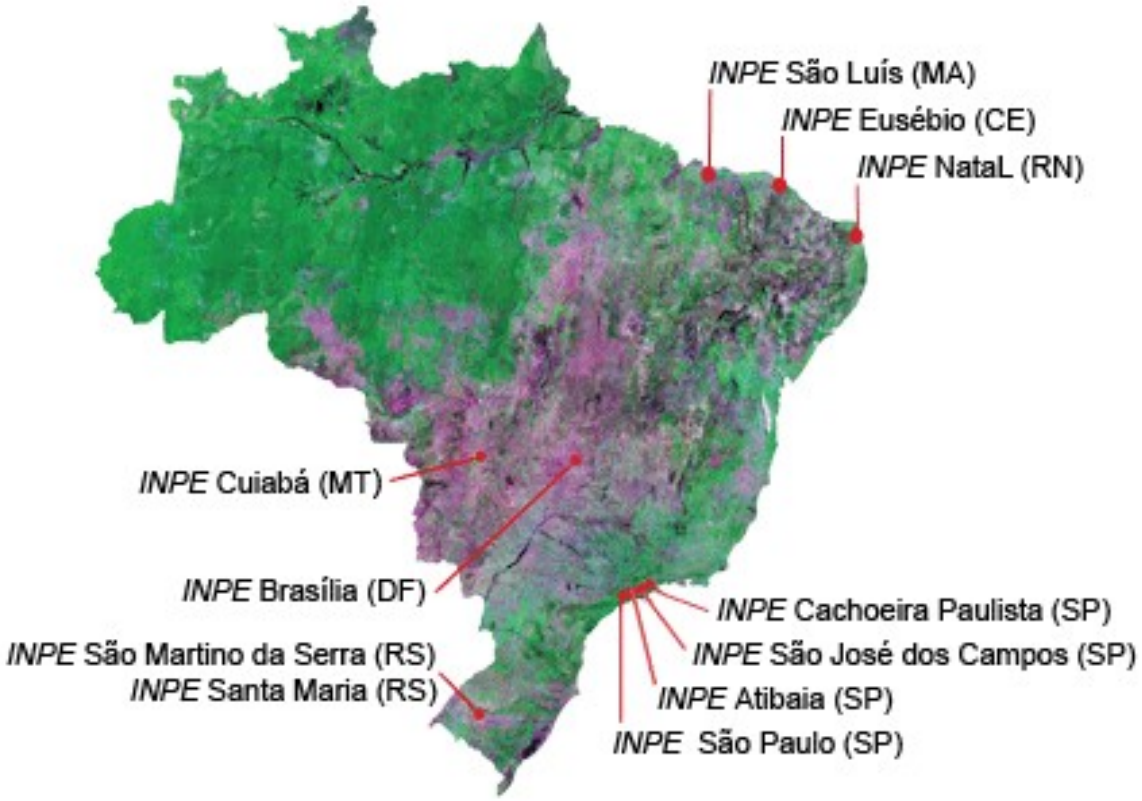
TerraLib as an Open Source Platform for Public Health Applications

Karine Reis Ferreira

September 2008

INPE – National Institute for Space Research

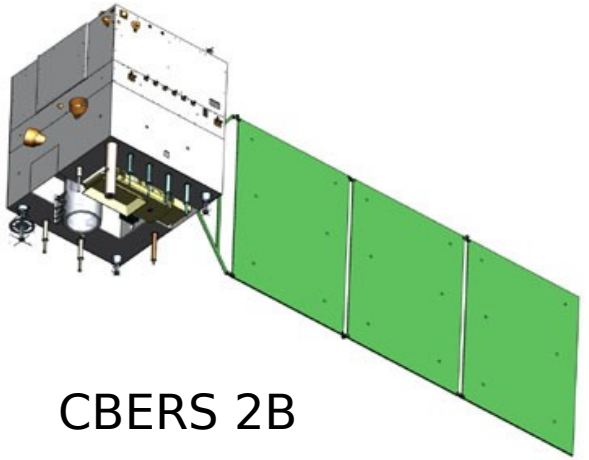
- Brazilian research institute
- Main campus is located in São José dos Campos in São Paulo state
- 1,600 employees
- 6 graduate courses



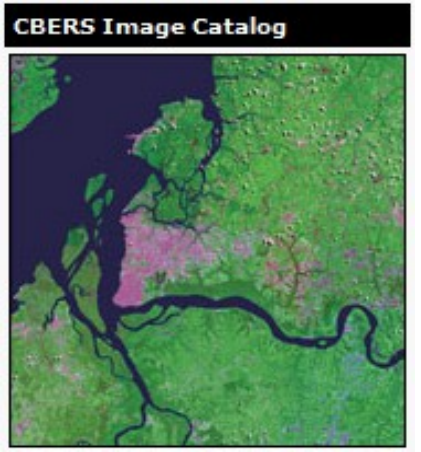
www.inpe.br/ingles

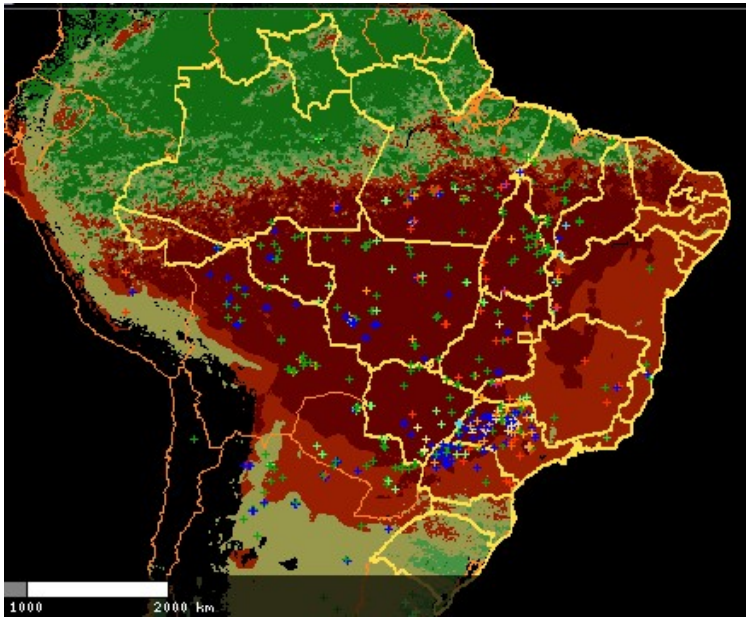
INPE – National Institute for Space Research

- Some researches and services:
  - CBERS – China-Brazil Earth Resources Satellite
  - Weather Forecast and Climate Studies
  - PRODES: Monitoring of Amazon Deforestation
  - PROARCO: Fire Monitoring
  - Free geo softwares



CBERS 2B





DPI – Image Processing Division

History developing geographical softwares

Free GIS
Geographical files and DBMS
Desktop and Multiplatform
Image Processing, Spatial Analysis, Edition, ...

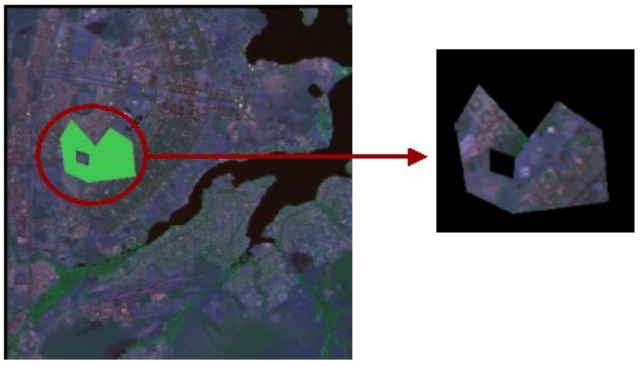
100.000
downloads

Free and **Open Source** Geographical Software **Library** (TerraLib) and Geographical **Application** (TerraView)
Spatial DBMS
Client-Server and Multiplatform

