RIADE, ACS, GRASS: research, business and free software

a browser and a 4D visualizer for time series of georeferenced data

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ABSTRACT

RIADE (*Ricerca Integrata per l'Applicazione di tecnologie e processi innovativi per la lotta alla DEsertificazione*) (Integrated Research for the Application of innovative processes and technologies for fighting Desertification) is a project co-financed by MIUR (Minister for Education, University and Research) for developing an integrated and technologically innovative information system for monitoring desertification processes in South Italy, with the aim to promote interventions for the safeguard of the territory.

Among the **requirement** of the RIADE project, there was the need to manage very heterogeneous data geographically and temporally organized, to visualize in **4D (3D + time)**.

ACS is the **technological partner** of the RIADE consortium, that includes also **ENEA** (Agency for New technology, Energy and Environment) and Nucleus for Research on Desertification (**NRD**) of the University of Sassari (**UNISS**).

The **choice** of the **software tools** to use and develop has fallen on **GRASS** for its technical features, for its integration with PostgreSQL, PostGIS e QGIS and also because, being free software, it decreases the problems and costs linked to the licenses of the proprietary software for the final users (mostly public researchers).

This work shows how the free software can represent a **convenient (business) opportunity** for a private Italian firm that mainly develops **software on commission**.

The features included in the GRASS distribution and in the other chosen modules didn't solve all the project requirements. ACS **task** has been to build an ***end to end*** **solution**, by integrating all the packages and implementing the missing functions, so that the user could see an **homogeneous environment**, in which the data could **automatically and seamlessly flow**, regardless of the **different data formats**, and could be selected and visualized in **4D (3D + time)**.

The various geographic data, both historic and acquired in the scope of the project (satellite images, field surveys, thematic maps), are ingested in a **PostGIS database** in which a **visual browser** is implemented through **QGIS**, that let the user to execute 2D **space-time queries** and to extract, convert and **automatically import** into GRASS, data from the areas of interest. These data can be viewed in **4D** by means of specifically implemented **NVIZ extensions**, for managing of **time series** and for **immersive 3D navigation (flythrough)**.

Introduction

RIADE (*Ricerca Integrata per l'Applicazione di tecnologie e processi innovativi per la lotta alla DEsertificazione*) (Integrated Research for the Application of innovative processes and technologies for fighting Desertification) is a project co-financed by MIUR (Minister for Education, University and Research) for developing an integrated and technologically innovative information system for monitoring desertification processes in South Italy, with the aim to promote interventions for the safeguard of the territory.

Despite the considerable patrimony of experience and knowledge related to desertification, only rarely the results of studies have been turned into structured and integrated systems. This

is largely due to focusing on local conditions or on individual processes rather than on their complex interaction. In the effort for understanding a phenomenon that involves geology, soil science, climatology, hydrogeology, agronomy and forestry, interdisciplinary synergy is a key issue. A more holistic and systematic approach to desertification through an integrated project such as RIADE has been developed.

RIADE is a three-years research project (2002-2005) carried out by Advanced Computer Systems A.C.S. S.p.A., ENEA (National Agency for New Technology, Energy and Environment) and the Nucleus for Research on Desertification (**NRD**) of the University of Sassari (**UNISS**), whose scope is to realize a structured and complex system for combating desertification. It shall provide a set of products for desertification modeling and forecast but also a decision making system for supporting the public administration in the environmental planning processes.

The project starts with the selection of a set of service-case areas, covering the Sardinia, Basilicata, Puglia and Sicily regions. In fact the Regions of South Italy are considered to be mostly at risk of desertification, where the phenomenon represents a real environmental emergency, which strongly influences the socio-economical development of the areas.

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Import Data/Metadata and Browsing

The various geographic data, both historic and acquired in the scope of the project (satellite images, field surveys, thematic maps), are ingested in a PostGIS database in which a visual browser is implemented through QGIS, that let the user to execute 2D space-time queries and to extract, convert and automatically import into GRASS, data from the areas of interest.

