Open Source applications in archaeology

Every single step of
archaeological research & excavation based on & supported by
open source software

In the next few minutes we'll summarise our experience of replacing our OS and the most common used archaeological softwares like ArcView©, Photoshop©, Photomodeler©, AutoCAD© or Microstation© (just to list some names), with Open Source Software.
Several considerations have influenced our decision to change: the first and most important one was the different ideology which stays behind the Open Source Movement: Not only software but every kind of knowledge is public property and should be accessible for everyone. We all know, how restrict copyright laws are hindering the progress of archaeological research, the interchange of ideas and the vulgarization of new theories and results. We've the same problem with most of the closed source software packages we use for archaeological aims: their source code isn't accessible and adaptations to our special needs are difficult and expensive.
Open source software offers a valid alternative.
We would like to difference already now between “open source” software and “freeware or shareware”: During our presentation we will not show you cost free programms for which you don't need to pay for a licence. It's true that most of open source software packages is gratis and free downloadable. This could be a reason for many archaeologists to require them, but this wasn't the most important thing for us. We were looking for alternatives, and we've found them for almost every kind of archaeological need.

We've devided a typical archaeological research-process in the fallowing 4 categories: Data acqusition, data processing, data management and presentation. Everyone of them can be supported by different open source softwares which we will present you step by step.

Data acquisition

Geophysical prospection
Surveying
Archaeological excavation

Data processing

Image processing with **GIMP**
Image rectification and georeferencing with **Grass**
Vectorizing raster data with **QCAD** & **Grass**
Working with digital terrain data in **Grass**
Orientation of Laserscans with **Scanalyze**
Statistical analysis with **R**, **Weka**, **Salstat**, **XGobi, Scilab,...**
Photogrammetrical reconstraction with **Stereo**
3D Reconstruction with **Blender**, **PovRay, Varkon**

