Ministério da Saúde

Fundação Oswaldo Cruz

Instituto Oswaldo Cruz

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Centro de Integração de Dados e Conhecimentos para Saúde

FIOCRUZ

Mathematical modeling of epidemics: the challenge of using big data in the dissemination of Zika, Dengue and Chikungunya viruses in Camaçari

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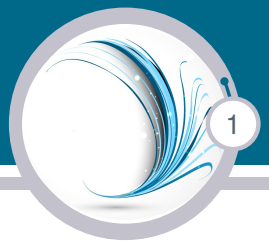

Introduction
- Zika Platform
- Mathematical Modeling
- Three Disease Scenario
- A Specific Problem

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- Hidden Zika Cases in Exanthematic Notifications

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Introduction
Zika Platform

Aim:

To study, as an epidemiological cohort, the impacts on the health and quality of life of the population affected by Zika Virus and Congenital Zika Syndrome / CZS. `https://cidacs.bahia.fiocruz.br`

Specific objectives of the platform are understanding three main periods:

- **Pre Zika:** dengue ocurrences from 2001 to 2013 (13 year);
- **Epidemic** Dengue + Chikungunya + Zika (DCZ) from 2014 to 2016 (3 years);
- **Post Zika** DCZ + other possible arboviruses (?) + CZS from 2017 to 2030 (14 years).

A characterization of these periods is being provided by studying linked and non linked data [1] related to disease morbidity, health sequels, and social services.

[1] (Brazilian National Notifiable Diseases Information System (SINAN) and Public Health Events Registry (RESP))

Mathematical Modeling

Model

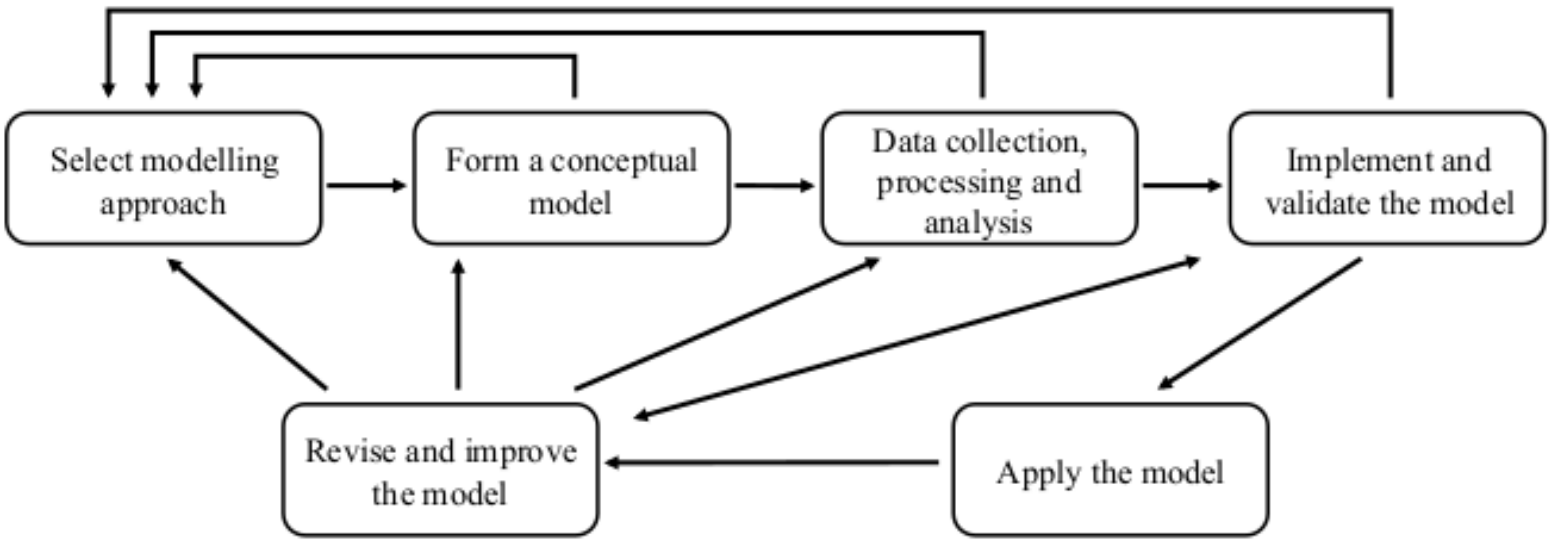
Conceptual tool that explains how an object (or systems of objects) will behave.