All importable data have a coupled metadata file (.mtd) where are placed main data information. Metadata are necessary to allow spatial/temporal browsing. Browsing could be done using main metadata also. A QGIS plugin has developed to allow user to fiendly access to Import Data/Metadata TCL application

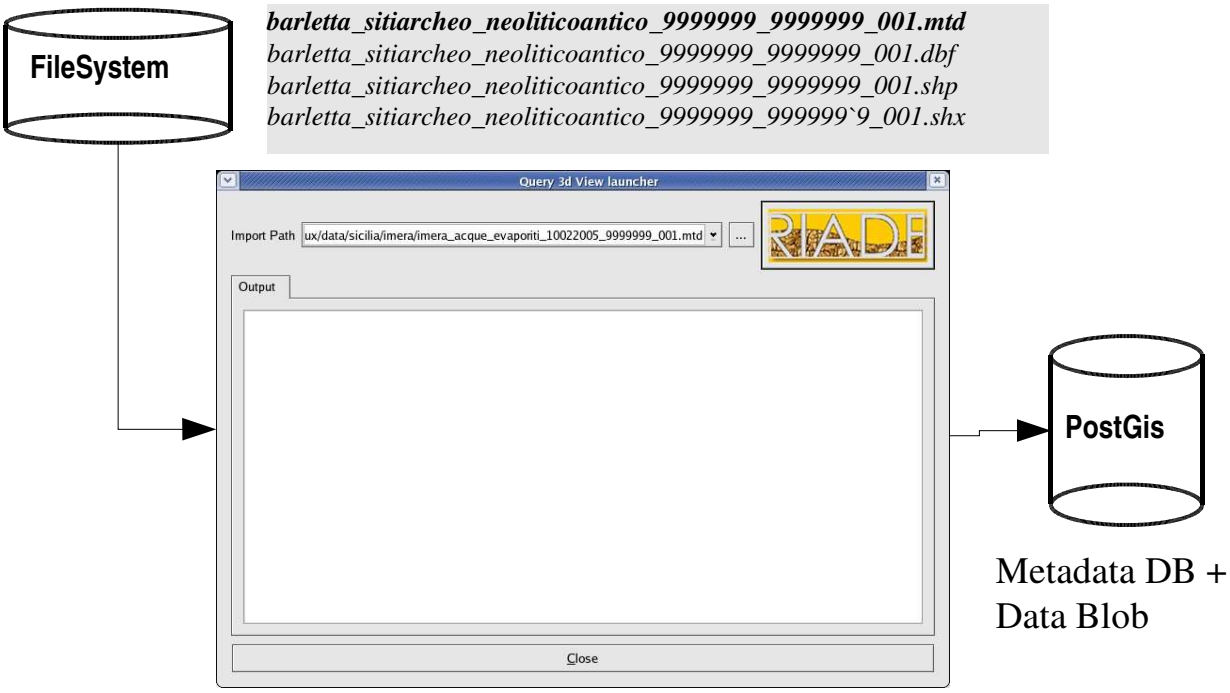

Figure 1 Import Data/Metadata Plugin

A QGIS plugin has been developed allowing user to 2D browse metadata archive. Browsing could be setting a query polygon plus a "Time Interval" and a "Where" clause. Metadata bounding box is archived in ED50 UTM32, so if they refer to UTM33 zone they can be shown doing an "on-the-fly" transformation using PostGis capabilities.

Every query become a QGIS PostGis Layer that belong its specific SQL query. Multiple Query polygon could coexists in the same QGIS project.

