

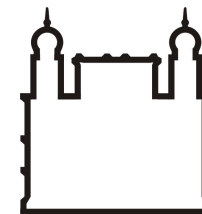


Ciência para a saúde da população brasileira

Seasonality and spatial dynamics of dengue fever

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Fiocruz, Rio de Janeiro
codeco@fiocruz.br

San Jose, january 2012



Ministério da Saúde

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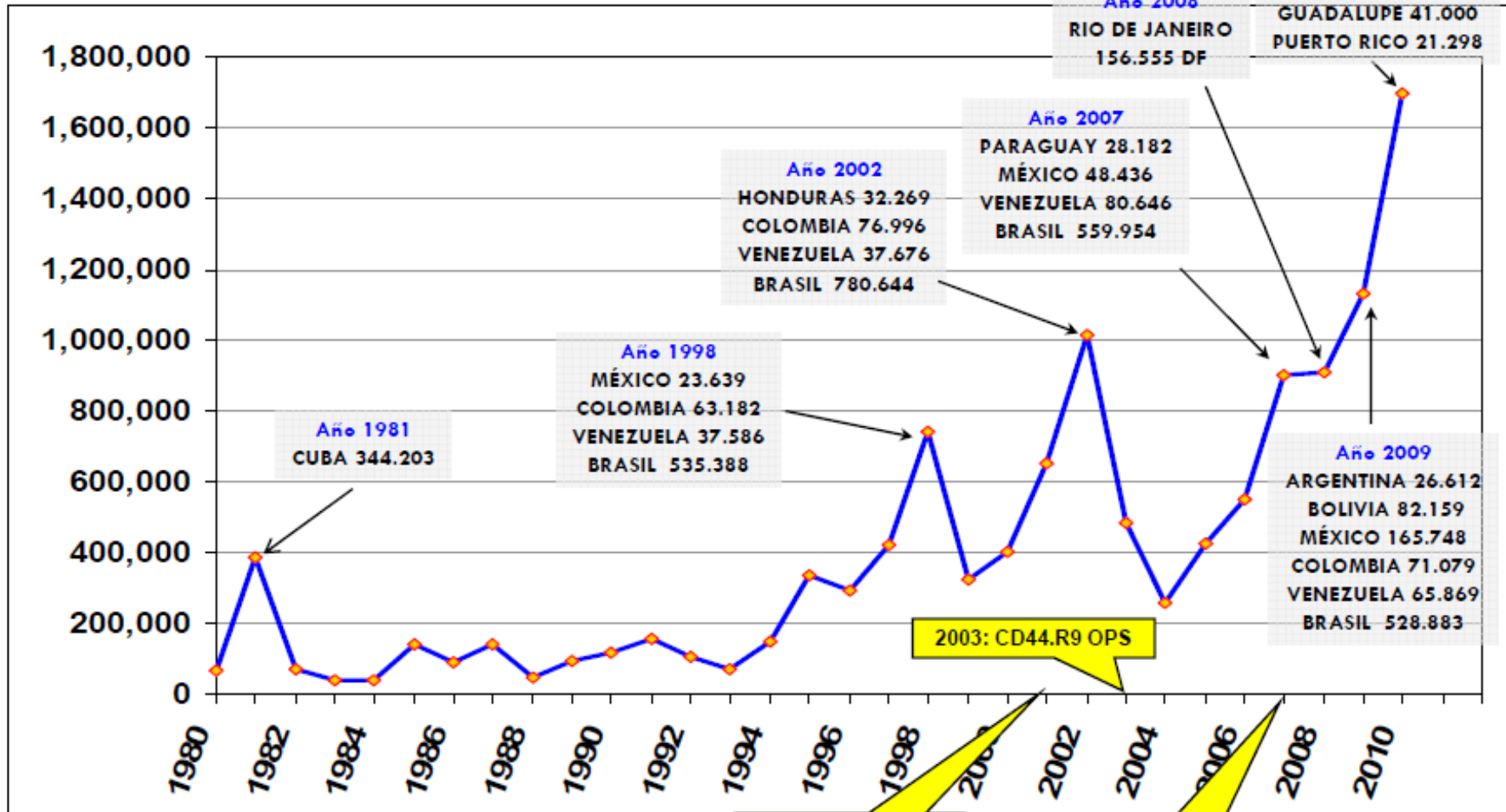
Fundação Oswaldo Cruz