Mathematical Models in Epidemiology

Allow us to predict:

- the population-level epidemic dynamics, considering the knowledge of epidemiological factors;
- the long-term behaviour from the early invasion dynamics;
- the impact of interventions on the spread of infection.

Mathematical Modeling Process



Dengue:

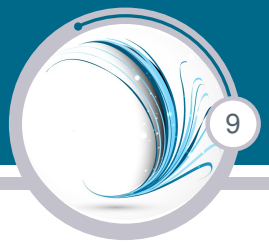
- dengue virus (genus *Flavivirus*) transmitted by mosquitoes of the genus *Aedes*;
- the first dengue epidemic in Brazil was documented in the 1980s;
- increase in the number of cases and hospitalizations; epidemics of great magnitude; notifications in municipalities of different population sizes; severe cases affecting people in extreme ages (children and elderly)...

Chikungunya:

- disease caused by virus of genus *Alphavírus* transmitted by mosquitoes of the genus *Aedes*; evidences of vertical transmission (pregnant - baby);
- first cases in Brazil occurred in 2014, in the states of Bahia and Amapá;
- affects the susceptible population without distinction of sex or age group; atypical manifestations affect several organs and systems, such as neuro-invasive diseases (Guillain-Barré syndrome - GBS and meningoencephalitis), causes renal disorders (including renal insufficiency acute) and heart diseases.

Zika:

- virus of genus *Flavivirus* transmitted by mosquitoes of the genus *Aedes*, vertically, sexually and others;
- first cases in Brazil occurred in 2015, especially in the Northeast region;
- increase in the number of cases of GBS; association of congenital malformations - notably the microcephaly.



Scenario:

Zika, dengue and chikungunya share the same vectors and cause similar symptoms. They are diseases with different speeds of dissemination with one event of simultaneous circulation in the population of Brazil (2015).

Ongoing issue:

Is it possible to assign unspecific notifications of exanthematic disease to DCZ viruses?