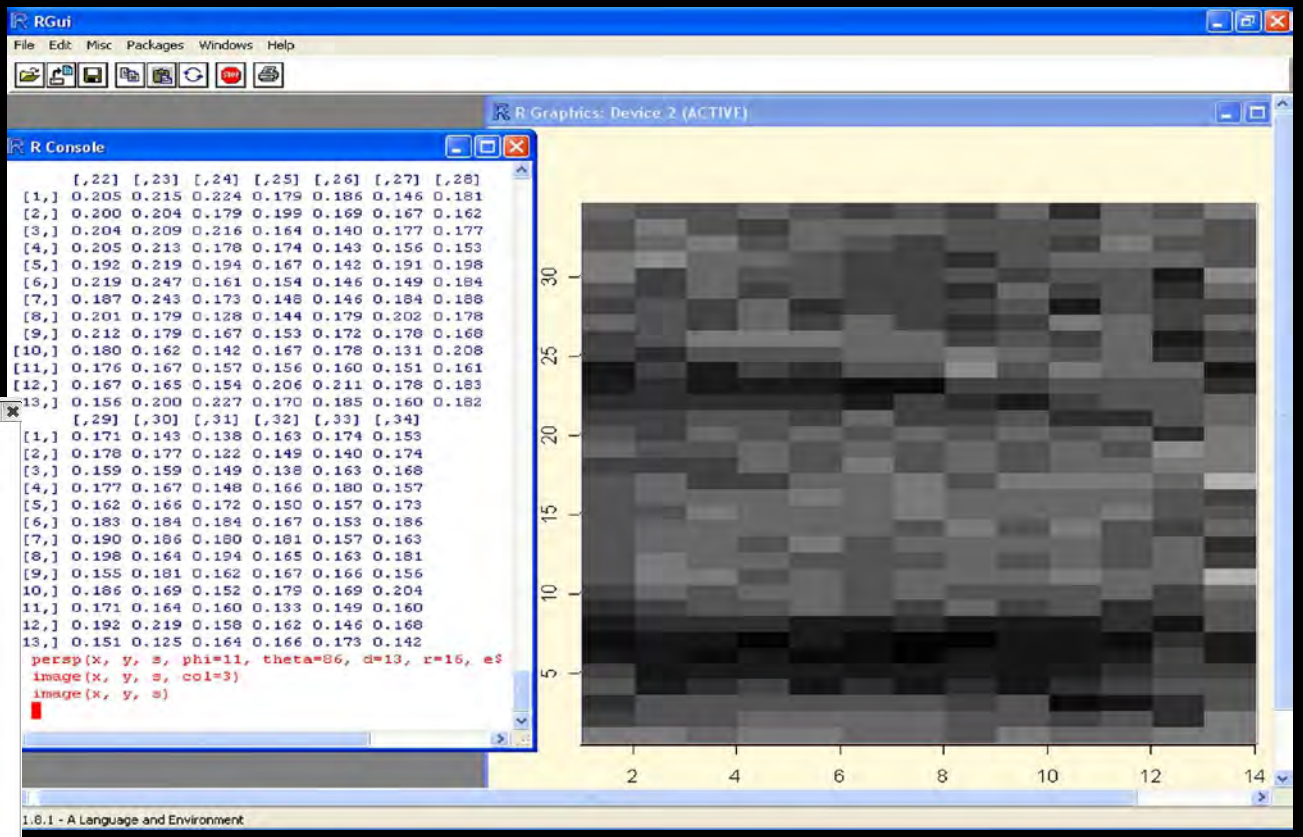
Data management

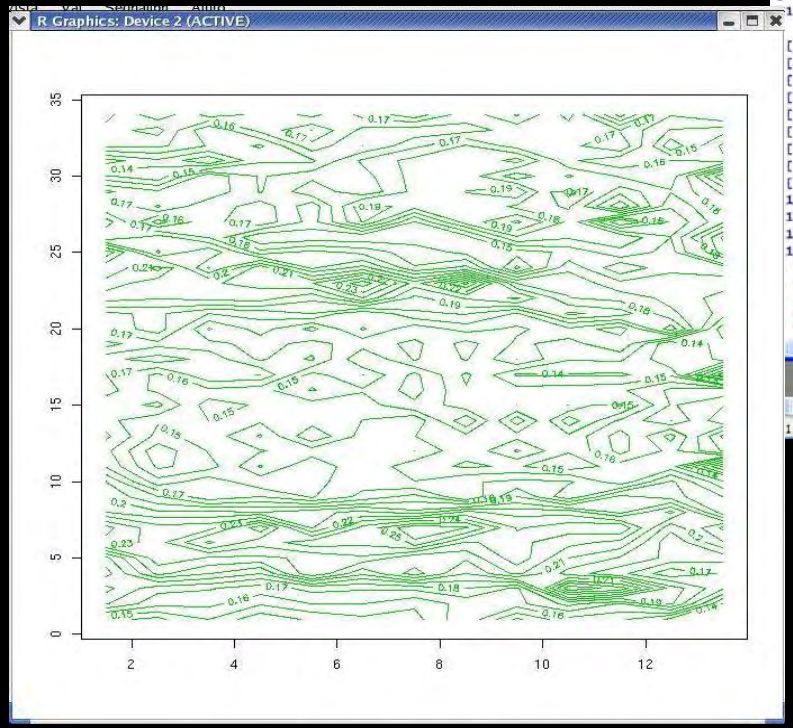
Databases (**MySQL**, **PostgreSQL**, **ODBC**,...)
GIS **Grass**

Presentation & **(Web-)Publishing**

WebGIS (**MapServer**, **MapLab**)

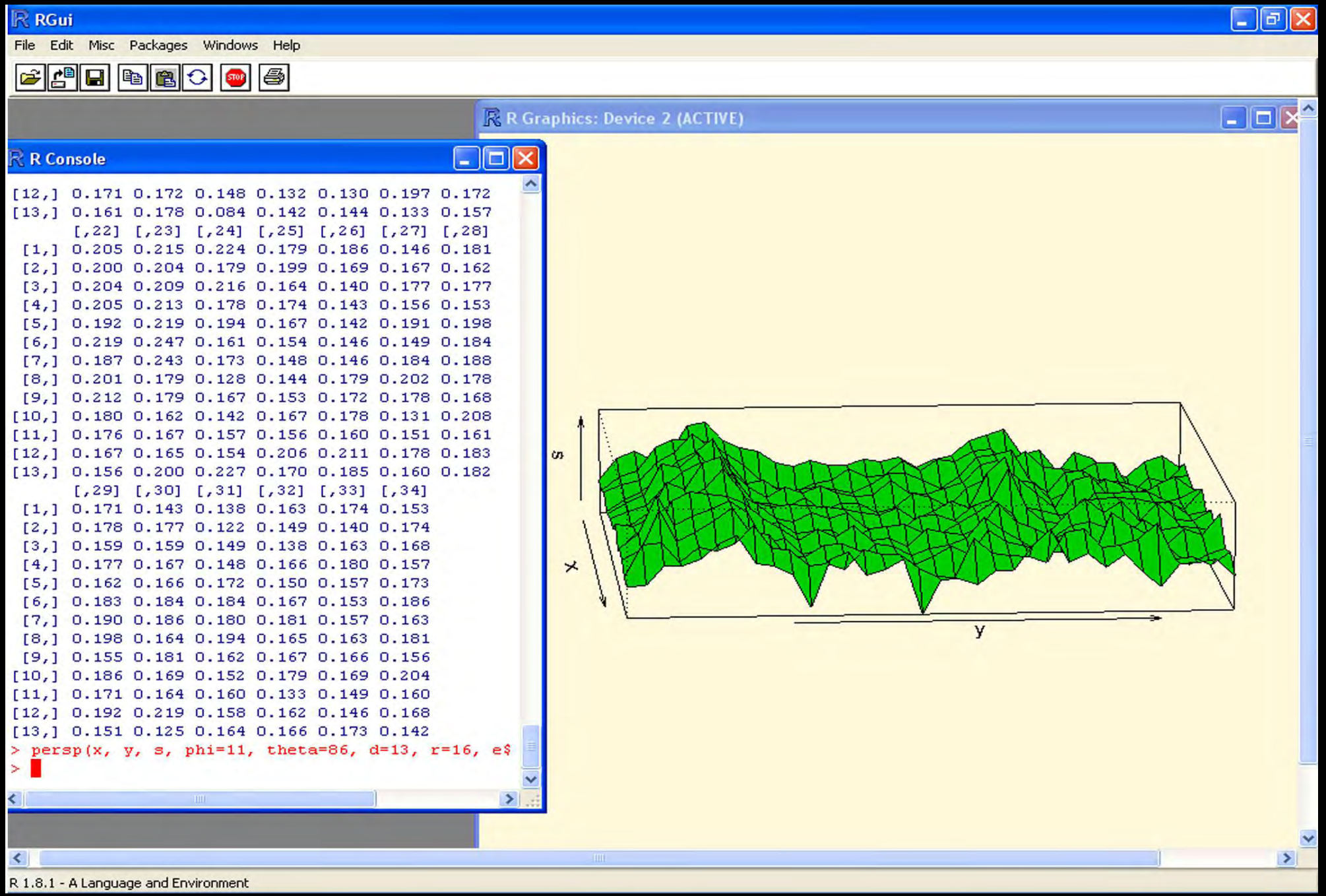
To collect the output information from our resistivity measuring system (RMS), we use a statistic package called "**R**". It offers quick possibilities to edit and visualize grids of values, as raster images or as vectors in 2 or 3 dimensions. Results can be exported to Grass GIS for furhter analysis. Later we'll see other capabilities of "R", these ones are very similar to well known closed source softwares like "Surfer©".