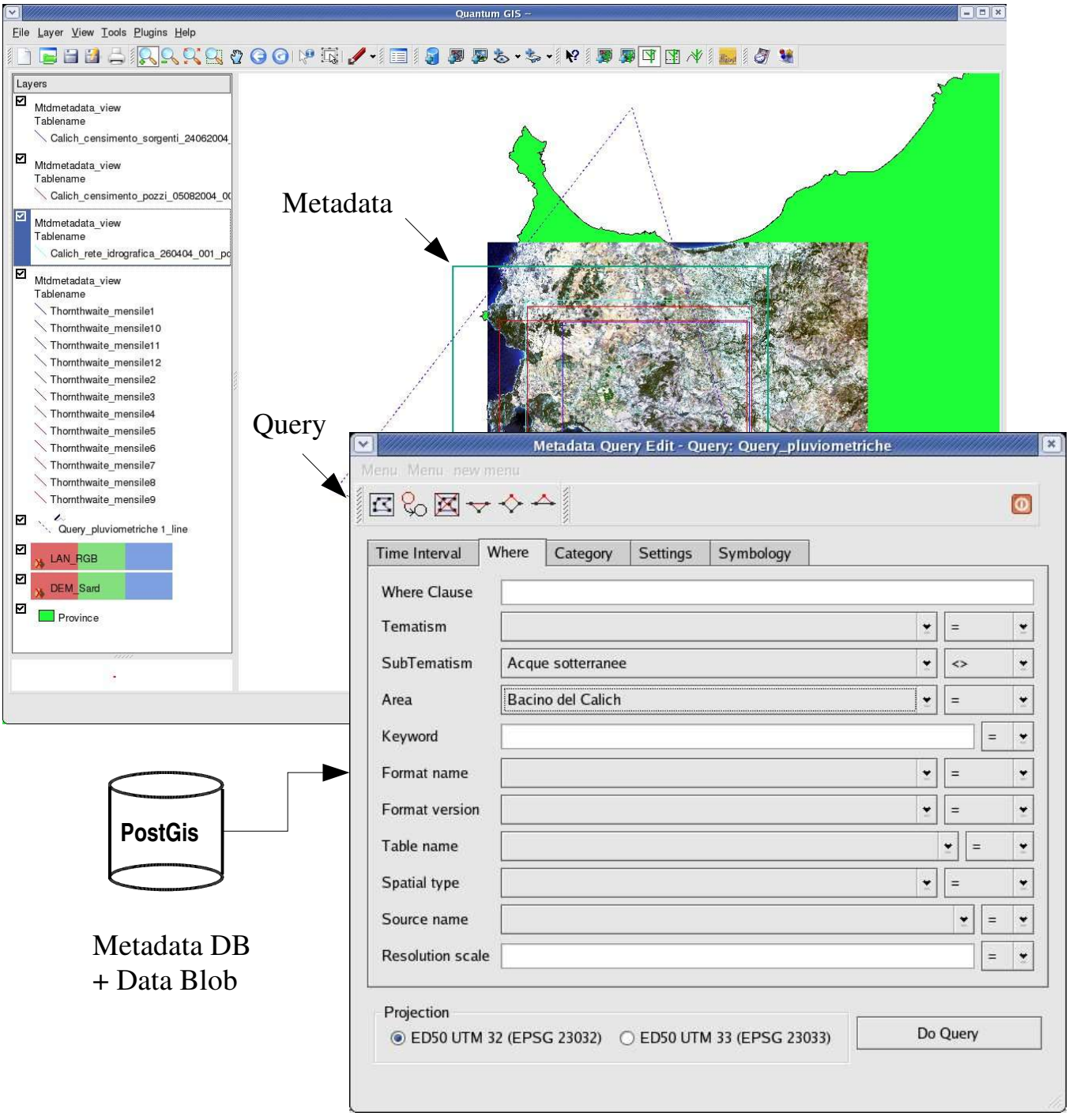

Figure 2 Query Builder Plugin

From QGIS Project to Time Series 3D Show

Browsed data included in QGIS project are then automatically translated and imported into GRASS, so they can be viewed in 4D by means of specifically implemented NVIZ extensions. The extensions developed specifically for this project are:

- Time Series
- Show (Time Series collection)
- 3D navigation (flythorugh).

A Show inherits QGIS project color settings allowing a simple way to associate 2D view with it's interactive 3D visualization.

