29%) in 2008 was more than *P. falciparum* malaria (33%, Figure 10). This was in contrast to what happened between 2006 and 2007, when *P. vivax* malaria fell by 8% while *P. falciparum* declined by 25%. An increase in the use of ACT in the Amazonas in 2007 was associated with decrease of *P. falciparum* malaria. Therapeutic efficacy studies carried out in all Amazon countries between 2001– 2006 had found high levels of failures to treatment with antimalarial drugs in use, leading to the introduction of ACTs.

Mortality decreased by 52% in 2008, compared to that reported in 2007(Figure 12). Eighty nine deaths were notified (Figure 11), but in absence of data from Peru, Haiti or Venezuela the picture is incomplete. Brazil had a decrease of 50% in malaria mortality; the decrease in cases of *P. falciparum* malaria being associated with the decline in mortality. Compared to 2000, mortality had declined by 75% in 2008.

MALARIA LOCALIZATION AND DISPERSION IN 2008

A very important aspect for understanding the magnitude of the problem in each country and the operational implications of the control efforts, and even the possibility of elimination, is to analyse the degree of localization and dispersion of transmission. The analysis at ADM2 level (municipalities, districts, cantons) shows that Brazilian and Colombian municipalities account for a large portion of the total burden of the disease in the continent.

In 2008, 1963 municipalities (or districts, or cantons) registered one or more cases of malaria, but this number drops to just below half (937 municipalities) when only those administrative units reporting more than 10 cases in 2008 are considered (Figure 17). In 2008, 283 municipalities of the Region had morbidity equal to or greater than 250 cases of malaria (Figure 17). Although in recent years the spread of malaria has been reduced, limited in some countries to very well-defined foci and associated with specific determinants, malaria remains a health problem in a considerable number of municipalities. *P. falciparum* malaria is more focalized; in 2008, 394 municipalities had casuistries higher than 10 cases while 109 municipalities had more than 250 cases in the year (Figure 18).

Sorting the territories of ADM2 level in descending order according to the number of cases and calculating the cumulative proportion of cases of the total for the Region (Figure 16) it is observed that 50% of the disease burden of the Region in 2008 was in only 44 municipalities/ districts, belonging to 6 countries (Brazil, Colombia, Guyana, Haiti, Peru and Venezuela). What is more significant in terms of pin-pointing the problem and the effect that high impact actions would have on specific territories of the Region is that only 12 administrative units (10 Brazilian municipalities, the municipality of Sifontes in Venezuela and the municipality of Maynas in Peru) contributed 25% of the malaria burden in the Region (Figure 16). The municipalities of Manaus and Porto Velho in Brazil together, account for 8% of the malaria cases in the Americas. These are very important nodes for flow of people and economic activity in the states of Amazon and Rondonia. The urban area of the municipality of Manaos has a population close to 2 million inhabitants and despite having urban development with major infrastructure constructions, the disorderly occupation in the periphery establishes the persistence of a belt of marginal areas with malaria transmission. In the Municipality of Sifontes in Venezuela, malaria transmission is associated with gold mining activities; it also has a high proportion of *P. falciparum* cases (3726 cases). The municipality of Tierralta, in Colombia, which in recent years has reported the highest number of cases in the country, had problems with the network of diagnosis in 2008, yet it reported more than 5,000 cases (Figure 16).

In 2008, 54 municipalities in the Americas reported more than 2,500 cases; this constitutes 55.6% of the malaria burden in the Region (Figure 16). These include 37 Brazilian municipalities, 9 Colombian municipalities, 3 municipalities from Peru, 2 from Venezuela, and 1 each from Haiti, Guyana and Bolivia.

API of municipalities was plotted against the number of cases reported by them in 2008 and the resultant graph subdivided into four quadrants based on two cut-off points: an API of 50, and 250 cases

reported. Municipalities from the Amazon sub-region predominated in the first quadrant, i.e., more than 50 cases per 1000 people and more than 250 cases reported in 2008. The municipality of Anajás on Marajo Island in the state of Pará, in Brazil, stood out for the severity of the disease situation in 2008, with an API of 452 cases per 1000 people, more than 12,000 cases in the year, 17% if which were *P. falciparum* malaria. Other municipalities that have lower API but a higher proportion of *P. falciparum* malaria include: Sifontes in Venezuela, Atalaia do Norte and Santa Isabe do Rio Negro in the North of Brazil, Olaya Herra in the department of Nariño in Colombia, and Bajo Baudó, also in the Colombian Pacific.

Along with these municipalities from the Amazon sub-region, the municipality of Wampusirpi in the department of Gracias a Dios, Honduras was also included in this first quadrant of priority municipalities (Figure 20). It reported 700 cases in 2008, 24% of which were caused by *P. falciparum* and had an API of 117 per 1000 people.

Dominican Republic municipalities, such as Dajabon that despite having 534 malaria cases all of which were due to P. falciparum, and an API of 19 per 1000, had an incidence level well below that in several municipalities from the Amazon sub-region during 2008. Dajabón is a locality that borders Haiti, where an international bridge facilitates flow of people from the locality of Ouanaminthe in Haiti. The external aid provided by the Carter centre in 2008 was aimed at sorting this problem in these communities.

Furthermore, almost all endemic municipalities and cantons of Central American countries remained in a quadrant that groups municipalities with an API lower than 50 per 1000 and less than 250 yearly cases (Figures 19 and 20).

As mentioned at the beginning of this report, the limitations of incidence data presented here must be emphasized. It is difficult to manage information that really corresponds to the place of origin of a case and there are variations in the method by which populations at risk are calculated by each country. Therefore, the reader must be cautious when interpreting the data presented here regarding the origin of the cases at ADM1 and ADM2 levels. The emphasis here is on the didactic nature of this publication intended to promote improvements in information management.

MALARIA IN PRIORITY GROUPS AND IN URBAN AREAS

Of the total malaria cases reported by the countries of the region in 2008, 11% were in children less than 5 years old and 34% were in less than 15 year olds (Figure 22). This shows that although malaria has a strong relationship with outdoor labour activities in many areas, especially affecting the young adult age-group, an important proportion of cases occur in children and are associated with transmission of disease in households. Panama, Belize and Haiti were the countries with the highest percentage of malaria in children (Figure 22). At the other extreme, El Salvador, Guyana and Costa Rica reported very few cases in children, which points to malaria associated with outdoor labour activities.

The proportion of cases in children less than 15 years old among total cases in a locality or malaria focus, is a parameter which guides prioritization of localities for

high impact actions to reduce household transmission, such as the use of LLINs and IRS. However, the incidence rates by age groups are difficult to monitor reliably due to the high mobility of these populations and the resulting variations in population denominators.

Urban malaria demands special attention from control programs given the high burden of disease that it occasionally generates and the logistical and operational viability of preventive and control actions. Unfortunately, the urban or rural origin of cases is a parameter that is not being carefully monitored by the information systems of the malaria programs in the region; thus, there was no data available for this variable in many countries. The accuracy of data reported by countries is debatable. However, the information provided can at least draw attention to the importance of this situation. For most countries among those who reported information on origin of cases (urban/rural), less than 20% of total cases in 2008 were of urban origin (Figure 22). Furthermore, among these countries (492,352 cases, 88% of the total of the Region), 13% of the total cases were or urban origin (64,237 cases). Nonetheless, in Nicaragua 66% of the cases were considered to be of urban origin (Figure 22). In countries where the disease burden is very high, such as Brazil and Colombia, urban malaria constituting 13% or 15% of total cases still translates into a significant number. A clear understanding of transmission dynamics of urban malaria may orient high impact interventions, which are more viable and less expensive in urban territories compared to other areas.

The information system in several Amazon countries allows monitoring of this parameter up till ADM-2 level. In 2008 municipalities such as Bajo Baudó, Tumaco and Guapi in Colombia reported 38%, 36%, and 68% respectively of the total cases to be or urban origin (Figure 50). This whole situation highlights the need to promote a more sensitive surveillance system with analysis done at local level to guide interventions that could have a major impact on the total disease burden in the country. Given the availability of ACTs and LLINs in the Region, control of urban *P. falciparum* malaria should become a priority goal for malaria control programs. It is noteworthy that anthropological and behavioural analysis of people is fundamental for understanding the transmission dynamics in these foci and for increasing the effectiveness of interventions.

Malaria is a serious public health concern in indigenous communities of some countries in the Americas. However, this is not adequately reflected in country level statistics for malaria. The information systems of malaria programs in many of the countries do not report data about this parameter, and where they do, there are deficiencies in data quality. In most countries in 2008, malaria in indigenous population constituted more than 10% (Figure 22) of total disease burden. At regional level, among the countries that reported data for this parameter (459,361 cases, 82% of the Region), 11% of total cases were in indigenous populations in 2008 (Figure 22). Particularly striking is the importance of this group amongst the population affected by malaria in Mexico, Panama and Guatemala, where the proportion of indigenous malaria was 50% and 65%, respectively. Guyana, Nicaragua and Paraguay also reported that 34%, 26% and 25% of total cases, respectively, were indigenous malaria, a significant proportion (Figure 22). This can be explained by the fact that indigenous populations form a majority among the general population in

areas of these countries where malaria transmission is predominant.

Of the 21 endemic countries, 11 reported to PAHO the number of malaria cases diagnosed in pregnant women in 2008 (Figure 22). There were a total of 5,740 cases of malaria in pregnant women, 6% of the total 91,105 malaria cases in women of childbearing age reported by the countries that registered this event. Haiti and Panama had the highest proportion of pregnant women among the total cases of malaria in women (13%). Given that pregnant women are not unduly affected with malaria compared to other women, the proportion of malaria in pregnancy among women of reproductive age should be similar to the general fertility rate of the countries. Proportions far below this rate suggest an under-registration of the event and, consequently, demonstrate a lack of special attention to pregnant women, who require careful management and a more rigorous follow-up than other women. The periodic monitoring of the proportion of pregnant women among the total malaria cases in women of reproductive age, allows detection of malaria foci or municipalities, cantons, provinces or states where they might be improperly treated.

In Haiti, it is assumed that this significant number of cases in pregnant women (506 cases) may be related to the efforts that different governmental and non-governmental organisations are making to improve maternal and child health situation in the country. This also explains the high proportion of cases in children less than 15 years of age compared to the total number of malaria cases in the country.

SURVEILLANCE, PREVENTION AND CONTROL OF MALARIA

DIAGNOSIS AND TREATMENT

Slide Positivity Rate (SPR) varied highly among countries of the region in 2008 (Figure 23); it ranged from 0.1% in Nicaragua to 21.8% in Haiti. The countries with the SPRs were El Salvador (0.03%), Nicaragua (0.1%), Mexico (0.2%), Panama (0.4%), Paraguay (0.4%) and the Dominican Republic (0.5%, Figure 23). In the Amazon sub-region, where the SPRs were much higher, Ecuador presented the lowest rates with 1.3 positive cases per 100 slides examined. Low SPRs may be due to a control program with intensive active case detection and an extensive network of health agents who test all fever cases for malaria. Nevertheless, in some situations, extremely low SPR may also be due to unspecific surveillance strategies, which leads to overloading of the system without a significant benefit in early detection of malaria cases, which is necessary to disrupt the transmission chain of the disease.

On the other hand, countries, or foci within the countries, with elevated SPR indicate that there may be a predominant diagnosis and treatment strategy based primarily on passive case detection, and health facilities focused on microscopy where patients have a very high probability of being diagnosed with malaria. Early detection of malaria cases by means of a sensitive yet efficient surveillance system, and its proper coordination with health services is the main strategy for malaria control. The high therapeutic efficacy of schemes currently used in the region and the low transmission intensity in many foci in the Americas, compared to other endemic regions, are factors in favour of this strategy. Control programs should concentrate their efforts to create strategies such that early diagnosis and treatment becomes an efficient, sustainable and has high epidemiological impact.

The use of Rapid Diagnostic Tests (RDTs) for diagnosis of malaria in the Americas in 2008 was limited, compared to the number of slides examined. The countries reported 8,025,168 slides examined, while 109,442 RDTs were used in the same period (Figure 26). In previous years the situation has been similar. Although there has been an under-reporting of RDT use by countries, it is still considered an alternative for diagnosis in areas where microscopes are difficult to access or unavailable.

The time taken for access to a parasitological diagnosis is a parameter that is monitored by the surveillance system in some malaria programs of the region. Although it should be continuously monitored, most of the countries do not systematically register the date of onset of symptoms and the date of diagnosis. In places where this is done, there are no database systems with the ability to record each individual case that would otherwise allow periodical analysis of this indicator. In 2008, ten countries provided information on the number of cases diagnosed in the first 72 hours after the onset of symptoms (Figure 24). Of the 418,448 cases reported in these countries, 294,766 (70.4%) were diagnosed within 72 hours of onset of symptoms. However Brazil, with its significant weight in the number of cases, influences these figures significantly. On an average, among the 8 reporting countries, 45% of people had access to diagnosis in less than 72 hours. Brazil has the best standards for timely access with 74% of cases diagnosed within the first 3 days from the onset of symptoms. This is an important accomplishment of the Brazilian health

system, considering the wide spread of malaria endemic territory.

Despite the remarkable decrease in the number of cases in Central America sub-region, available information suggests that access to malaria parasitological diagnosis in the sub-region continues to be delayed. Attention is dominated by a healthcare scheme of administration of presumptive treatment and subsequent confirmation by blood slide examination. The availability of a more timely parasitological diagnosis in endemic areas, and especially for *P. falciparum* malaria, is vital for improving the case surveillance strategy.

Early introduction of treatment is very effective in reducing malaria transmission. Gametocytes, the sexually reproductive forms of the parasite responsible for its transmission to anopheles mosquito, take several days to appear in the blood. This gives a window in the parasite's life cycle which is exploited by early introduction of treatment for disrupting malaria transmission. The potential of ACTs in reducing gametocytemia during the early days after treatment is an advantage that current malaria programs have for controlling *P. falciparum* malaria.

In 2001, Peru and Bolivia introduced the use of ACT as first-line of treatment for uncomplicated *P. falciparum* malaria (Figure 29). In 2002, the eight Amazon countries formed the Amazon Network for the Surveillance of Antimalarial Drug Resistance (RAVREDA), which, supported by the AMI (Amazon Malaria Initiative) project and funded by United States Agency for International Development (USAID), promoted the assessment of treatment schemes being used in the sub-region. This led to completion of 88 efficacy studies in a 4-year period. The results were used for changing treatment policies in all the countries that share territories in the Amazon forest that are endemic for malaria, by introducing ACT as the first-line of treatment for *P. falciparum* malaria.

Presently Brazil, Guyana, Suriname and Colombia use the combination of artemether and lumefantrine (AL) as first-line of therapy. Bolivia, Peru and Venezuela use artesunate and mefloquine (AS+MQ) combination while Ecuador and Peru, on its Pacific coast, use artesunate and sulfadoxine-pyrimethamine (AS+SP).

P. falciparum malaria has decreased remarkably in the past years in the region (Figure 27). Although there are multiple determinants of the disease burden, the effect of policy changes in many endemic areas of these countries has been so evident that, undoubtedly, part of the decrease has to be attributed to the new medication.

Although, *P. vivax* malaria cases have also decreased since 2005 along with *P. falciparum* malaria, the decline has been more pronounced in *P. falciparum* malaria than in *P. vivax* (53% and 43%, respectively, for the total Region). In Brazil the decrease in 2008 was 68% for *P. falciparum* and 40% for *P. vivax* compared to 2005 and in Colombia it was 48% for *P. falciparum* and 27% for *P. vivax*. In Suriname and Guyana and in Colombian departments with high proportion of P. falciparum, the decline was remarkable in the years following the introduction of ACTs. In contrast, in Venezuela, despite the introduction of ACTs in 2007, an increase in the number of *P. falciparum* cases was observed.

PREVENTION AND VECTOR CONTROL

The use of LLINs has started to spread in the Region. The GFATM projects have been an important funding source for the use of LLINs in several countries. In 2008, 538918 LLINs were distributed across the Americas. These along with the bednets distributed during the 2005 - 07 period, which should still be having a protective effect in the households using them, amount to a total of 1,726,652 bed nets (Figure 31).

Besides preventing human contact with anopheline mosquitoes, bed-nets may also be beneficial for reducing contact with other vectors such as sand flies and *Culex quinquefasciatus*, which causes both nuisance and diseases like lymphatic filariasis.

The largest numbers of LLINs were distributed in Haiti and Guatemala in 2008, followed by Ecuador & Colombia (Figure 31). Analysis of the LLIN coverage attained, the number of LLINs cumulatively distributed in the last 4 years per 10 cases of malaria reported in 2008, shows that Nicaragua had the highest coverage at 2,890 LLINs per 10 cases in 2008) (Figure 31). Guatemala, Suriname and Ecuador follow in that order of descending LLIN coverage attained. El Salvador, Bolivia and Panama also have attained a high LLIN coverage.

Some countries of the Amazon sub-region (Brazil, Bolivia, Colombia, and Ecuador) in 2008 developed a strategy for distribution of LLINs in high-risk ADM-2, with the support of the AMI project. The methodology consisted of promoting strict compliance to operational guidelines that lead to the highest impact and improved efficacy of this intervention. This was accompanied by entomological assessments, conducted to characterize the changes in vector behaviour. The implementation methodology was adopted by some GFATM funded projects in the region of the Americas. The PAMAFRO project along the border of Colombia and Ecuador is one such example. After one year of using mosquito nets in some areas, a significant epidemiological impact of the intervention could be seen.

Indoor residual spraying (IRS) with insecticides remains a widely used intervention in most countries of the region. In 2008, Nicaragua reported that 359,550 people were protected by IRS, which corresponds to 4,718 protected people per 10 malaria cases in the country (Figure 30). Venezuela, Argentina, Paraguay, Panama, Belize, Ecuador, and Mexico also had a significant IRS coverage compared to the cases reported in 2008. In Ecuador the number of cases dropped remarkably, but spraying level remained relatively similar to that of previous years, thus reaching a high coverage of IRS in relation to the number of cases. In Brazil the number households sprayed is very high but it was not reported in 2008. The low residual effect of pyrethroids, currently being used for IRS, is an important constraint for some countries.

Despite the use of IRS in the region for years, in several scenarios where the issue was recently discussed with entomologists, it has become evident that incorrect practices of IRS are frequent. Among the issues that arose in an analysis promoted by the AMI project in 2005, it was apparent in many situations that IRS was used without regard to the coverage of households or the frequency of cycles required for it. The disconnection between entomology and

field operation is frequent in many countries; residual effect of insecticides, which is a critical parameter, is not appropriately monitored by the programs. The low residual effect of pyrethroids being currently used is a factor that threatens the sustainability of IRS, especially when working in scattered localities with low disease burden where the operational cost of IRS is extremely high. In 2008 however, under the AMI project, experiences in Brazil and Colombia were promoted which showed an improved impact of IRS when the efforts focused on localities with a high burden of disease and when the coverage requirement and periodicity were guaranteed. An instance in the department of Chocó, Columbia showed important operational advantages with the use of organophosphates. In Brazil, the strategy of targeted residual spraying combined with LLINs completely removed the need for spatial application of insecticides during 2008.

Dengue fever, which is transmitted by the *Aedes aegypti* mosquito, is endemic in most countries of the region. Thus, some countries use ultra-low volume (ULV) fumigation to combat this vector, a practice which has also been incorporated in some of the malaria programs to combat anopheles mosquito. However, the efficacy of this practice has not been proven yet.

In 2008, in Mexico and Central America experiences about malaria control by community participation were consolidated. Under the Regional Program of Action and Demonstration of Sustainable Alternatives for Malaria Vector Control, known as the DDT/GEF Project, community participation was used in improvement of the environment and households to reduce anopheline breeding grounds, and in insecticide use.

PROGRAM FUNDING

In 2008, for most of the malaria-endemic countries in the Americas, public resources were the main source of financing for malaria control programs (Figure 35). In Haiti, the financing depended almost entirely on the project financed by the GFATM. In Guyana and Nicaragua too, the respective projects of the GFATM had a very important weight in the total financing of the programs. Until 2008, a total of 11 of the 21 endemic countries of the Region of the Americas had benefited from projects financed by the GFATM. Bolivia, Guatemala, Guyana, Haiti, Honduras, Nicaragua and Suriname have been supported by country projects and Colombia, Ecuador, Peru and Venezuela have benefited from the PAMAFRO project activities, which worked on the endemic areas along the shared borders of these countries.

