Towards a R-centric architecture for multi-purpose geographical analysis on heterogeneous multi-source data

Arlette ANTONI, Thierry DHORNE and Yann LE GUYADEC

Université de Bretagne Sud
Université Européenne de Bretagne
Lab-STICC / Valoria

UseR! - 8,9 and 10th July 2009, Rennes - France

Framework

- Geographical Information Systems (GIS) are used to
  - display
  - manipulate
  - analyse

geographical (map) data

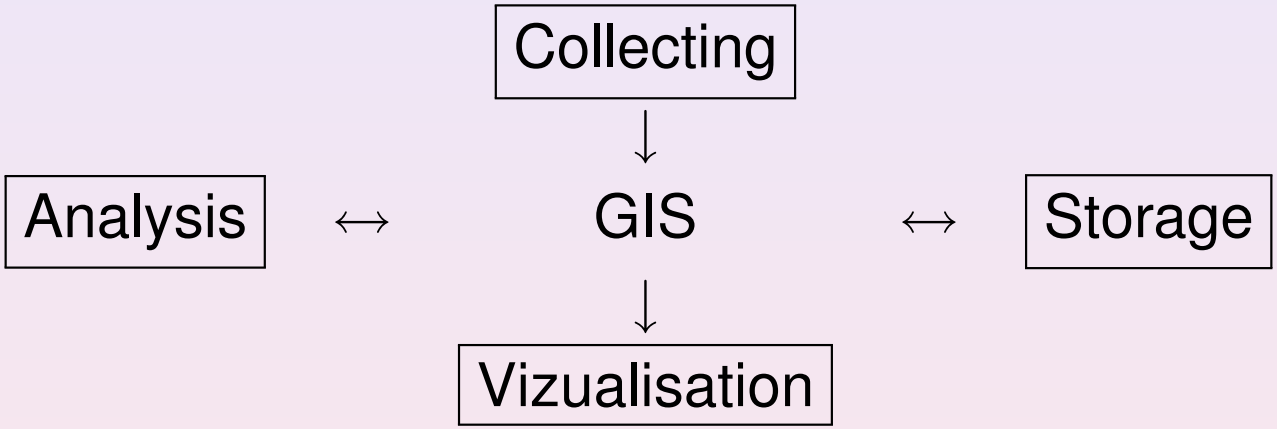
→ geographical data are data that contain a reference to a place (on the earth)

- our original purpose was to

→ (try to) provide a R-centric architecture to

- manage geographical information
- represent geographical information
- execute geographical analysis

Classical GIS



GISes and Analytics

- a very interesting paper

de Andrade Neto, Ribeiro and Fook *Integration of Statistics and Geographic Information Systems : the R/TerraLib case*

→ GIS have limited capacity to perform advanced analysis

→ statistical softwares have limited access to GIS technology

★ hence the need for integration

- full integration
- loose coupling
- close coupling

New Paradigm - I

- new evolutions need to take time into account

→ in various ways

  - varying environments : coverage
  - real-time acquisition
  - spatio-temporal point processes
  - spatio-temporal trajectories (both GPS assisted)
  - time-moving surfaces and volumes
  - ....

- and
  - multi-sensor approaches (visible, IR, radar,....)

New Paradigm - II

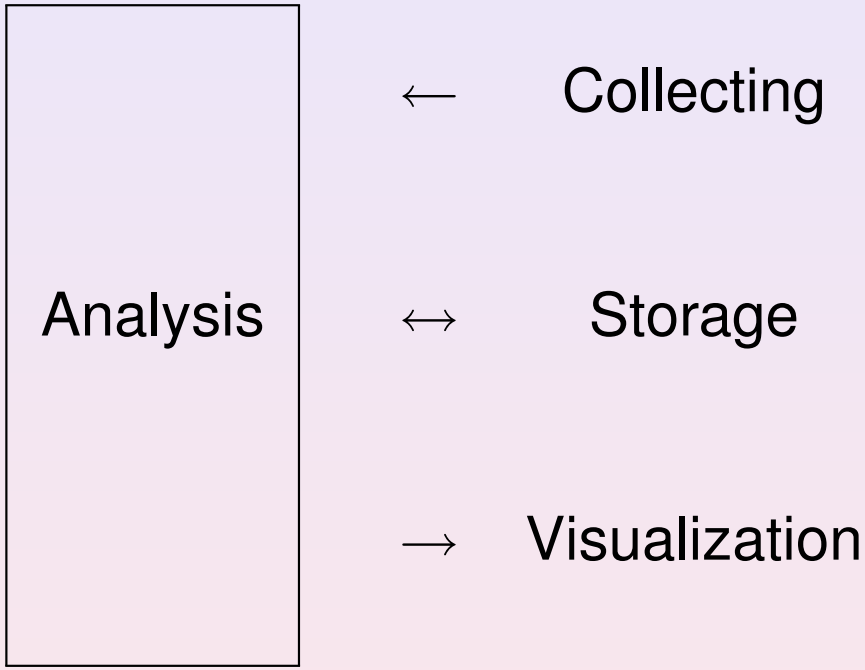
- the respective part of analysis with respect to
  - collecting
  - storage
  - visualization

is growing and growing

→ need to develop more and more tools

→ interest in collaborative design and conception

Analytics-centric GIS



★ idea to become R-centric

Collecting

- static raster = images (many formats)
- dynamic raster = videos (mpeg and consistent)
- attributes (native)