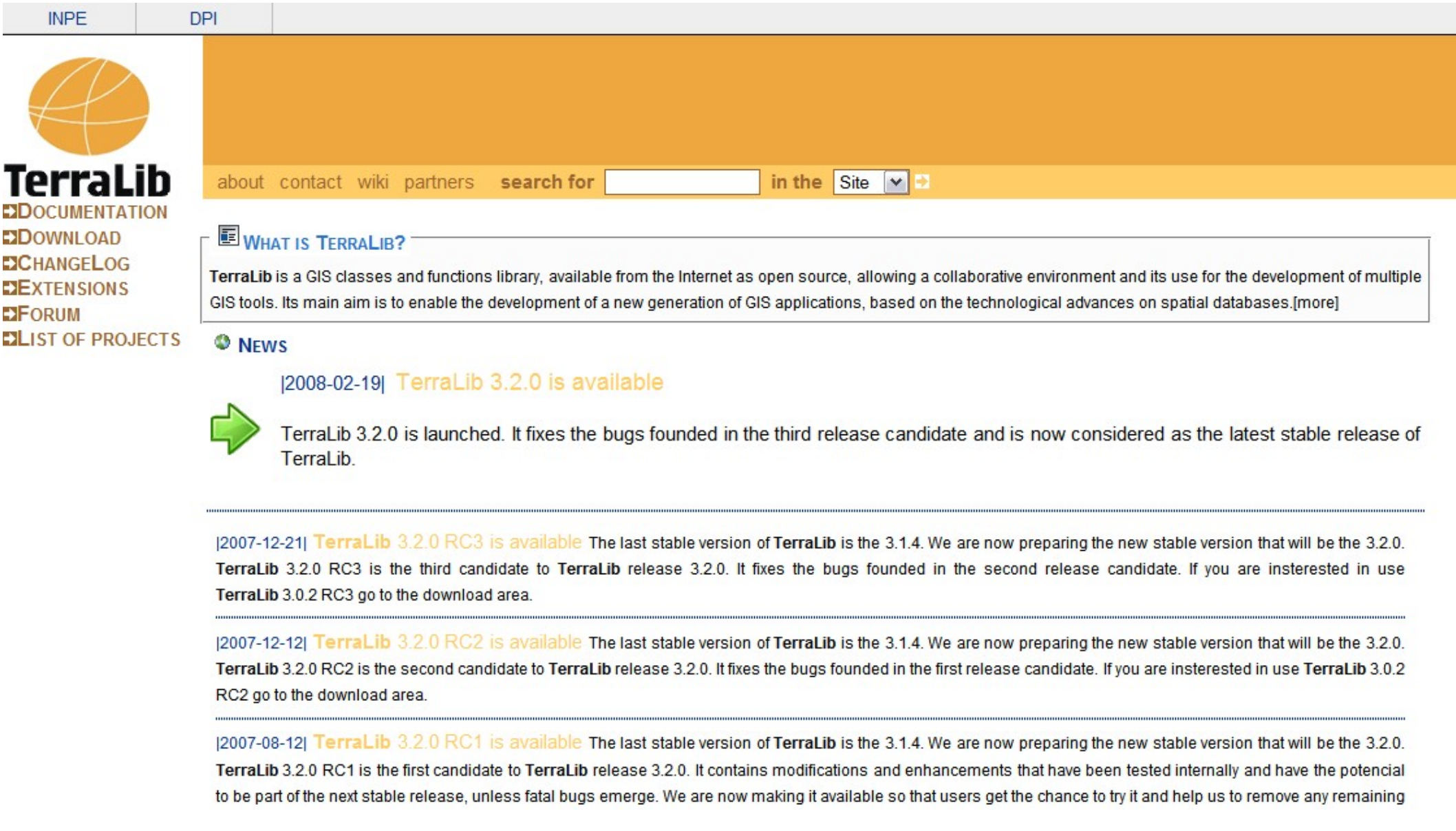
1991 2001 now

TerraLib

- Library to develop geographical applications
- C++ language
- Free and Open Source – LGPL
- Extensive use DBMS
  - MySQL, PostGIS
  - Oracle, Oracle Spatial, SQLServer
- Spatial operations, image processing, spatial analysis, ...

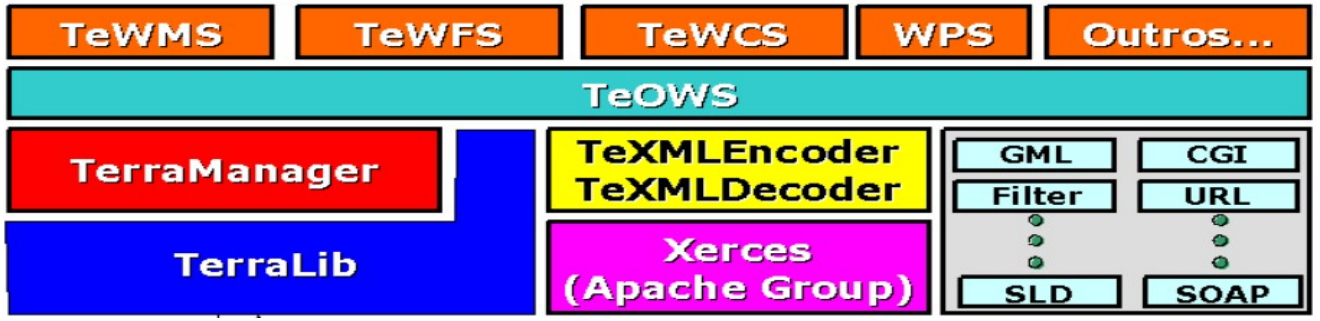


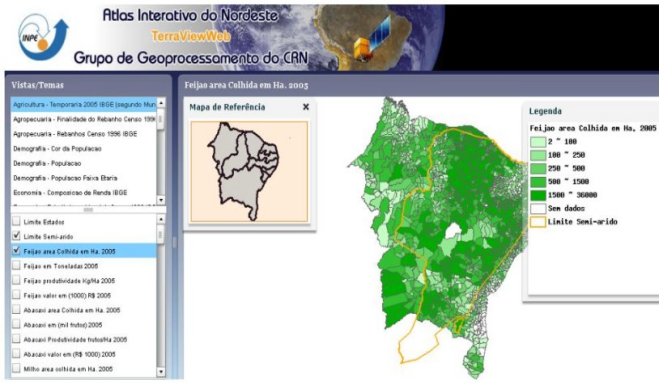
TerraLib web site (www.terralib.org)