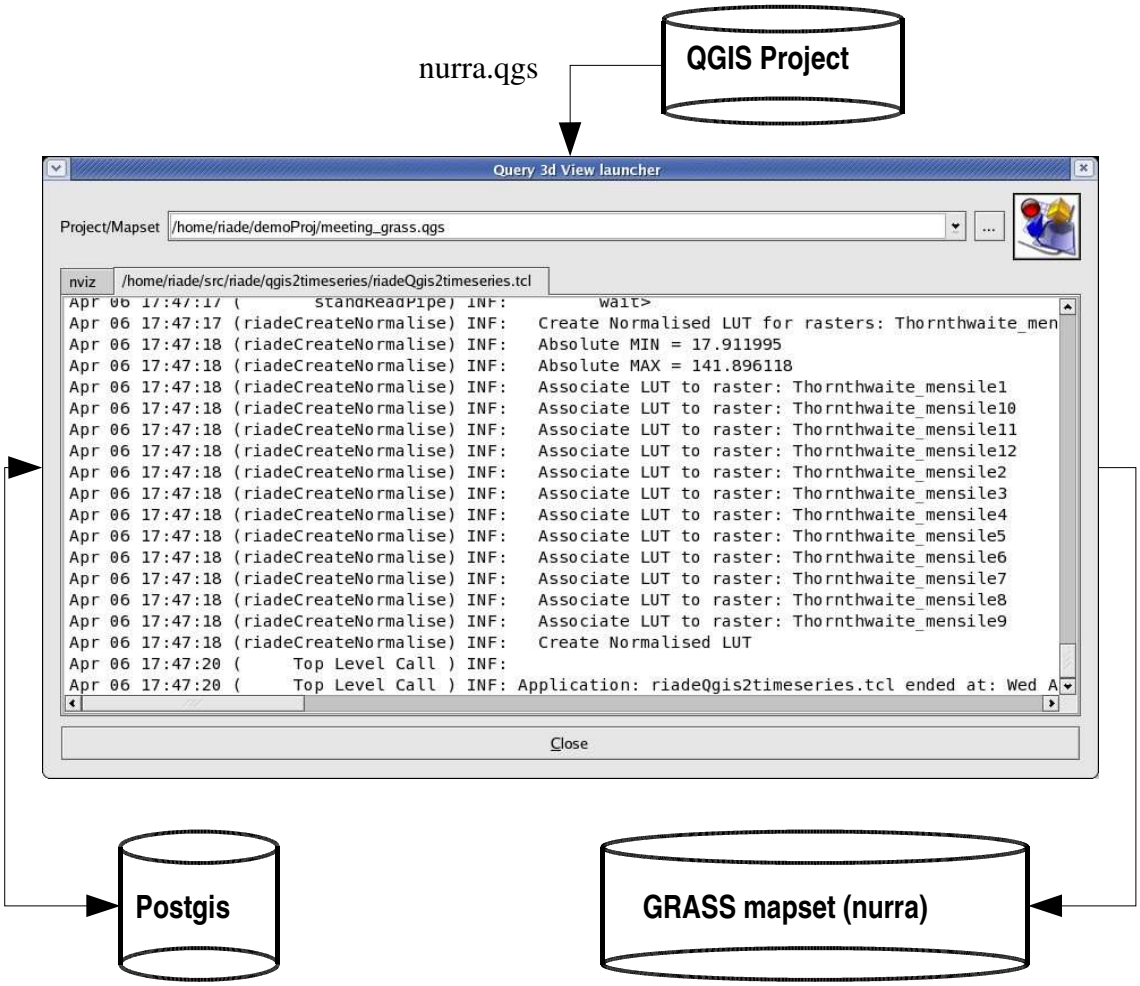

Figure 3 3D View builder Plugin (.qgs => show)

3D view prepare plugin allows to automatically extract DB archived data and import them in a new GRASS mapset that has the same name of the QGIS project and the same 2D view region shown int the QGIS browser. Extracted data are organized in a 4D Show XML format using time stamp archived in DB metadata. 4D show is interactively shown with new NVIZ Time Series capability.