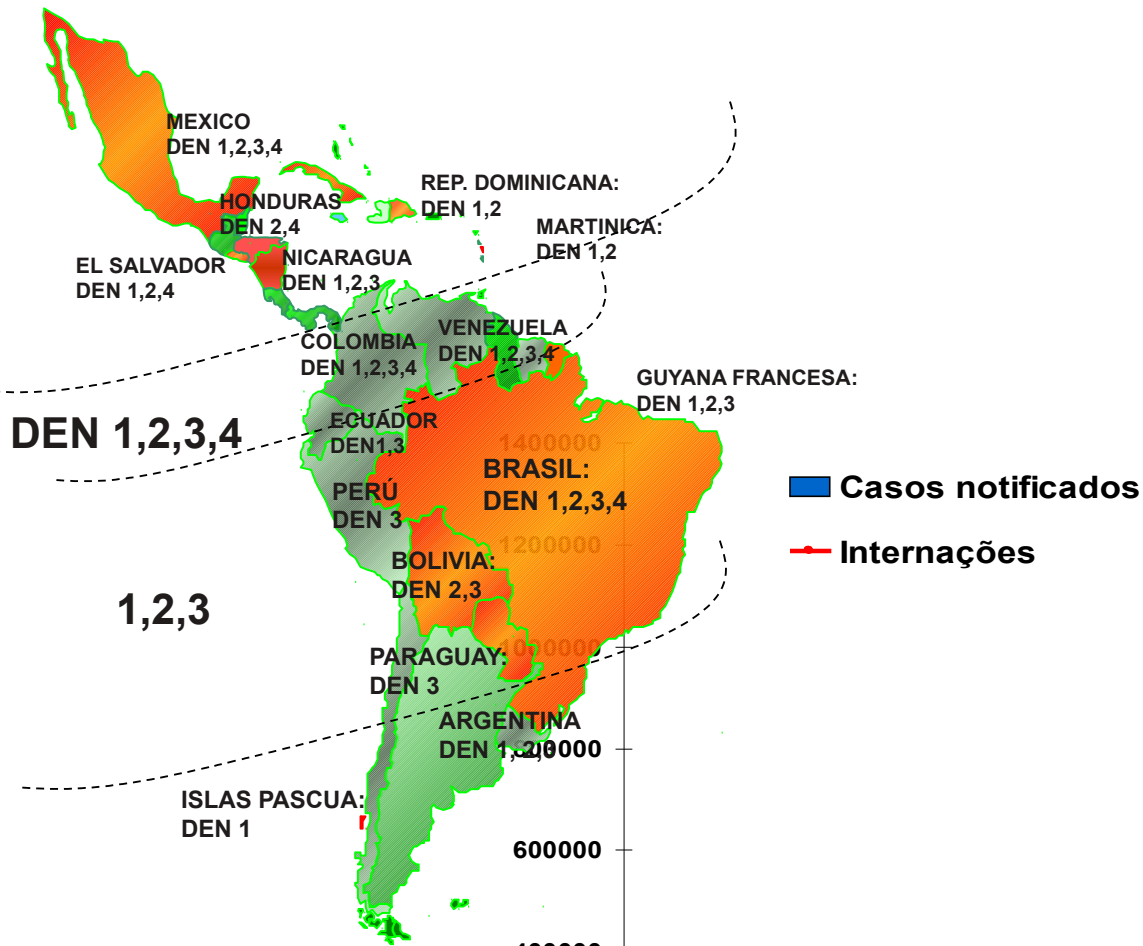
In the world

Dengue, countries or areas at risk, 2010

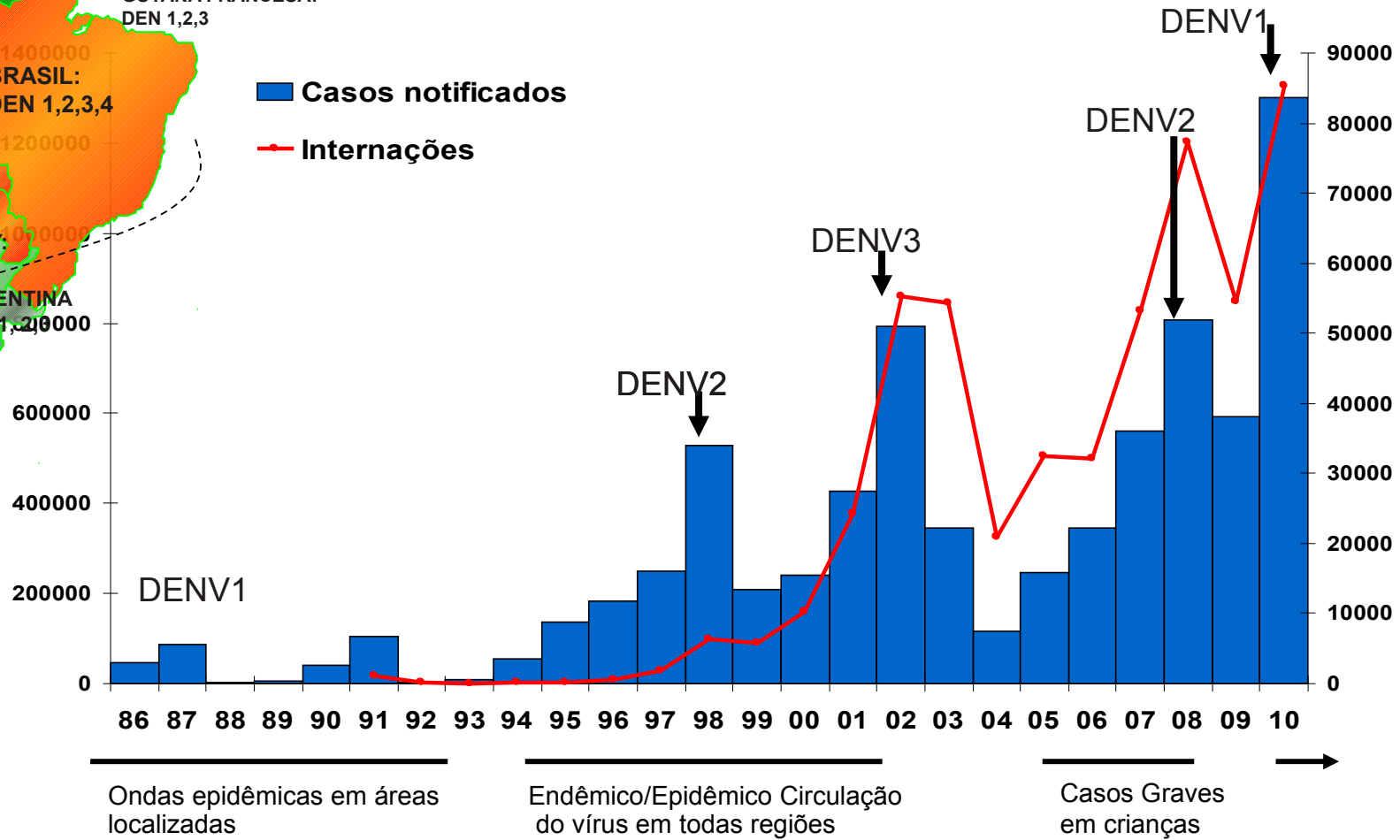


Evolución del dengue en las Américas 1980-2010





In Brazil



Rio de Janeiro

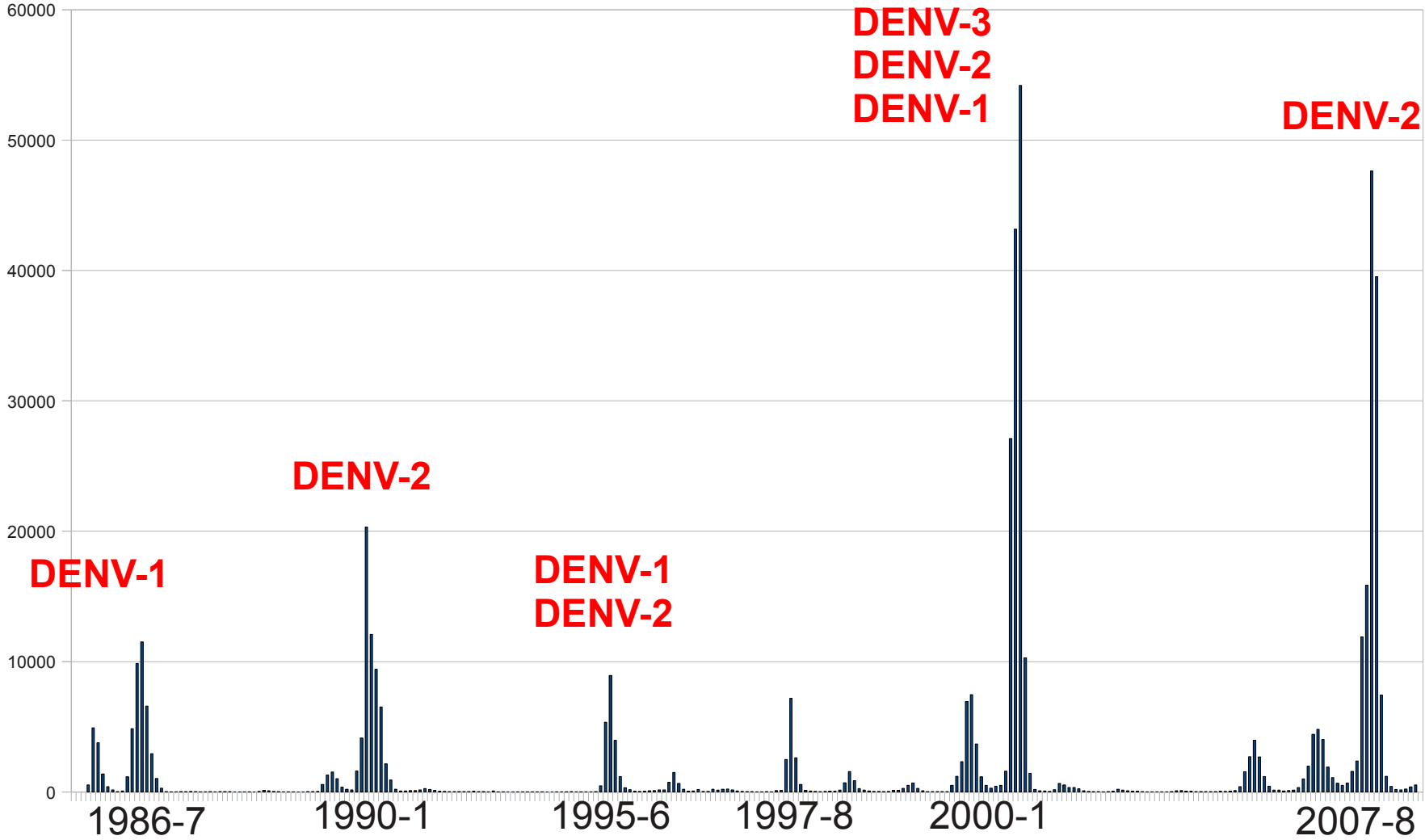


Population: 6.000.000
Neighborhoods: 160
Favelas: 749
Premises: 2.000.000
Population
in Favelas: 1.000.000



Port-of-entry of DENV 1, 2, and 3

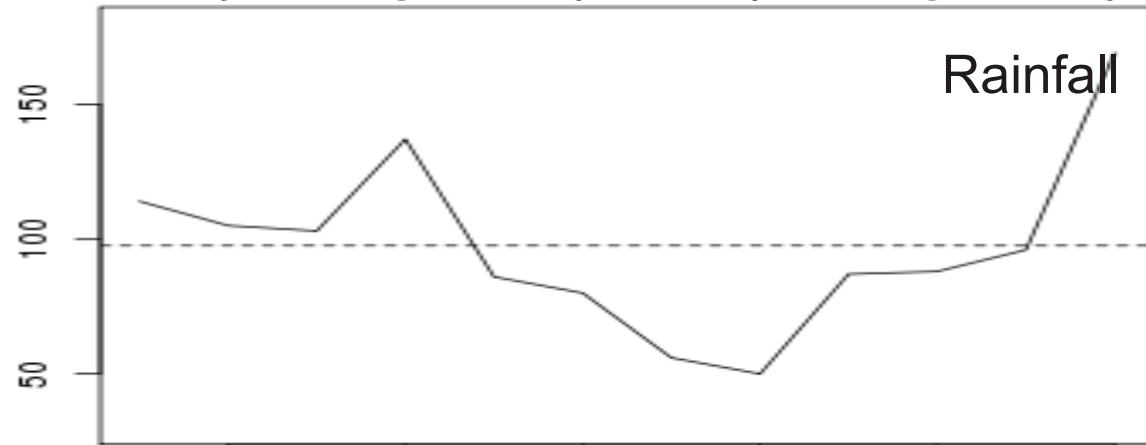
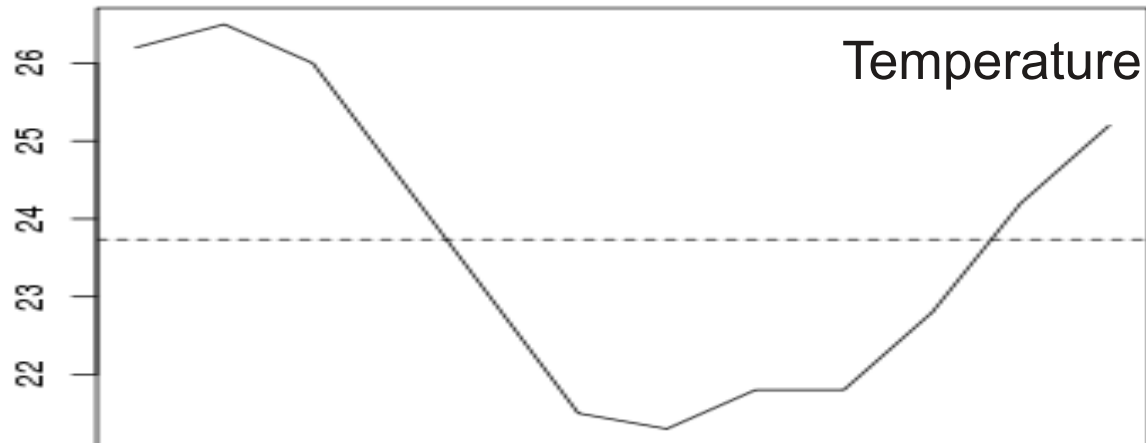
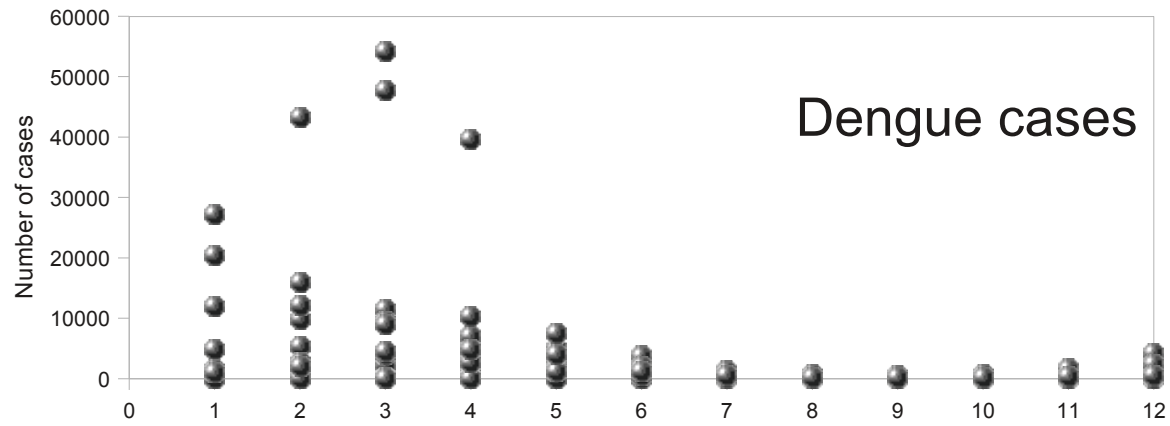
Dengue in Rio de Janeiro