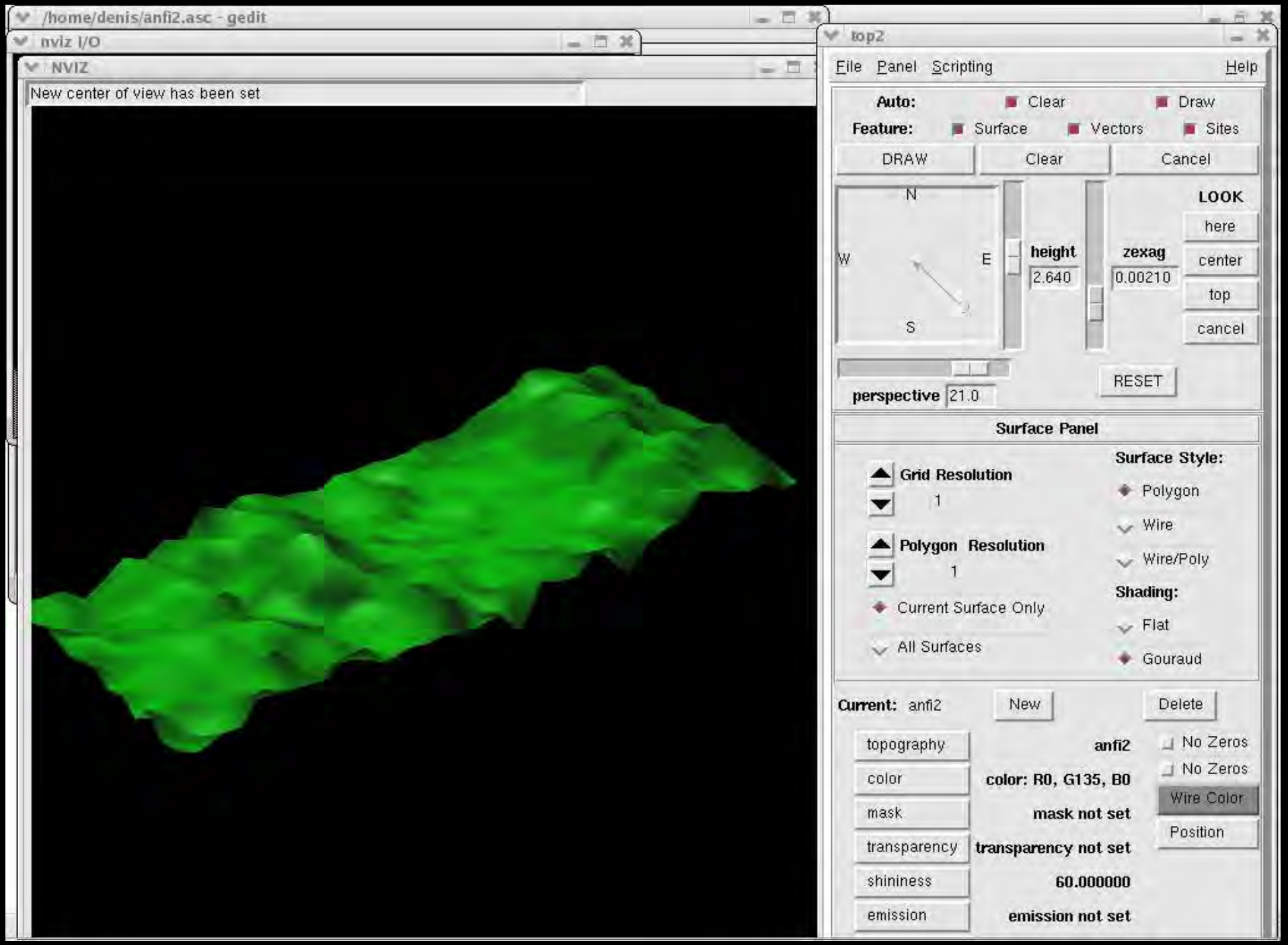


Import of prospection data (ASCII)