Extracting

- extracting $\Rightarrow$ collecting + analytics

→ manual coordinate entry

→ attributes (extracted)

→ error detection

→ reference coordinate

Data storage and management

- spatio-temporal data bases
- → spatial query, time query, attribute query
- time access optimization (or not)
- → batch or on-line process (stream analysis)
- specific management (copy, subset, merge,...)
- changing projection system

What does R provide ?

- for data storage
- → R and relational data bases
- → R and spatial data bases (PostGIS, QGIS)
- → mapproj (maps projection)

Restitution

- map design and layout (logical)
- map printing (physical)
- graphics
- videos
- metadata (generated by analysis)

What does R provide ?

- for image analysis

adimpro	Adaptive Smoothing of Digital Images	
biOps(GUI)	Image processing and analysis	analytics
pixmap	Bitmap Images (“Pixel Maps”)	interactive
RImageJ	R bindings for ImageJ	external
		and... medical
ReadImages	Image Reading Module for R	
rimage	Image Processing Module for R	

What does R provide ?

- for maps management

mapdata	Extra Map Databases
mapproj	Map Projections
maps	Draw Geographical Maps
maptools	Tools for reading and handling spatial objects

What does R provide ?

- for visualization

rgl	3D visualization device system (OpenGL)
shapefiles	Read and Write ESRI Shapefiles
lplots	interactive plots

Analysis

- usual (GIS)
  - interpolation
  - connectivity, proximity and adjacency
  - map design cartography
  - bounding dissolve, spatial data overlay,
  - scaling, scrolling, moving window analysis
  - map algebra

★ new analytics

  - spatial classification
  - flow analysis
  - trajectory analysis
  - ....

→ almost everything provided in R packages

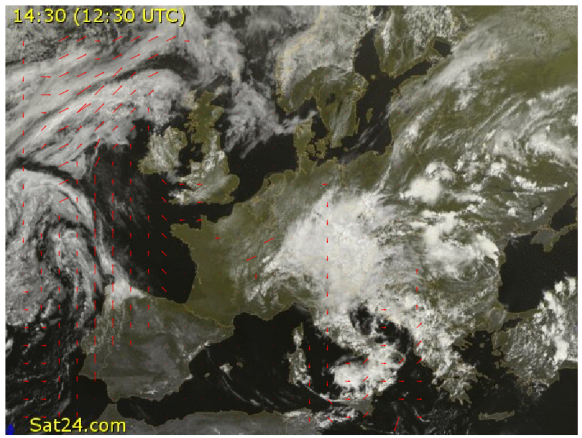
Many things more

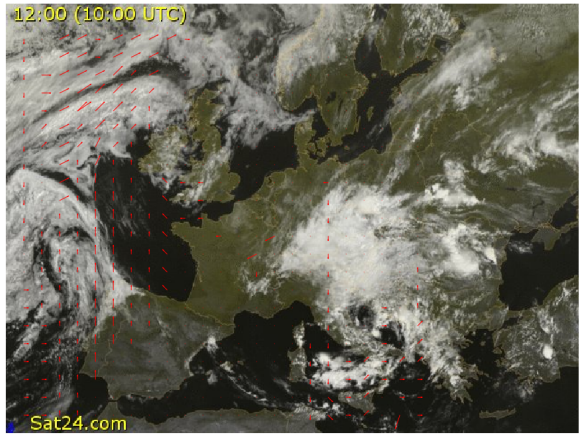
- RPyGEo
- rgdal : links to Geospatial Data Abstraction Library
- RSAGA : links to SAGA GIS
- RgoogleMaps
- stem
- spgrass6 : interface with GRASS 6 GIS
- the competive work of R. Bivand !
- ★ how to screen and organize everything ?