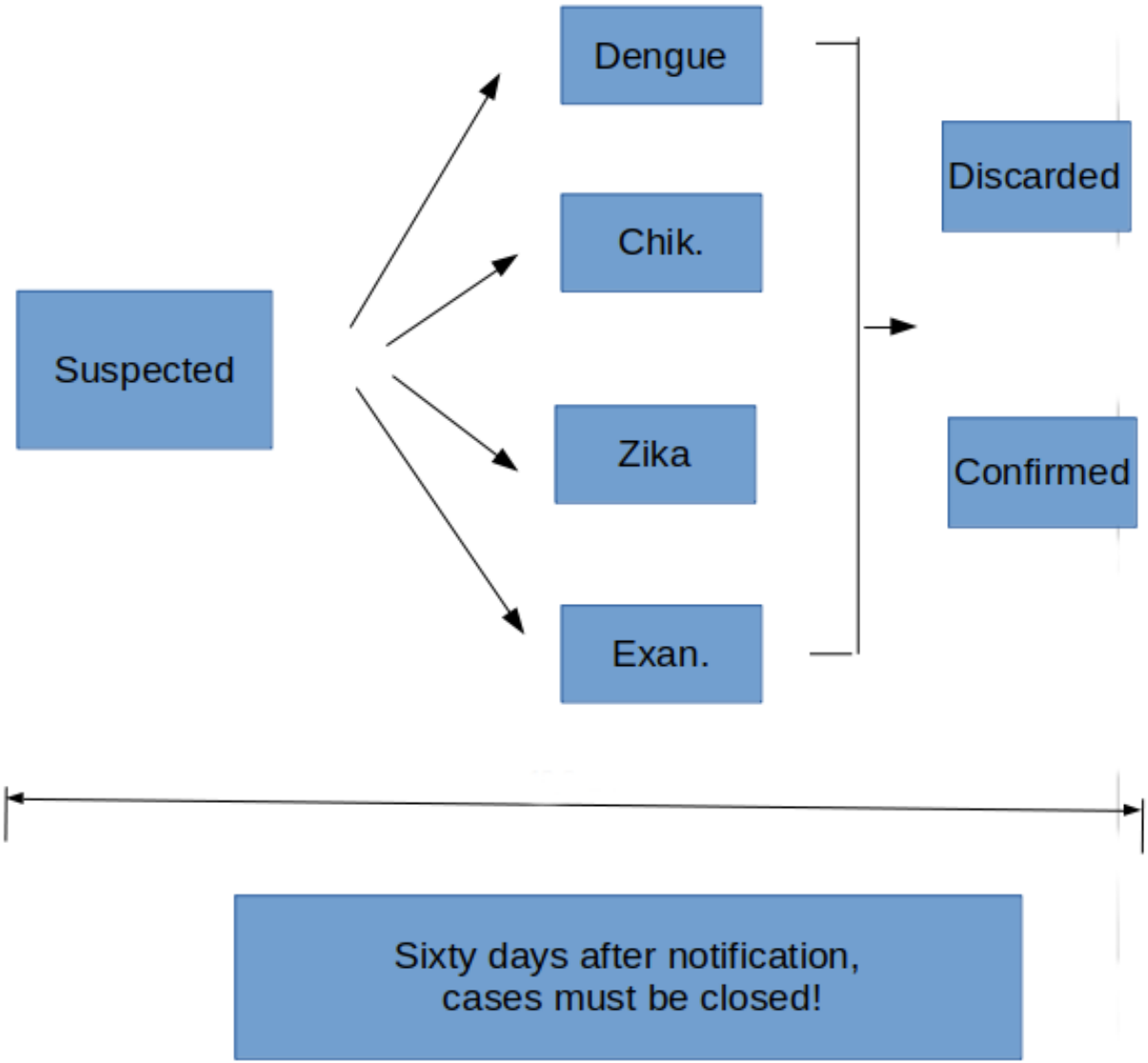
Framework:

Use data survey of one municipality (Camaçari) to validate data mining of unspecific notifications.

Estimating Incidences
Definition of a Case

- **Suspected:**
  - analysis of symptoms;
  - geographical association;
- **Confirmed:** cases that were confirmed through a laboratory test.
- **Discarded:**
  - Laboratory test is negative;
  - clinical and epidemiological investigation is compatible with another disease;

Estimating Incidences
Definition of a Case



Estimating Incidences

The first barrier: case notification!

Case 1

The number of notified Dengue incidence that were neglected by the lack of knowledge of Zika disease in the territory of Brazil.

Case 2:

It is estimated that only 20% of people, infected by the Zika virus, present symptoms. These symptoms usually includes maculopapular rash (exanthem), pruritus, fever, arthralgia, and myalgia, likely to be confused with Dengue.

Exanthematic Cases in Camaçari

Sample of 5940 people that searched for medical care in the city of Camaçari.