Display as **raster image or contour line map**

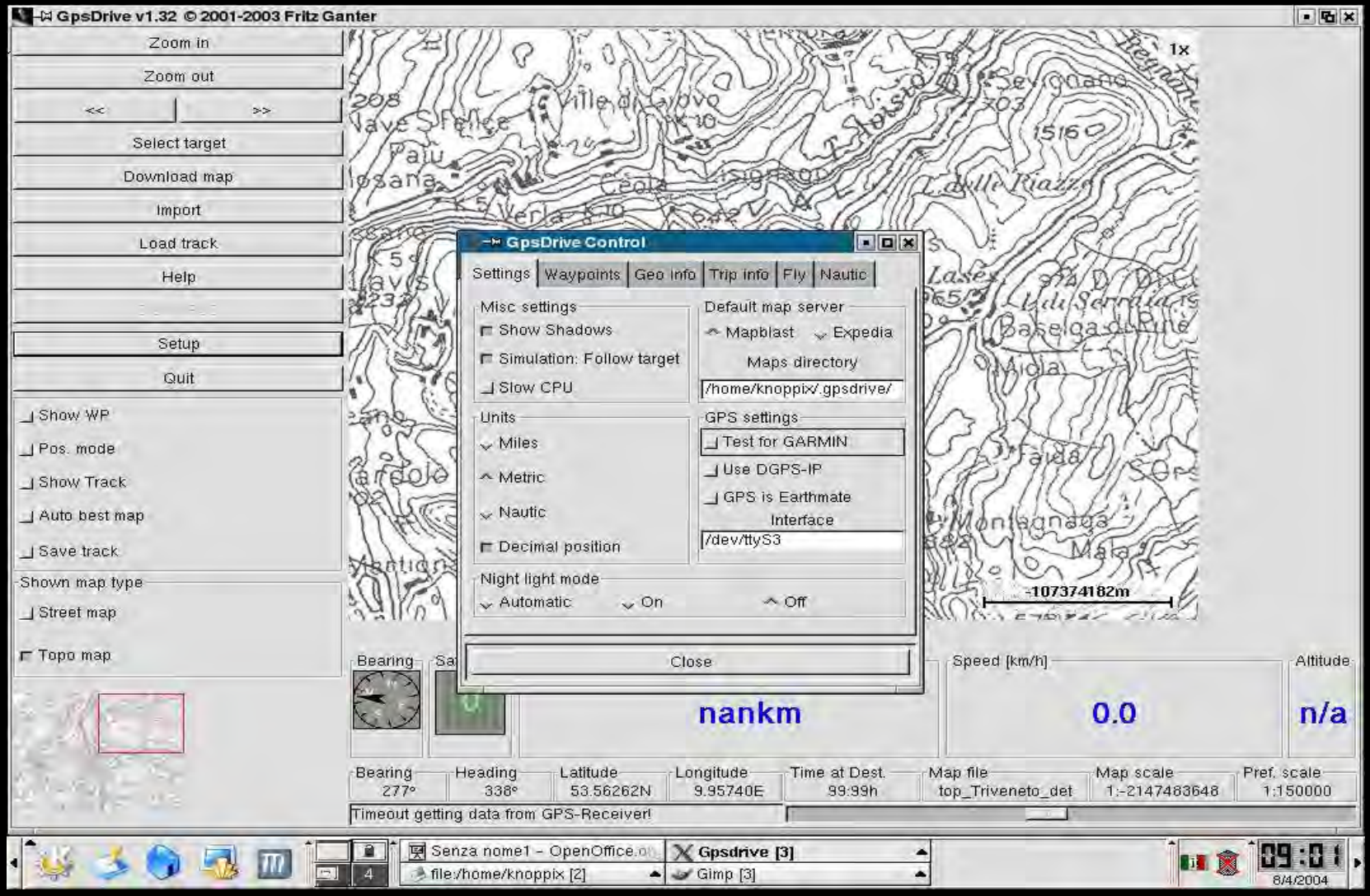


3D Visualization of prospection data in “R”