For the eighth round of GFATM projects opened in 2008, several countries of the region presented proposals, out of which the GFATM approved individual projects for Brazil, Colombia, Ecuador, Bolivia and the Dominican Republic, thus creating a favourable situation to consolidate the accomplishments for reducing malaria in the Region during the next few years.

During 2008, the USAID funded AMI project completed 7 years of operation, with significant accomplishments in technical cooperation and malaria surveillance in the countries of Amazon sub-region. The project has been coordinated in the countries by PAHO, with active participation of other institutions: the United States Centers for Disease Control (CDC), Management Sciences for Health (MSH), United States Pharmacopeia (USP), Links Media and Research Triangle Initiative (RTI). In 2008, USAID funding for this project was around two million U.S. dollars. Although the specific amounts for each country are not significant in the context of the operational costs of the programs, the USAID support, under PAHO coordination, has been essential to promote strategic changes in the control programs of these countries.

The DDT/GEF project in Mexico and Central America funded by the UN Environment Program (UNEP), with the Global Environment Facility (GEF) organization, operated between 2003 and 2007 with a funding of approximately 13 million dollars.

Other donors that supported the malaria programs in the Region during 2008 include the European Union, the Carter Center and the Bill and Melinda Gates Foundation.

MALARIA IN NON-ENDEMIC COUNTRIES

In 2008, countries which are non-endemic for malaria in the Americas reported 1321 cases of this disease. United States of America (USA) reported the highest number of cases, as it has in the past decade while Canada has been the country with second-highest number of cases. Almost all of these cases in non-endemic countries are imported and occur in citizens returning from endemic countries, immigrants from endemic countries, and military personnel. Only the Bahamas and Jamaica in 2008 reported indigenous origin of malaria cases (Figure 47). African countries were the principal area of origin of these cases, while Haiti and French Guyana ranked as the top two countries among American nations from which cases were imported (Figure 48), but this analysis for 2008 did not include information derived from USA or Canada. In the previous year (2007), the leading source of cases in USA was from African countries (64.4%), followed by Asian nations (21.9%). In 2007, countries in the Americas accounted for 11.3% of cases in USA, with 78.6% of these originating in Central America and the Caribbean region. The trend of malaria in non-endemic countries has presented two peaks since 2000, in 2004 and 2006 (Figure 46). These peaks correspond to outbreaks of malaria in Jamaica in 2004 and in the Bahamas in 2006. Currently the two countries have controlled outbreaks and are trying to prevent reintroduction of malaria in the area. Jamaica in 2008 reported 18 indigenous cases of malaria.

These recent outbreaks of malaria in endemic countries stress the importance of surveillance and monitoring, especially in areas with high numbers of tourists and favorable ecological conditions for malaria transmission by the presence of Anopheles species involved in transmission.

SURVEILLANCE OF ANTIMALARIAL DRUG RESISTANCE

Since 2001, the therapeutic response to malaria treatment is being monitored in the Americas within the framework of the Amazon Network for the Surveillance of Antimalarial Drug Resistance (RAVREDA) activities, funded by USAID through AMI. In this period, 80 efficacy studies (or as part of bigger studies) have been carried out and their results were used by Amazon countries to change treatment policies and to introduce improvements to first-line therapeutic schemes for the treatment of uncomplicated *P. falciparum* malaria. Currently, all countries sharing the Amazon basin use ACT as first-line of therapy.

Figures 41-46 present the results of the studies carried out by RAVREDA since 2001. The surveillance strategy for the Region recommends that malaria programs should perform monitoring studies every two years for early detection of possible changes in the therapeutic response. Although by 2007-08 some countries started to complete this interval after the initial studies performed in 2002-06, the remarkable reduction in the number of *P. falciparum* malaria cases has hindered the possibility of carrying out new efficacy studies.

In 2008 only Guyana performed a *P. falciparum* efficacy study (Figure 40) and Colombia, on the initiative of an independent research group that was not related to the network, began an evaluation of the official first-line of treatment in the country (Artemether+lumefantrine). In October 2008, the second therapeutic efficacy test (TET) of the Artemether+lumefantrine combination carried out in Guyana ended. The 14 month study evaluated the therapeutic response of 90 patients, 63 of which completed the follow-up. Therapeutic failure was observed in one patient (Figure 40). The results of this study in Guyana form a very significant contribution for the malaria programs that use Coartem® as first-line of therapy. Although the therapeutic response continues to be appropriate after 3 years of usage, it is important to point out that parasitemia persistence on day 3 was observed in study participants. This is in contrast to a previous study done in 2004 when parasites were eliminated in 100% of the study participants on day 3 of the follow-up. This is a significant finding in the light of information available from Southeast Asia, where slow parasite clearance from blood following treatment with ACT has been detected[1].

Prospective evaluations of clinical and parasitological response of study participants treated with chloroquine for *P. falciparum* malaria carried out in Nicaragua and Honduras in 2007 and 2008, also funded by the AMI project, show a good clinical response in all evaluated subjects. These two studies were performed according to the methodology specified by WHO. Although the studies had low number of subjects lost to follow-up, the small sample size (25-30 subjects) in both studies would limit the probability of finding an event like drug resistance which has less 5% chance of happening. The Honduras study was interrupted by the end of 2008, but till the date of publishing of this report, the

[1] WHO. Containment of Malaria Multi-Drug Resistance on the Cambodia-Thailand border. Report of an informal consultation Phnom Penh, 2007

sample size had been extended to 60 subjects.

In spite of the low number of *P. falciparum* malaria cases in Central America sub-region, there is a risk of case importation from countries within the sub-region, from the Amazon sub-region or from other regions of the world. Although available information suggests that 4-aminoquinolines are still highly effective in treating the strains circulating in these countries, it is necessary to manage an ACT emergency stock for the treatment of imported cases from multidrug-resistant regions. It is a priority issue to establish a surveillance strategy for therapeutic response in case of *P. falciparum* malaria. Countries that are currently in the stage of advancing towards a possible elimination of P. falciparum, having a very low number of cases, such as some countries in Central America sub-region, the treatment should be supervised in all cases and they should be subject to a systematic follow-up with clinical and parasitological controls at least until day 28[2].

In September 2008, PAHO, with the support of USAID and in coordination with other WHO regions, held a meeting of experts in Washington, DC to discuss a strategy for the surveillance of *P. falciparum* resistance in low transmission situations. The difficulty of performing studies in the Amazon sub-region and the specific situation in Central America sub-region were discussed and recommendations were made for maintaining an effective surveillance of resistance emergence and dissemination in the Region.

The changes in therapeutic schemes supported by efficacy studies and the results of the work model with the countries in the RAVREDA-AMI project led to readdressing the project needs. Thus in 2004, lines of work were developed related to the access, quality and use of medications. During 2008, with the technical support of MSH and USP, efforts to correct the deficiencies in the processes of provision, distribution and quality of antimalarials, and the use of medications in health facilities in each of the countries were continued.

[2] WHO. Methods for surveillance of antimalarial drug efficacy. 2009

INFORMATION ANALYSIS IN MALARIA CONTROL PROGRAMS WITH DATABASE SYSTEMS WITH INDIVIDUAL NOTIFICATION

In recent years, some countries of the region have implemented malaria information systems with individual notification of cases in databases. This has allowed analysis of malaria behaviour with the desired degree of disaggregation by any level of the health system.

It is fundamental for institutions that are responsible for program management, and planning of resources and interventions at ADM1 (departments, states, provinces), and even at the central level, to understand the behaviour of malaria in the foci. Planning for active case detection, diagnosis and treatment, and decision making in vector control depend on an efficient management of information at the local level. Information analysis is possible at local level with manual tabulation of data and the continuous monitoring of behaviour in the localities, but for a more technical program management from a higher level automated information management of individual cases is required.

For several years now, the Brazilian control program has systematized the entry of information on a central database via the Internet in every municipality of the Amazon Region. In the past few years this system has improved in timeliness and coverage of data, and information analysis. Since 2006 the AMI Project, funded by USAID and coordinated by PAHO, has supported the creation of central databases in Guyana, Suriname and Ecuador as well as databases at local level in Bolivia and Colombia.

In 2008 there was major progress in the consolidation of such information systems in these countries. In Colombia, the Ministry of Social Protection and the National Health Institute boosted the implementation of individual notification for all events of public health concern. In this way, the Public Health Surveillance system (SIVIGILA) took an important step forward in 2008 that will greatly benefit malaria control. By the end of 2008, more than 78% of the information had been entered into the national database and even a larger proportion, that was not automated, was reported in the new formats, even in the more remote areas.

In the Departments of Beni and Pando, in Bolivia, during 2008 a database was implemented that allowed the information in both departments, where most of the country's disease burden concentrates, to be readily available in electronic format, increasing the potential for analysis.

The malaria control program in Ecuador has developed and been using, since 2005, the Ecuador Epidemiological Malaria Surveillance System (SIVE MAE) for the automatization of case information. This system has been modified and improved on several occasions in the past three years. In 2008 it reached a high level of implementation; ninety five percent of the cases reported in the country in 2008 were assimilated in this database which includes the necessary variables to guide the decision making in malaria control.

Monitoring of malaria situation and the planning of control strategies was continuously aided in 2008, as in previous

years, in Guyana and Suriname by the national malaria information system, which incorporates individual patient records. In Venezuela, for years now, the regional bureau maintains a database with individual case records. The efforts to maintain an electronic database of individual cases are rewarded with a huge potential for analysis, using currently available analytical software.

In Peru, by the end of 2008, individual case notification began feeding a malaria surveillance database.

Figures 42-45 present examples of the potential of malaria information systems that have individual case records. In Guyana the information system allows registering for each case, the probable locality of infection and the locality of the facility where the diagnosis was made. Changes in malaria transmission dynamics demand a continuous revision of the diagnostic network structure in the localities where the cases originate.

Management of information using databases with individual records allows analysis at the level of locality of origin and diagnostic facilities for all levels of the program management in a timely fashion. Figure 47 presents such an example of analysis with Guyana's database. The geographic coordinates of localities have been included in the malaria program database, which allows a very detailed spatial analysis of the disease according to site of infection and place of diagnosis. This example shows that a significant portion of cases are being diagnosed at a place different from the place of origin and reveals a need for improvement in provision of diagnosis

This level of analysis is critical in guiding policies for diagnosis and treatment and for strengthening the health services in general, and it is also essential in guiding vector control. The selection of localities for vector control should start with a stratification exercise that helps identifying localities with high morbidity and defining the foci.

Concerning vector control, information management using databases facilitates relating individual case information to the results of entomological studies. In 2008, within the AMI project framework, results of entomological studies were also incorporated in databases in Colombia, Brazil, Bolivia, and Ecuador.

It is noteworthy that there is a need to revitalize the expertise in clinical entomology in national malaria programs of the Region. Understanding the transmission dynamics in the foci and guiding interventions, apart from improving entomological information management, requires reliable information about vector behaviour and variations in entomological parameters in response to interventions.

In Bolivia, the information system recently developed for the Departments of Beni and Pando, registers dates for onset of symptoms, and for treatment provided by the health system. The analysis of time difference between these dates allows evaluation of the timeliness of diagnosis and detects the stage in the process of treatment and diagnosis at which the main shortcoming lies. Figure 48 shows the comparative analysis of the time elapsed between the onset of symptoms, blood slide examination, its reading and treatment; it reveals that for many municipalities the main drawback in the process lies in the provision of timely

diagnosis. The time elapsed between taking a blood slide and the initiation of treatment is short, but early access to diagnosis remains the main challenge of the control program and services.

Another example of automated information management is Ecuador where the system records, among other variables, the parasitemia of each case on the day of diagnosis. When comparing the cantons of origin according to this parameter, it is possible to identify places with high parasitemia, and where there is a prolonged interval between the onset of symptoms and reading of blood slides (Figure 49). This shows the need to define strategies to improve accessibility and/or compliance of communities to disease diagnosis.

Figure 50 has information from SIVIGILA in Colombia and it illustrates how information management, using databases with individual case records, allows easy cross-referencing of information between variables at the level of disaggregation required. For example, it is very important for an ADM1 level (province) to monitor the number of incident cases in a particular ADM2 level and being diagnosed by other ADM-2 levels. Figure 49 illustrates this at the municipality level (ADM2) but this comparison between place of origin and place of diagnosis can be done at any level of disaggregation if individual case records are maintained in electronic databases.

The concept of relational databases is another element which adds great analysis potential to the system. The simultaneous management of information on different aspects of malaria control related to individual case record databases through locality and diagnostic facility codes multiplies analytic possibilities and allows creating an information system that includes every aspect of malaria control.

Monitoring of urban malaria, which should be a priority issue for control programs, can be improved by typifying appropriately localities of origin and by management of relational databases, where individual cases relate through locality codes to tables where these are properly characterized.

Collecting and maintaining individual case records and structuring the flow of information to feed the surveillance databases are the most demanding operational steps in the automatization of the system. The next aspect is to develop and impart analysis training and establishment of a culture of using information. In health systems, analytical capacity is weak and information usage still low; this limitation discourages any effort to automate information management. In this sense, in recent years there has been progress in the region in providing health services with the capacity and the tools for the analysis of malaria information, supported by the AMI project in the countries of Amazon sub-region.

In 2008, significant progress was made in this direction in Brazil, Bolivia, Colombia and Ecuador. In all of these countries automatized analysis protocols were developed with data tabulation tool that is now available in malaria programs at the central level and in some of the ADM1 (states, departments, provinces). During this period, PAHO has worked together with these countries in order to develop capability for generating automatic reports with time and space variations of important parameters for malaria program on updating the databases. Some of these parameters are indicators used for

monitoring the management of diagnosis and treatment at ADM1 and ADM2 levels or of specific health units. For example, the monitoring of time variations in the proportion of cases diagnosed in the first 72 hours from onset of symptoms in each municipality of origin, the proportion of *P. falciparum* cases, or the changes in the proportion of urban transmitted cases, become indicators easily monitored which may develop into very concrete goals for the management of programs at the different levels.

Countries with projects funded by the GFATM are expected to mobilize resources for improving the information management of health systems in general and malaria programs in particular.

The prospect of some countries of the Region progressing towards malaria elimination or at least the elimination of *P. falciparum* transmission raises the challenge of reorganisation of control programs and puts emphasis on the need of information management using individual case records. Limiting of transmission to endemic areas only, understanding the transmission dynamics in each endemic area and the capacity to implement surveillance of individual cases are critical for this initial restructuring of programs. Therefore, in addition to advancing the adoption of new tools now available, it is necessary to promote an analysis of errors made in the past and lessons learned.

Malaria burden and geographic distribution

Figure 1. Number of cases by ADM 2 level (municipality, district). 2008

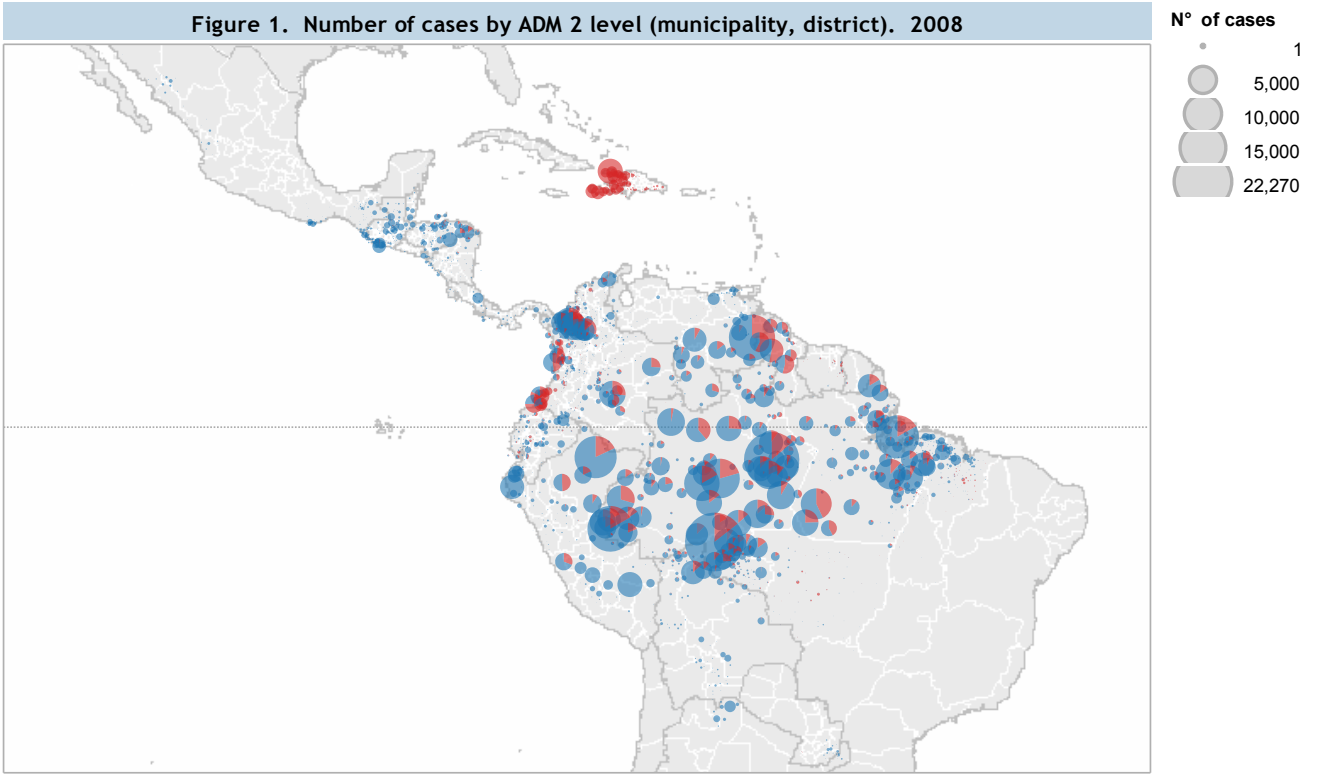
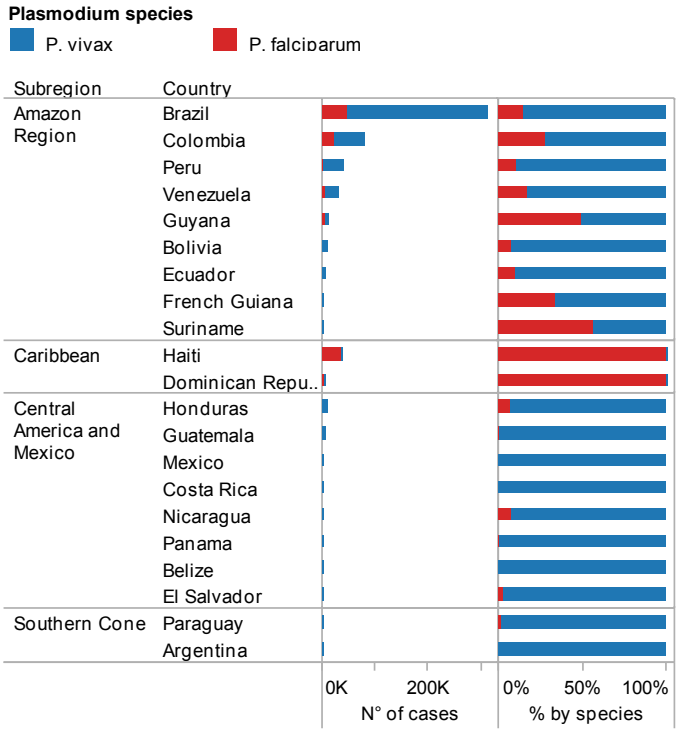


Figure 2. Number of malaria cases by country and species in 2008



Country	P. falciparum	P. vivax	Total
Brazil	49,181	266,371	315,630
Colombia	22,392	56,838	79,230
Peru	4,492	37,722	42,214
Venezuela	5,540	26,437	32,037
Guyana	5,741	5,920	11,815
Bolivia	836	8,912	9,748
Ecuador	491	4,495	4,986
French Guia..	1,105	2,149	3,264
Suriname	838	639	1,490
Haiti	36,769	6	36,774
Dominican R..	1,839	1	1,840
Honduras	610	7,615	8,225
Guatemala	50	7,148	7,198
Mexico	0	2,357	2,357
Costa Rica	0	966	966
Nicaragua	61	701	762
Panama	4	740	744
Belize	0	538	538
El Salvador	1	31	33
Paraguay	7	333	341
Argentina	0	106	106
Grand Total	129,957	430,025	560,298