0 DHF **462 DHF**
CF = 0.8:10.000

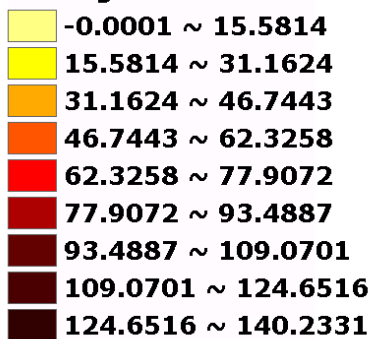
1831 DHF
CF = 3.15:10.000

CF = 5.8:10.000
(36% children)

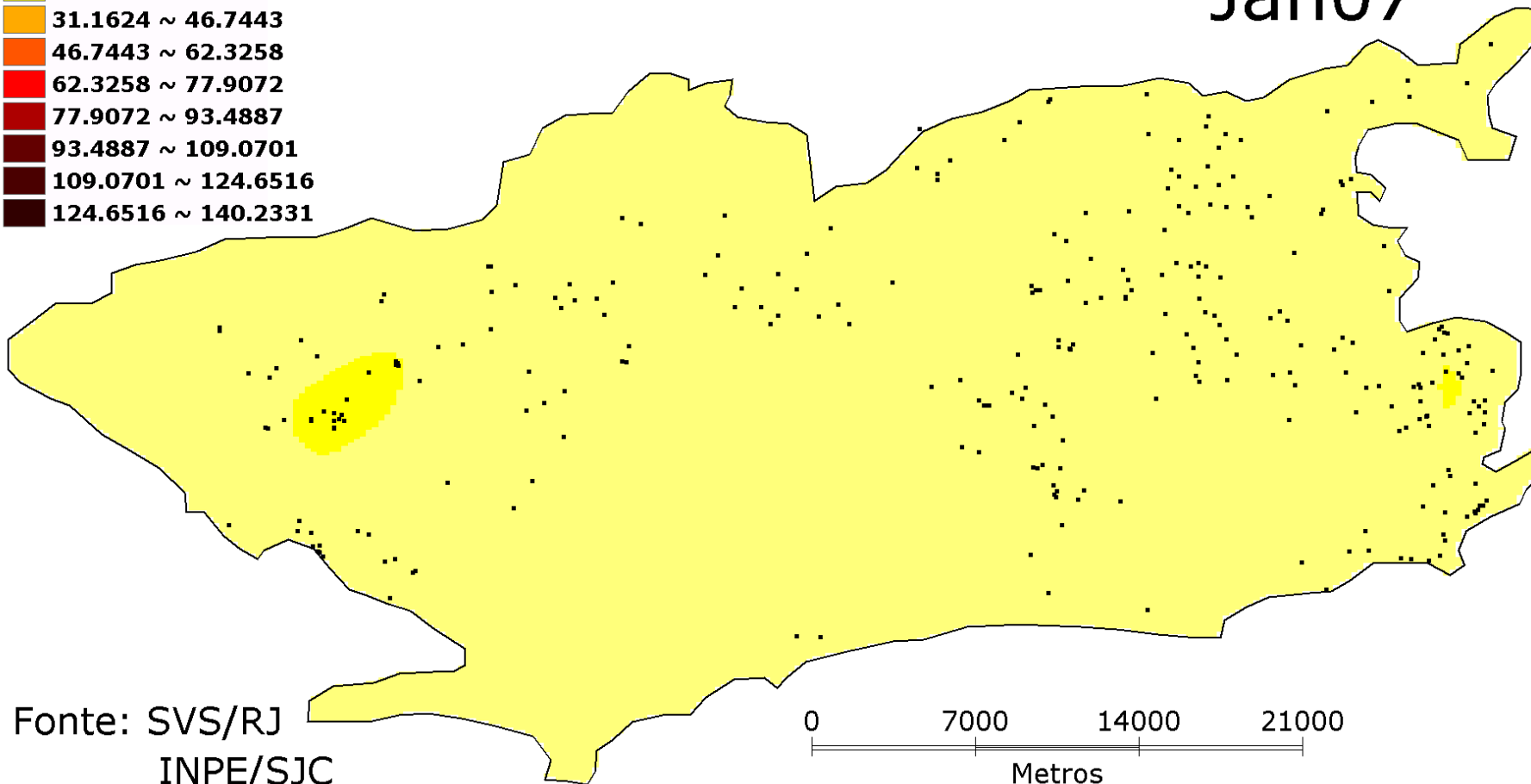


Município do Rio de Janeiro - Casos de dengue 2007

Legenda



Jan07

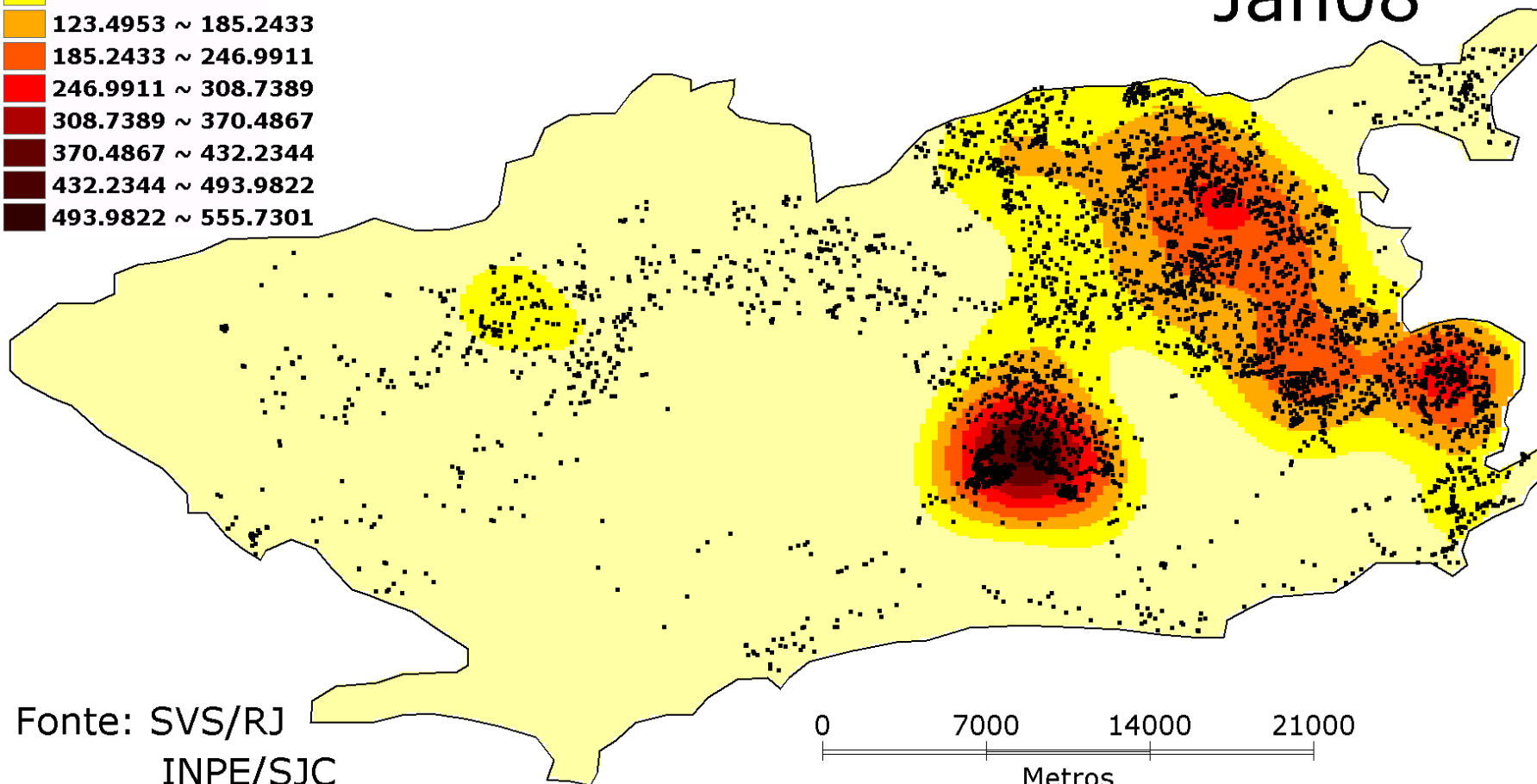
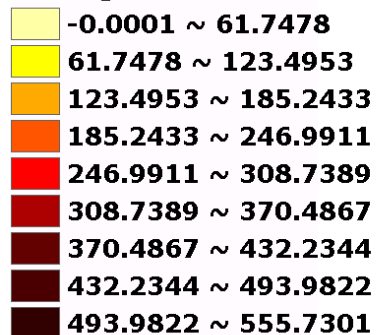