Time Series (TS)

The Time Series (TS) feature is a way of collecting together set of rasters (both color and elevations), vectors and sites. The sets are treated “as one” through some metadata files that link each map to a specific “show time” so they are replaced accordingly to a virtual clock that can be manipulated through the user interface in a “manual” or automatic way.

Each association has been called a *keyframe*.

To interact with the Time Series a “Time Series Panel” has been added to the as a new entry in the Panel menu:

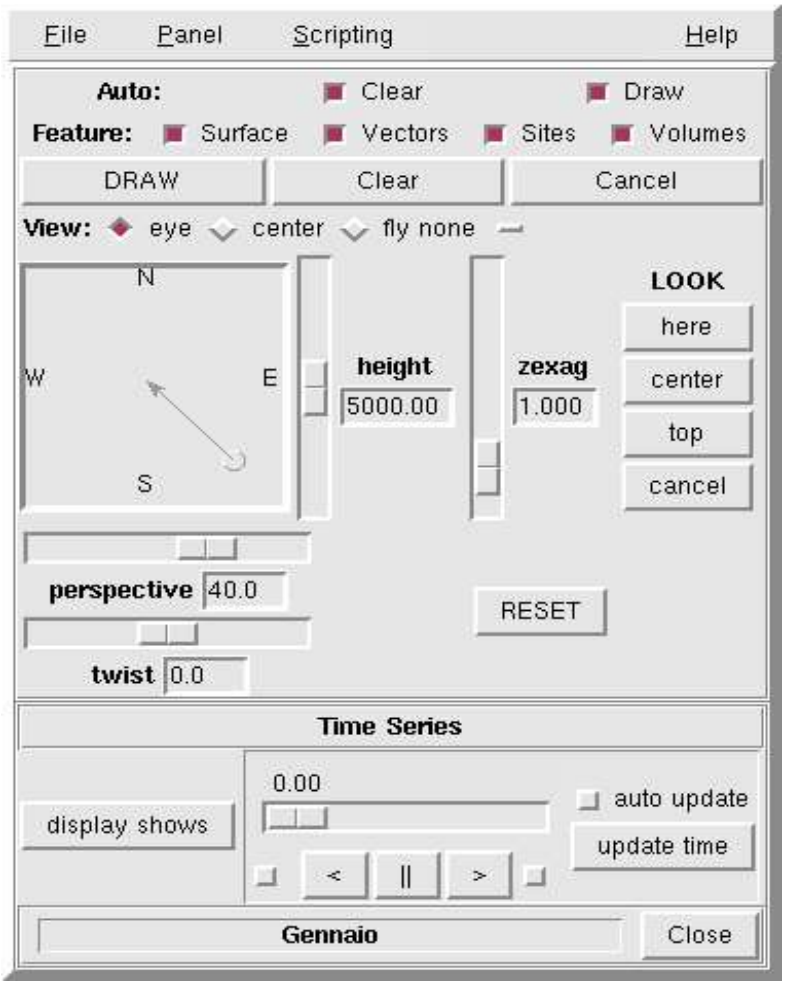

Figure 4 The *Time Series* Panel

Coherence with NVIZ spirit that let it to be used also on low budget computers has been kept by inserting an “update time” button similar to the “DRAW” button. When changing “show time” the visualization window isn't updated automatically because the redrawing can take too much time and the application can become unusable. If the machine is powerful enough, the user can set the “auto update” button.

A performance optimization has been gained, modifying the internal buffers for surfaces: when a surface is loaded for the first time, it is kept in memory instead of being thrown away when a new surface is loaded. This reduces the loading time greatly when the same image has to be viewed again and the time series can be effectively seen as a real time animation.

Collections of different types of data are linked temporally to each other by way of a “show” that is basically a collection of data items and a link of a normalized “show time” to a set of *time_labels* that represents a “real world time”.