Figure 3. Number of malaria cases by ADM2 level (municipality / district) in 2008

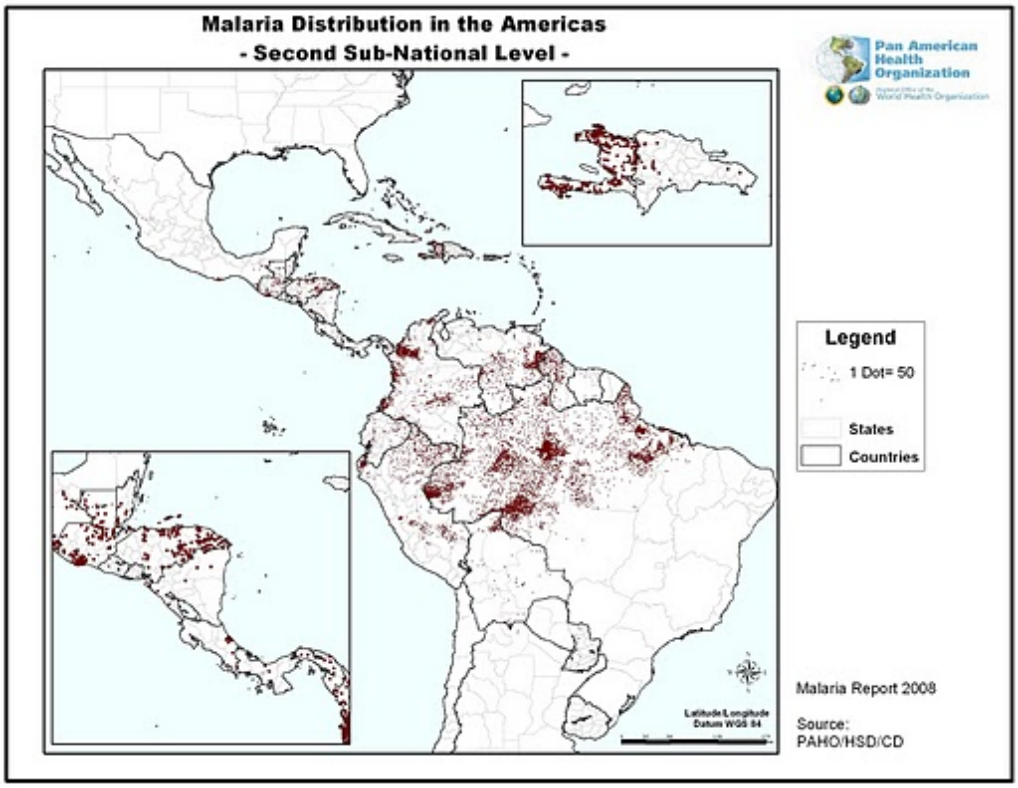


Figure 3a. Number of malaria cases and annual incidence by ADM2 level (municipality / district) in 2008

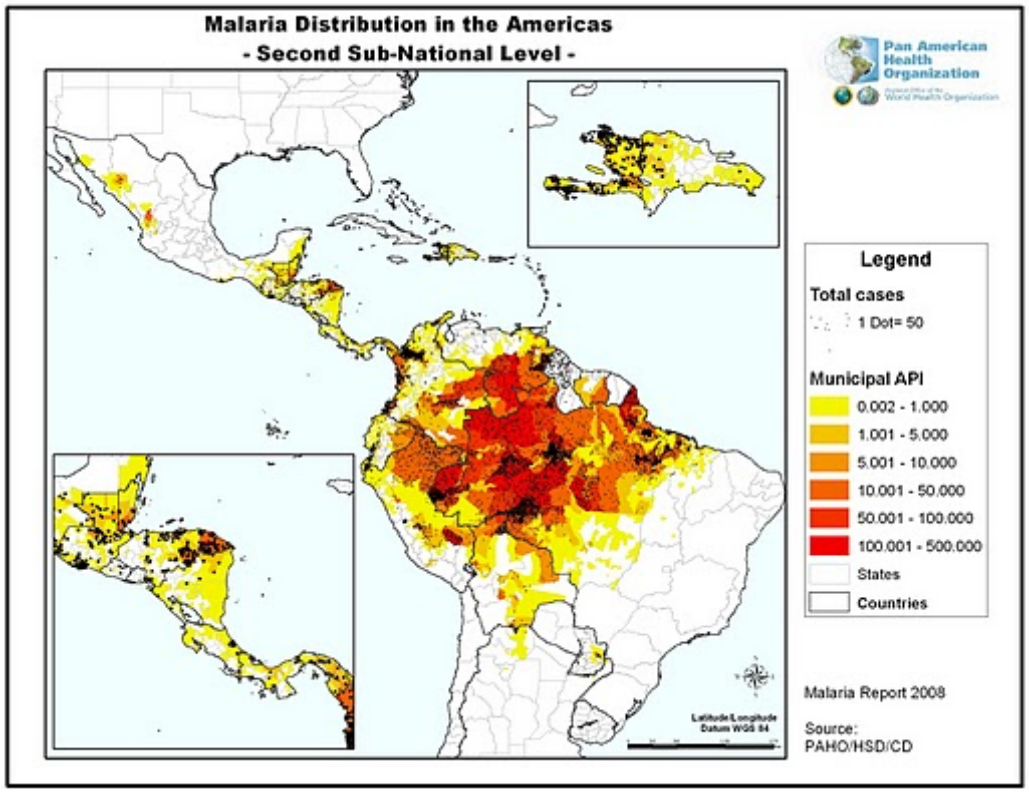


Figure 4. Number of cases by ADM2 in Mesoamerica and northwest region of Colombia. 2008

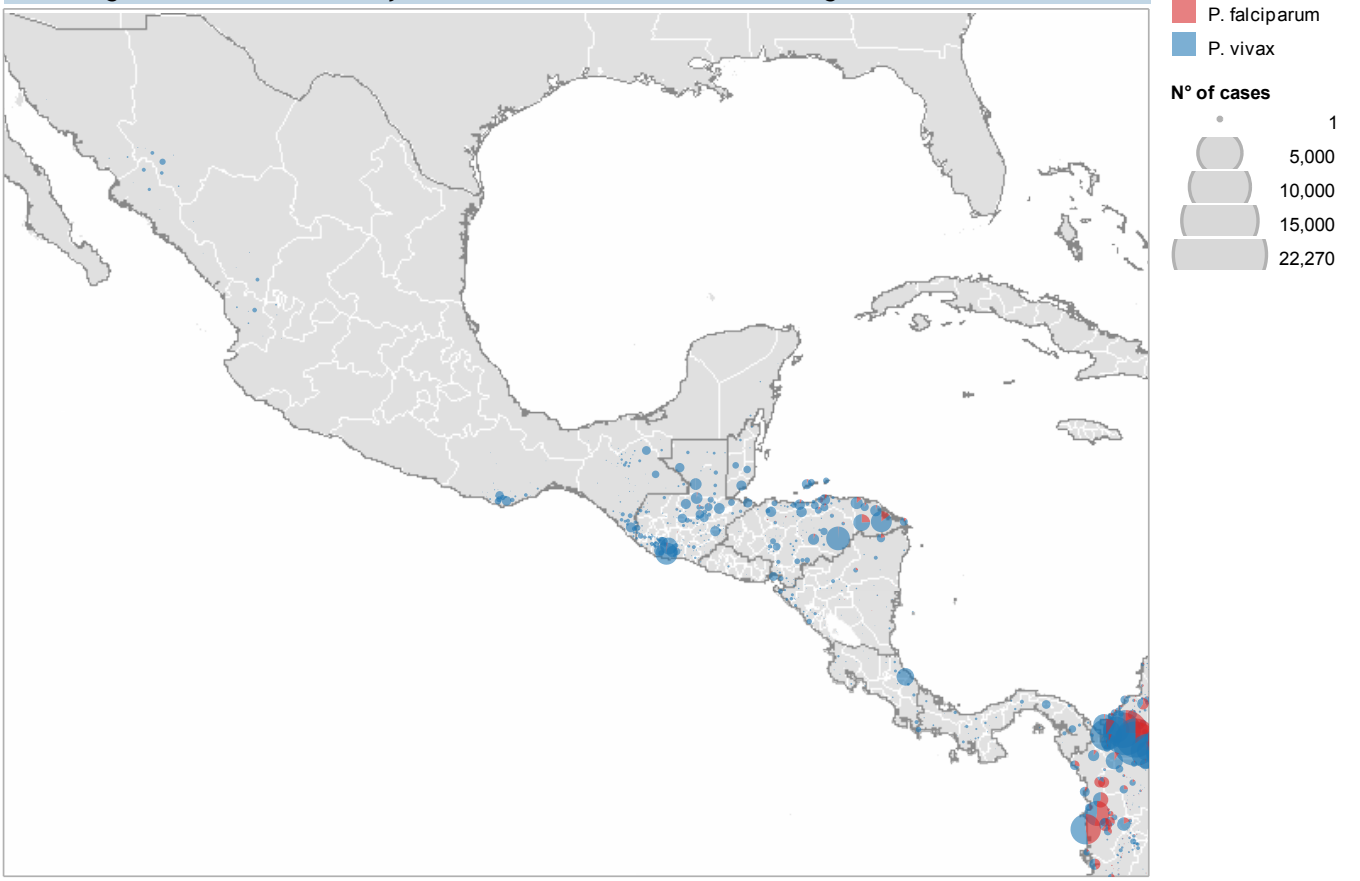


Figure 5. Number of cases by district in South American countries. 2008

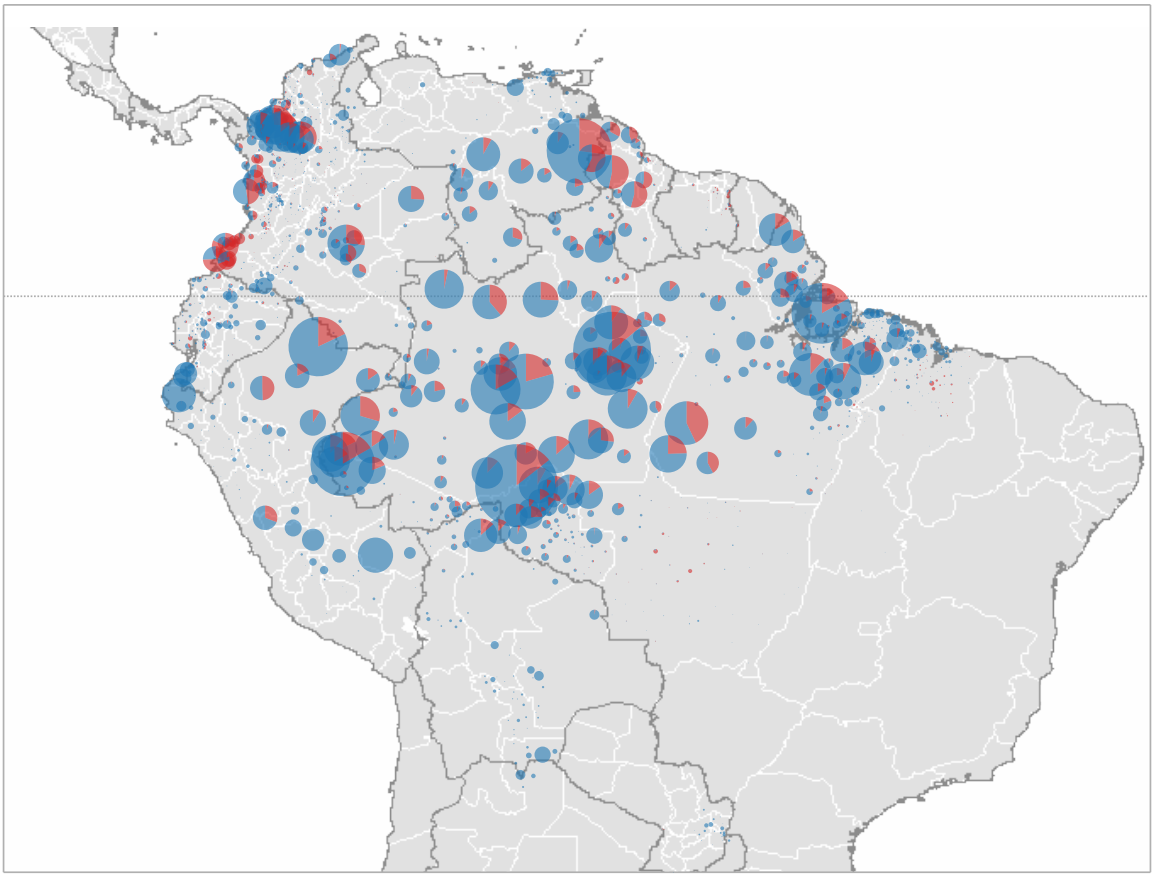


Figure 6. Malaria annual incidence by ADM 2 level (municipality / district) in 2008

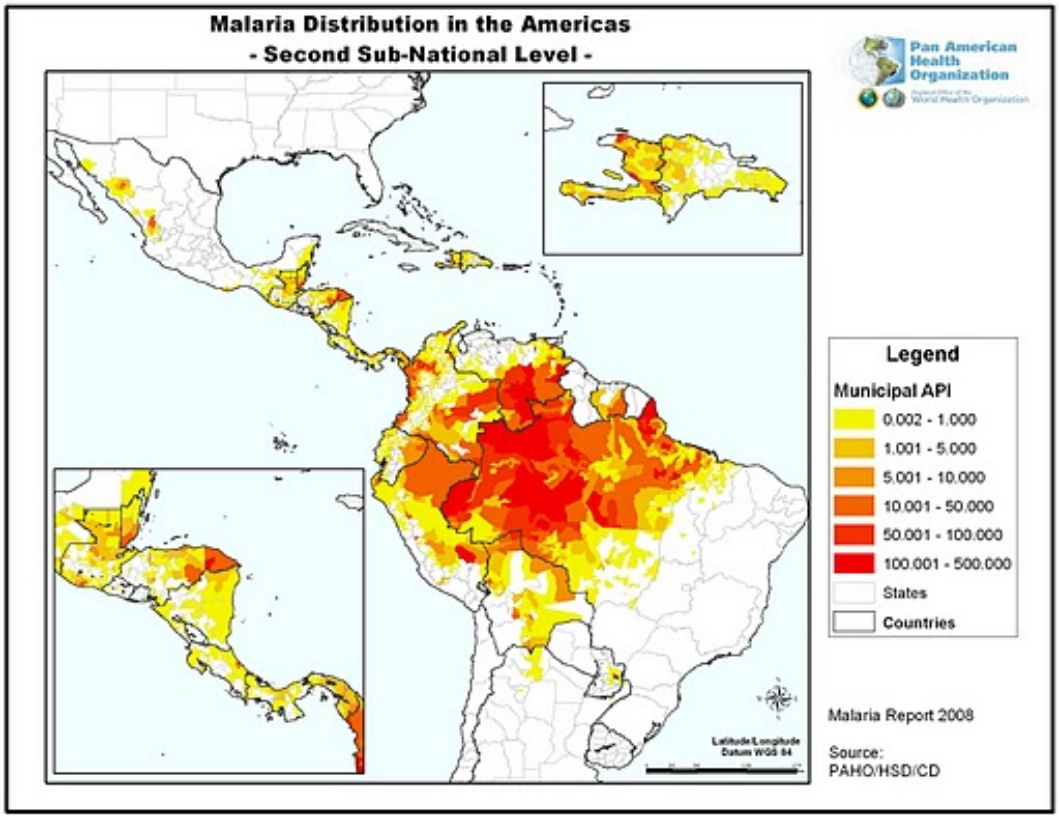
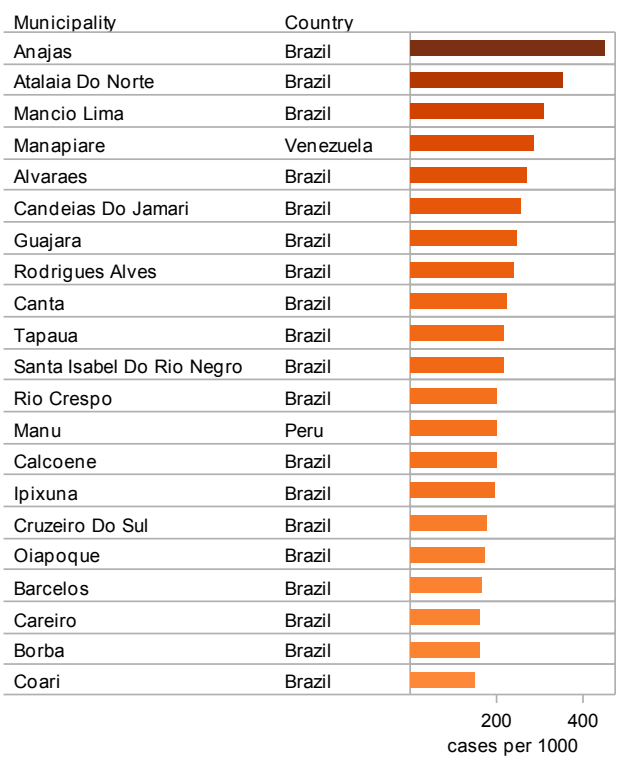
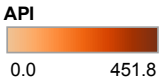