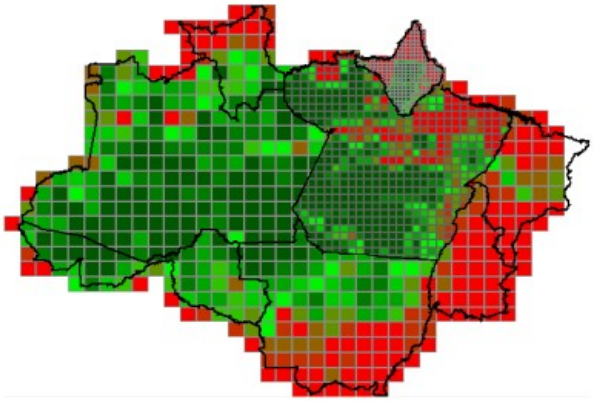
TerraLib

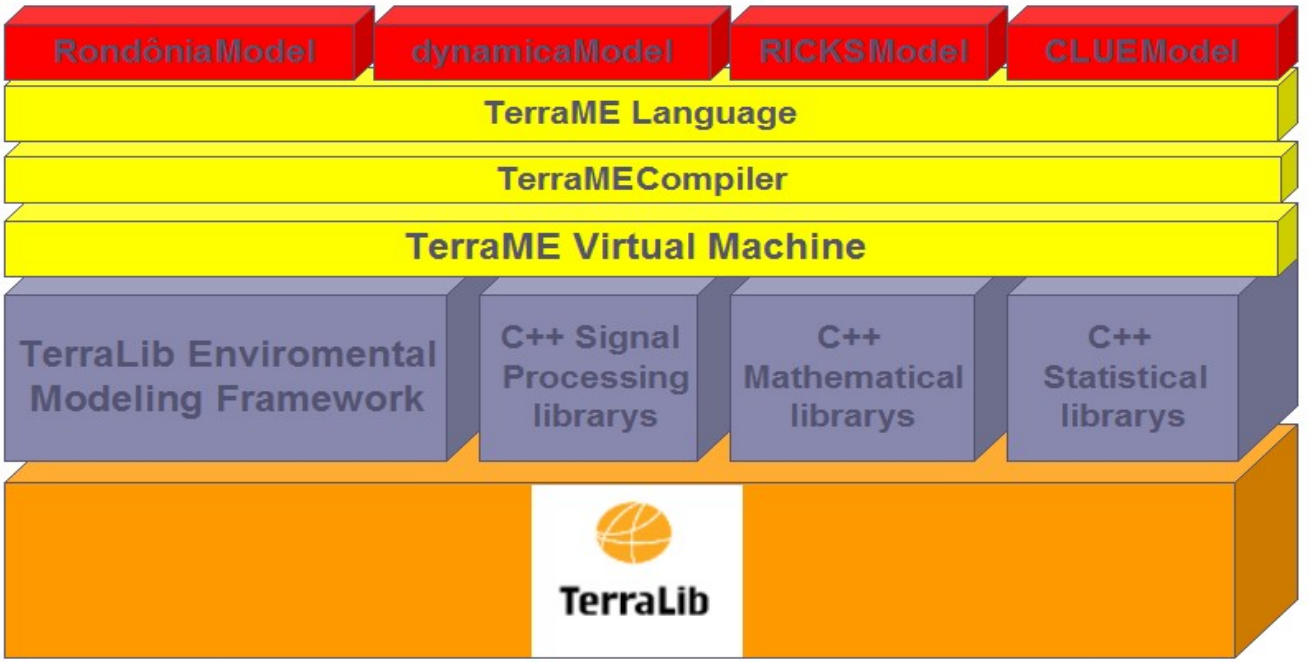
OGC Web Service support





Environmental Modeling support



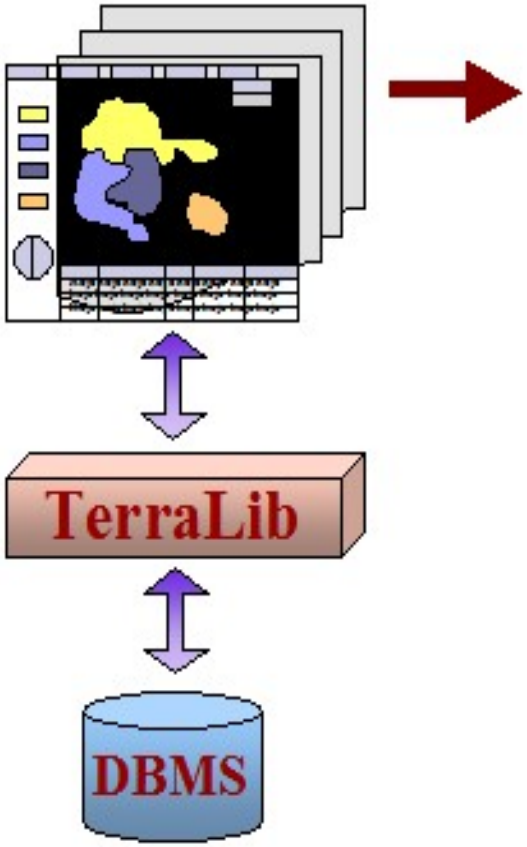


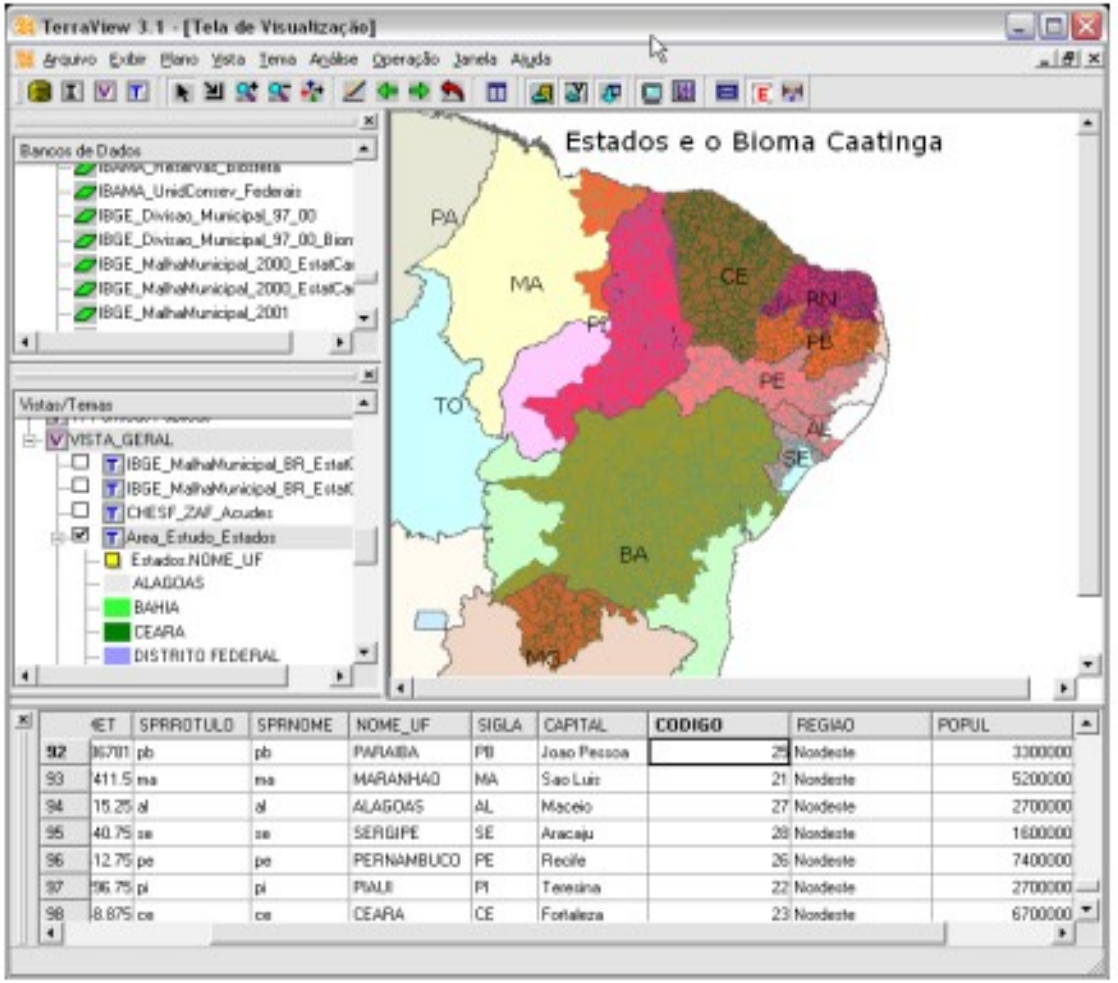
TerraView

- Geographical application built using TerraLib
- Is an example of:
  - how to build a geographical application using TerraLib
  - what you can do using this library
- Free and Open Source – LGPL

TerraView

Set of graphical interfaces (QT toolkit) that use the TerraLib functionalities.



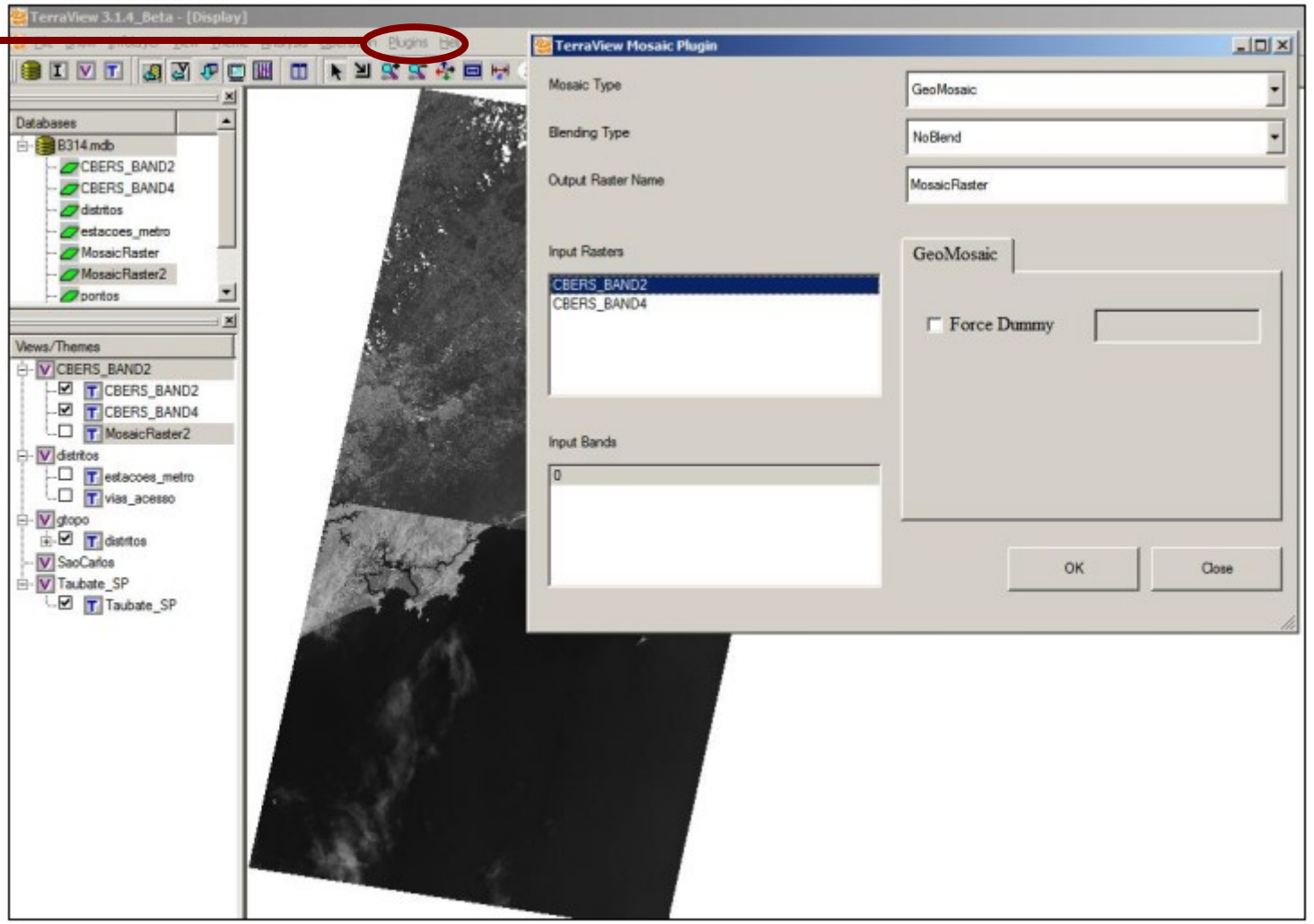


TerraView web site (www.dpi.inpe.br/terraview)

TerraView Plug-ins

Add new graphical interfaces and functionalities to TerraView and customize it through plug-ins

Plug-ins menu



Ex.: Mosaic Images Plug-in

Brazilian Public Health Problems

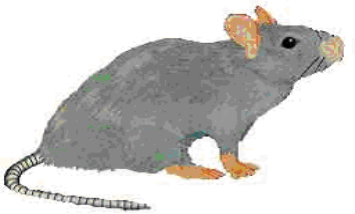
- Endemic Diseases
  - Dengue Fever
  - Malaria
  - Leptospirosis

Aedes aegypti mosquito

Anopheles mosquito

Cases in Brazil

	Infected	**Died**	**year**
Dengue Fever	559,954	158	2007
Malaria	457,659	59	2007
Leptospirosis	2,698	301	2005