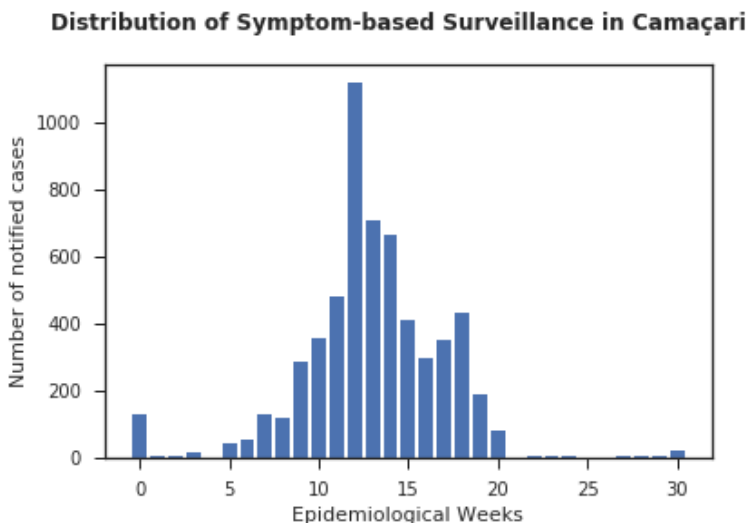
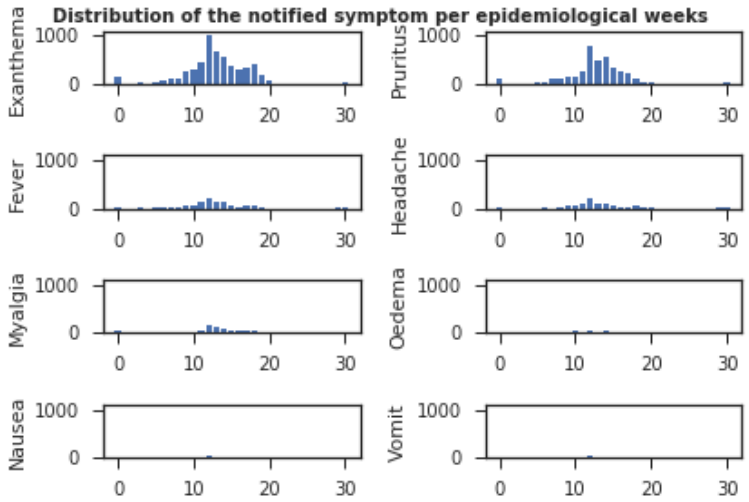


Figure: Exanthematic notifications. Potential non-identified cases of Zika infection in Camaçari, Brazil, in the year of 2015.

No further indication of infection by either of three viruses.

Exanthematic Cases in Camaçari

The reported symptoms: exanthema (90.30%), pruritus (62.15%), fever (16.95%), headache (13.28%), myalgia (12,60%), oedema (3.84%), nausea (2.56%) and vomit (1.28%).



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Exanthematic Cases in Camaçari