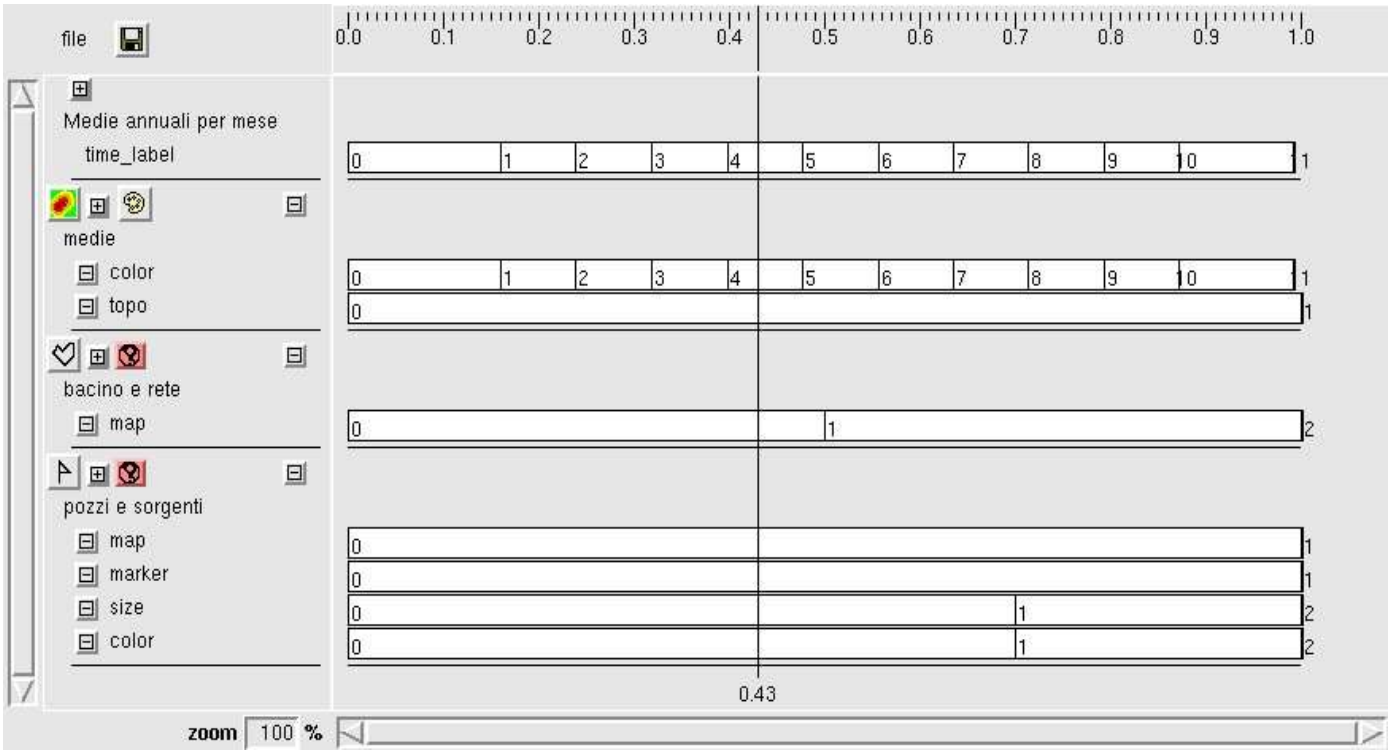

Figure 5 A show with all its show items and keyframes for each one

Every *show item* can have each of its properties linked to time with a *keyframe*. All the properties except the maps, can be edited, changed and visualized so to choose the best visual properties for the “show”.

3D navigation (flythrough)

A more immersive way of 3D navigation through the data has been added. Its main benefits are that it uses the mouse buttons and movements to "fly through" the data, instead of the GUI, and, if the machine is powerful enough it lets the user to navigate the data at high resolution (as if the "DRAW" button is continuously pressed).

This way of navigating has been added to the official versions of GRASS.

Looking to figure 2 it can be seen that on the "view" choices a "fly" has been added. It is actually a menu that let the user choose among three different ways of moving: *basic*, *simple* and *orbit*. More on these three in a moment.