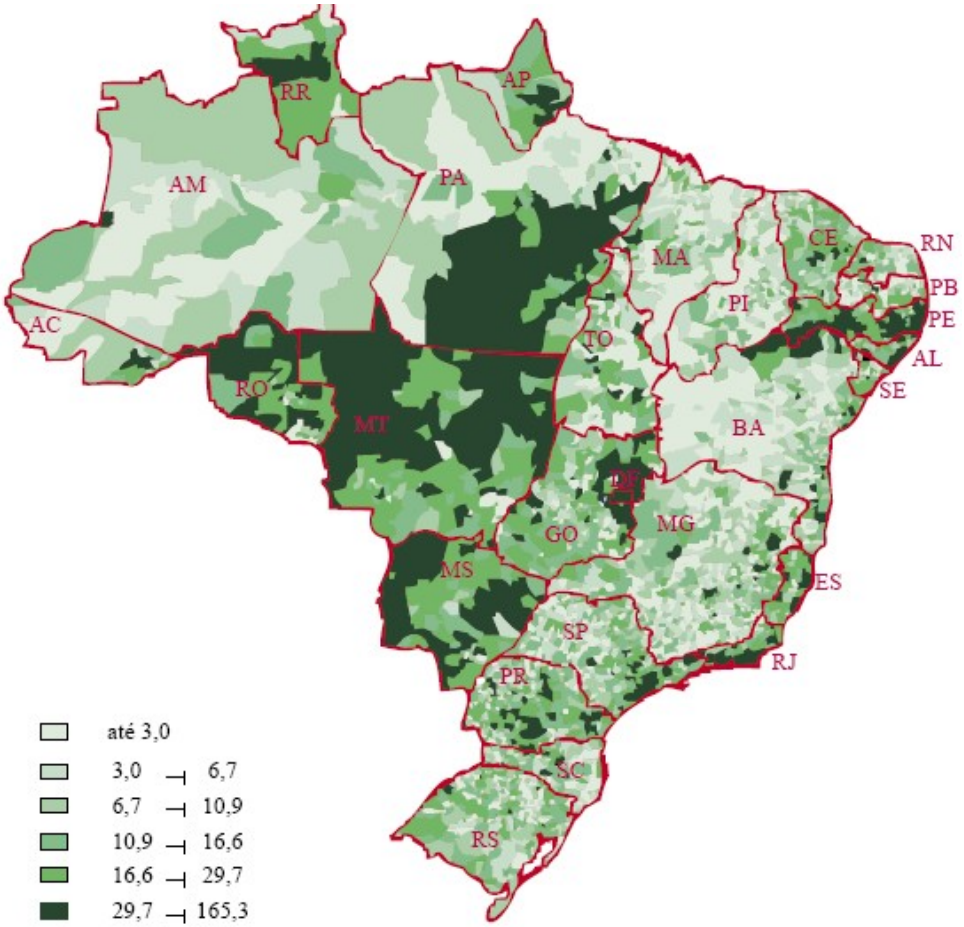


[Source: Ministry of Health, 2008]

Brazilian Public Health Problems

- Violence
  - Total rate: 27 homicides per 100.000 inhabitants per year
  - 30 or 40 times higher than that of England, France, Austria and Japan

Homicide rates 2002/2004



[Source: Julio Jacobo Waiselfisz, 2007]

Applications for Public Health

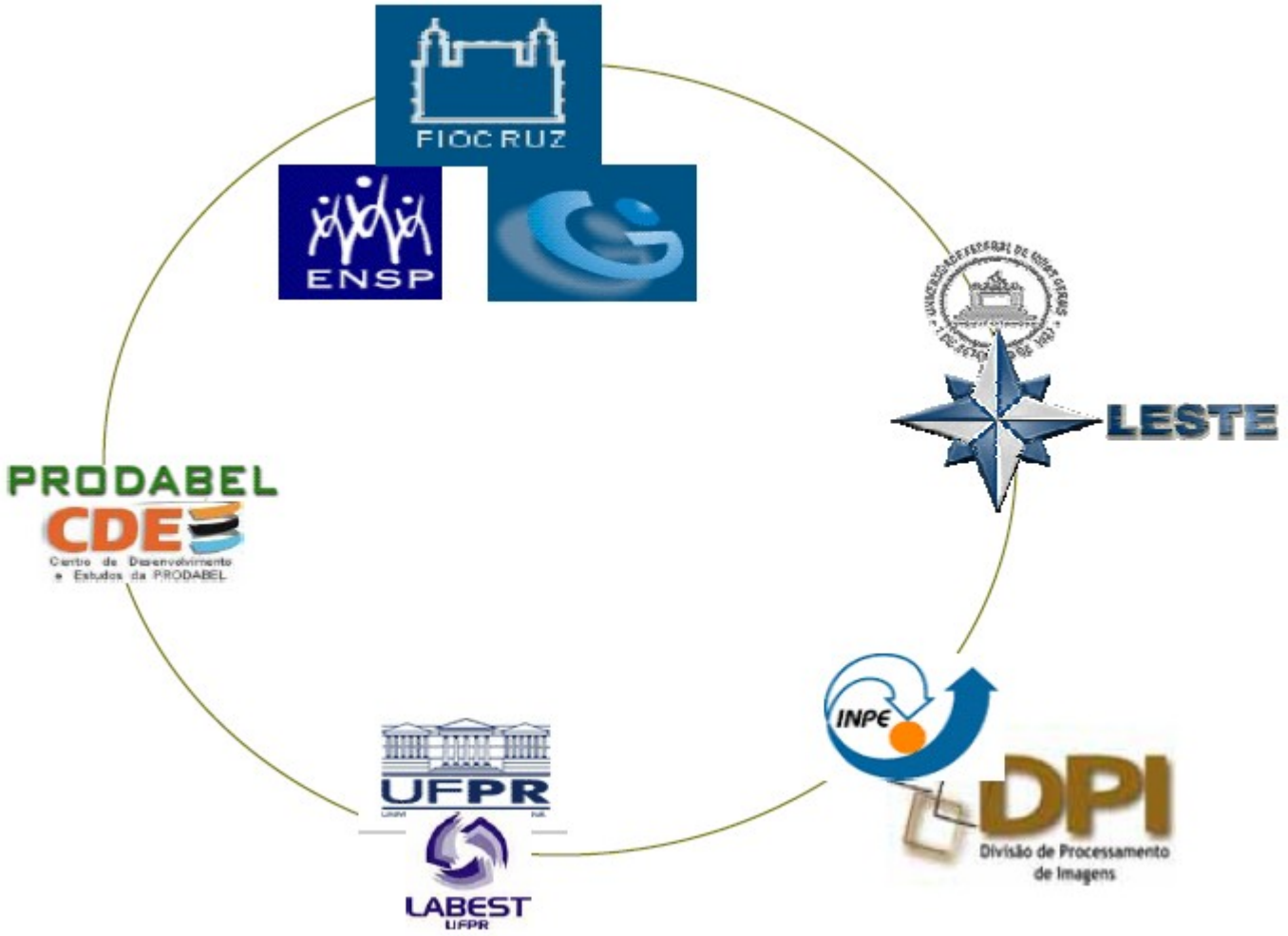
- Software tools able to:
  - detect epidemic outbreaks and spatio-temporal clusters
  - model and identify risk and protection factors in endemic and epidemic moments
  - integrate environmental information, risk factor detection, and warning methods

TerraLib Solutions for Public Health

- Projects networking health institutes, universities and government department:
  - Join specialists from different areas
  - Examples: SAUDAVEL and EUREQA
- Free and open source tools
  - Built using TerraLib library
  - Examples: TerraStat, TerraCrime, aRT and TerraCluster plug-ins