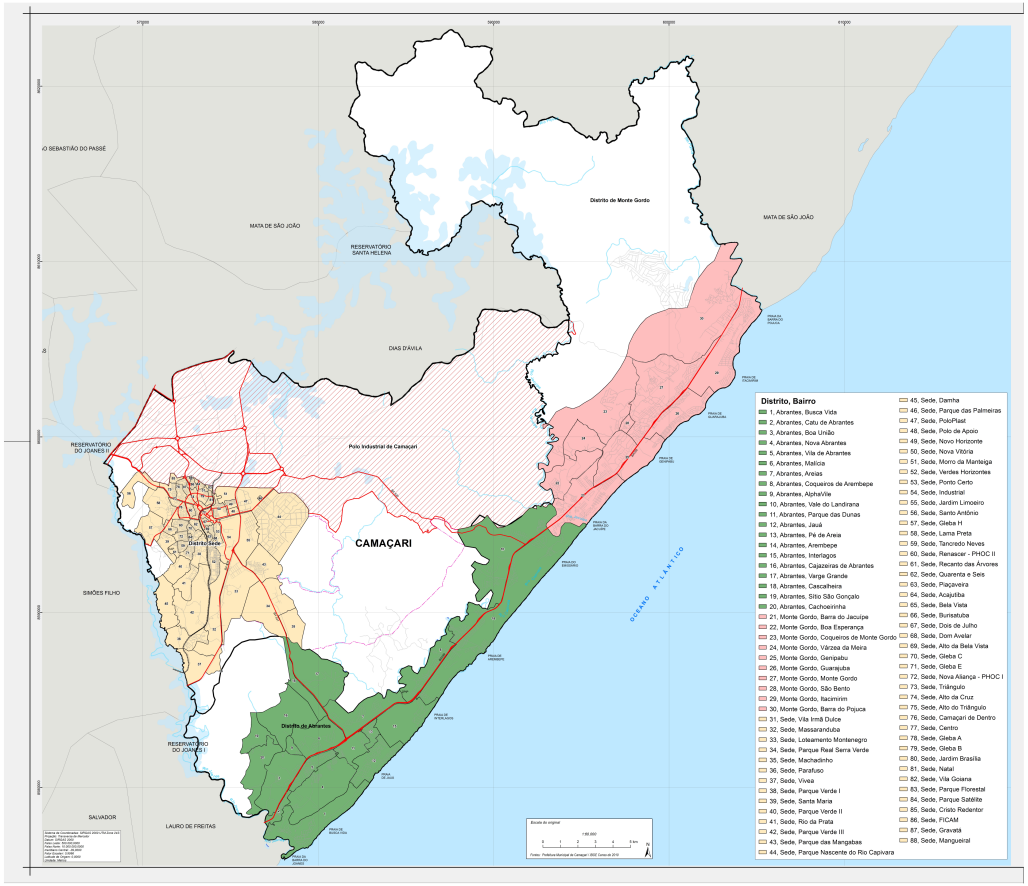

Figure: Camaçari, Brazil. Map from Base Cartográfica do Municipio de Camaçari.

Exanthematic Cases in Camaçari

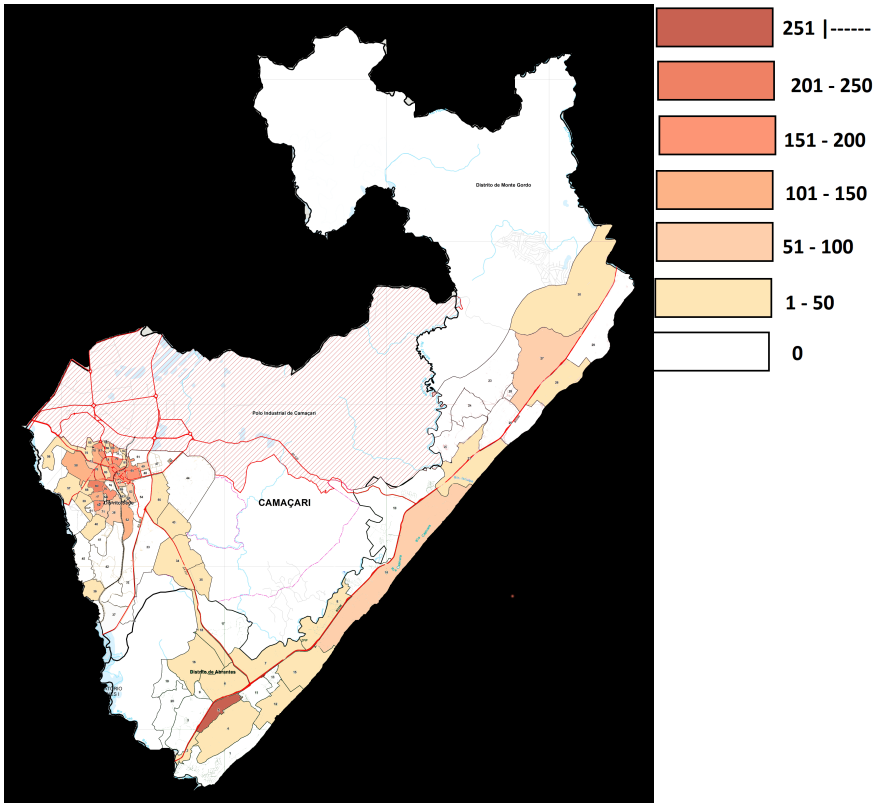

Figure: Spatial distribution of exanthematic notificationsin Camaçari, Brazil, in the year of 2015. Map from Base Cartográfica do Municipio de Camaçari.