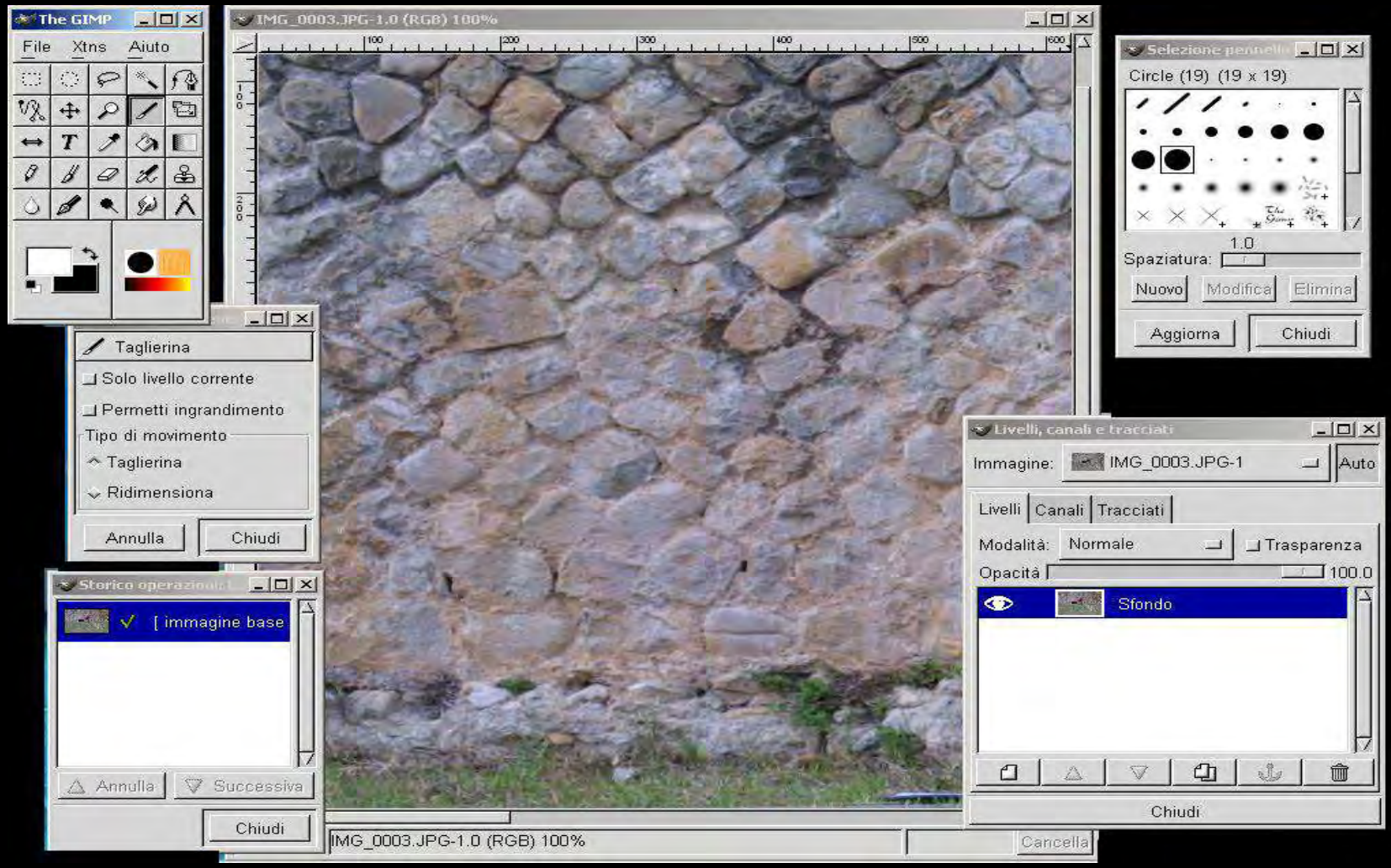


Processed Prospection data from “R”
imported in Grass GIS

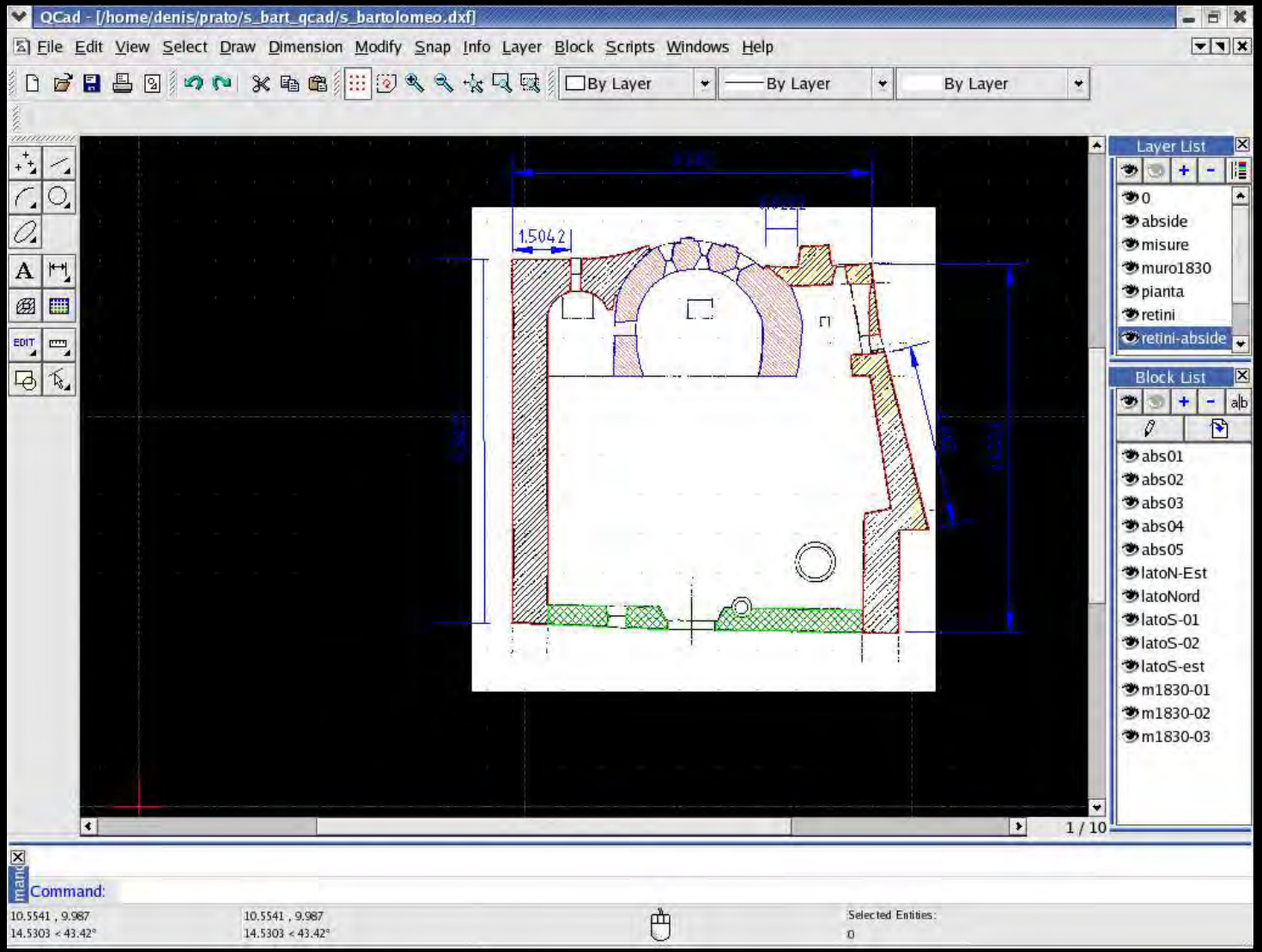
Also for the communication between notebooks/workstations and GPS recievers there exist different open source softwares. We've tested one called **GpsDrive**, it allows you to import and georeference topographical maps, to upload tracks and waypoints from different GPS recievers like Garmin or Maghellan, and to navigate with all standard GPS-tools (Bearing, heading, speed, altitude,...)



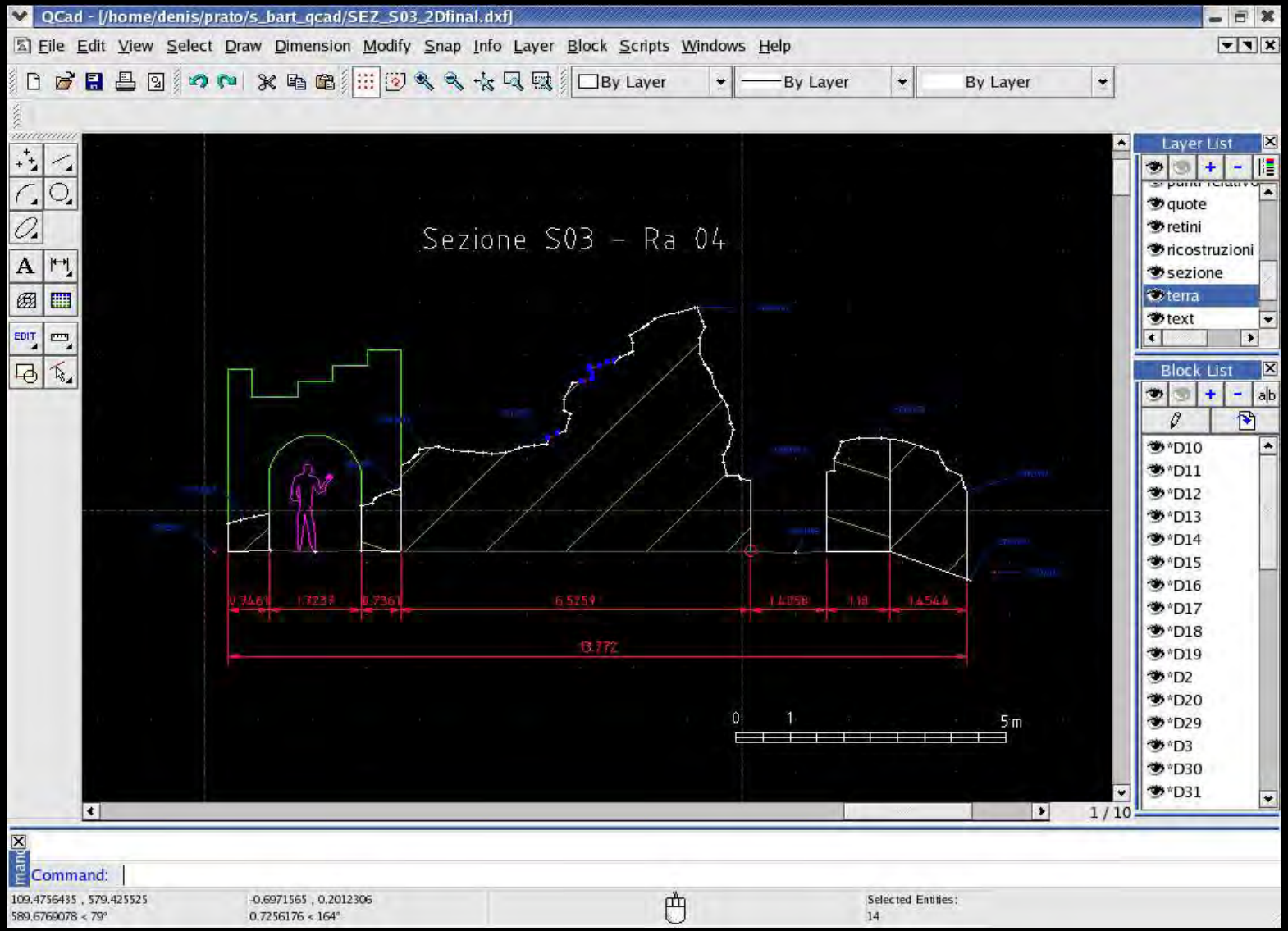
The Gimp is one of the most popular open source softwares. It simply offers most of the potentialities which we can find in softwares like Photoshop© or PhotoPaint©: retouching, composing and authoring images. Image processing applications like Gimp are indispenable for archaeologists every day work. You can use it without problems both on Windows or Linux platforms. Finally you can use the Gimp with all standard Photoshop© Plug-Ins(Photoshop-Tools).