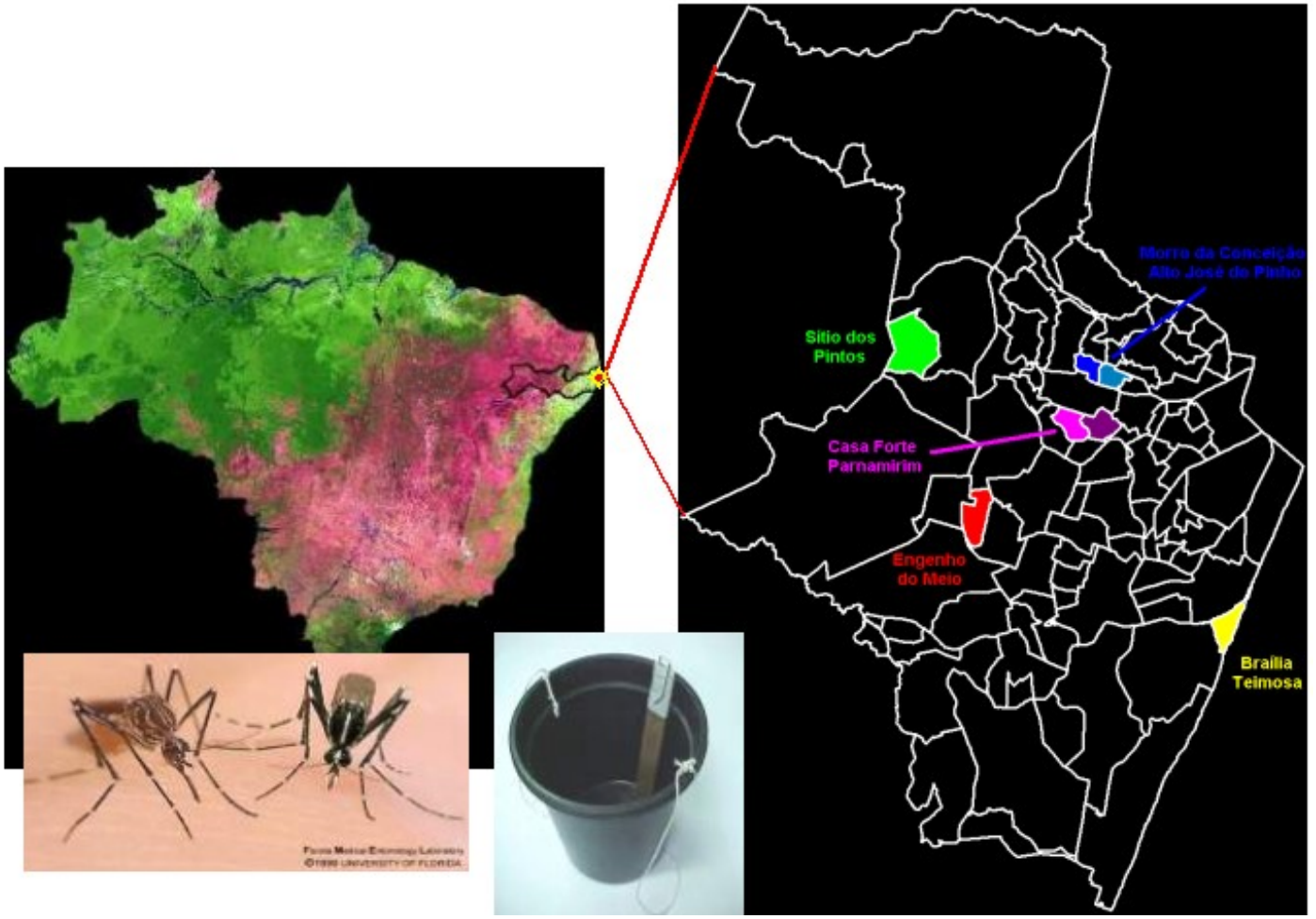
SAUDAVEL Project

A Surveillance System to control, alert and intervene epidemic and endemic diseases, like Dengue Fever and Leptospirosis.



SAUDAVEL Project

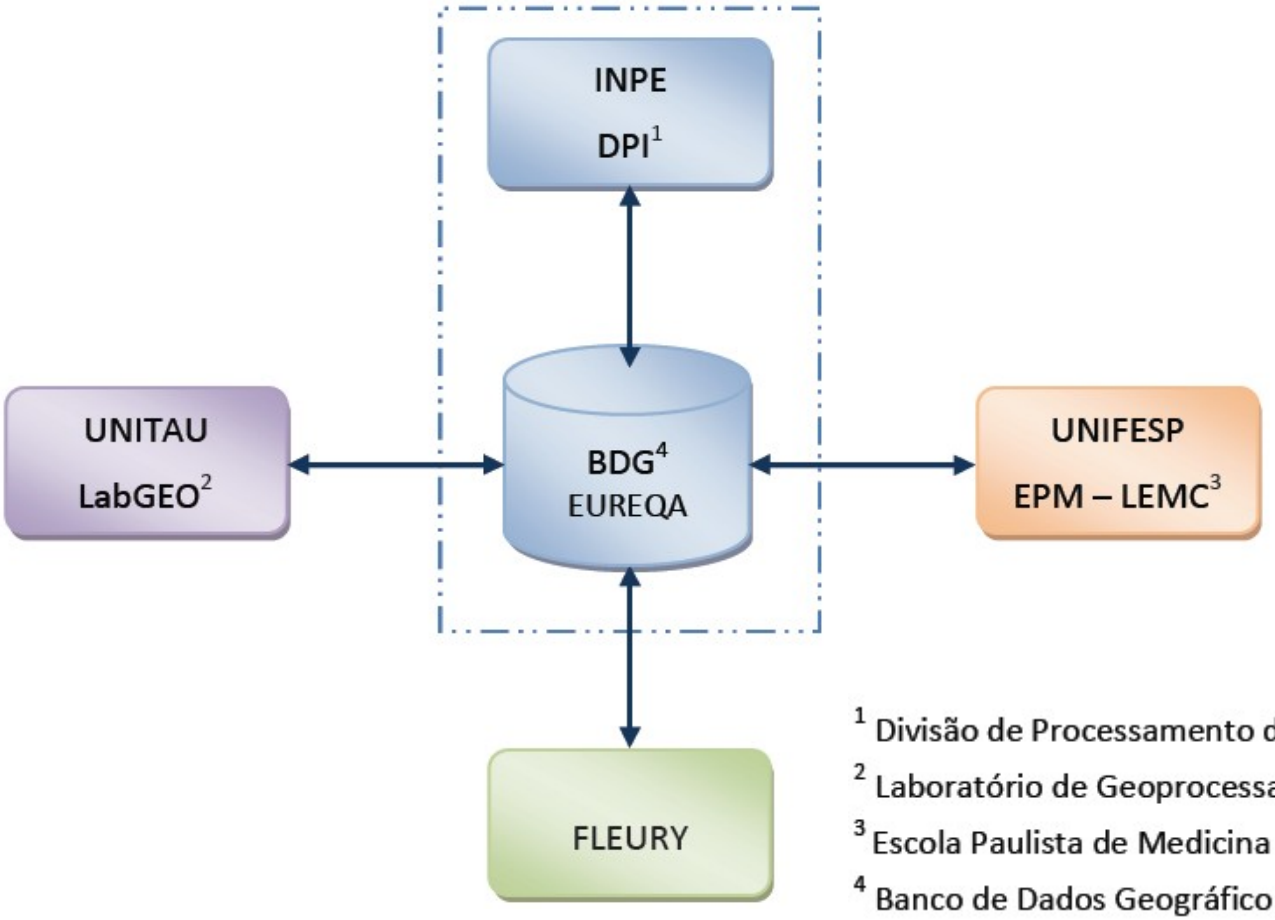
Central experiment: Monitoring Dengue Fever in Recife city, based on egg traps for *Aedes aegypti* and *Aedes albopictus* mosquito.



100 geo-referenced egg traps in each site.

EUREQA Project

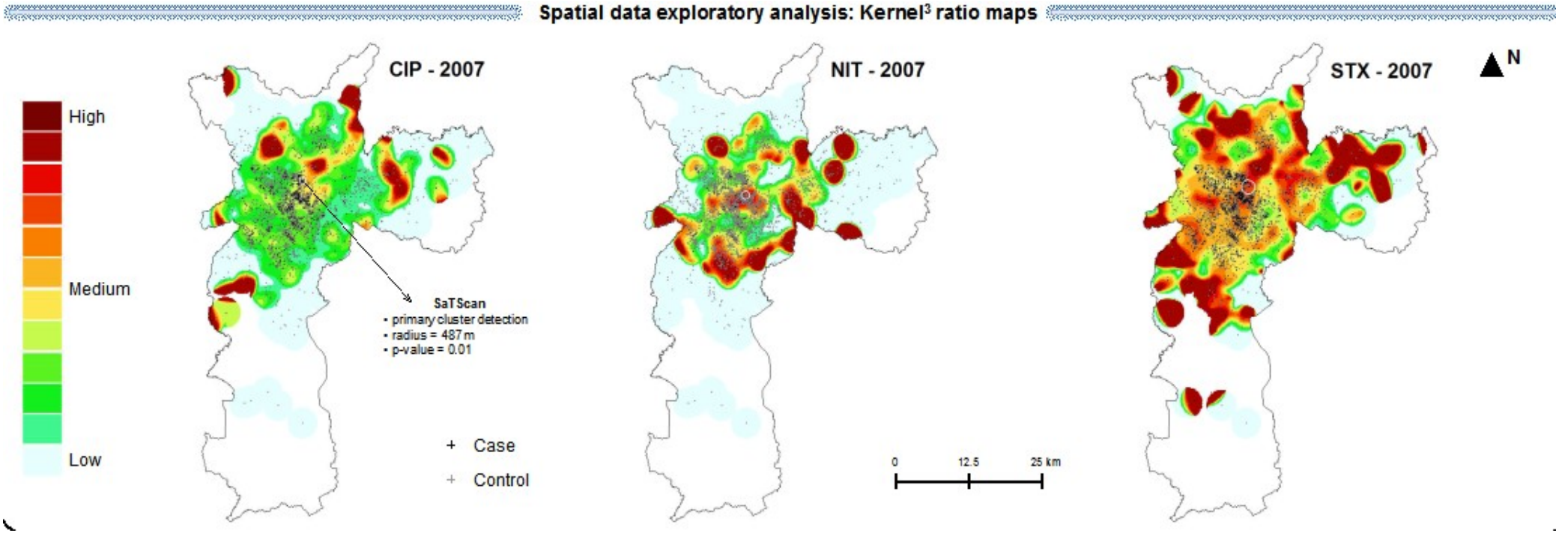
Goal: Explore bacterial infections and resistance dynamics and their spatio-temporal correlations with antimicrobial usage density.