Figure 7. N° of cases and annual incidence by country

Figure 8. 25 municipalities with highest incidence in 2008





Morbidity and mortality variations 2000-2008

Figure 9. Number of cases by specie 2000-2008

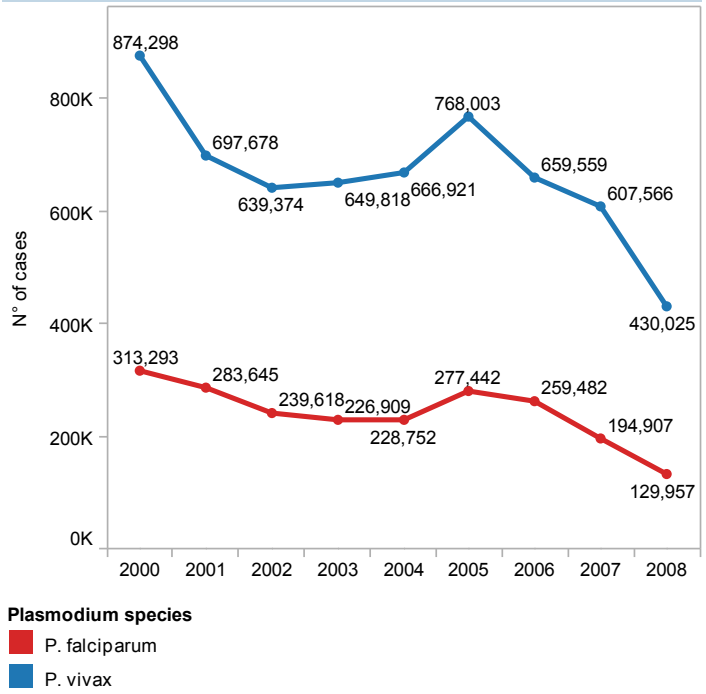


Figure 10. Annual variations in number of cases

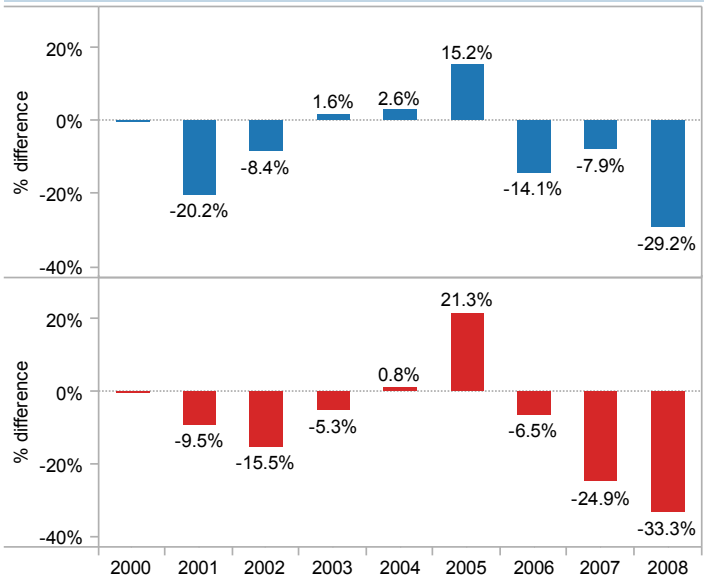


Figure 11. Number of malaria deaths 2000-2008

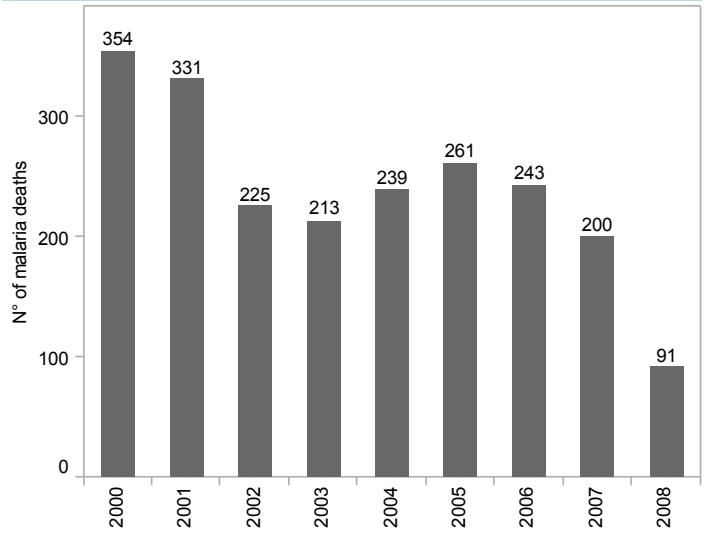


Figure 12. Annual variations in mortality

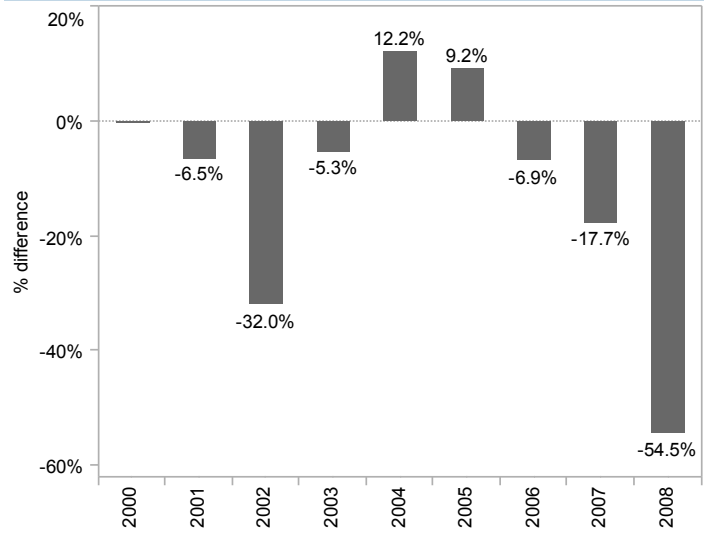


Figure 13. Number of malaria cases 2000 - 2008

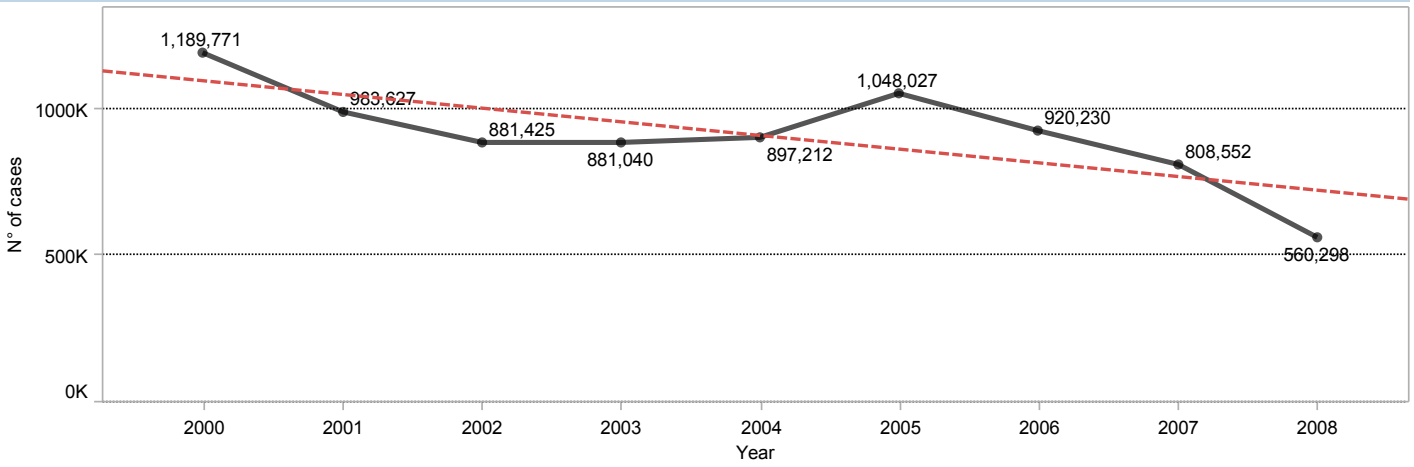


Figure 14a. Annual variation in number of cases by country

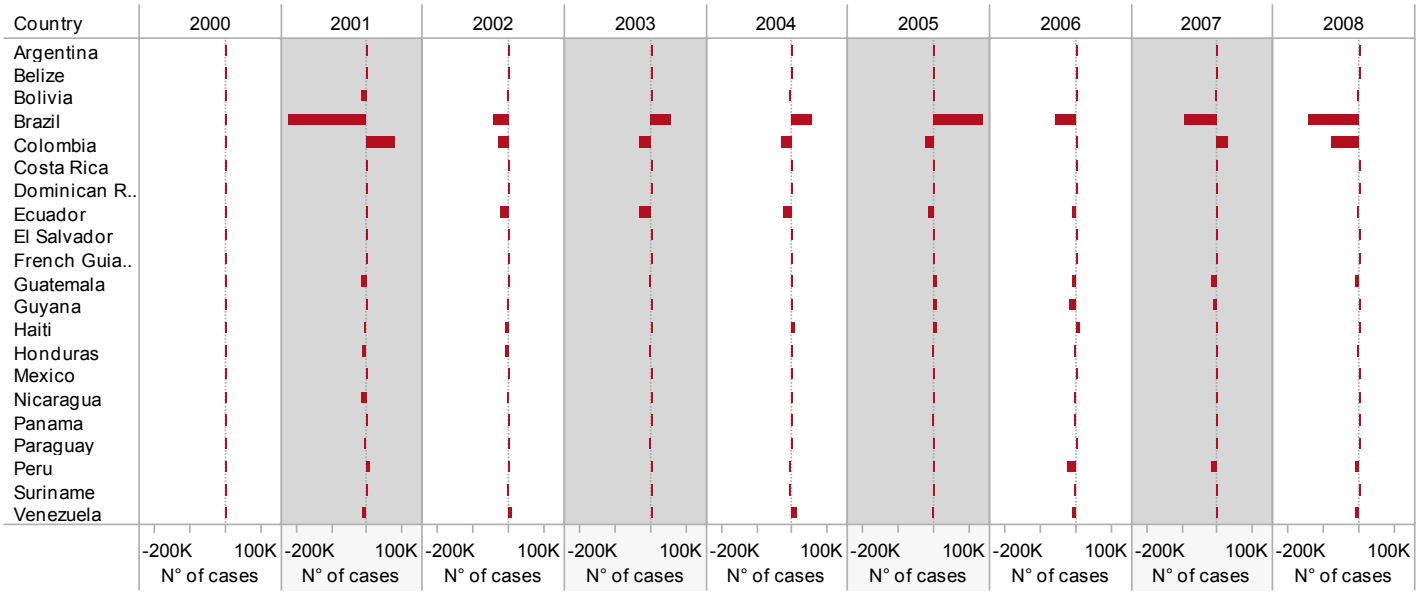


Figure 14b. Annual variation in number of cases by country (percent difference from previous year)

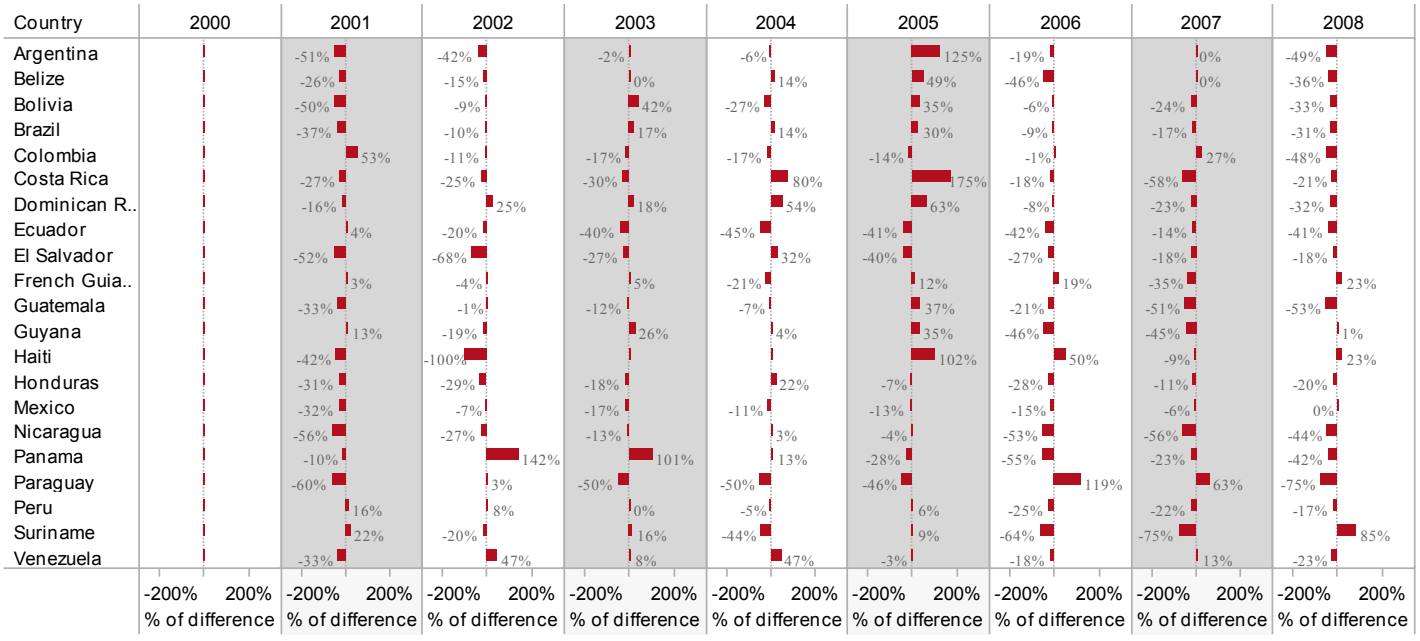


Figure 15a. Change in malaria incidence in Americas, 2000-2008

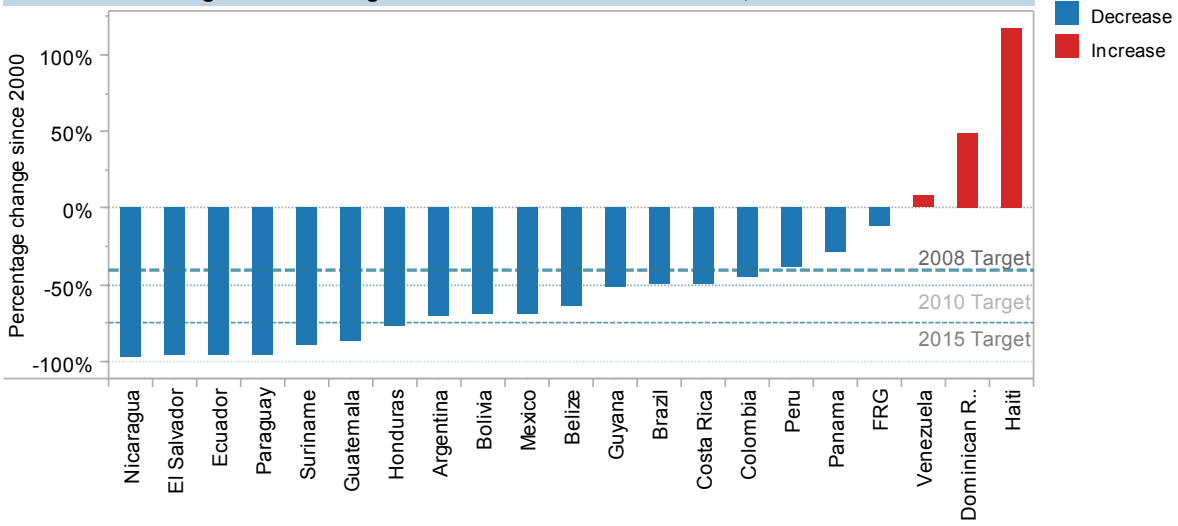


Figure 15b. Total number of malaria cases in endemic countries of the Americas, 2000-2008.

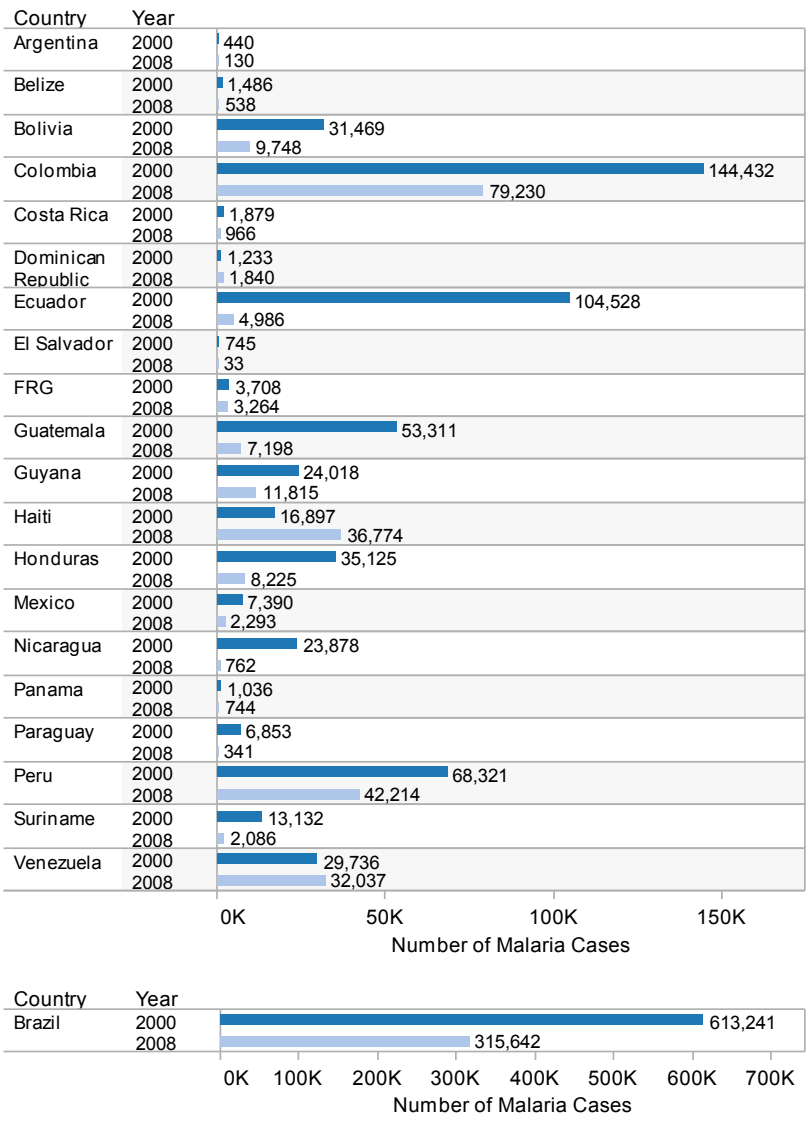
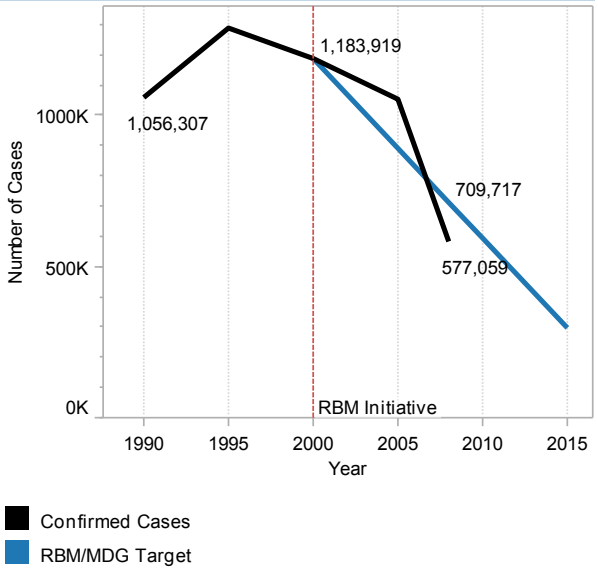


Figure 15c Malaria Cases and targets in America, 1990-2008.



Brazil in different scale
DOM- Dominican Republic, FRG- French Guiana.