Fonte: SVS/RJ
INPE/SJC

Município do Rio de Janeiro - Casos de dengue 2008

Jan08

Legenda

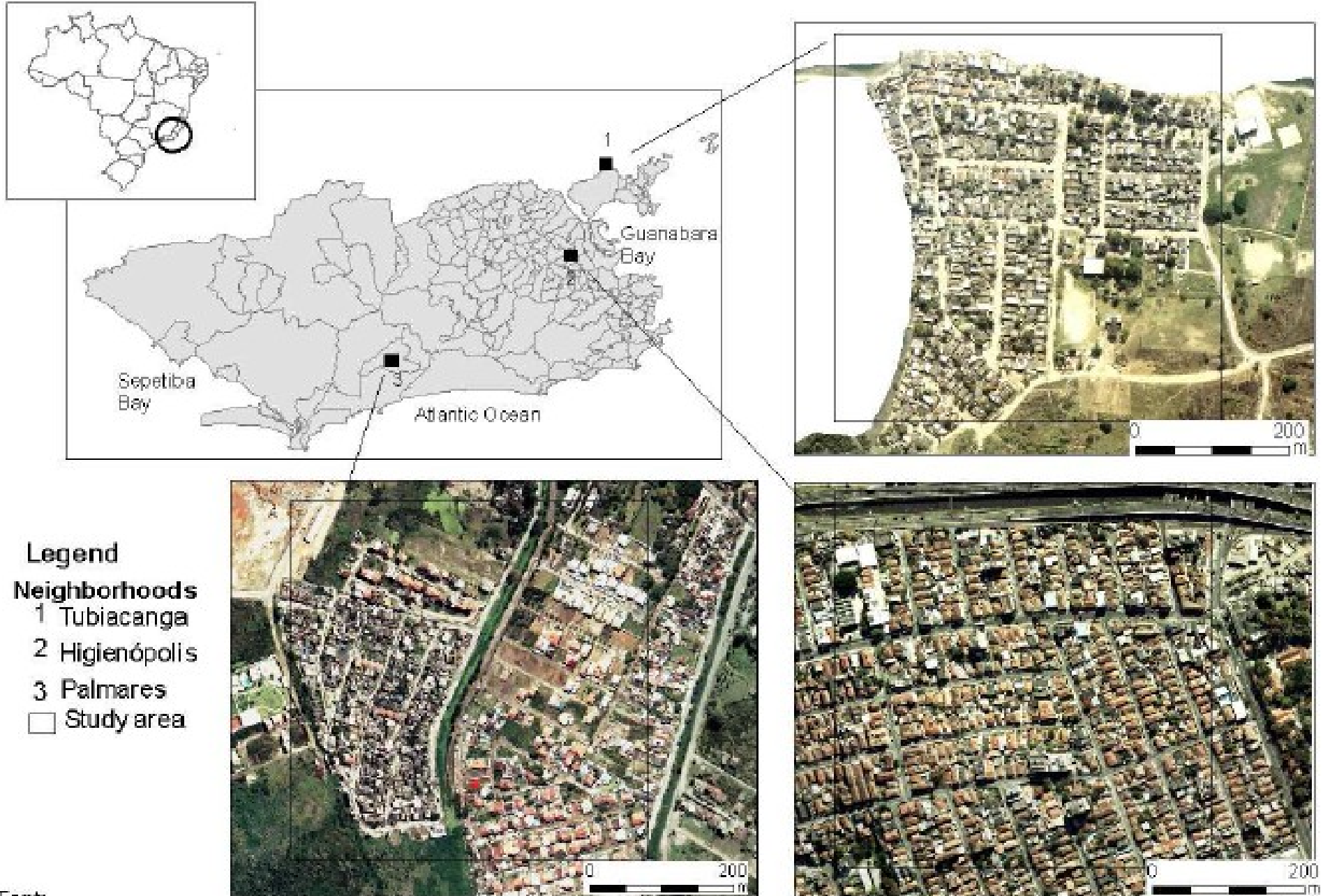


Fonte: SVS/RJ
INPE/SJC

Study goals:

- To understand and model quantitatively the seasonal dynamics of dengue:
 - Early warning
 - Climate change
 - Best timing for control strategies
- To understand spatial heterogeneity

82 week entomological survey with ovitrap and adultrap (september 2006 to march 2008)



Font:

Ortophoto: PorataGeo - IPP- Rio de Janeiro

Digital map: Geoprocessing Laboratory - ICICT/ Fiocruz

TARGET

TRAP

INDEX



Ovitrap

Eggs/trap

% Positive traps

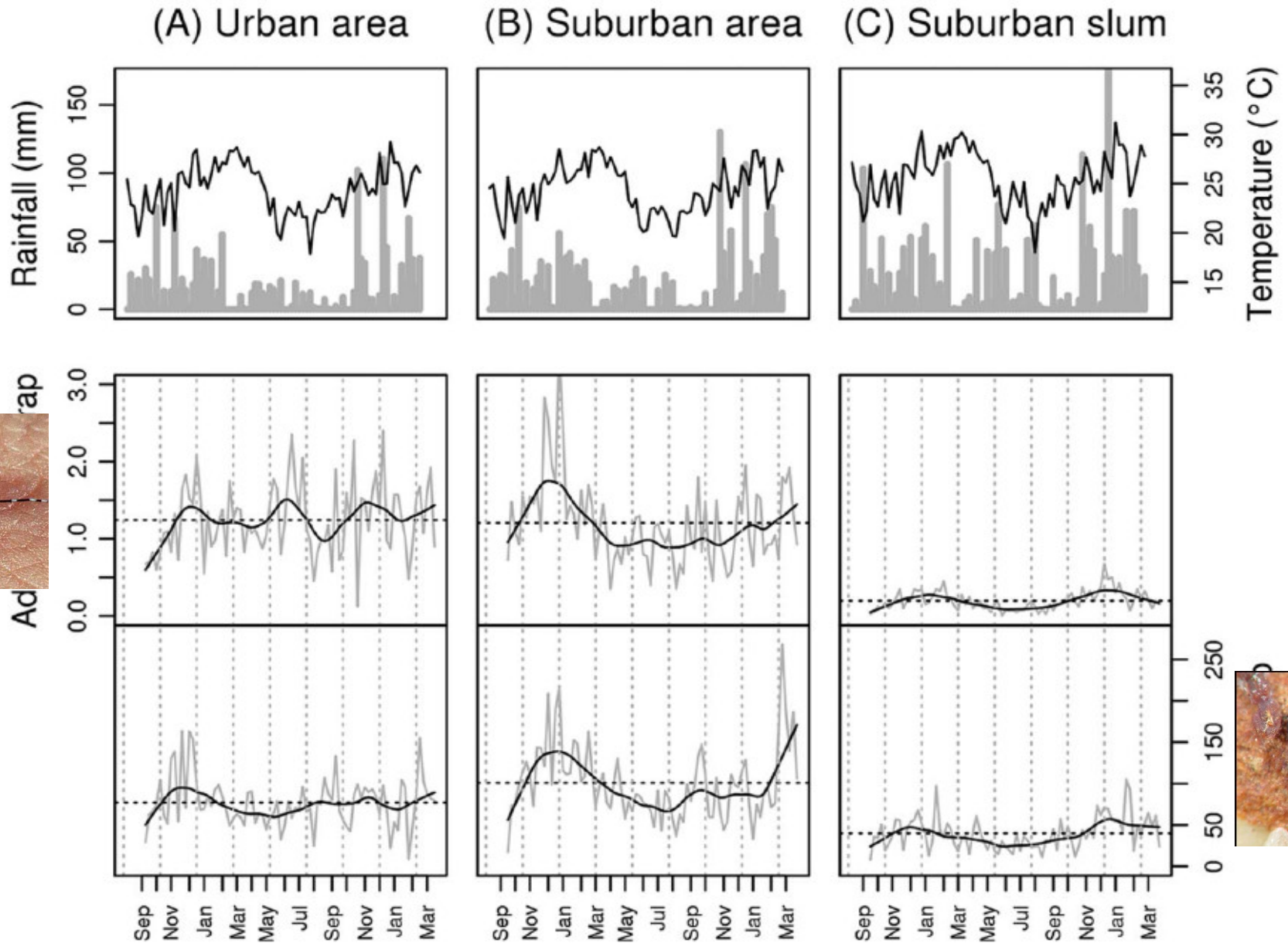


Mosquitrap

Adults/trap

% Positive traps

Time series of captured adults and eggs: seasonality?