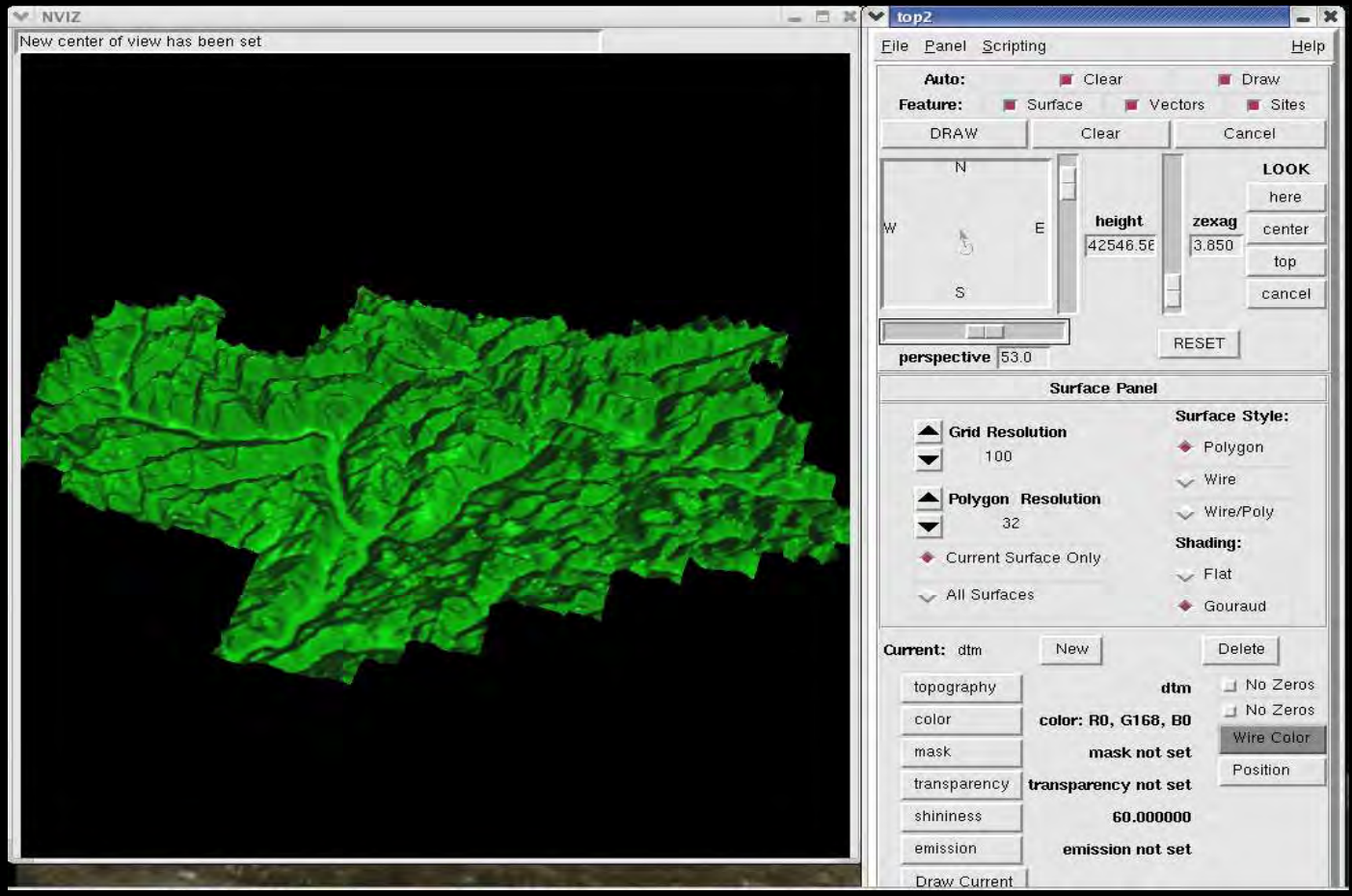
A central part of almost every modern excavation is the use of some kind of CAD applications. In this moment open source still doesn't offer solutions which can compete with the latest versions of Autodesks AutoCAD© or with Microstation© especially what concerns 3D drawing. But for archaeological basic needs we've tested with success an open source software called **QCAD** .How you can see on the screenshot behind me, QCAD has a very familiar user interface, that shows all principal functions of a normal closed source CAD.



You can not only use it to vectorize raster images, but also for construction and architectural drawings like prospects or secdtions. Shortly we expect the release of BlenderCAD which will offer full developed 3D-CAD functions.