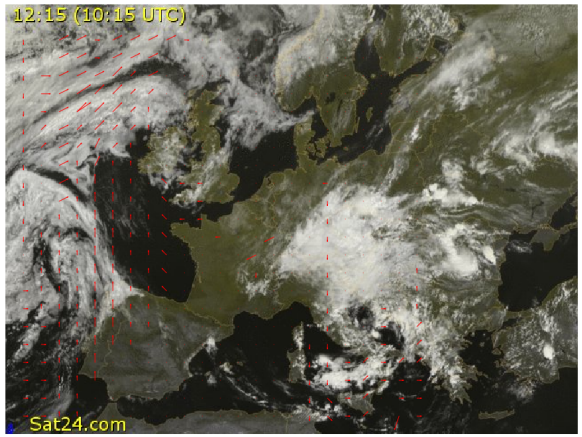
Application
Test

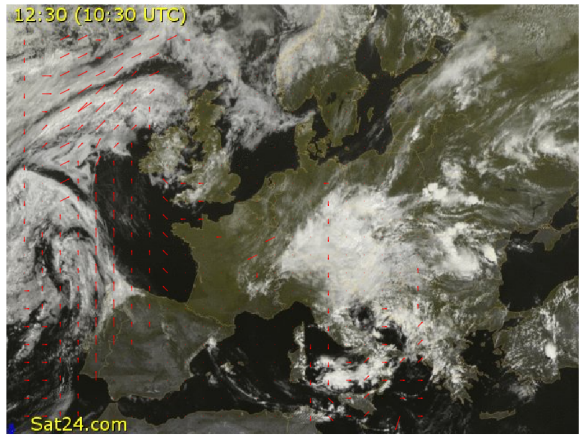
- get geographical video
- load it in R (sequentially)
- do some analysis
- add some layers (analytic or hand)
- export the maps
- make a movie
- ★ wait for some new media tools in R

Application
Sequence

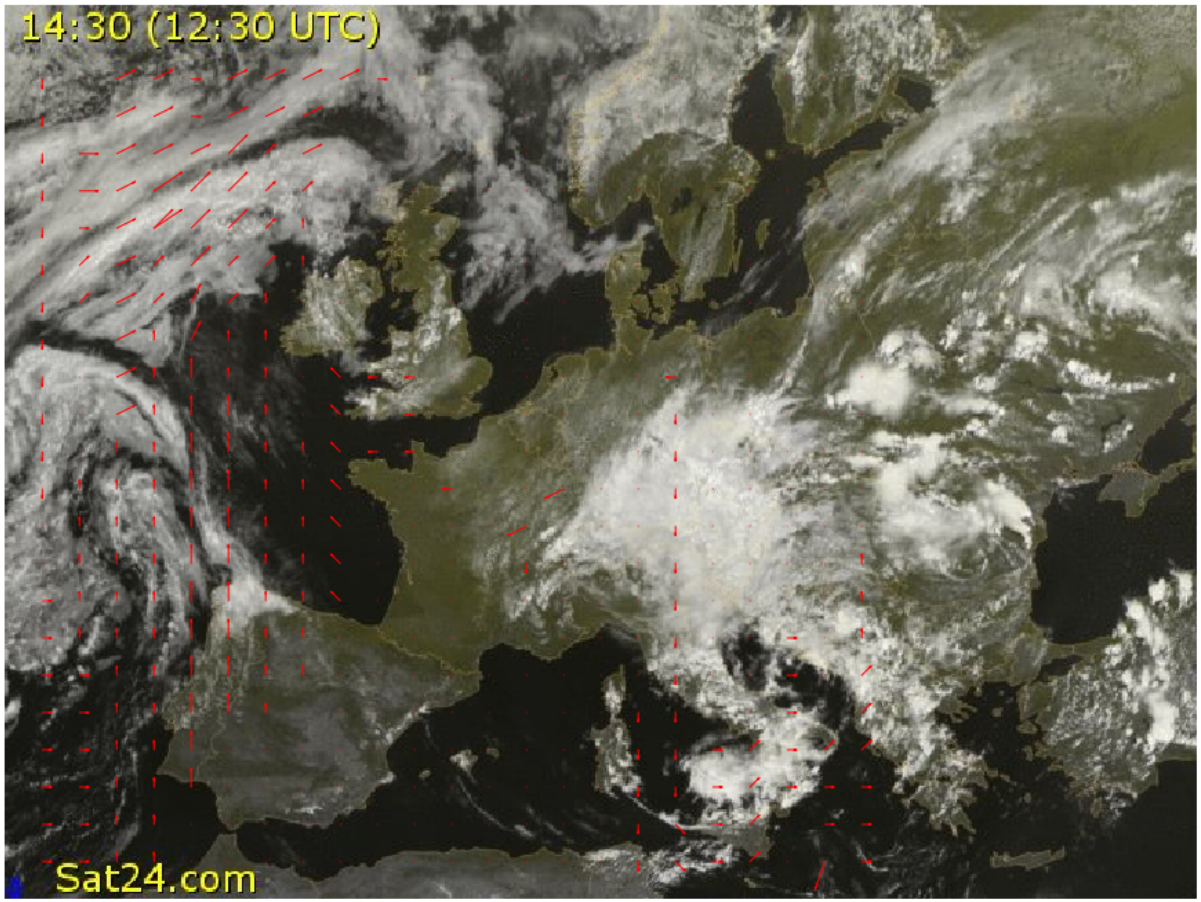








Application
Image



Conclusions

- how to validate the interest of a R-centric GIS ?

→ generic acquisition systems (multi-type and multi-formats)

→ a consistent storage system (till where to go ?) (Spatial SQL or not)
  - with special emphasize on the equilibrium R-storage and data-base-storage

→ normalized (extended) visualization tools

→ extension and interoperability of analytics application
  - free jungle, eastern market, or soviet ?

★ real need for integration strategy (and tools) !

★ find the best compromize between end user and keen developer