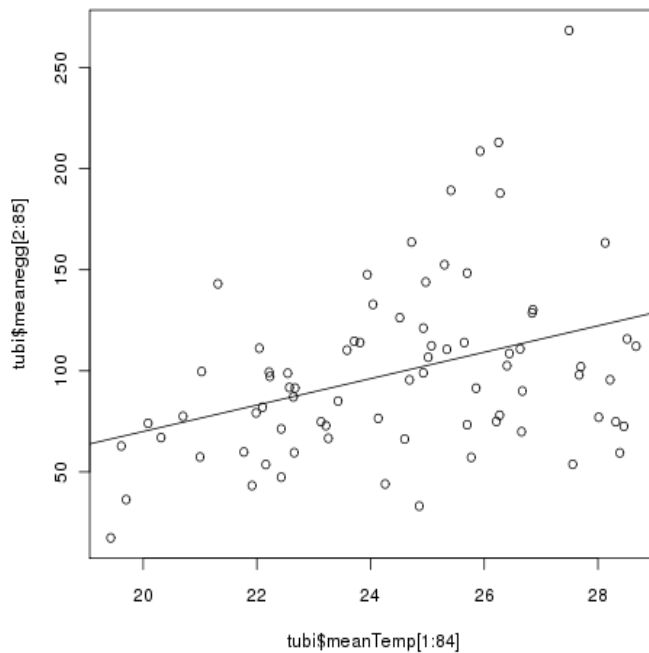


General linear modeling: quantitative predictions of the effect of climate on mosquito abundance

Hypotheses:

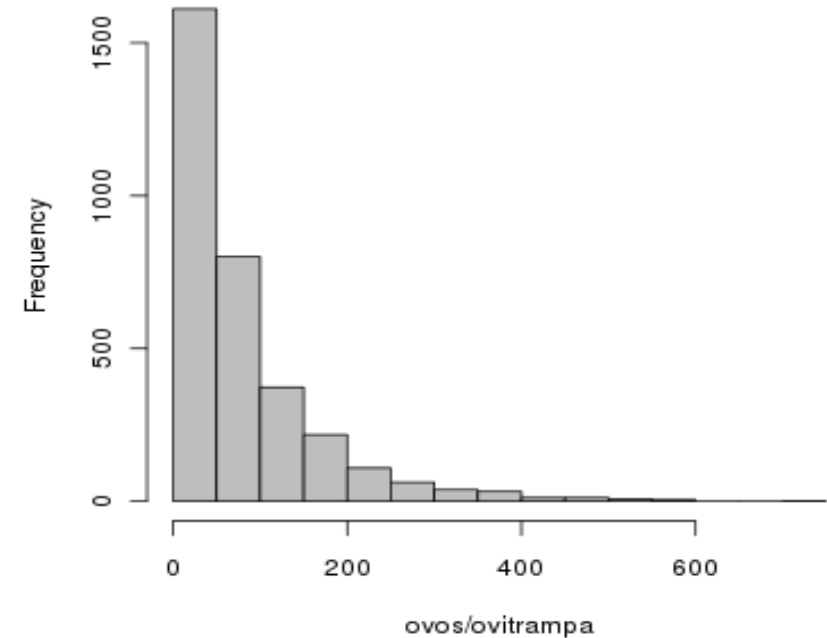
- Higher temperatures imply more mosquitos with a certain delay
- More rainfall imply more mosquitos with a certain delay

Eggs (t)

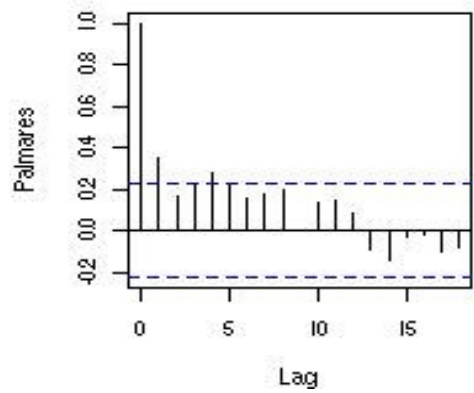
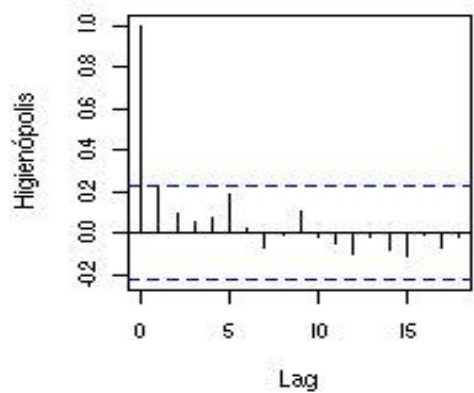
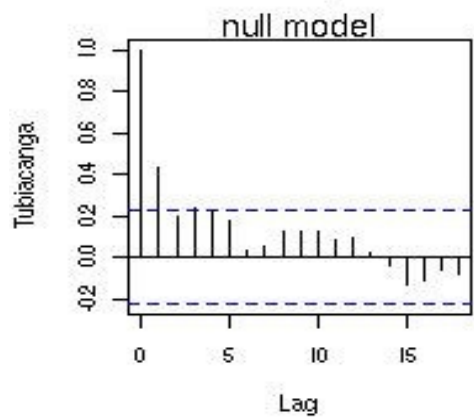


Temperature (week-1)

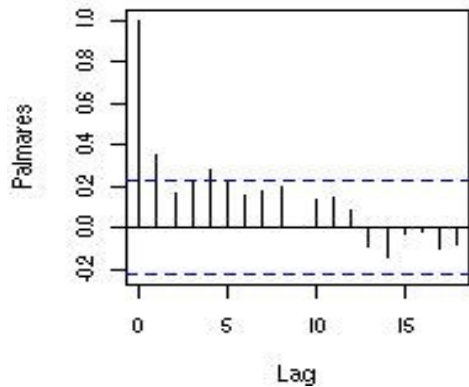
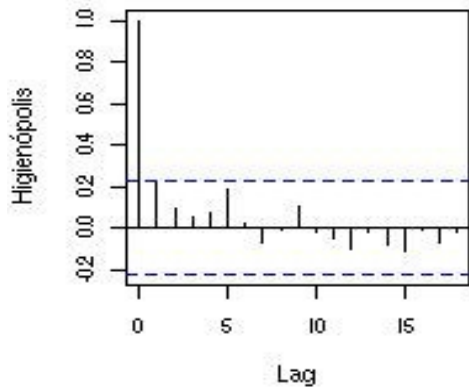
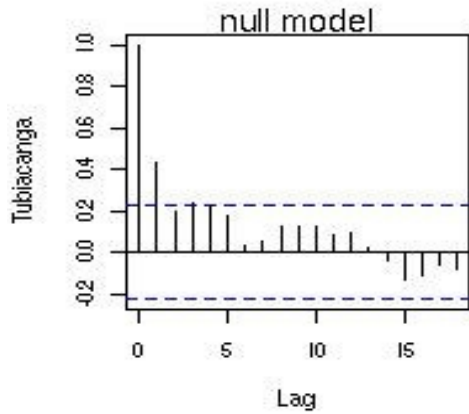
Negative
Binomial distribution



Auto-correlation structure



Auto correlation structure



Models:

$$Y_t \sim \text{NegBin}$$

$$E[Y_t] = a_0 \quad \text{null}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} \quad \text{AR1}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} + a_2 \text{Temp}_{t-m} \quad \text{+ temperatura}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} + a_2 \text{Temp}_{t-m} + a_3 \text{Chuva}_{t-n} \quad \text{+ rain}$$

Model comparison

- Likelihood based criterion (AIC)
- Pearson's correlation
- Residuals

GAM model was required:

Smooth temperature term (non linear)



AR(1)+TEMP(1)+CHUVA(4)