Figure 16. Municipalities with higest malaria burden and accumulated proportion, 2008

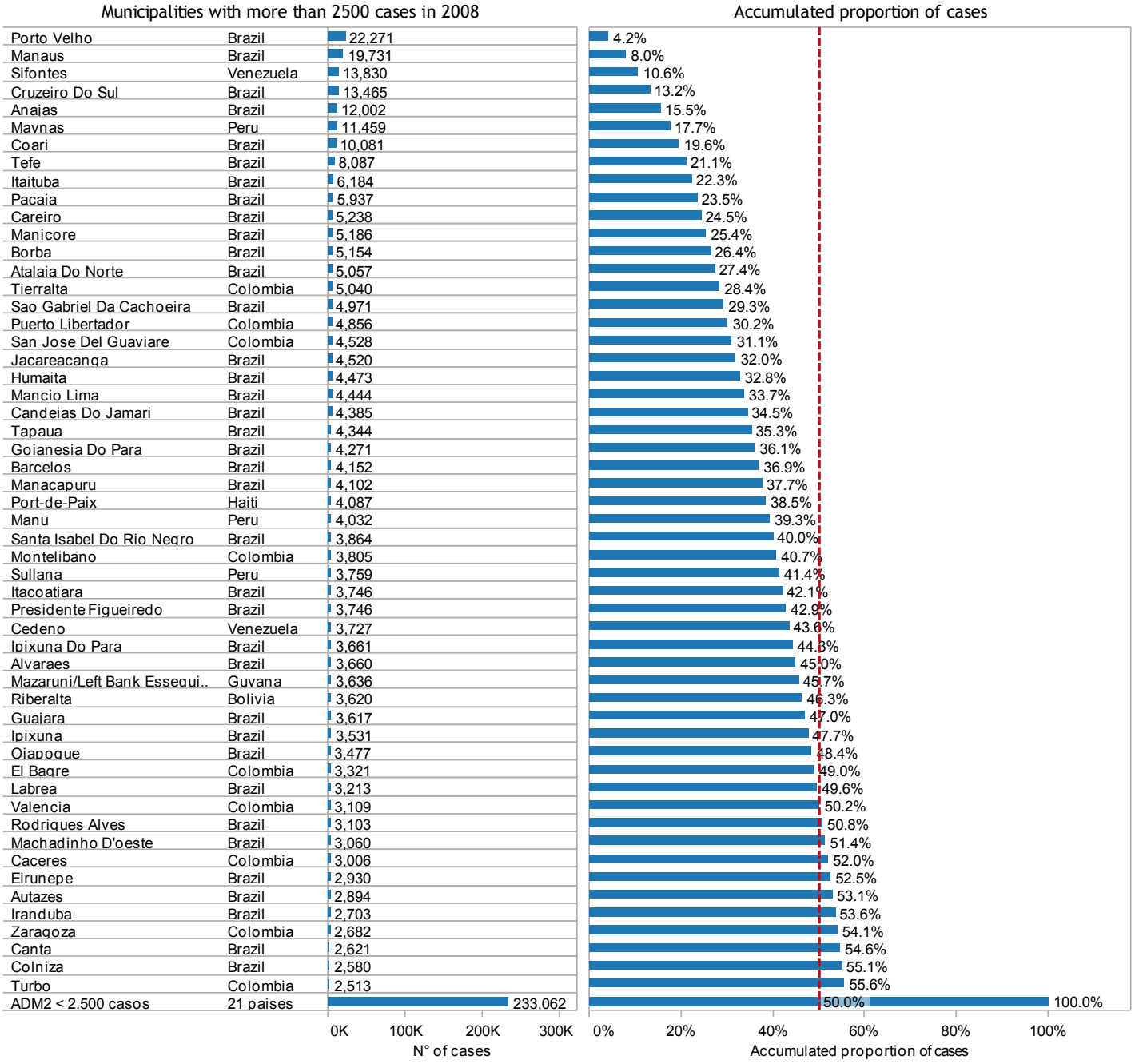


Figura 17. Muncipalities by number of malaria cases

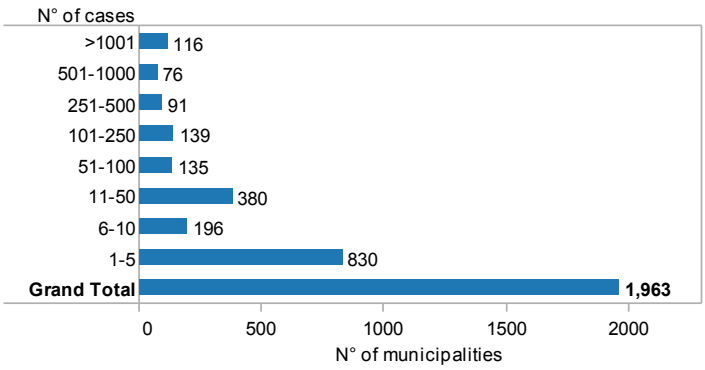


Figure 18. Municipalities by number of P. falciparum cases

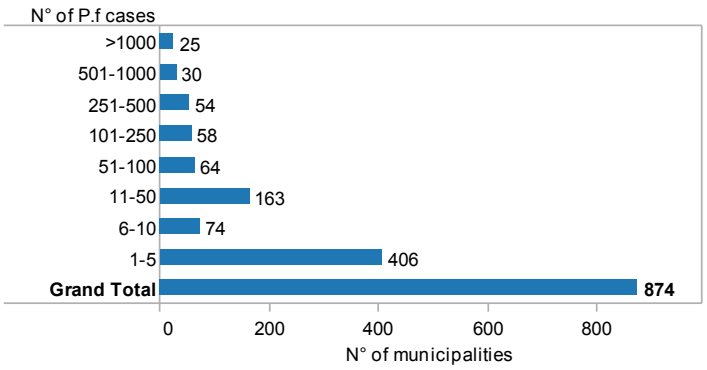


Figure 19. Municipalities by N° of cases, API and % of P. falciparum

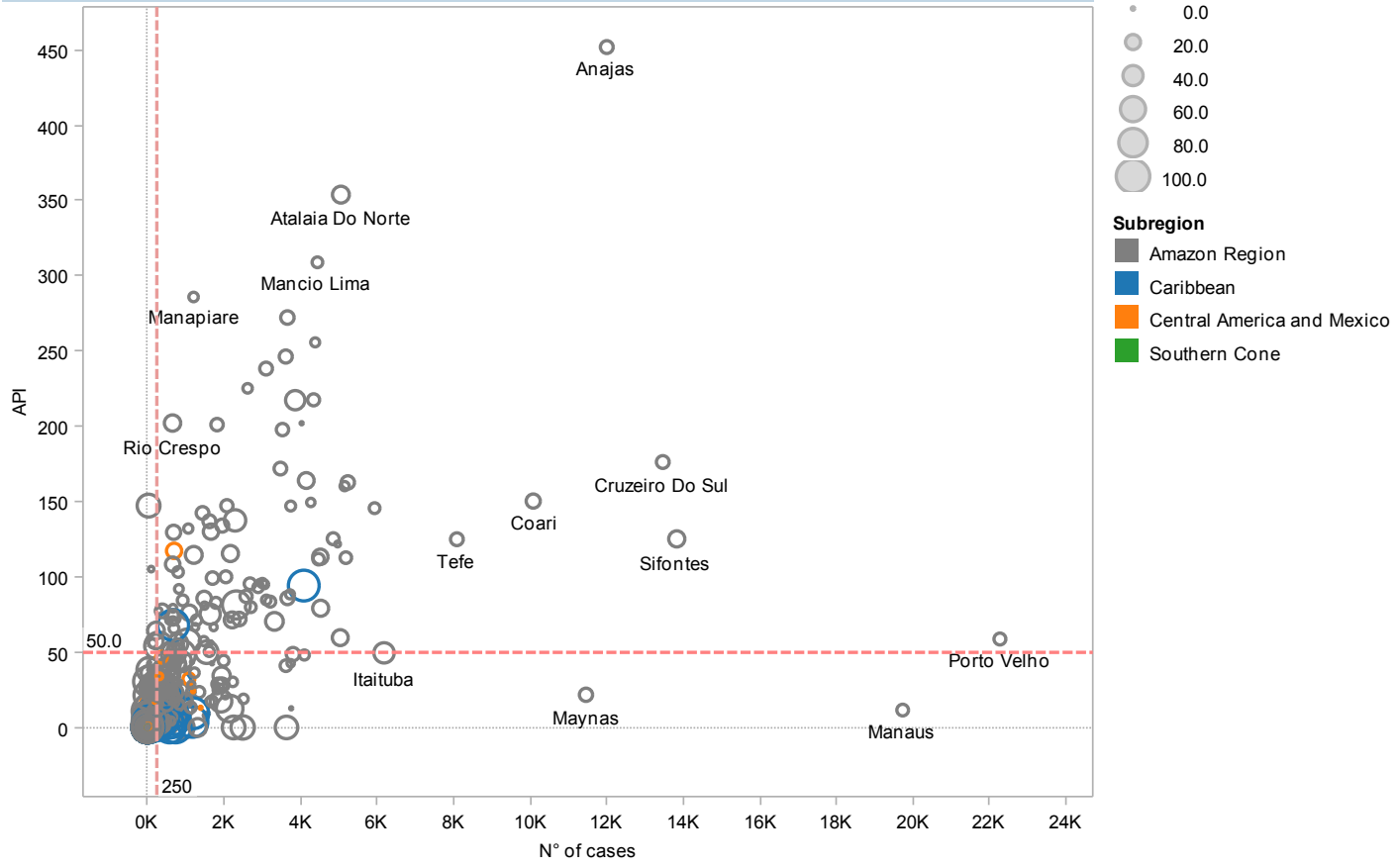


Figure 20. Municipalities by N° of cases, API and % of P. falciparum (logarithmic scale)

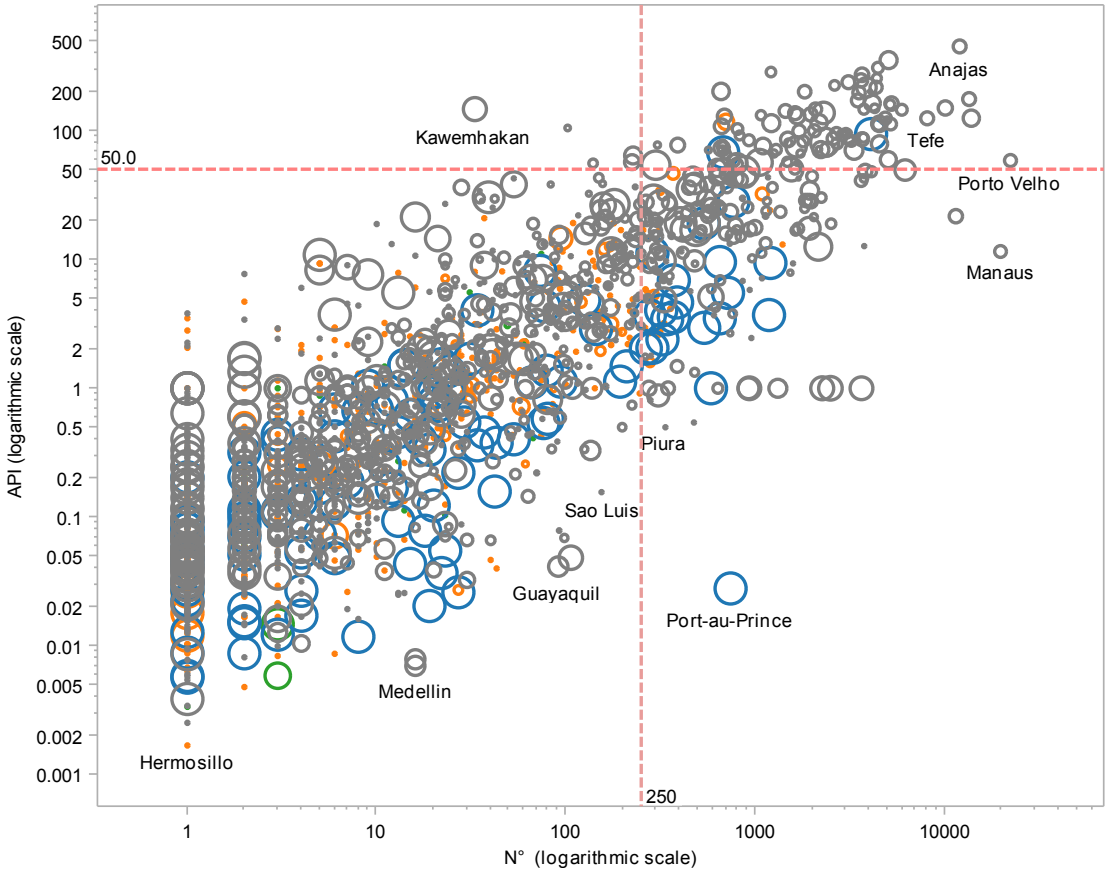


Figure 21. Number of municipalities (ADM2 level) by risk level

N° of municipalities with API> 9 x 1.000

Belize	6
Bolivia	19
Brazil	155
Colombia	70
Costa Rica	1
Dominican Republic	18
Ecuador	11
Guatemala	16
Honduras	12
Mexico	3
Nicaragua	1
Panama	1
Paraguay	3
Peru	11
Suriname	8
Venezuela	14
Grand Total	349

N° of municipalities with API > 49 x 1.000

Belize	6
Bolivia	2
Brazil	69
Colombia	18
Dominican Republic	17
Ecuador	5
Guatemala	9
Honduras	1
Nicaragua	1
Paraguay	2
Peru	1
Suriname	1
Venezuela	7
Grand Total	139

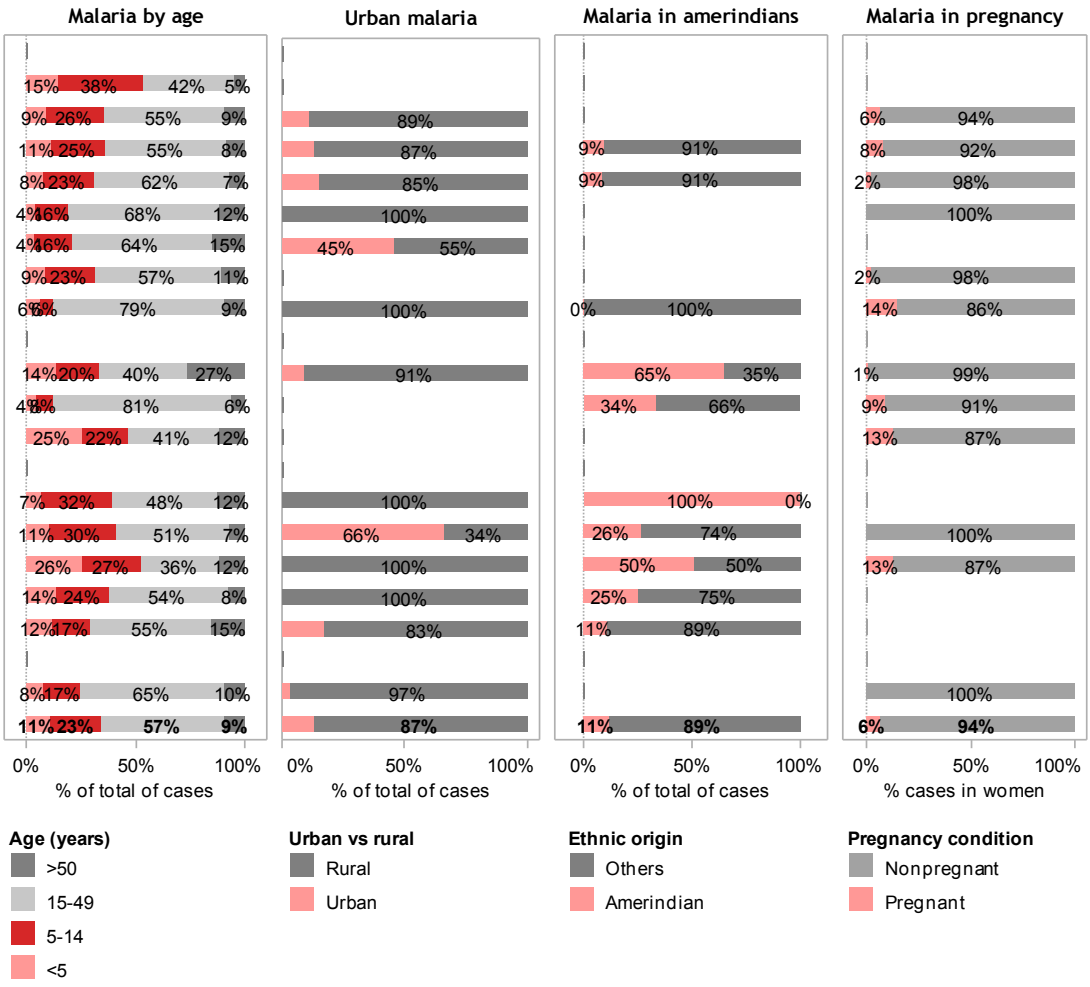
N° of municipalities with API > 99 x 1.000

Bolivia	1
Brazil	38
Colombia	2
Honduras	1
Peru	1
Suriname	1
Venezuela	4
Grand Total	48

Figure 22. Malaria situation in specific groups

N° of cases by country

Argentina	106
Belize	538
Bolivia	9,748
Brazil	315,630
Colombia	79,230
Costa Rica	966
Dominican Republic	1,840
Ecuador	4,986
El Salvador	33
French Guiana	3,264
Guatemala	7,198
Guyana	11,815
Haiti	36,774
Honduras	8,225
Mexico	2,357
Nicaragua	762
Panama	744
Paraguay	341
Peru	42,214
Suriname	1,490
Venezuela	32,037
Grand Total	560,298



Malaria diagnosis

Figure 23. Slides examined and Slide Positivity Rate (SPR) in 2008

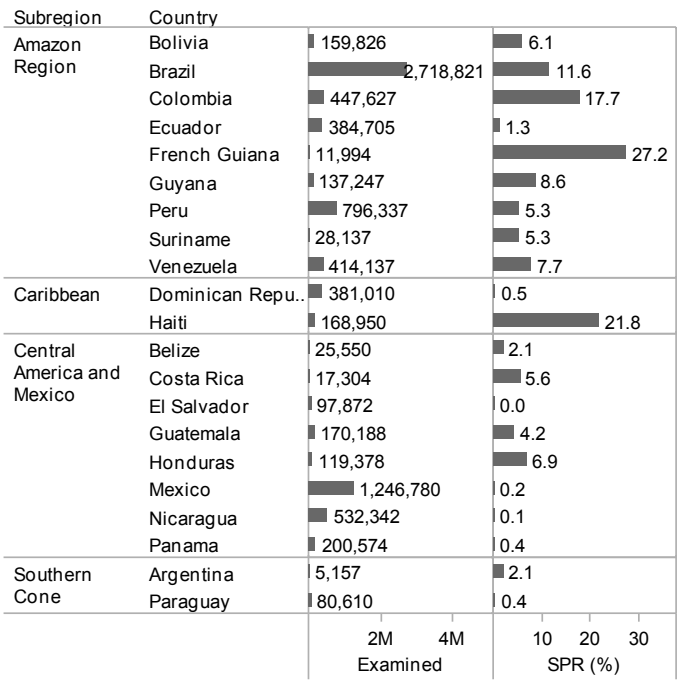


Figure 24. Time span between onset of symptoms and diagnosis

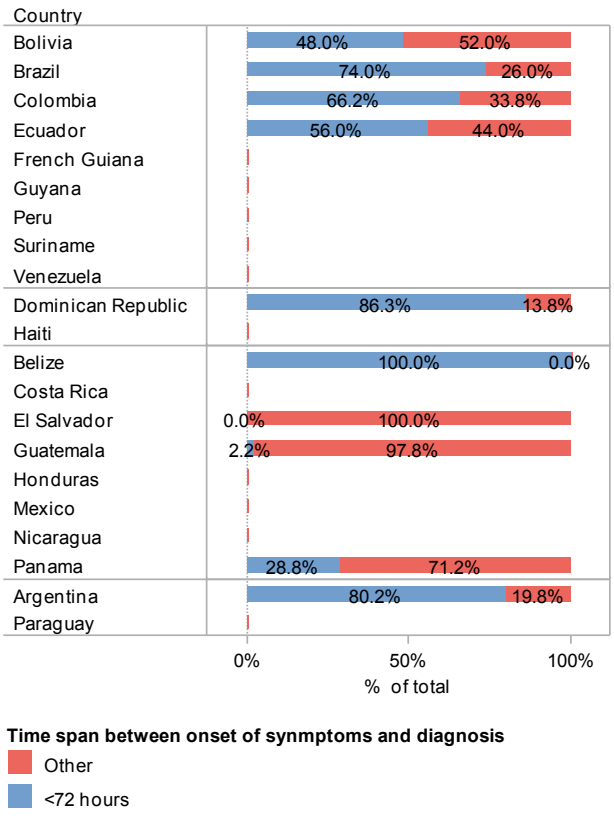


Figure 25. Correlation between Slide Positivity Rate and API in 2008

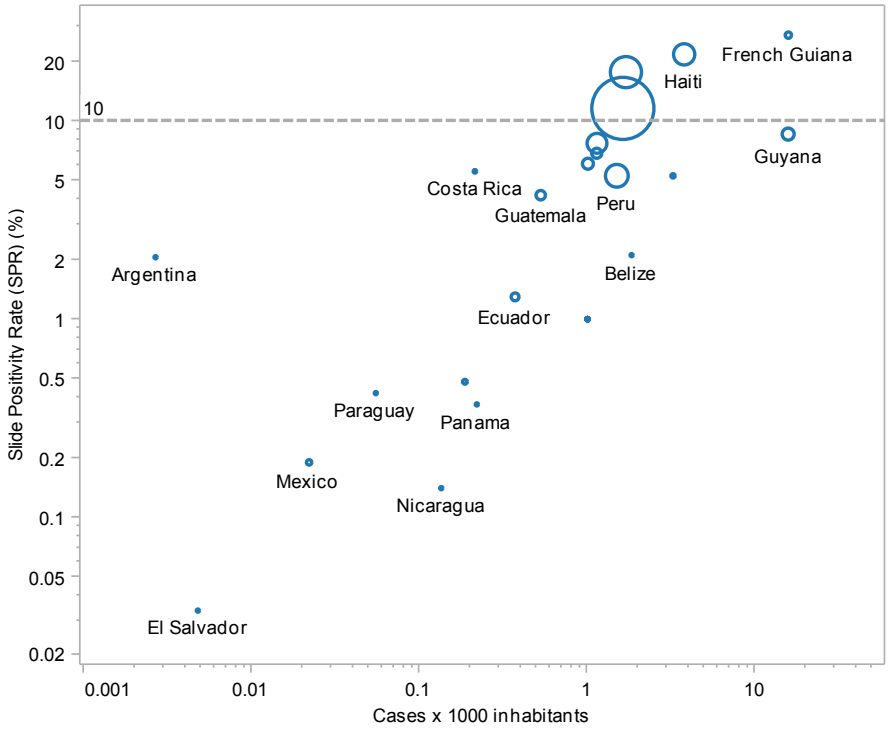
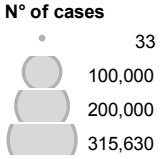