[1] Divisão de Processamento de Imagens
[2] Laboratório de Geoprocessamento
[3] Escola Paulista de Medicina – Laboratório Especial de Microbiologia Clínica
[4] Banco de Dados Geográfico EUREQA

EUREQA Project

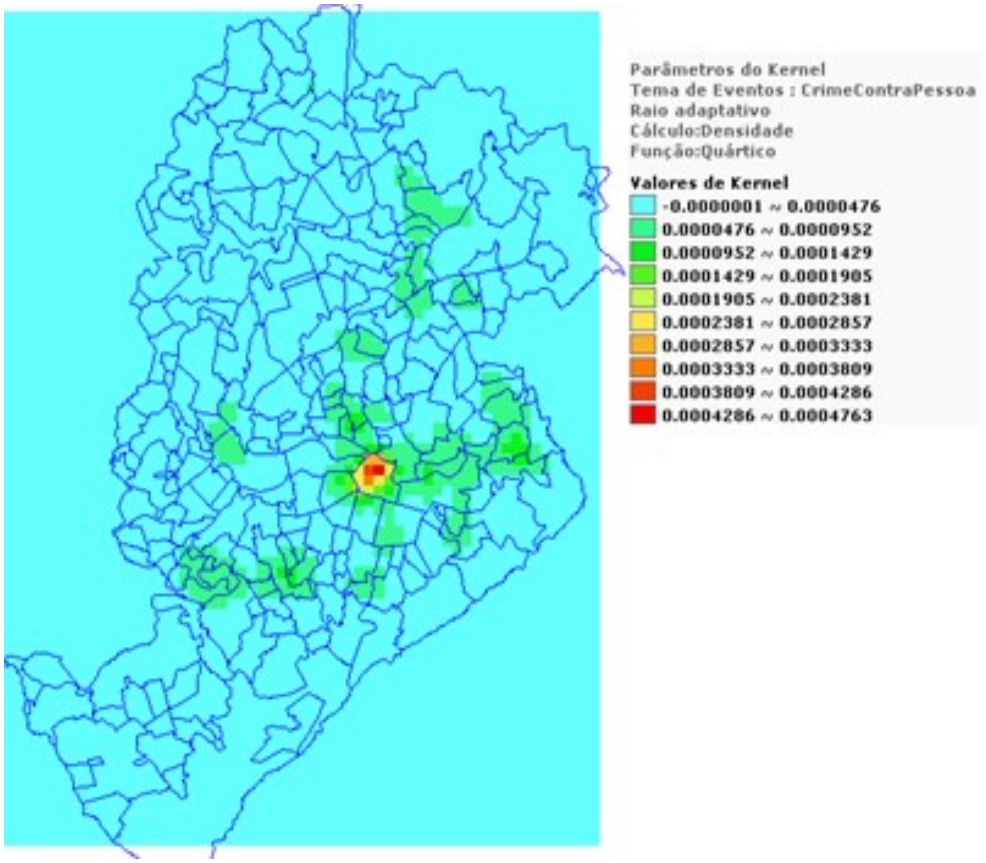
Case study: community urinary tract infections (cUTIs) caused by *Escherichia coli* bacteria in São Paulo city.



TerraStat

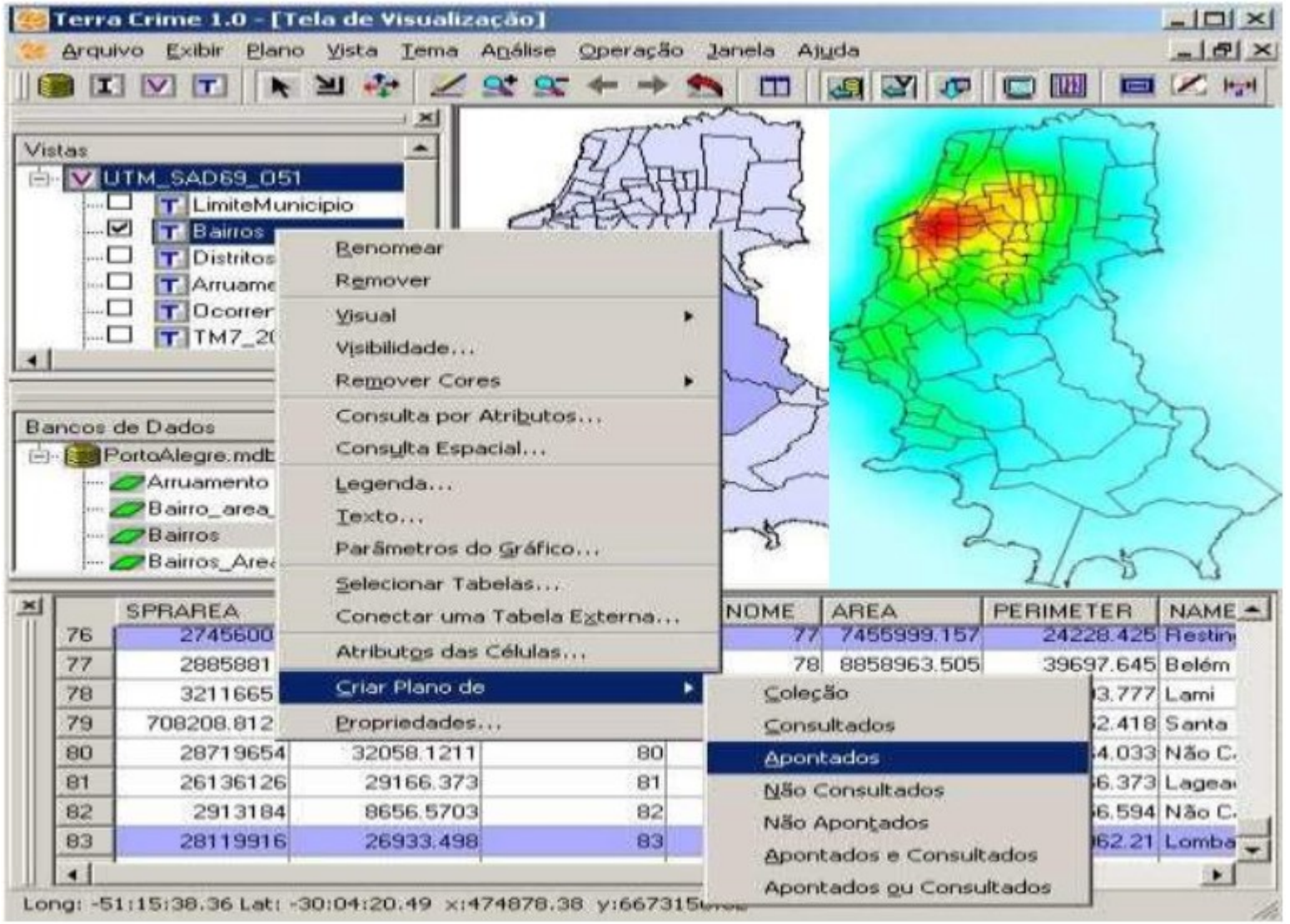
- A library with spatial statistic functions:
  - Moran Index, Local Mean, ...
  - Kernel Map and Kernel Ratio Map
  - Skater
  - Semivariogram
  - Empirical Bayes

- Developed by LESTE and INPE
- Distributed with TerraLib



TerraCrime

A surveillance system to control and alert crime occurrences.



CRISP
+
LESTE
+
INPE

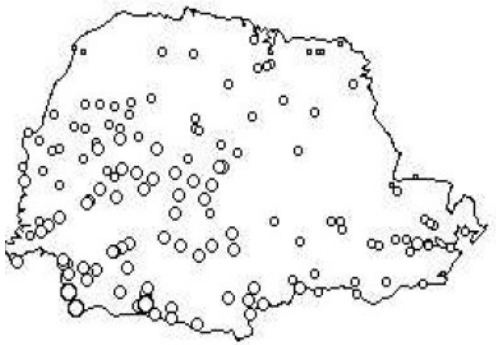
aRT = R-TerraLib API

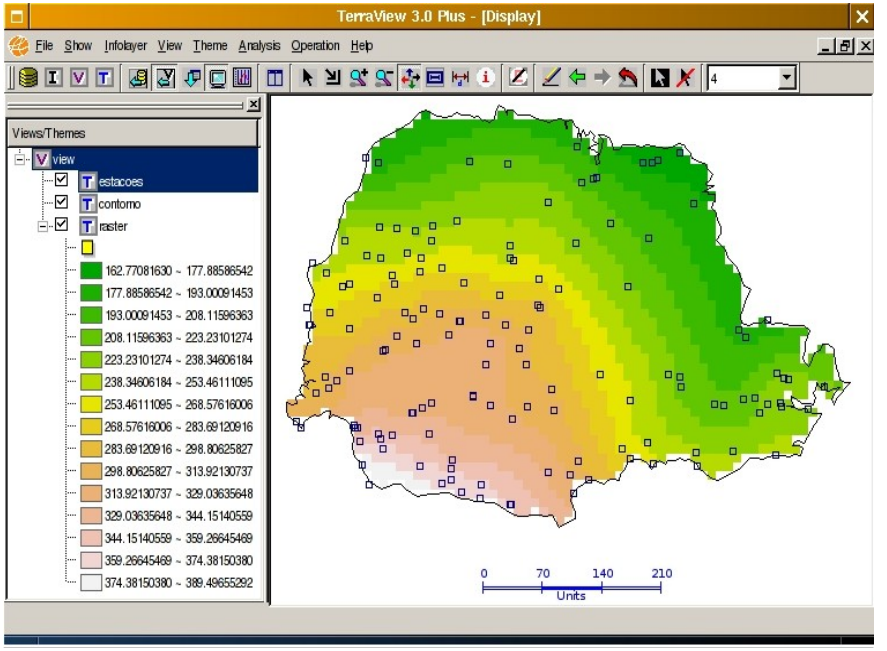
- Interface between the statistic software **R** and the geographical library **TerraLib**.
  - **R**: language and environment for graphics and statistical analysis (http://www.r-project.org/)

- Developed by Laboratory of Statistics and GeoInformation (LEG) at Federal University of Paraná.