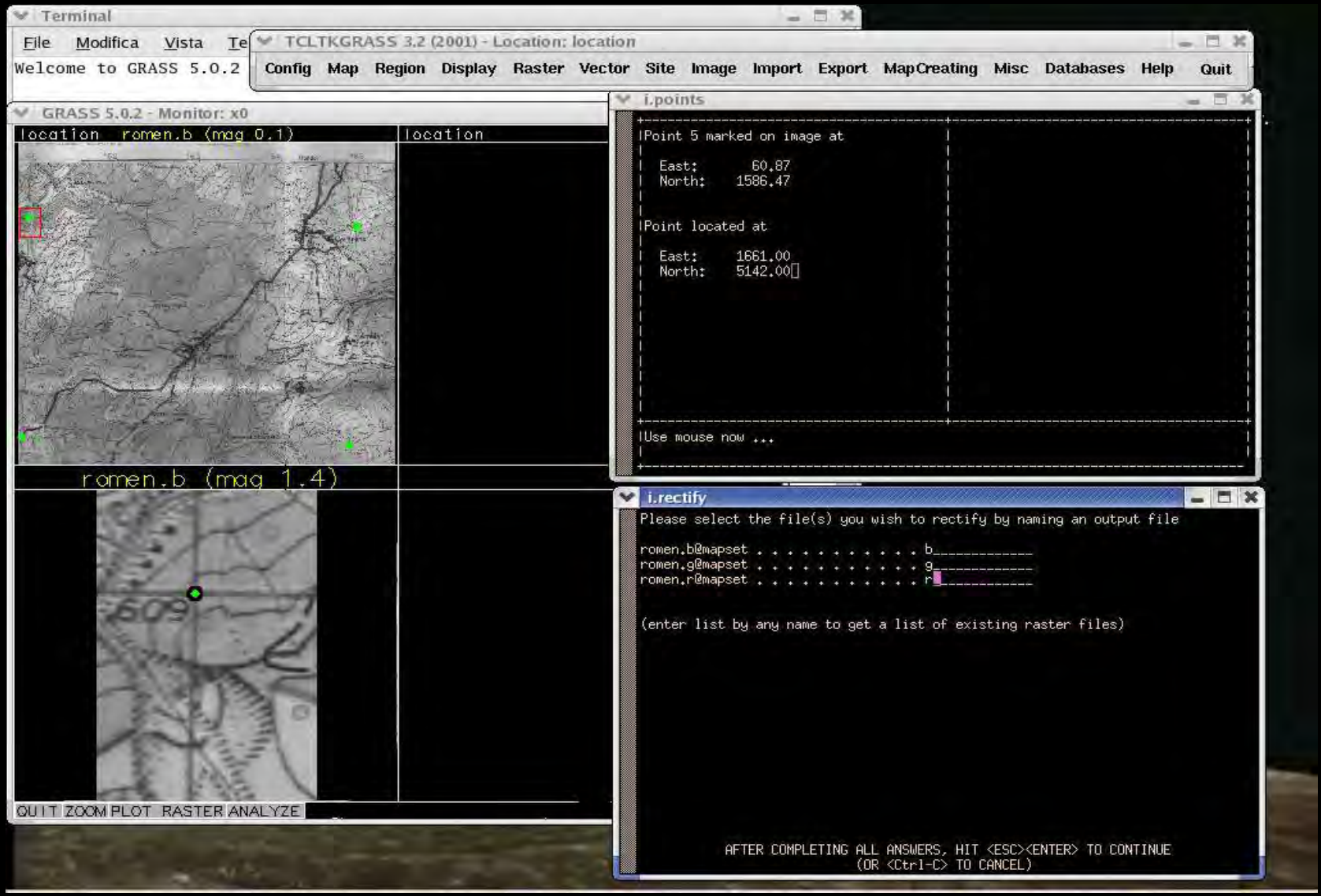


The heart and meeting point of all the information we produce during an archaeological work process is the Geographic Information System. For that aim we have **Grass**, a very powerfull open source software package, which is on the same level as diffused GIS like ArcView© or ArcGIS©. For many purposes it's even better. Without any compatibility problems you can import various kinds of raster data like topographical maps or DTM's as ASCII or from ERDAS© and ArcInfo©. Further vector data like ArcView Shapefiles, AutoCAD-DXFs or through a direct conection from a Garmin GPS reciever.



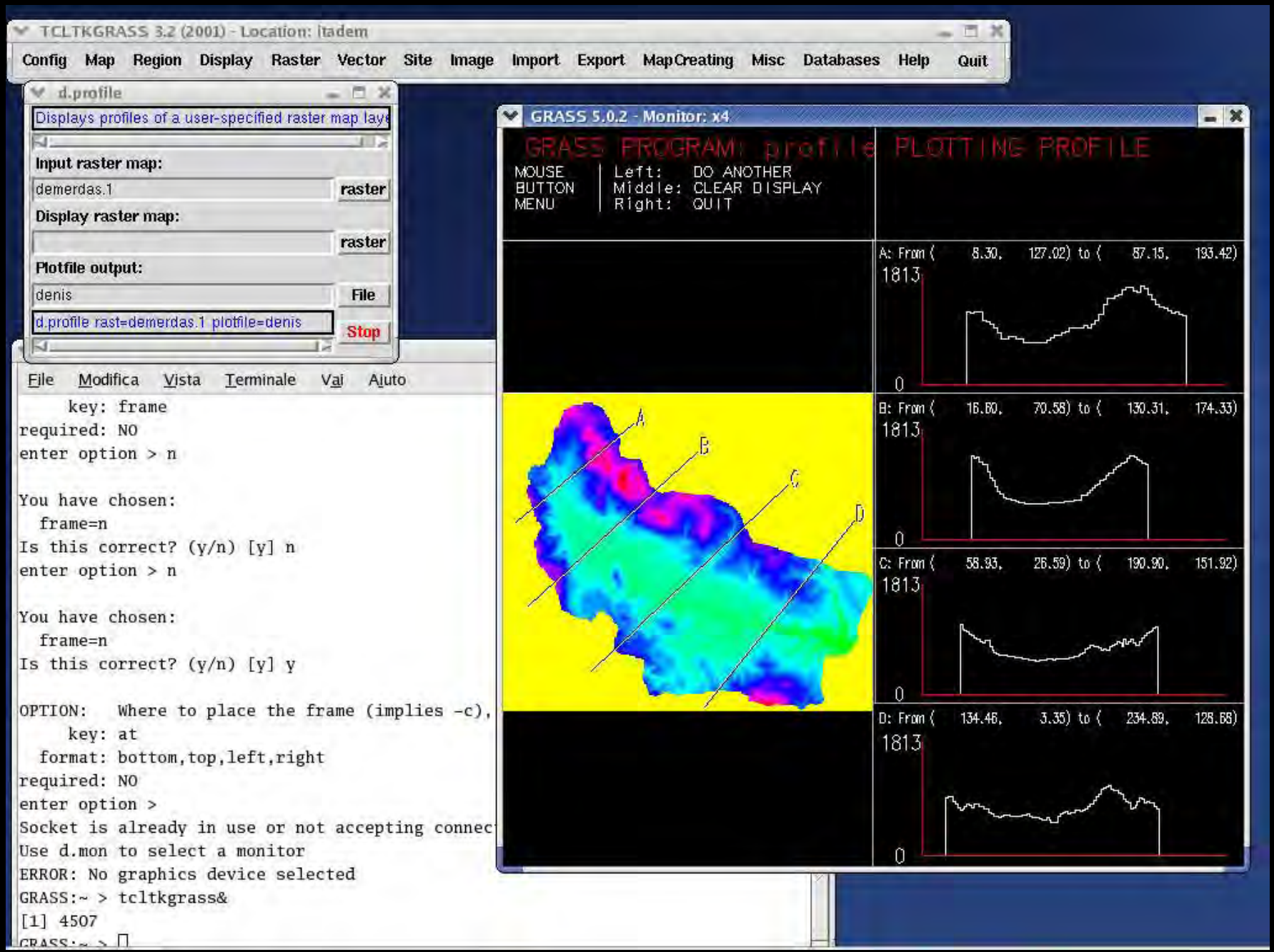
Amongst other things Grass is optimized for interpolation, management, application and visualization of digital terrain data