Exanthematic Cases in Camaçari

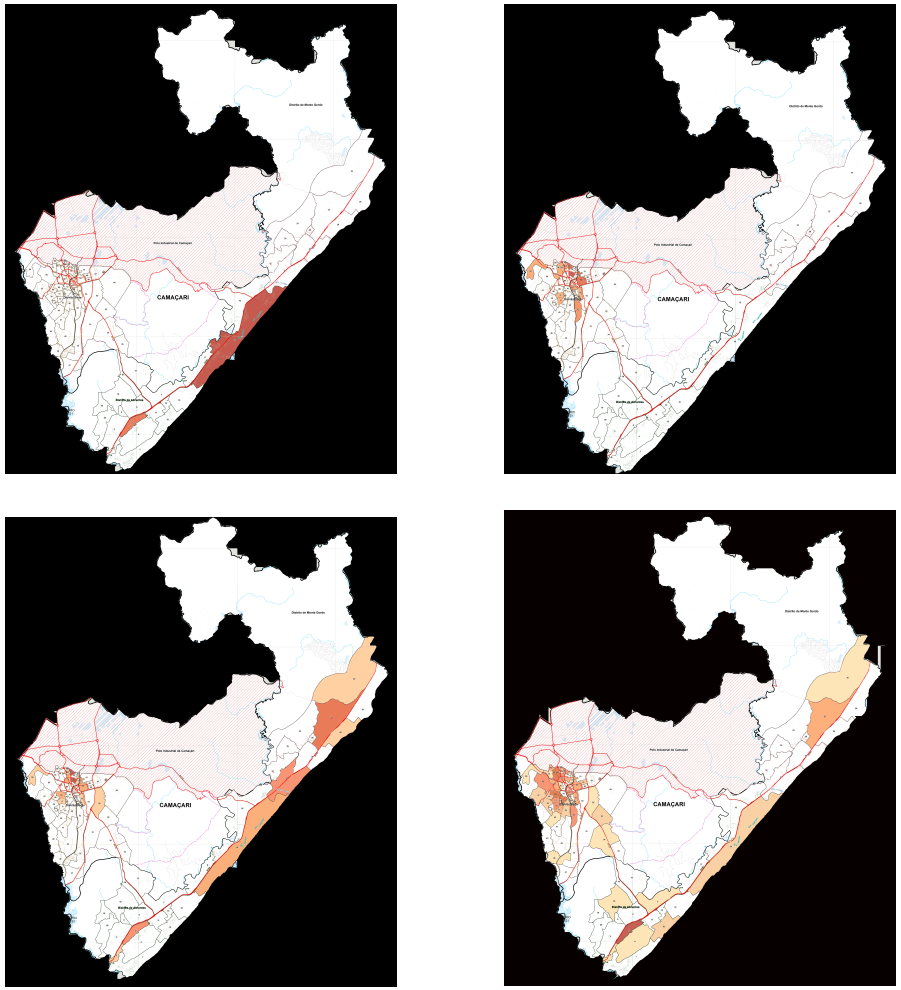

Figure: Spatial distribution of exanthematic notifications. Up-left: 1st week; up-right: 6th week; down-left: 7th week; down-right: 12th week.

Next steps

- Obtain temporal and spatial distributions of DCZ notifications for the same period in Camaçari, Brazil;
- Identify dissemination patterns for each virus infection;
- Provide a decomposition of unspecified distribution among directions in phase space of three diseases.

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Thank you! Questions?