- Available at http://www.est.ufpr.br/aRT

aRT





data

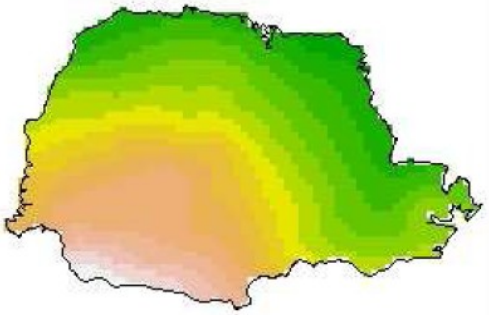
R packages

TerraLib

statistics

Spatial DBMS

- spatial statistics
- geostatistics
- global and local spatial patterns
- analysis of point patterns



- Handle raster and vector data
- Store and retrieve them from spatial DBMS
- Geoprocessing algorithms, such as neighborhood construction

aRT = R-TerraLib API

- R package for information exchange
  - GRASS, RarcInfo and aRT
- **aRT**: R package that encapsulates TerraLib concepts

```
conn      = openConn()
db        = openDb(conn, "dbname")
thpoints  = openTheme(db, "themepoints")
thcontour = openTheme(db, "themecontour")

points  = getPoints(thpoints)
contour = getPolygons(thcontour)
data    = getData(thpoints)

raster = krige(points, contour, data)

l = createLayer(db, "lraster")
addRaster(l, raster)
thraster = createTheme(l, "themeraster")
```

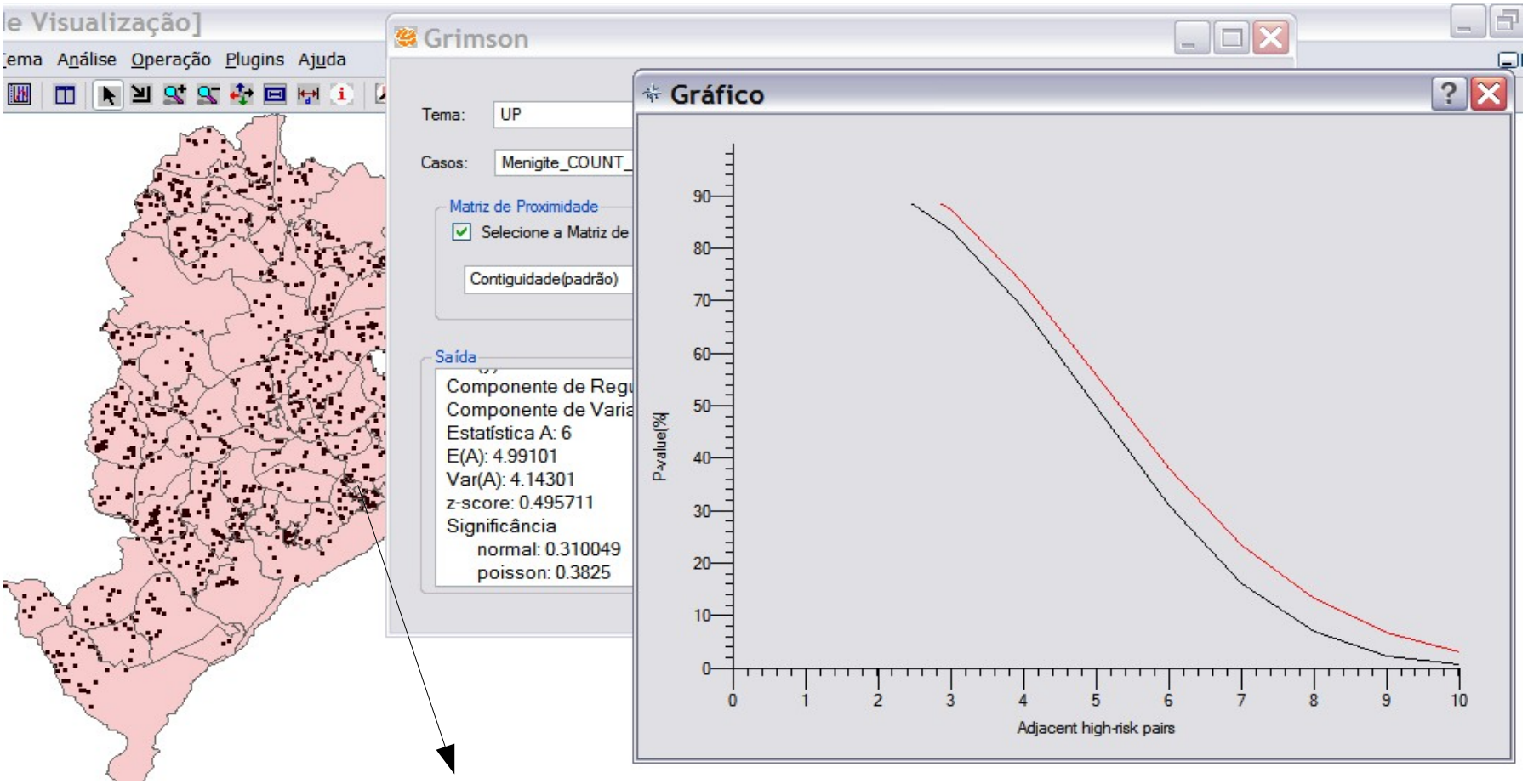
TerraCluster

- An ongoing collaborative project
  - INPE (National Institute for Space Research)
  - LESTE (Spatial Statistics Laboratory at Federal University of Minas Gerais)
  - SVC (Secretary of Health Surveillance)

- 25 TerraView plug-ins for:
  - Spatial temporal cluster detection
  - Analyses of point patterns
  - Rate estimation

TerraCluster: Grimson plug-in

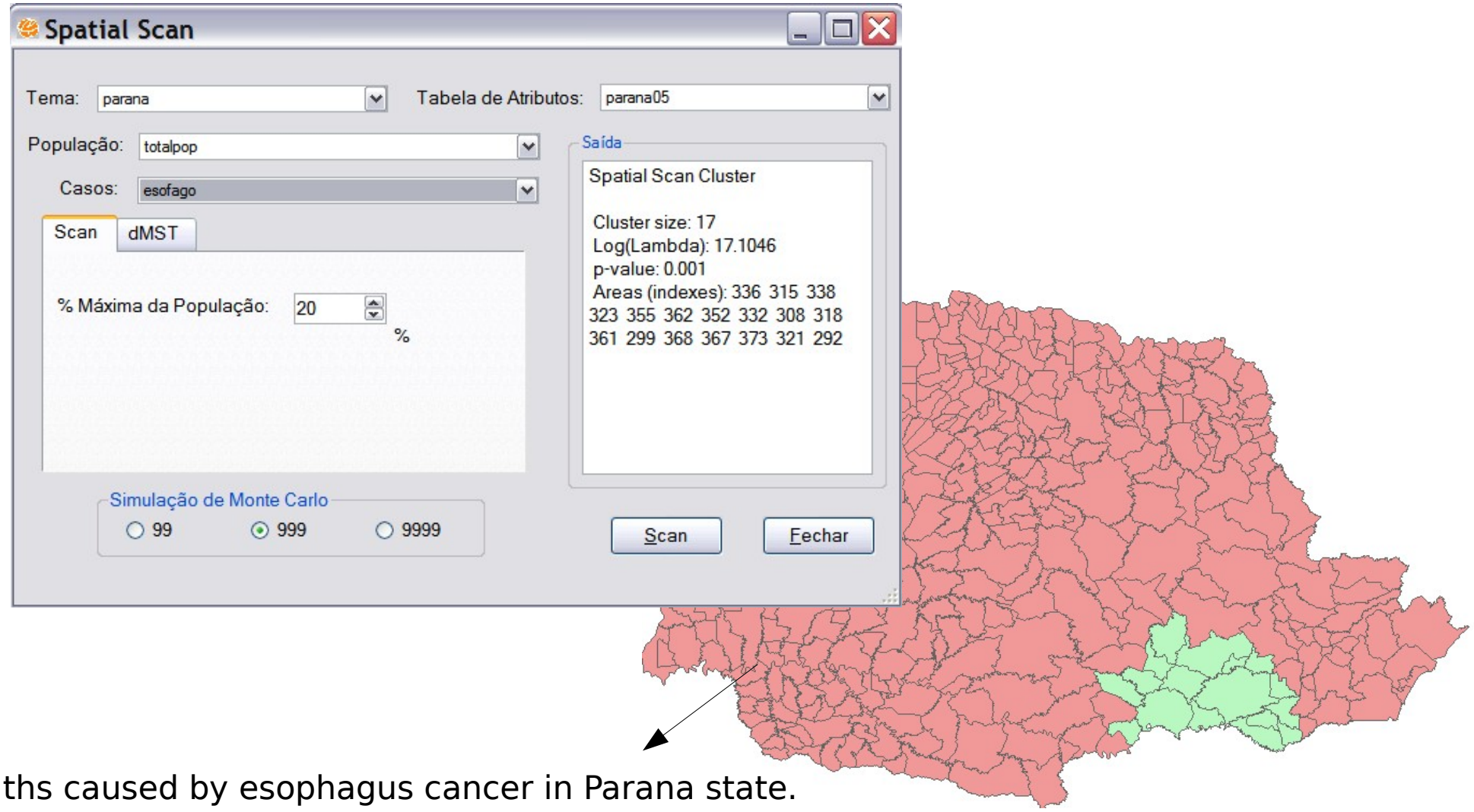
A method to detect if objects with high risk are randomly distributed in space



Cases of meningitis in Belo Horizonte city.