Figure 26. Cases diagnosed by microscopy and by RDT

Year	Microscopy	RDT
2000	8,986,300	0
2001	9,030,911	0
2002	8,801,765	0
2003	8,530,988	0
2004	8,577,357	0
2005	11,571,817	6,000
2006	8,254,029	32,173
2007	7,978,927	44,173
2008	8,025,168	109,442



Introduction of Artemisinin based Combination Therapy

Figure 27. Number of P. falciparum malaria cases, 2000- 2008

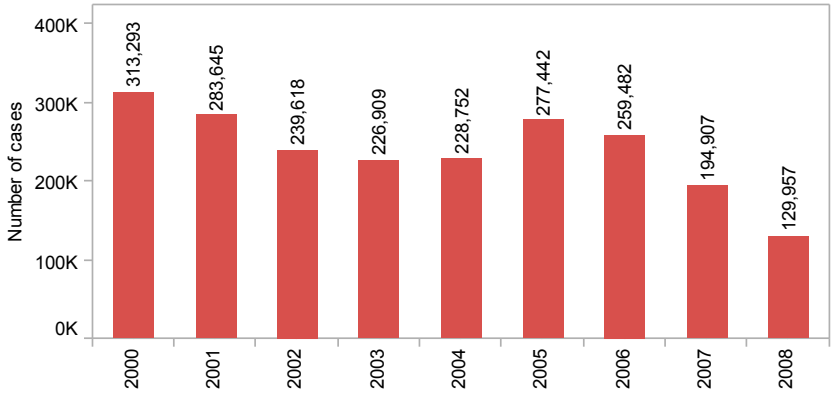


Figure 28. Proportion of malaria cases by species, 2000-2008

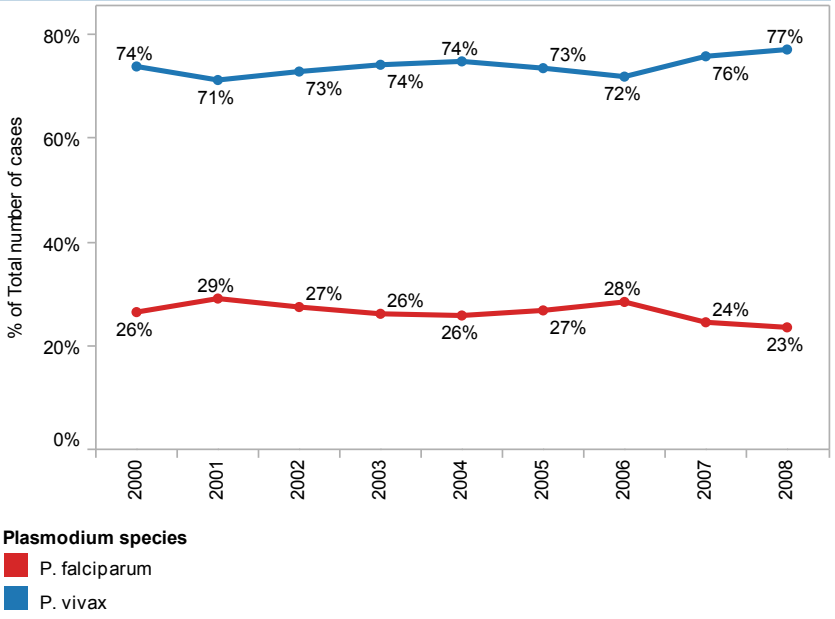
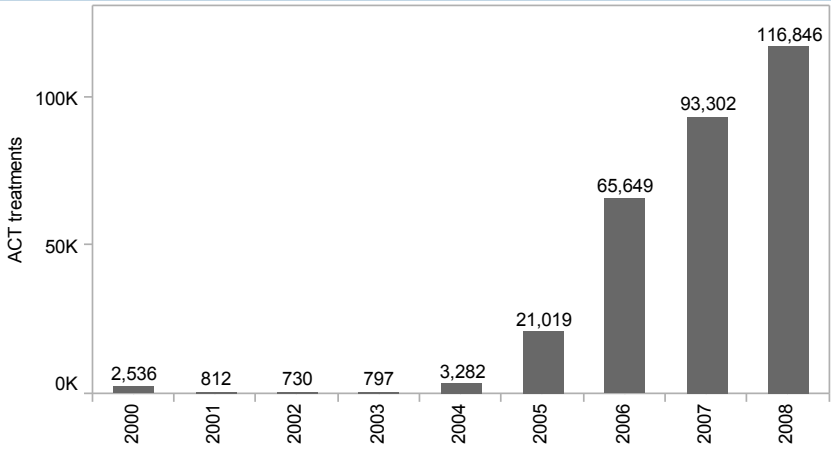


Figure 29. Number of ACT treatments distributed by year



Vector control interventions

Figure 30. Indoor residual spraying coverage

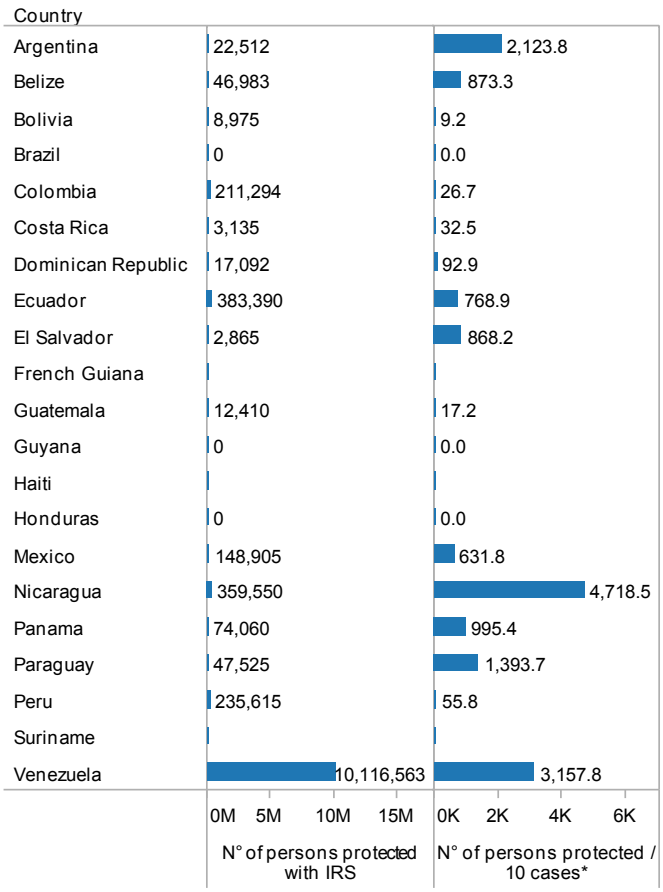
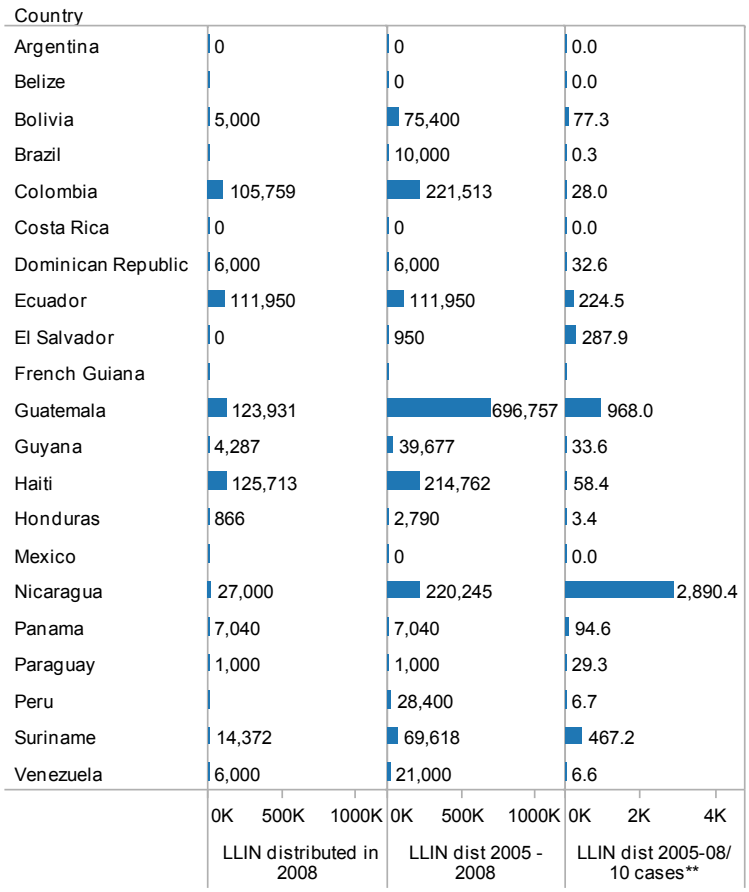


Figure 31. Long lasting impregnated net coverage



* = persons protected per10 malaria cases in 2008
** = LLIN distributed between 2005- 2008 per 10 malaria cases in 2008

Vector control interventions and financing

Figure 32. Indoor residual spraying coverage

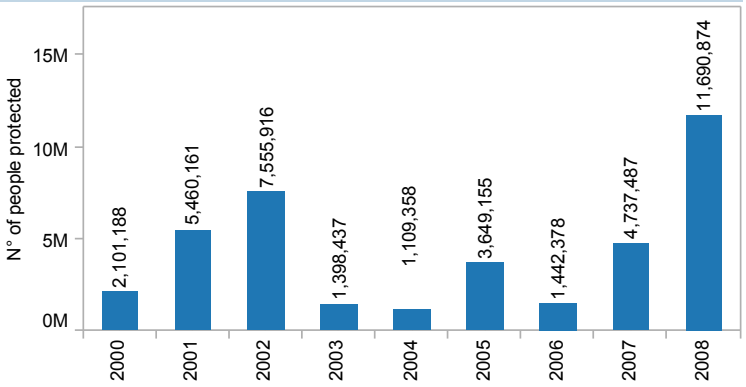


Figure 33. Long lasting impregnated net coverage

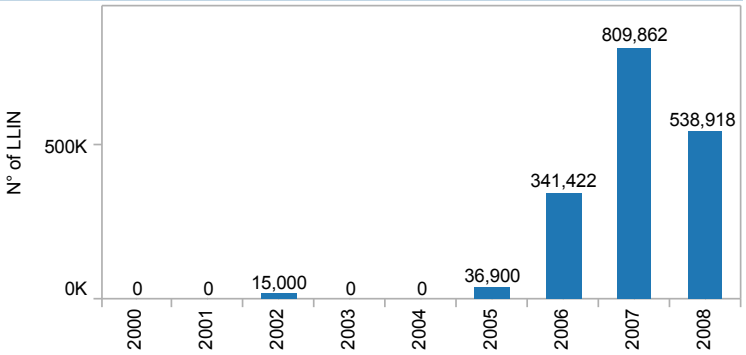


Figure 34. Conventional insecticide impregnated net coverage

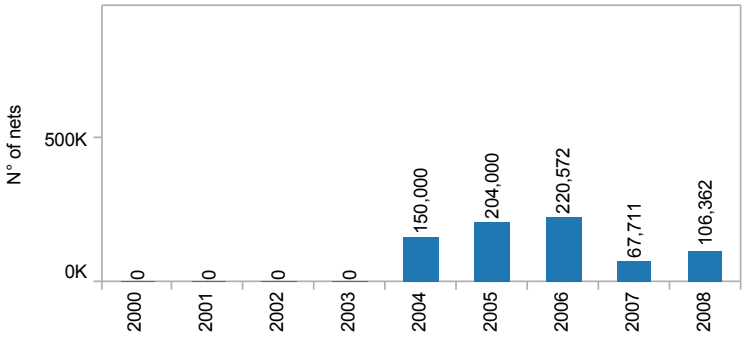
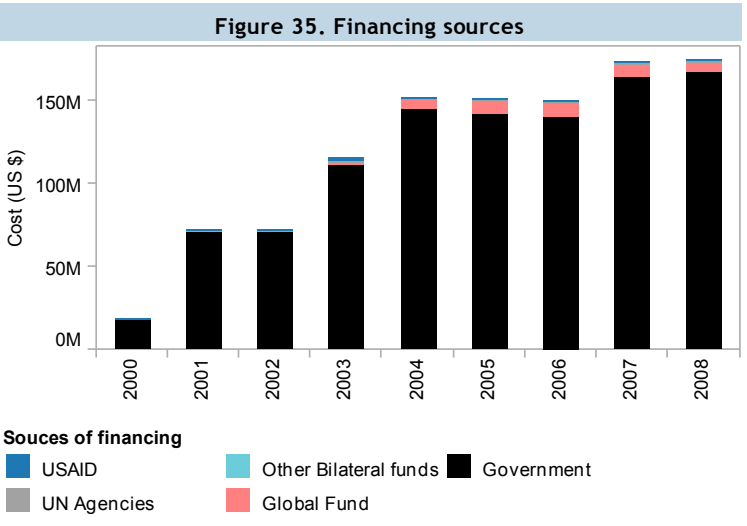


Figure 35. Financing sources



Malaria in Non-endemic countries

Figure 36. Number of cases by country where cases were detected 2000- 2008

Country	Year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Anguilla	0	0	0	0			0		0
Antigua & Barba..	0	0	0	0				1	1
Bahamas	2	4	1	3	2	1	49	6	14
Barbados		5				3			
British Virgin Isla..	0	0	0		0		0		0
Canada	462	445	366	370	369	348	318		
Cayman Islands	3	0				2	1		
Chile	7	0	5	7	7	5	3	5	
Cuba	53	0	29	30	26	9	33	35	19
Dominica	0	0	0	0				0	
Grenada		0				1	0	0	0
Guadeloupe	7	7	12		7		6		12
Jamaica	7	6	7	9	141	88	194	199	22
Martinique	7	11	12	16	10		10		14
Monteserrat	0	0	0	0			0		0
Puerto Rico	1	0	1	1	0	1	2	3	2
Santa Lucía	3	0	2	1				0	
St. Kitts & Nevis	0	0	0	0					0
St. Vincent & the..	0	0	0	0			0	0	1
Trinidad & Toba..	17	0	8	10	15	8	8	14	
Turks and Caico..	0	0							
United States of ..	1,402	1,383	1,337	1,278	1,324	1,528	1,564	1,505	1,224
Uruguay	2	0	24	90	54	27	15		12
US Virgin Islands	1	2		0		0		0	0
Grand Total	1,974	1,863	1,804	1,815	1,955	2,021	2,203	1,768	1,321

Figure 37 . Number of cases by country 2008

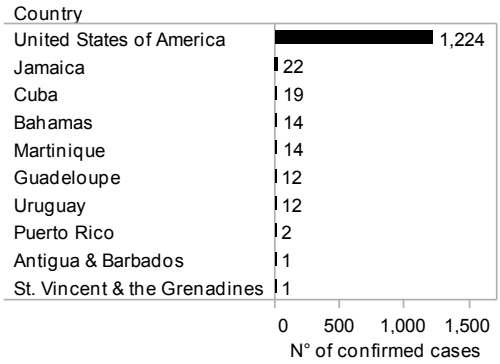


Figure 38. N° of cases by country of origin

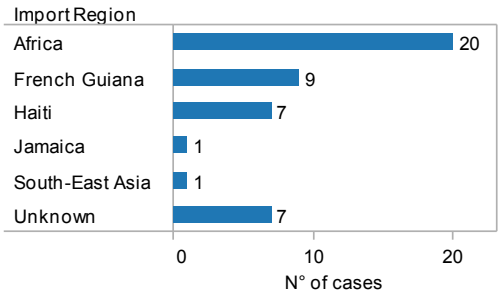


Figure 39. Number of malaria cases in Non-endemic Countries, 2000-08.