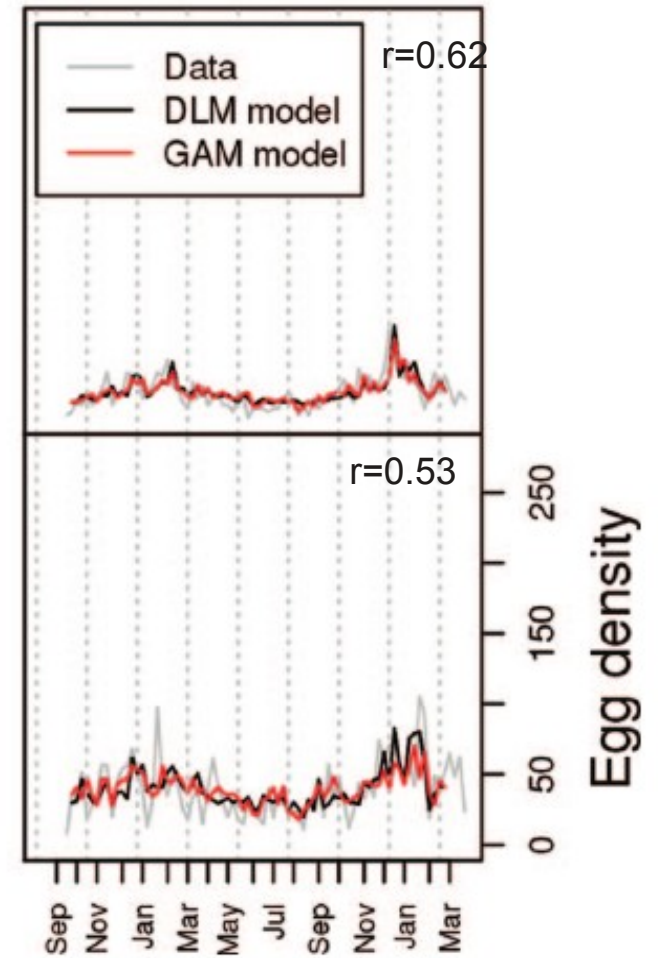
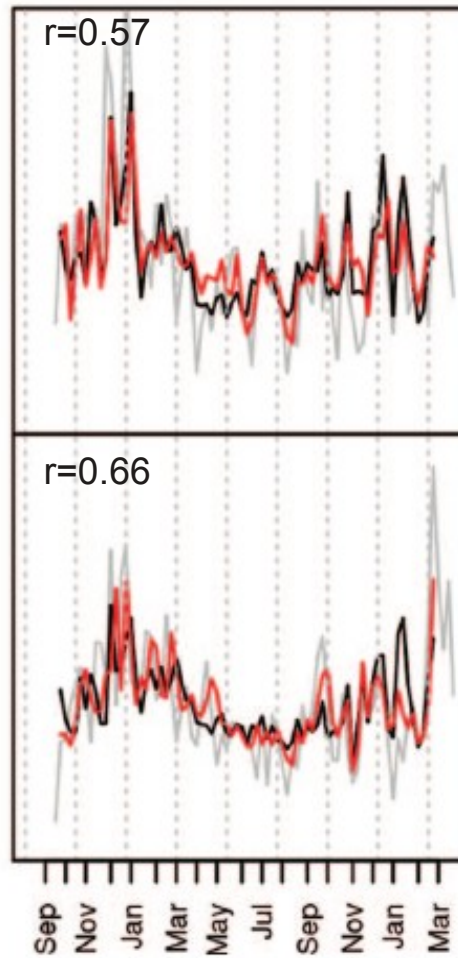
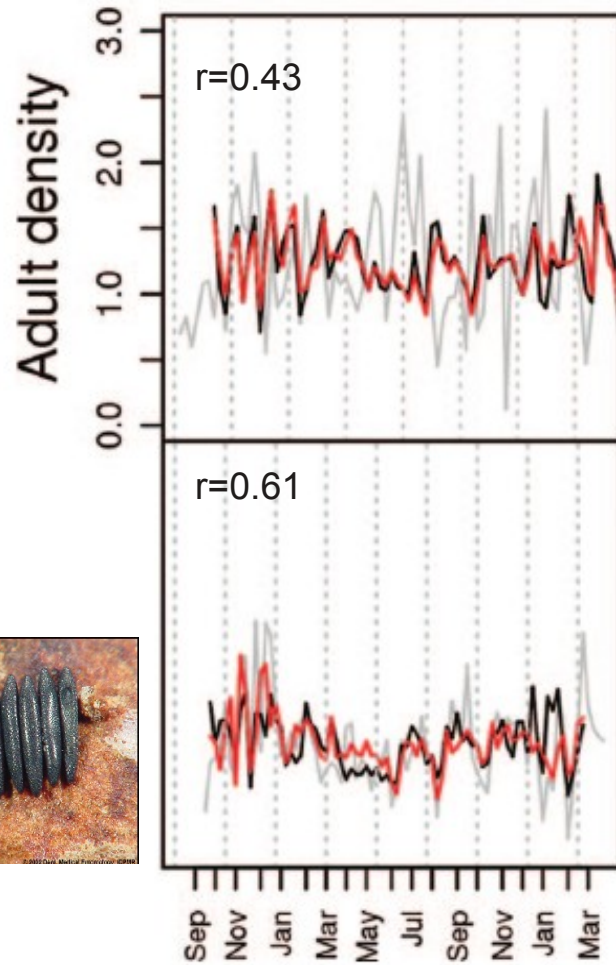
AR(1)+TEMP(1)

AR(1)+TEMP(1)

(A) Urban area

(B) Suburban area

(C) Suburban slum



AR(1)+TEMP(1)

AR(1)+TEMP(1)+CHUVA(1)

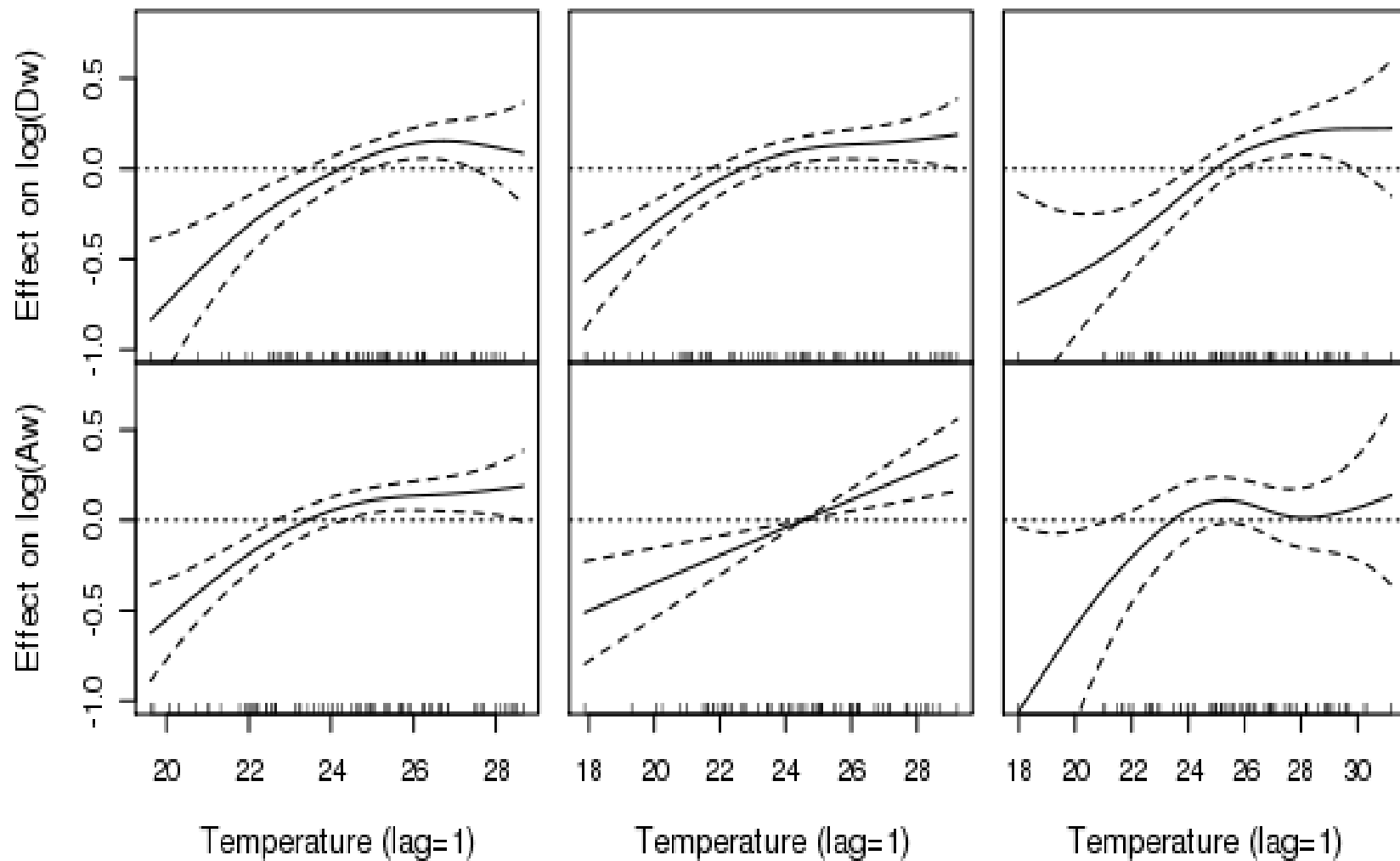
AR(1)+TEMP(1)+CHUVA(4)

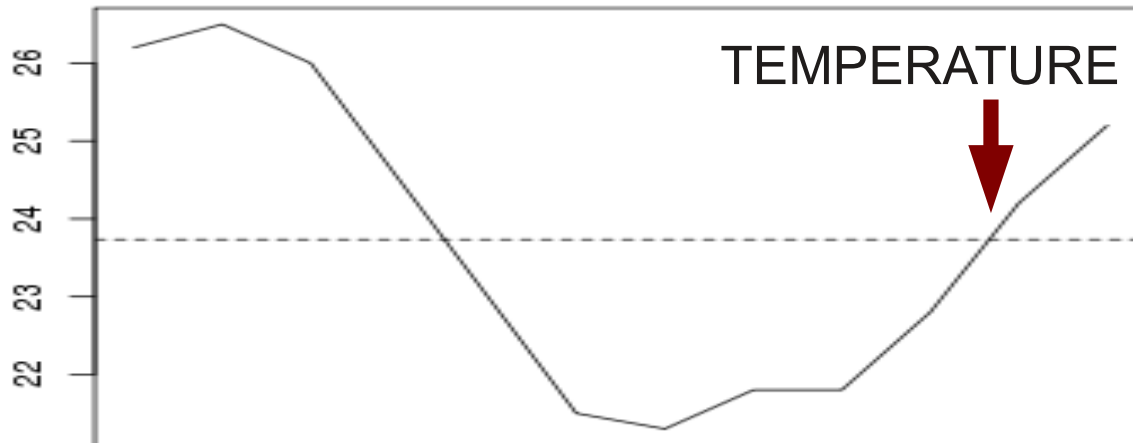
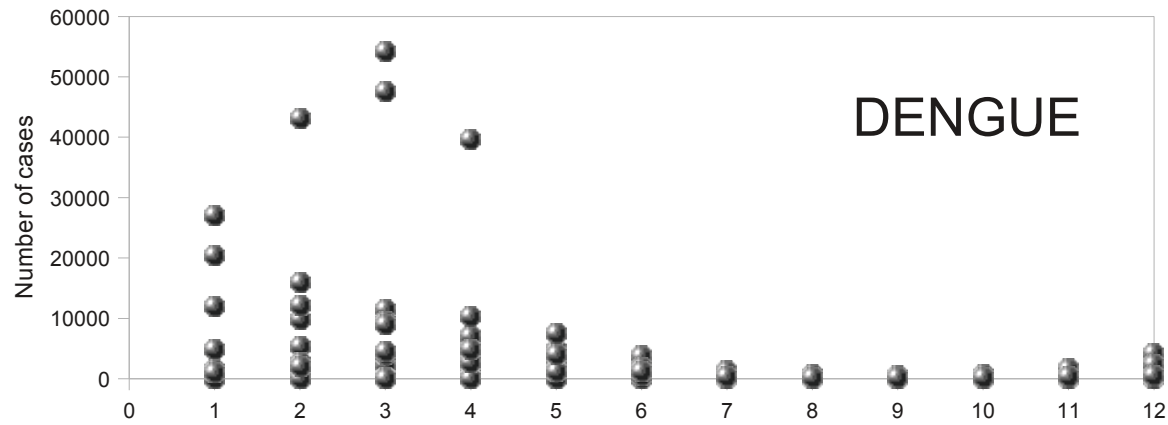