TerraCluster: Spatial Scan plug-in

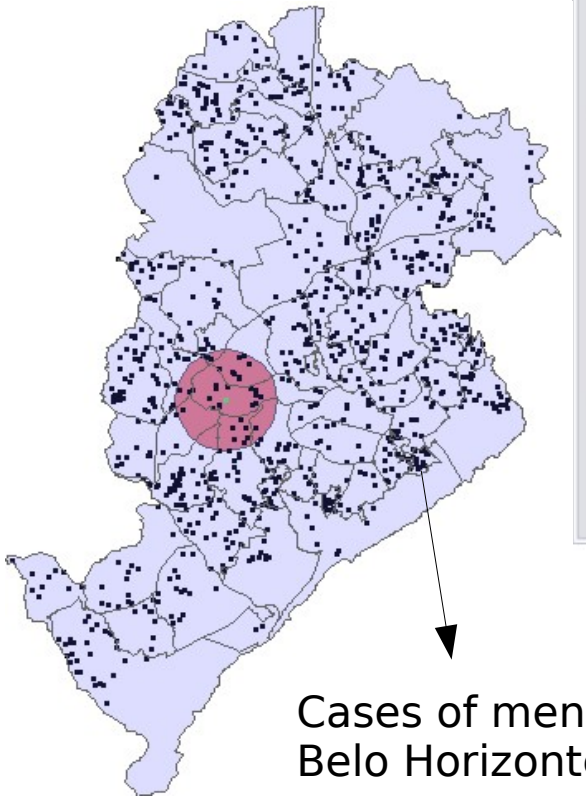
A method to detect to detect spatial cluster



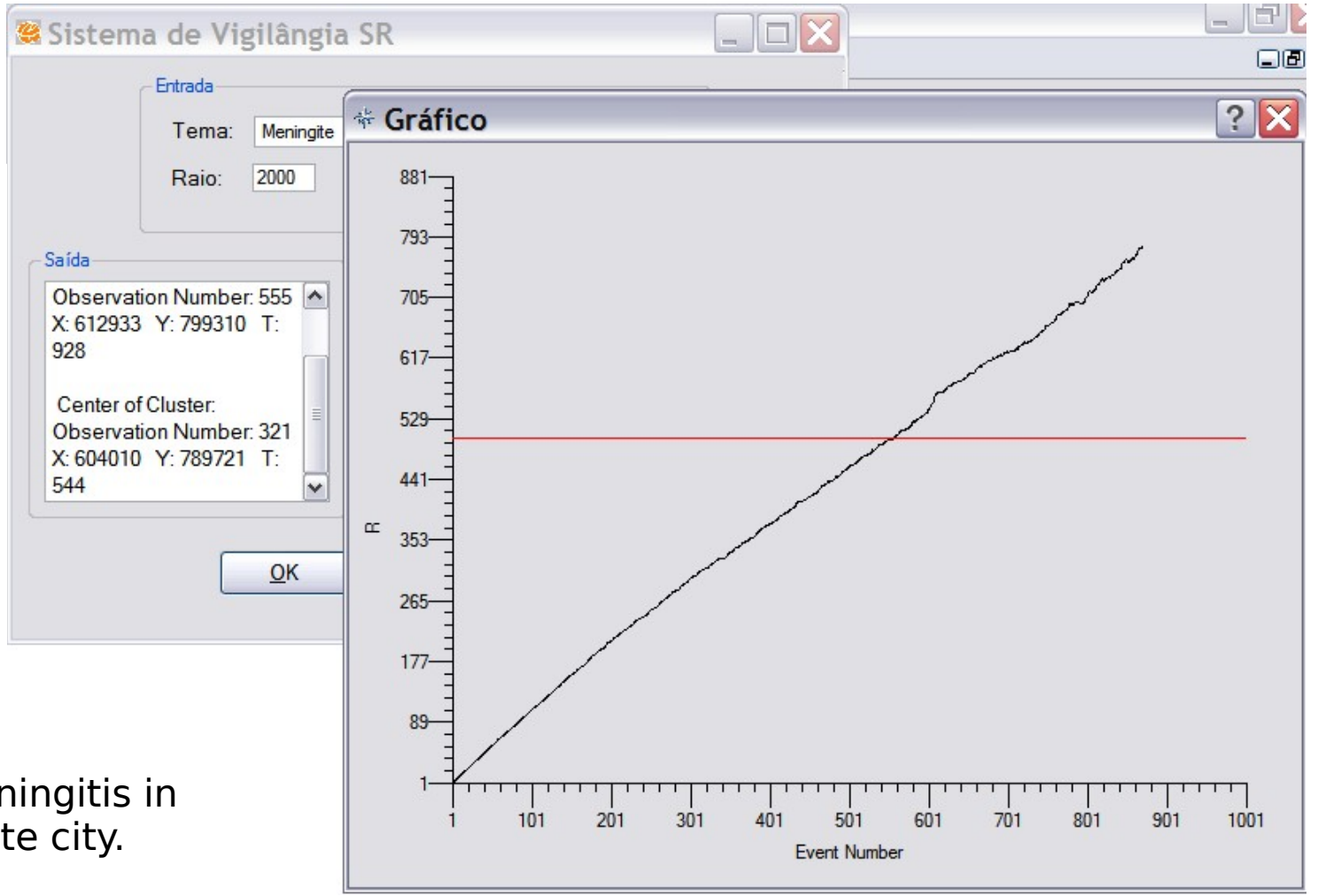
Deaths caused by esophagus cancer in Parana state.

TerraCluster: Shiryayev-Roberts Surveillance System plug-in

A method to detect and alert spatio-temporal clusters based on events



Cases of meningitis in Belo Horizonte city.



TerraCluster

Download plug-ins at:

www.est.ufmg.br/leste/terracluster

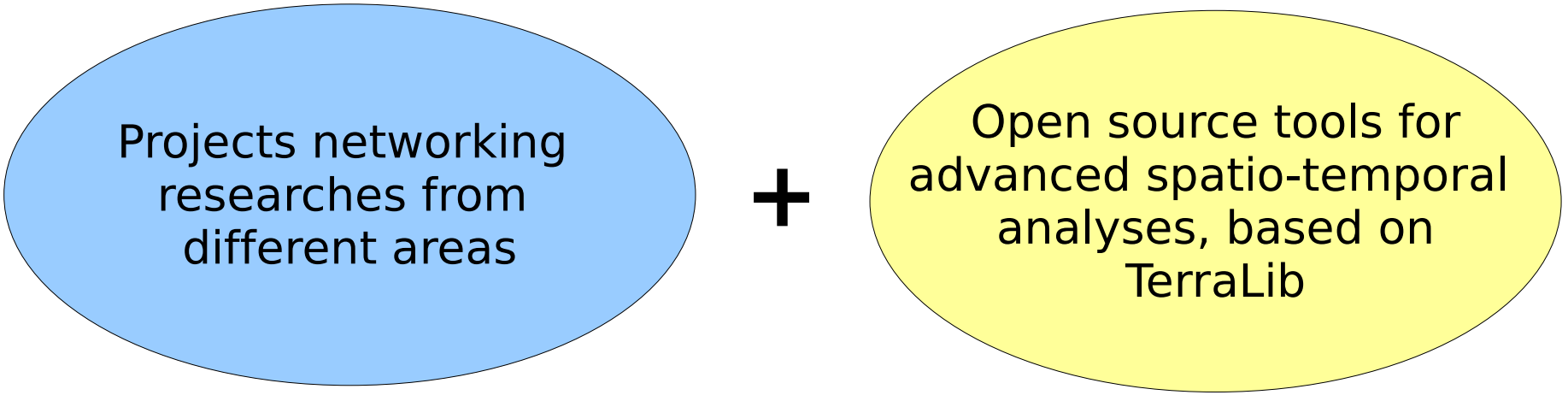
Some references about implemented methods:

Grimson, R.C. (1989) Assessing patterns of epidemiological events in space-time. In *Proceedings of the 1989 Public Health Conference on Records and Statistics*. Hyattsville, MD: National Center for Health Statistics.

Assunção, R., Costa, M., Tavares, A. and Ferreira, S. (2006) Fast detection of arbitrarily shaped disease clusters. *Statistics in Medicine*, 25, 723–742.

Correa, T.R. and Assunção, R.M. (2007) Shiryayev-Roberts Method to Detect Space-Time Emerging Clusters. In: Davis, C.A Jr. and Monteiro, A.M.V. (eds.) *Advances in GeoInformatics*, Heidelberg: Springer, 283–291.

Conclusion



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Thank you!

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