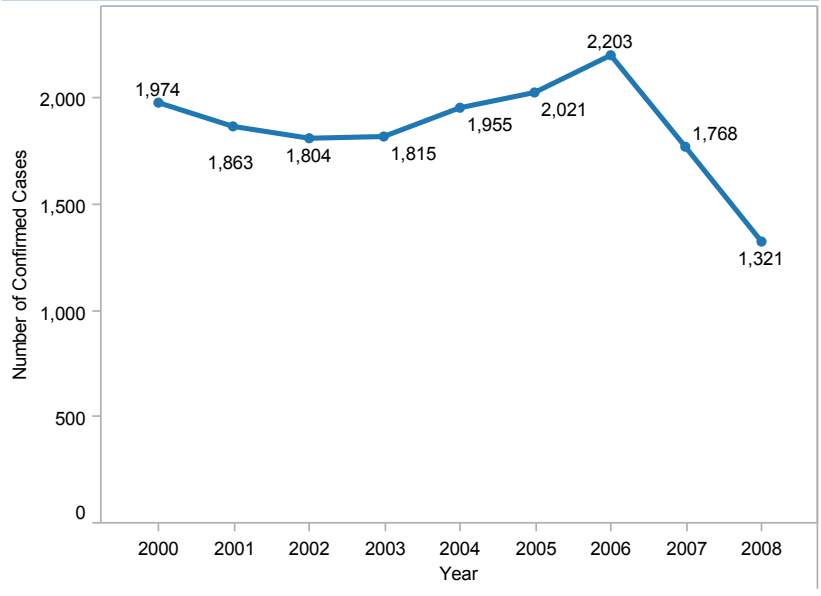


Figure 40. Cases imported vs indigenious by country 2008

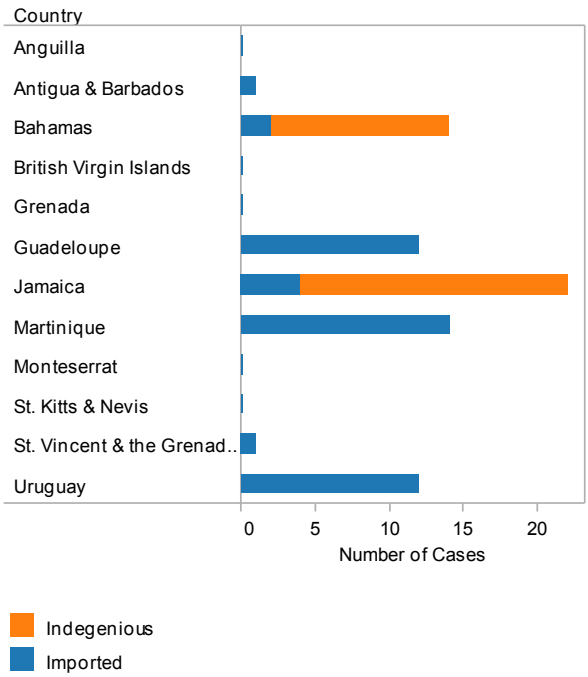


Figure 41. Therapeutic failure in P. falciparum malaria treated with chloroquine

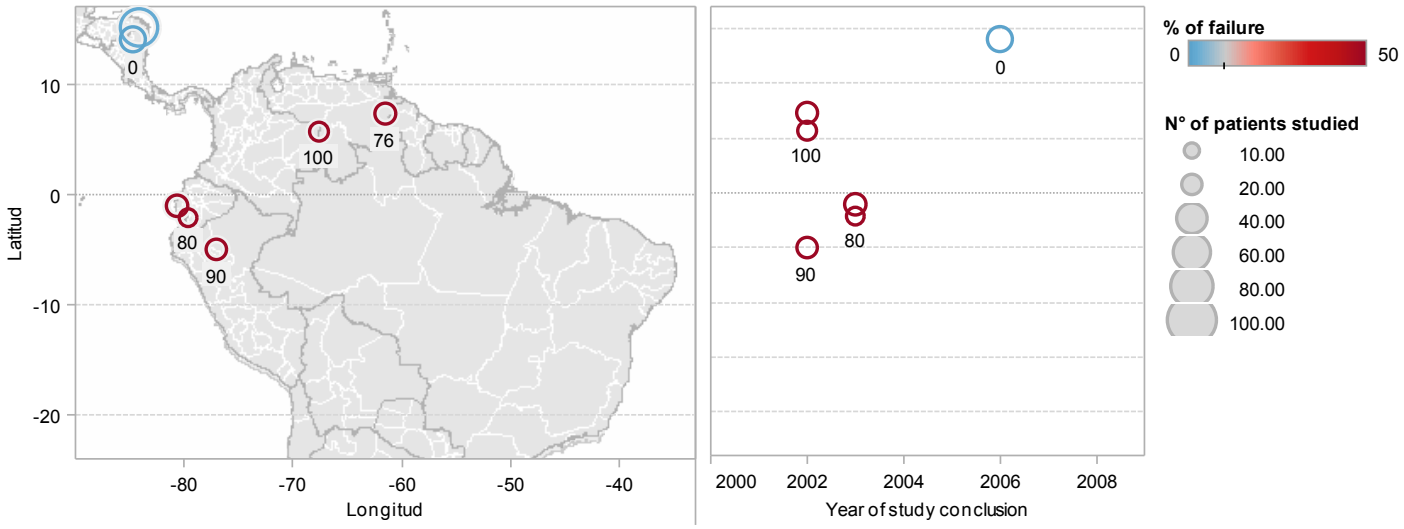


Figure 42. Therapeutic failure in P. falciparum malaria treated with amodiaquine

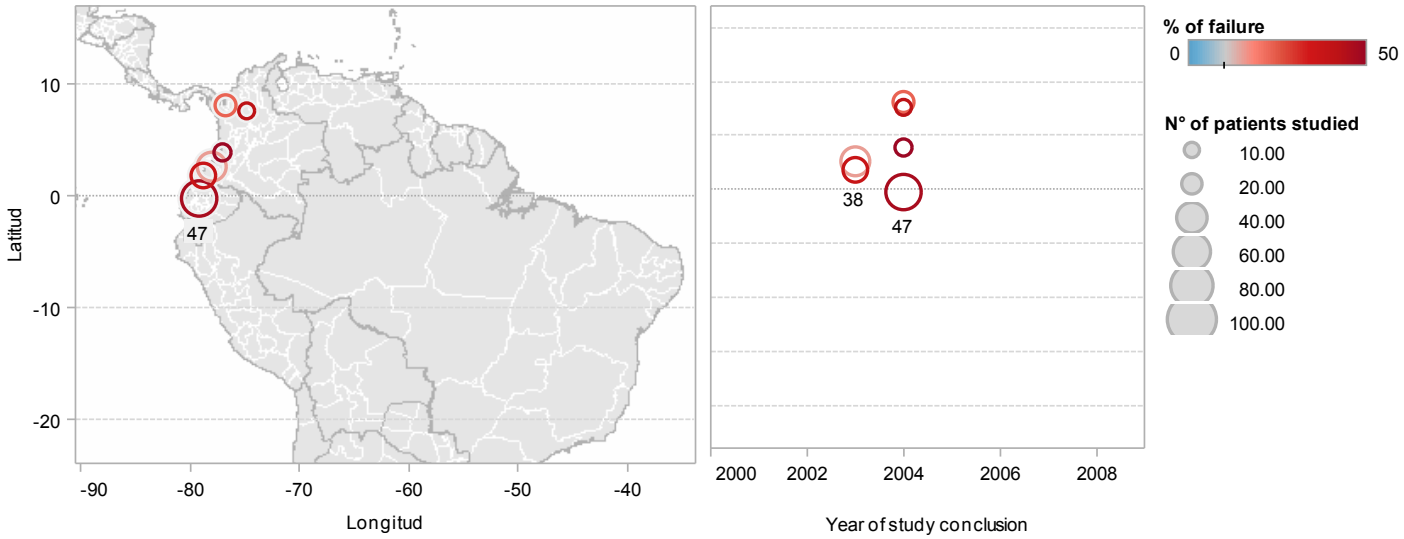


Figure 43. Therapeutic failure in P. falciparum malaria treated with sulfadoxine-pyrimethamine

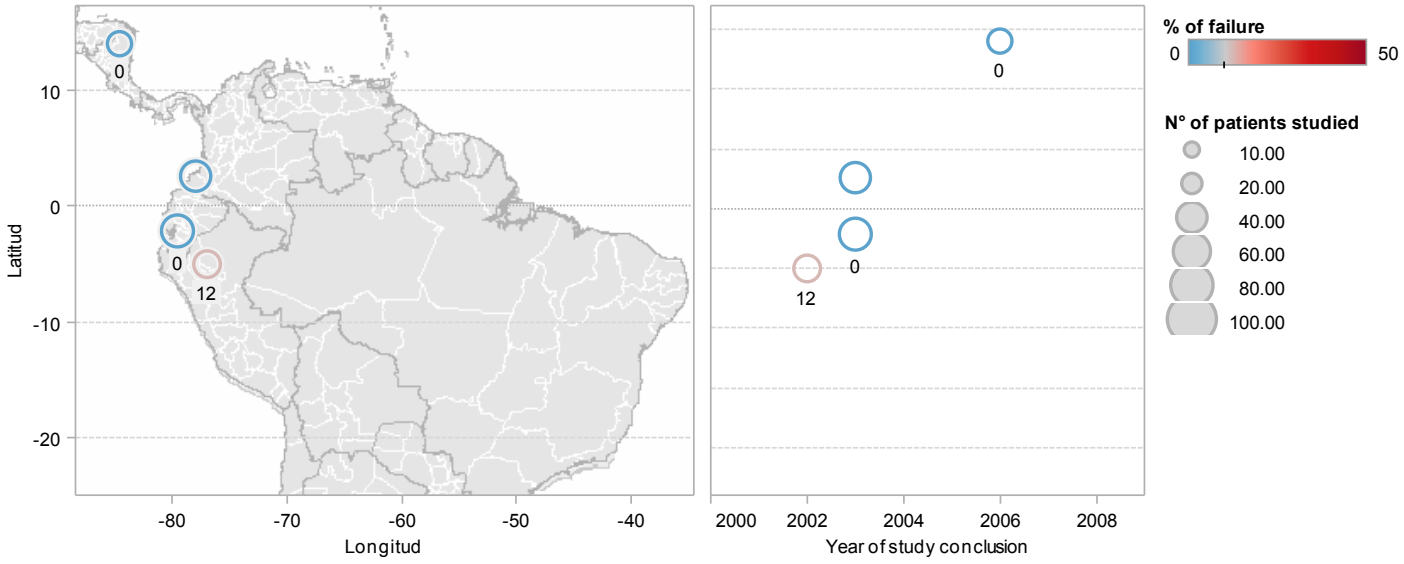


Figure 44. Therapeutic failure in P. falciparum malaria treated with artesunate- sulfadoxine-pyrimethamine combination

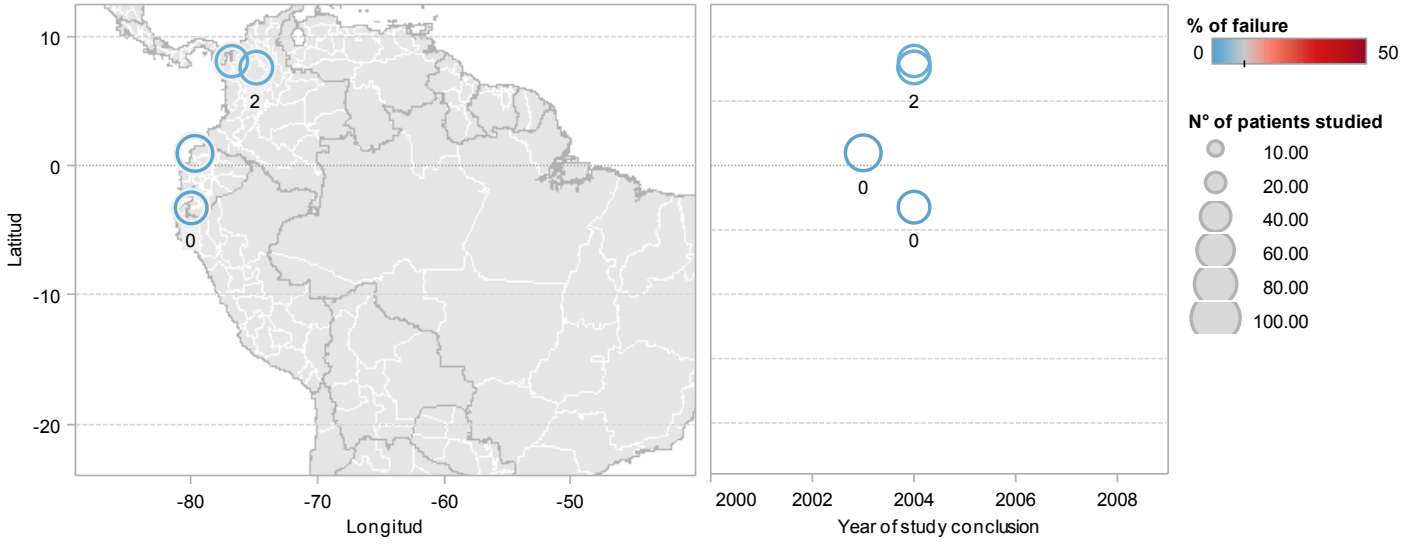


Figure 45. Therapeutic failure in P. falciparum malaria treated with artesunate - mefloquine combination

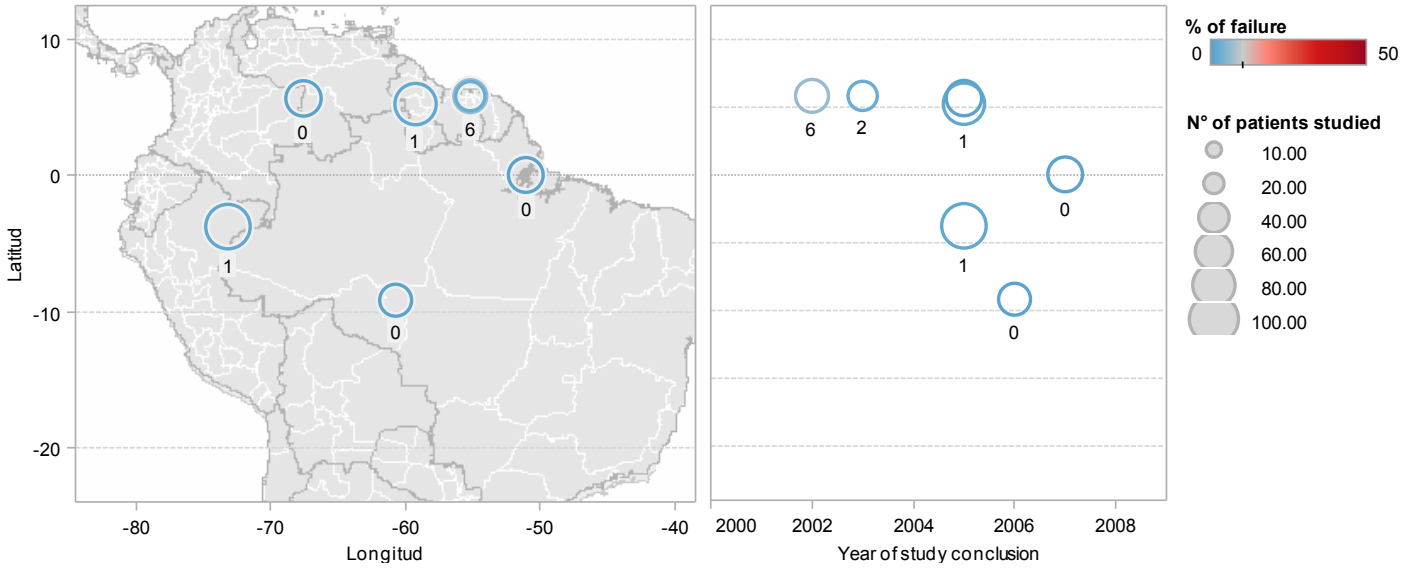


Figure 46. Therapeutic failure in P. falciparum malaria treated with artemether- lumefantrine combination

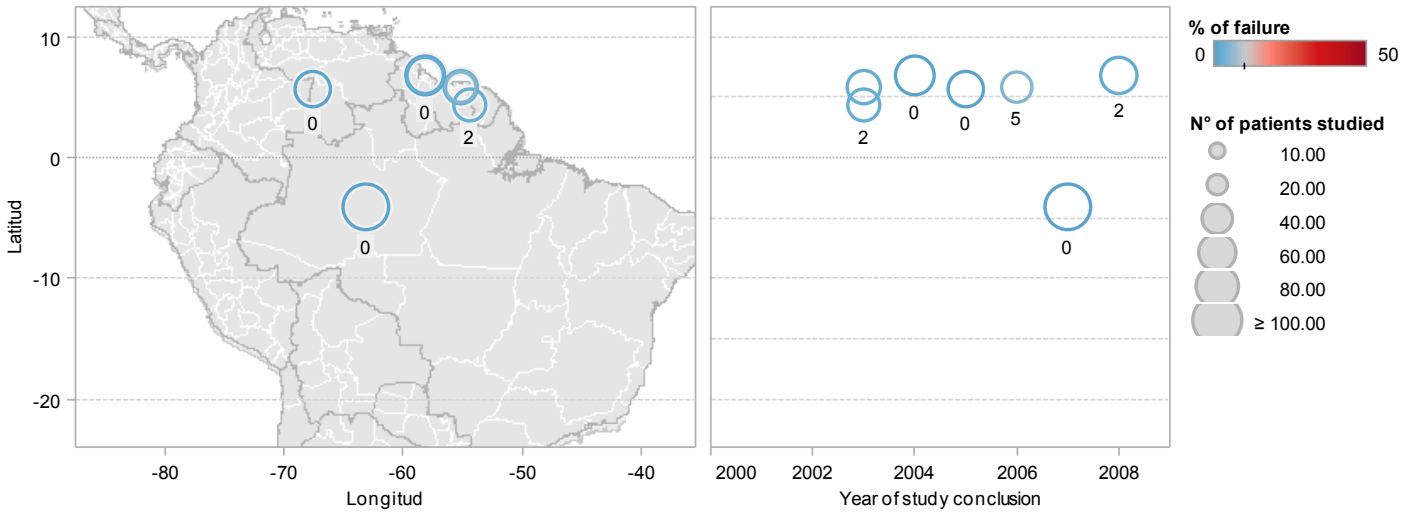


Figure 47. Example of analysis with data from the malaria information system in Guyana

Figure 47a. Number of cases by place of infection

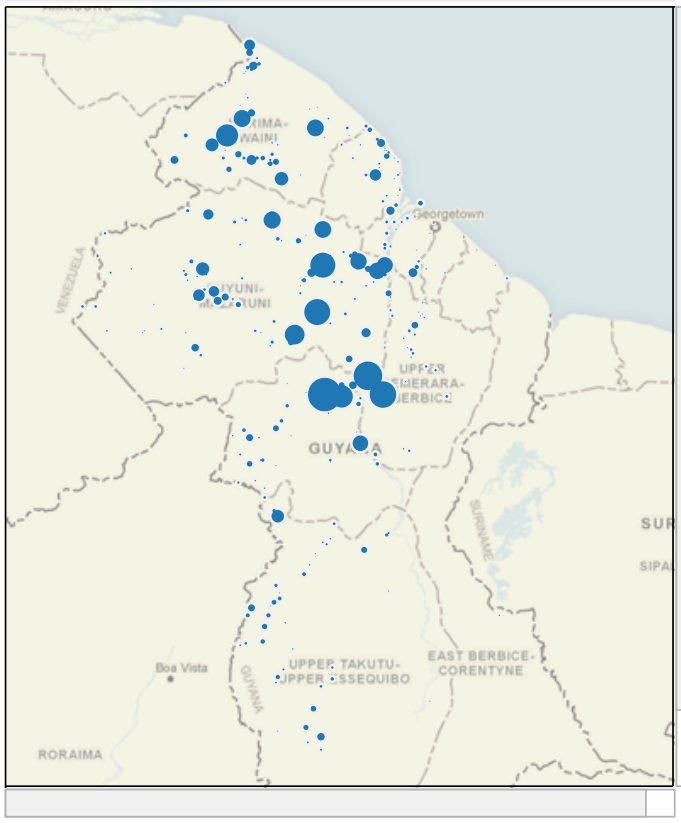
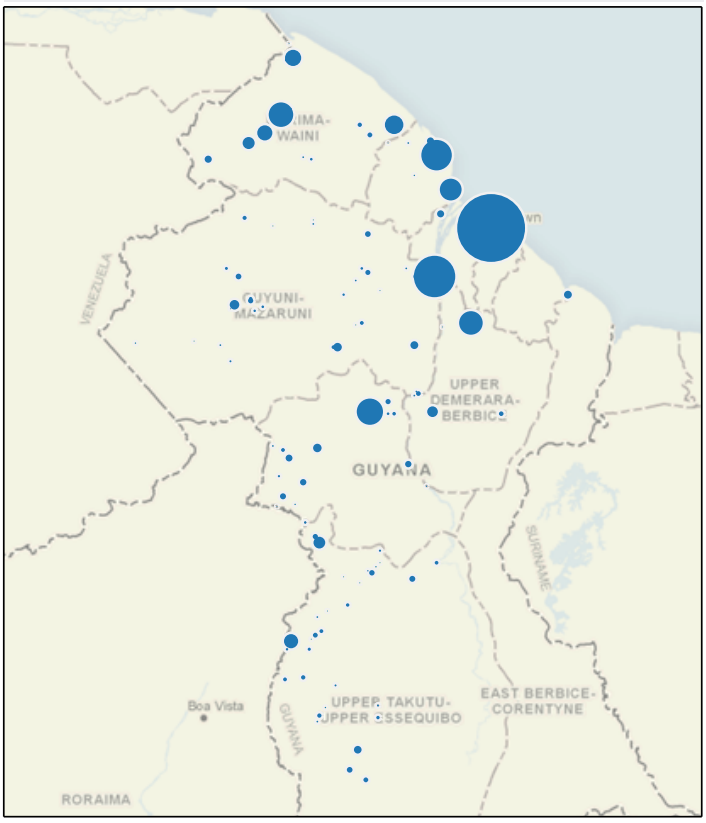


Figure 47b. Number of cases by place of diagnosis (locality)



Number of cases

1 · 1,000 · 2,000 · 3,000 · 4,000 · 4,745

Figure 47c. Locality in descending order of origin of cases (top 30)

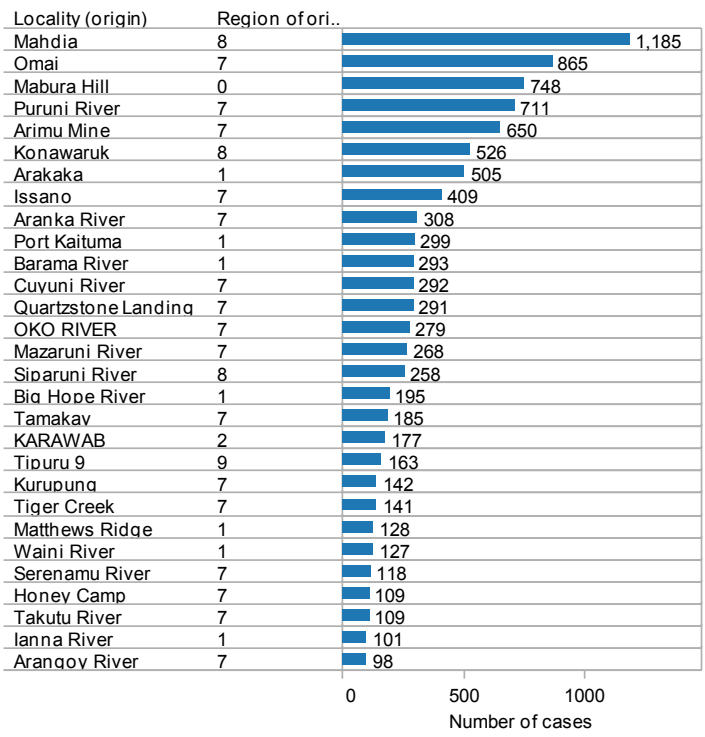


Figure 47d. Locality in descending order of diagnosis of cases (top 30)