Choosing one of the fly mode changes the use interface as in figure 4.

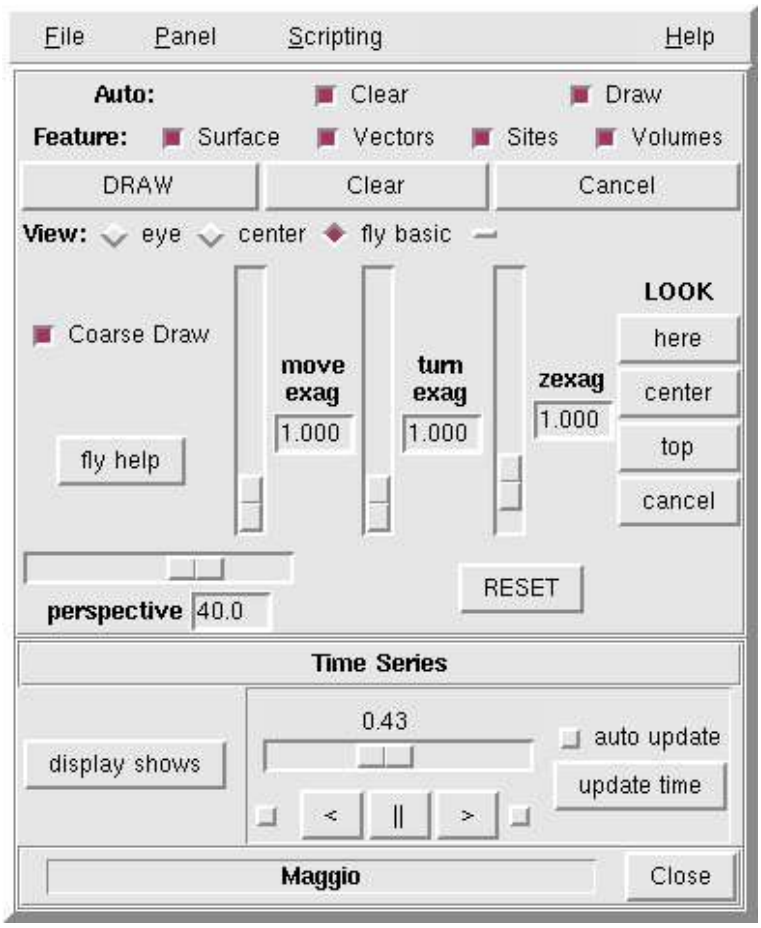

Figure 6 The flytrhough interface

There are two new scale sliders to adjust the moving ad turning speeds to the needs of the specific display. Then there is a checkbox that by default is set to coarse draw, but if unchecked, it lets the user navigate at high resolution. Furthermore there is a "fly help" button, because it can be very useful to have at hand the various mouse button/movements combinations. Clicking this button the window in figure 5 is opened. It is almost auto-

explicative.

The *basic* and *simple* navigations lets the user fly as on an airplane. The point of view can be moved both in direction and in position.

The *orbit* navigation always looks in the center of the object and the point of view can be moved as it is in orbit of the object.

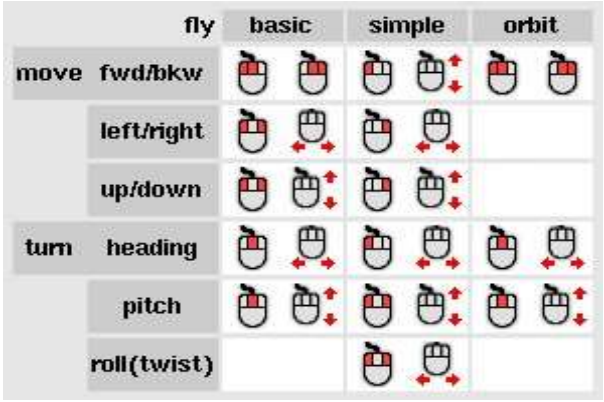

Figure 7 The flytrhough help

Conclusion

This work shows how the free software can represent a **convenient (business) opportunity** for a private Italian firm that mainly develops **software on commission**.