(A) Urban area

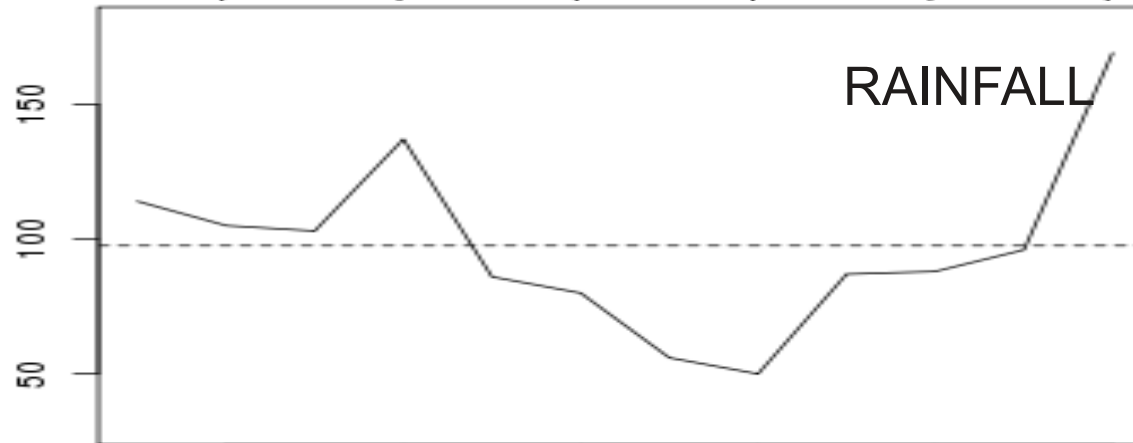
(B) Suburban area

(C) Suburban slum





Mosquito growth



Serological survey

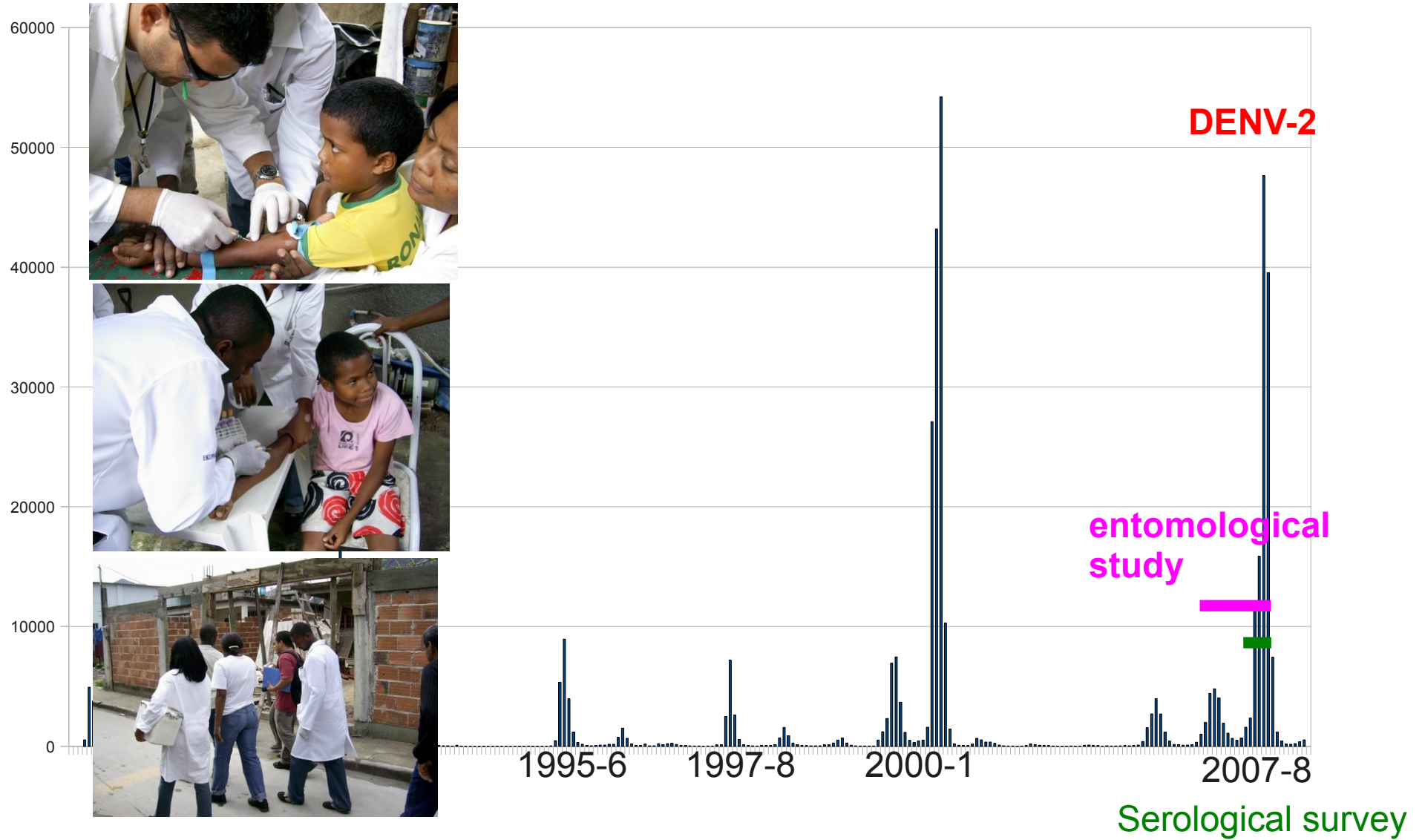


Table 1. Serological surveys, July-November 2007 and February-April 2008 in three areas, Rio de Janeiro, Brazil.

Area (type)		Serum sample (IgM) - Surveys			Serum sample (IgG) - Surveys		
		1 st	2 nd	Seroconversion paired sample (IgM)	1 st	2 nd	Seroconversion paired sample (IgG)
Higienópolis (Urban)	<i>n</i>	43	29	28	43	29	28
	Positives	1*	4**	2	37	27	1
	Median Age (range)	28.5 (4-79)	42 (4-79)	40.50 (4-79)	28.5 (4-79)	42 (4-79)	40.50 (4-79)
Tubiacanga (Suburban)	<i>n</i>	157	122	117	157	122	117
	positives	2 ⁺	5 ⁺⁺	4	90	75	4
	Median Age (range)	11 (4-74)	12 (4-74)	12 (4-74)	11 (4-74)	12 (4-74)	12 (4-74)
Palmares (Suburban slum)	<i>n</i>	126	107	102	126	107	102
	positives	6 [†]	15 ^{††}	11	72	73	8
	Median Age (range)	11 (1-52)	11 (1-52)	10 (1-52)	11 (1-52)	11 (1-52)	10 (1-52)
Total	positives/total	9/326	24/258	17/247	199/326	175/258	13/247

Number of asymptomatic individuals: *1; **2; ⁺ 2; ⁺⁺ 4; [†] 4; ^{††} 10.