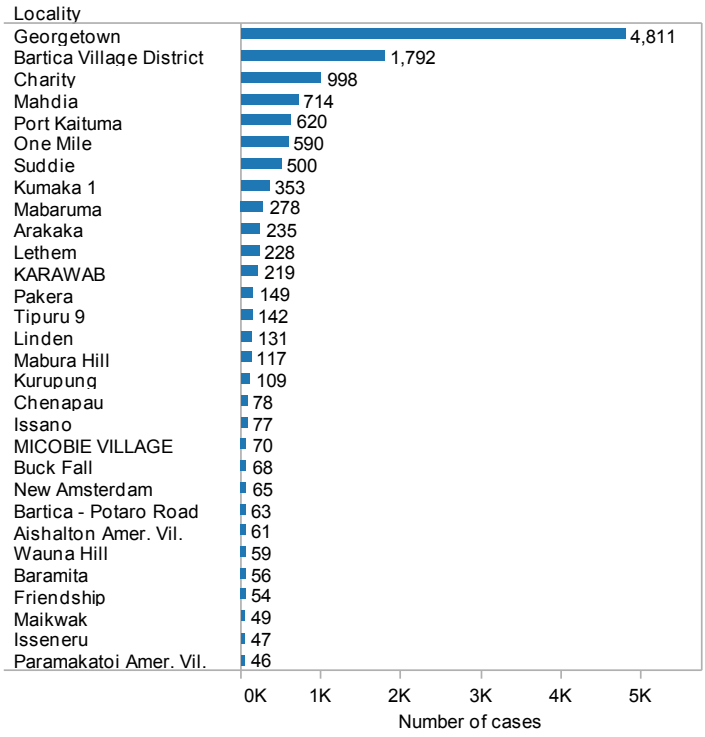
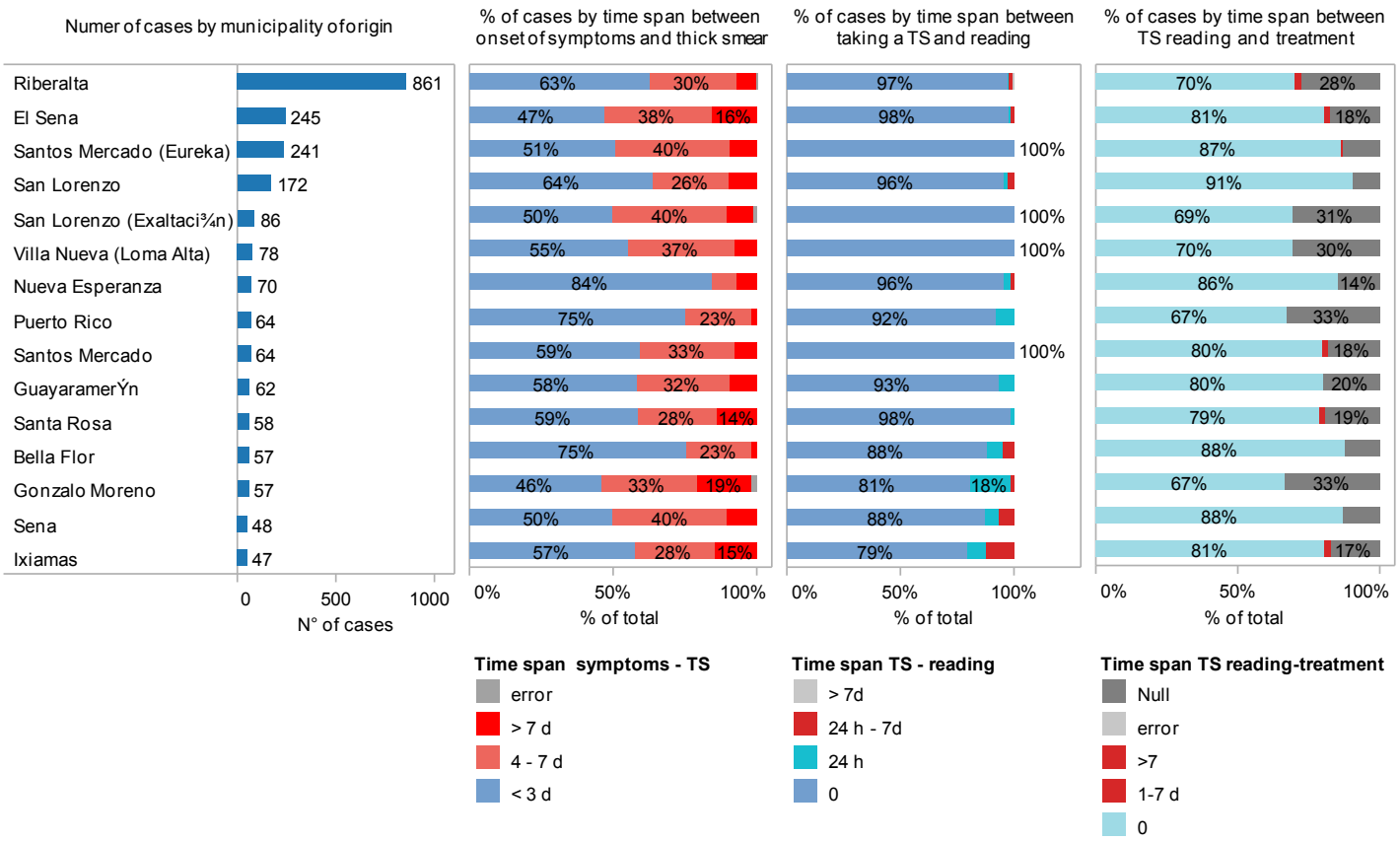


Figure 48. Examples of analysis with data from the malaria information system in Bolivia, 2008



Number of cases by time span between symptoms and treatment

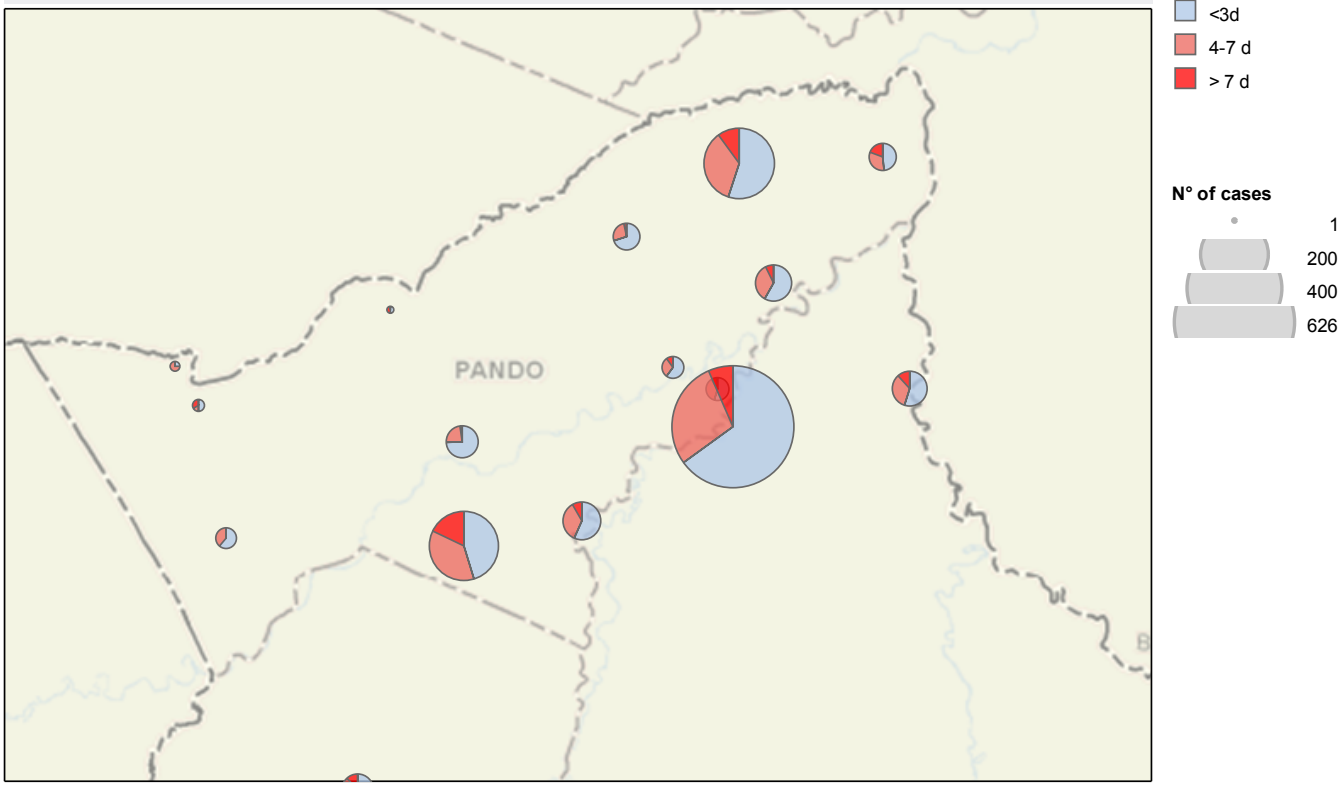
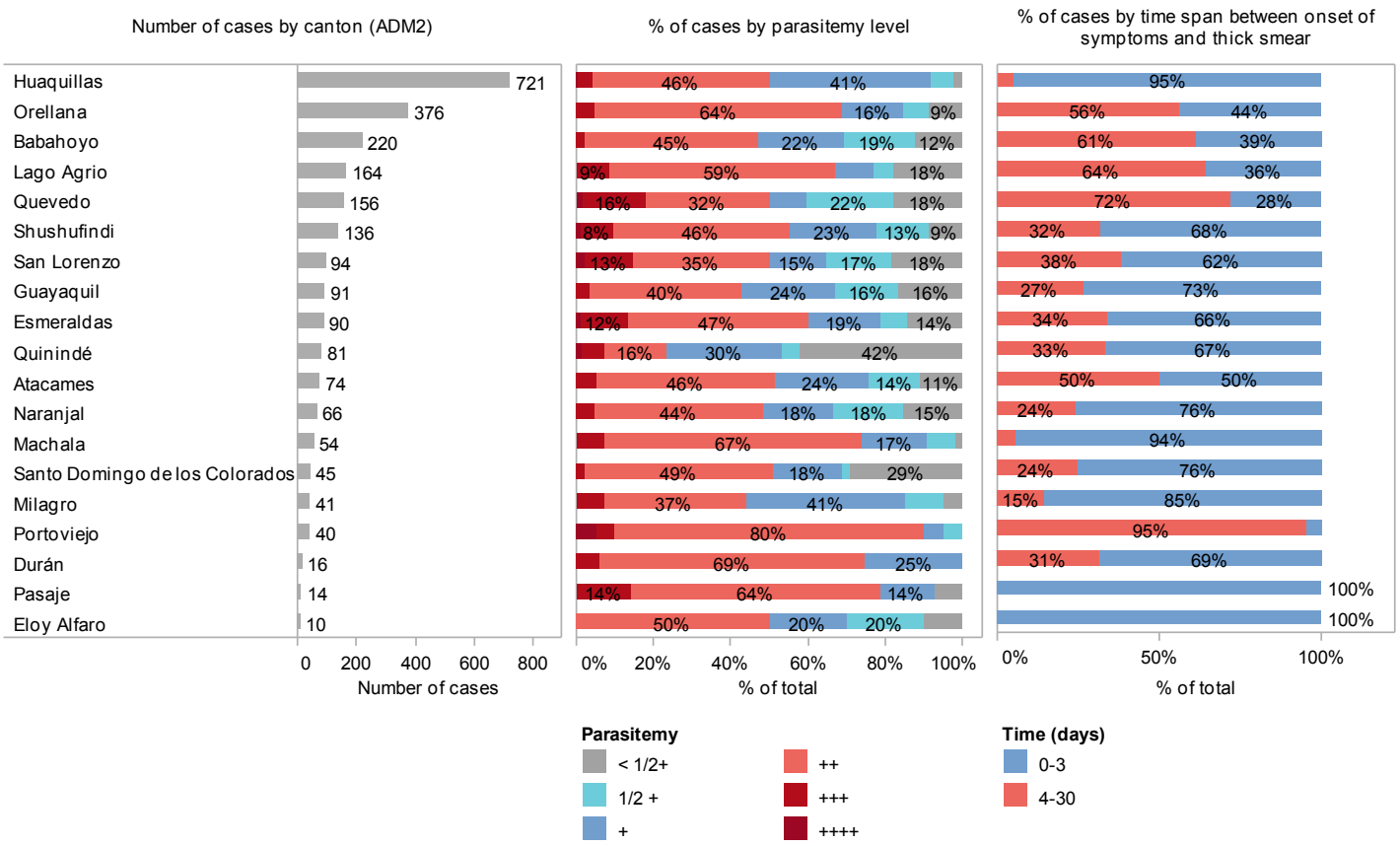
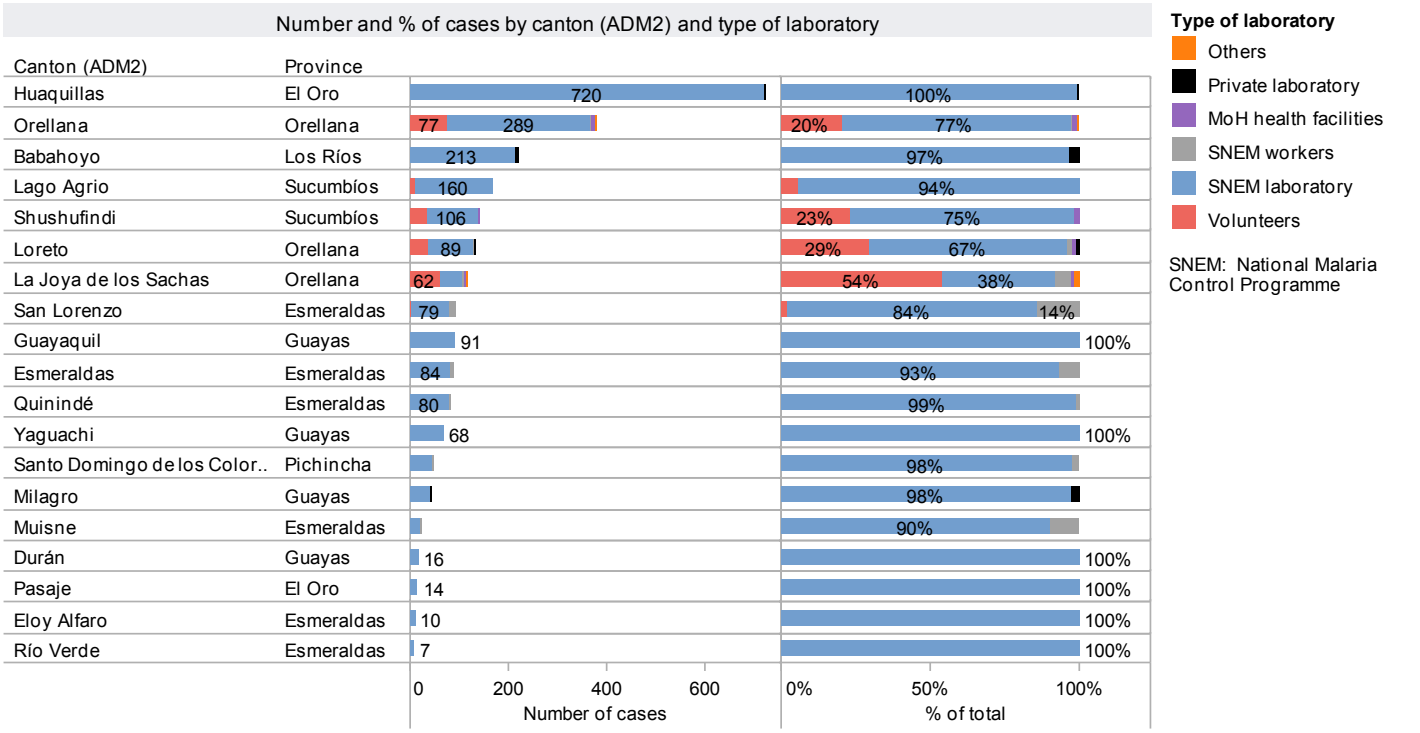


Figure 49. Example of analysis with data from malaria information system in Ecuador, 2008





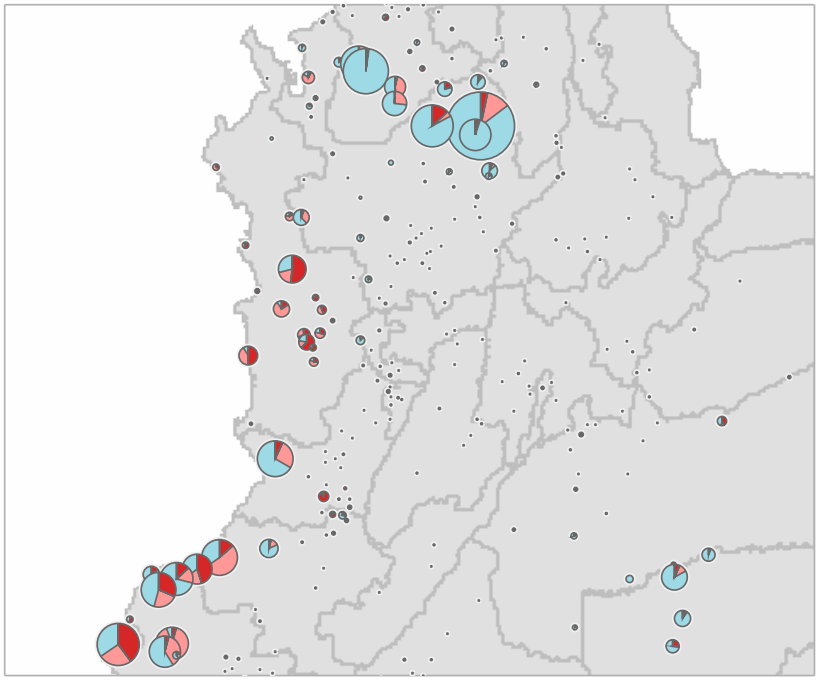
Fgure 50. Examples of analysis with data from malaria information system in Colombia, 2008

Number of cases by municipality (ADM2) of origin and municipality of diagnosis

Municipality (ADM2) of diagnosis / Department (ADM1) ofdiagnosis

Municipality of origin	Department	EL BAGRE ANTIOQUIA	TIERRALTA CORDOBA	CACERES ANTIOQUIA	VALENCIA CORDOBA	OLAYA HERRERA NARIÑO	TUMACO NARIÑO	ROBERTO PAYAN NARIÑO	CAUCASIA ANTIOQUIA	SAN JOSE DEL GUAVIARE GUAVIARE	ZARAGOZA ANTIOQUIA	BAJO BAUDO (PIZARRO) CHOCO	CUMARIBO VICHADA	PUERTO LIBERTADOR CORDOBA	EL RETORNO GUAVIARE	TURBO ANTIOQUIA	SAN PEDRO DE URABA ANTIOQUIA	TARAZA ANTIOQUIA
EL BAGRE	ANTIOQUIA	2,568							128		6							
TIERRALTA	CORDOBA	1	1,140															
CACERES	ANTIOQUIA	2		817					221		3							1
VALENCIA	CORDOBA		15		802												2	
OLAYA HER..	NARIÑO					757	2											
TUMACO	NARIÑO						681											
ZARAGOZA	ANTIOQUIA	191							31		358							
ROBERTO ..	NARIÑO					20	2	543										
SAN JOSE ..	GUAVIARE									365								
BAJO BAUD..	CHOCO											191						
CUMARIBO	VICHADA												159					
EL RETORN..	GUAVIARE									47					110			
PUERTO LI..	CORDOBA		1						1					154				
CAUCASIA	ANTIOQUIA	7							103									
TURBO	ANTIOQUIA															77	8	
SAN PEDR..	ANTIOQUIA																59	
TARAZA	ANTIOQUIA								5									3
NECOCLI	ANTIOQUIA																	
RIOHACHA	GUAJIRA																	

Number of urban and rural malaria cases by municipality (ADM2) of origin. Colombia 2008



Type of locality

- City / town
- Big villages
- Small rural villages

Number of cases

1
1,000
2,000
2,955