RIADE as every research project, keeps public its results to all the scientific community.

Some of them could be abandoned, but some other could be used as a base for the next step in gathering further knowledge.

The development of free software proceeds in the same way: its achievements are available to the community. But its benefits are an advantage also for the companies that consider know-how and creativity their most important assets. By choosing free software for developing software on commission, these companies can build high quality products, focusing on innovation (not reinventing the wheel), and become also the natural choice for the request of further enhancements in the future by potential customers.

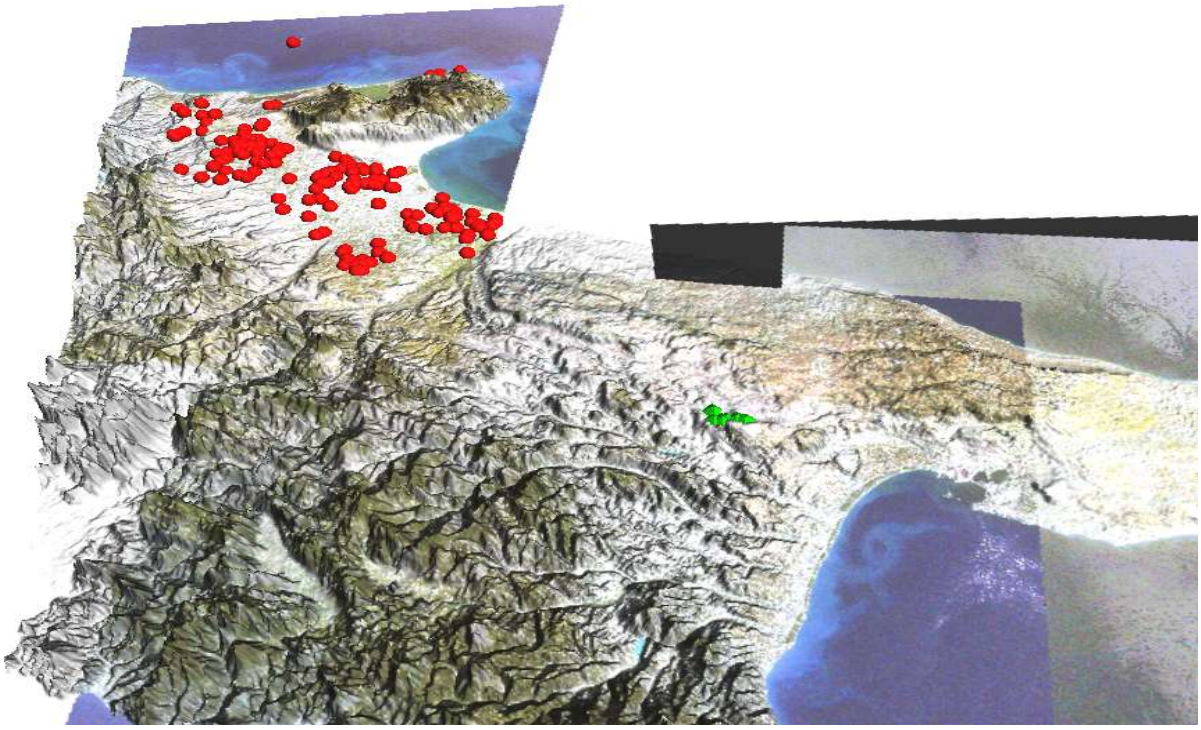

Figure 8 An example of an area of interest for the RIADE project

Aknowledgements

We thanks all the GRASS, NVIZ and QGIS community and especially developers that inspired our work and helped us to avoid to rewrite a huge amount of code.

Many thanks to RIADE students that helped us to test this prototype producing some really helpful test data.

Many thanks to all RIADE researcher that allowed to populate DB with significant data.

References

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http://www.qgis.org – QGIS home Page

http://www.postgis.org – PostGis Home Pace