Recent dengue infection was defined by the detection of DENV IgM antibodies in any sample (first or second sample) within the last 6

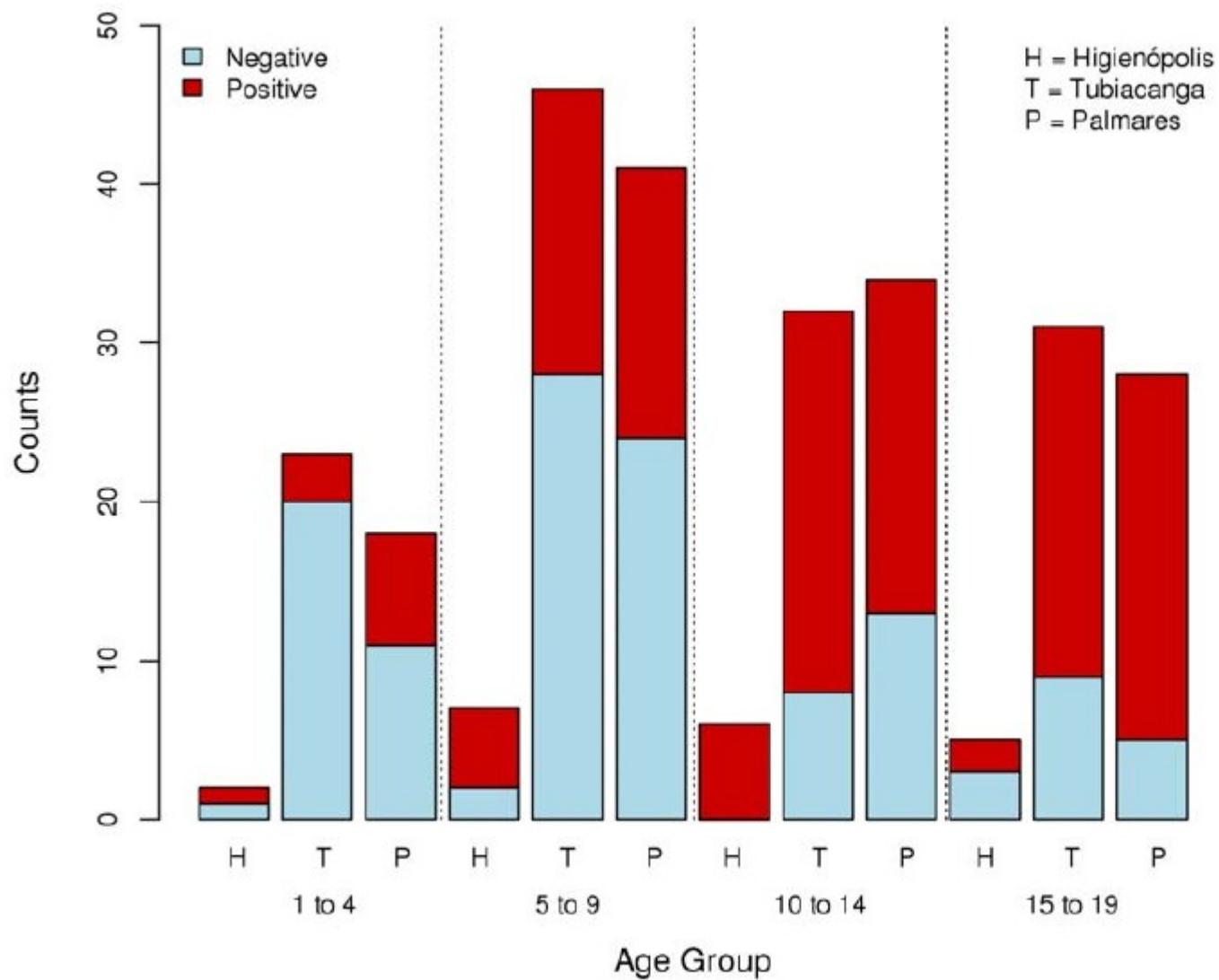


Figure 4. Dengue seroprevalence per age group. Dengue seroprevalence per age group (1 to 4, 5 to 9, 10 to 14, 15 to 19), red are positive and blue indicate negative cases in Higienópolis (urban), Tubiacanga (suburban) and Palmares (suburban slum) neighborhoods in Rio de Janeiro, Brazil.

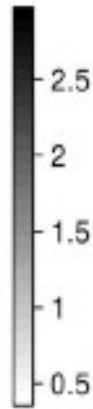
Table 2. Individual risk factors odds ratio for seroprevalence in three areas, Rio de Janeiro, Brazil.

Risk factor	Higienópolis			Tubiacanga			Palmares			
	N	OR	P	N	OR	P	N	OR	P	
Sex	Male	22	1	73	1		61	1		
	Female	22	1.179e+08	0.99	89	1.93	0.05	70	0.66	0.26
Age	0–10 years	10	1	77	1		64	1		
	11–20 years	10	1.000e+00	1.00	55	7.91	0.001	60	3.42	0.01
	21–100 years	24	3.662e+08	0.99	30	25.39	0.001	7	4.15	0.22
Self-reported past history of dengue	No	34	1	143	1		106	1		
	Yes	10	2.478e+07	0.99	19	5.00	0.05	25	5.35	0.05
Yellow fever vaccination	No	40	1	147	1		129	1		
	Yes	4	7735420.4	0.99	15	1.96	0.27	2	1.634e+06	0.98

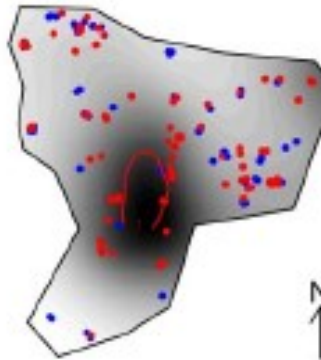
Seropositivity odds ratio



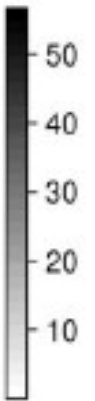
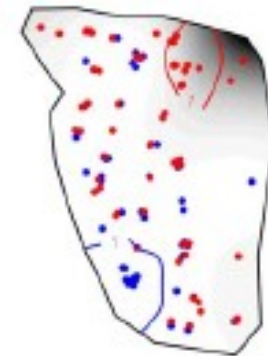
Higienópolis



Tubiacanga



Palmares

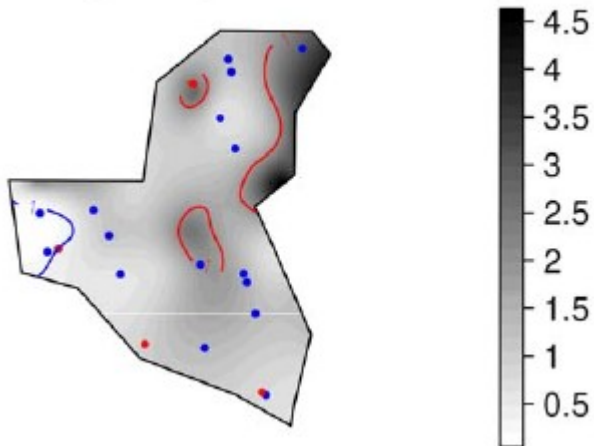


● Seropositive cases

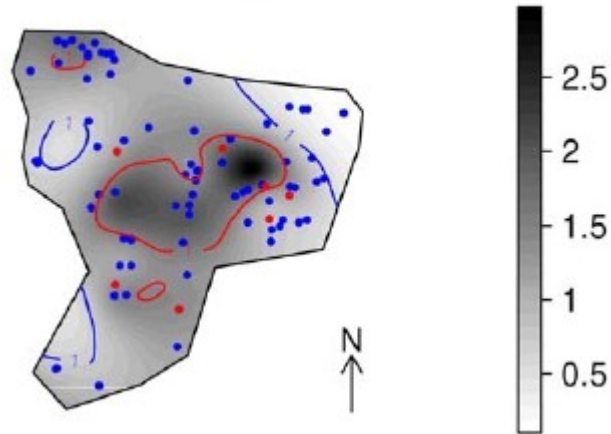
Mosquito density x recent infections



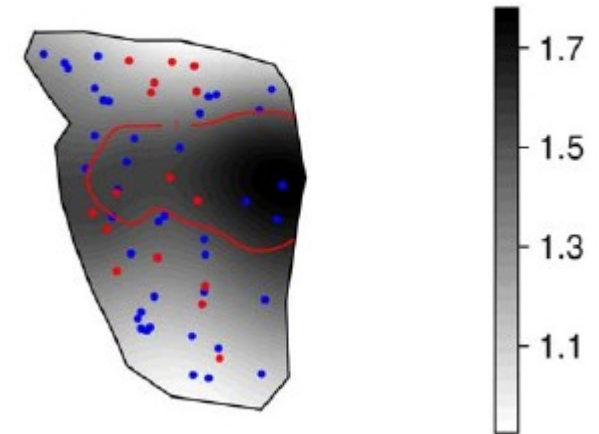
Higienópolis



Tubiacanga



Palmares



● Recent cases

Main results

- There is a threshold at 22-24 C above which *Aedes aegypti* is not constrained by temperature.
- Temperature at lag 1 and rainfall can account for 50-60% mosquito abundance variability
- There is a lag of ca. 2 months between mosquito increase and dengue cases increase
- No direct association between mosquito's hotspots and risk of infection
- Apparent association between risk of infection and closeness to high commutation areas.

Temporal Distribution of *Aedes aegypti* in Different Districts of Rio De Janeiro, Brazil, Measured by Two Types of Traps

N. A. HONÓRIO,^{1,2} C. T. CODEÇO,³ F. C. ALVES,⁴ M.A.F.M. MAGALHÃES,⁵
AND R. LOURENÇO-DE-OLIVEIRA¹

J. Med. Entomol. 46(5): 1001-1014 (2009)

Spatial Evaluation and Modeling of Dengue Seroprevalence and Vector Density in Rio de Janeiro, Brazil

Nildimar Alves Honório^{1*}, Rita Maria Ribeiro Nogueira², Cláudia Torres Codeço³, Marilia Sá Carvalho³, Oswaldo Gonçalves Cruz³, Mônica de Avelar Figueiredo Mafra Magalhães⁴, Josélio Maria Galvão de Araújo², Eliane Saraiva Machado de Araújo², Marcelo Quintela Gomes¹, Luciane Silva Pinheiro¹, Célio da Silva Pinel⁵, Ricardo Lourenço-de-Oliveira¹

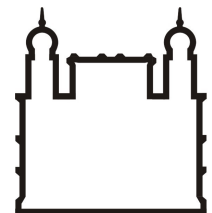
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- **Rede Pronex Modelagem em Dengue CNPq**



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