Like ArcGIS, Grass has intigrated tools for rectification and georeferencing.

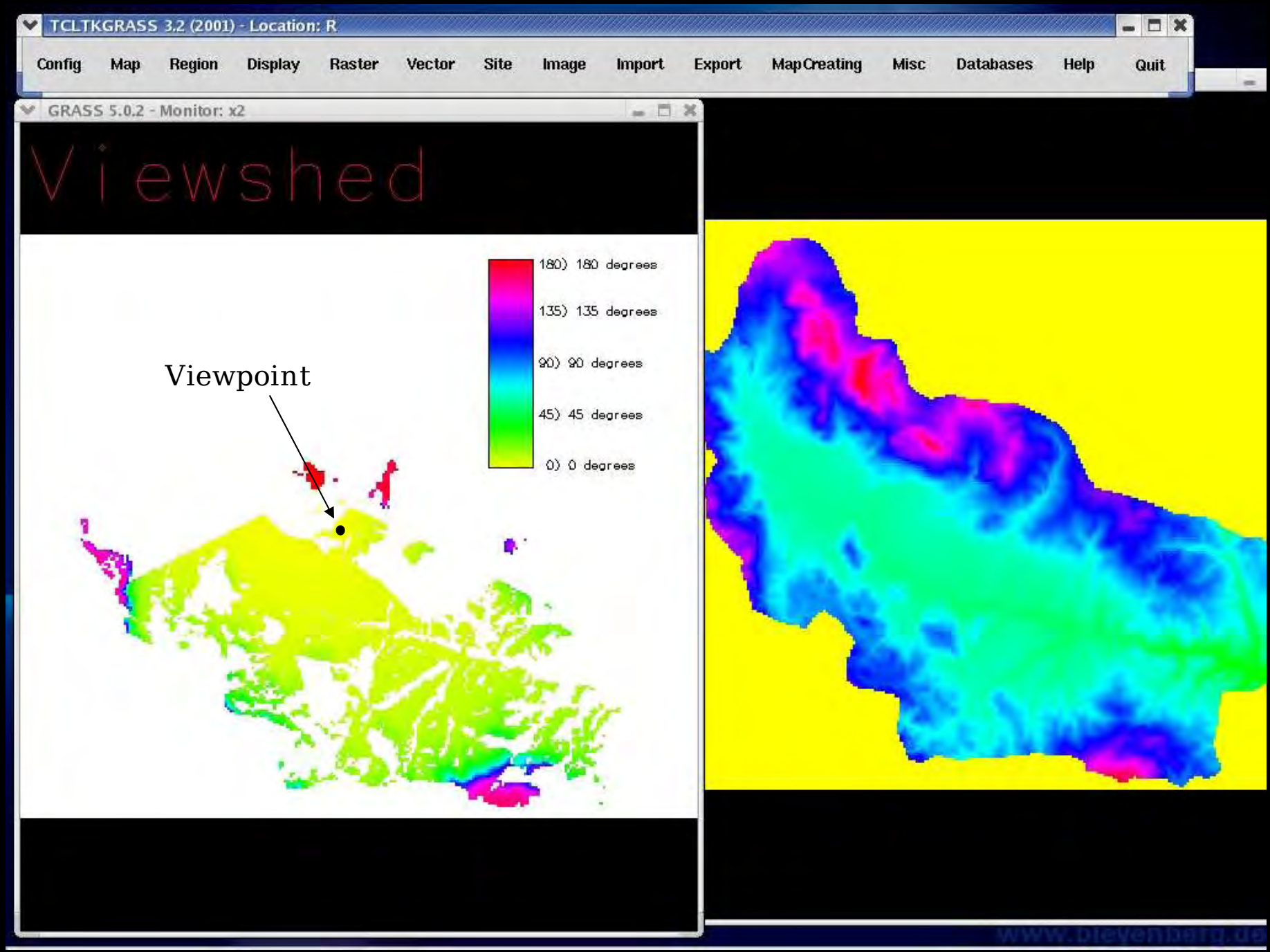


Amongst ohter things Grass is optimized for interpolation, management, application and visualization of digital terrain data, analysis like aspect, slope, hillshed, viewshed and many others included (as we see in te next pages).

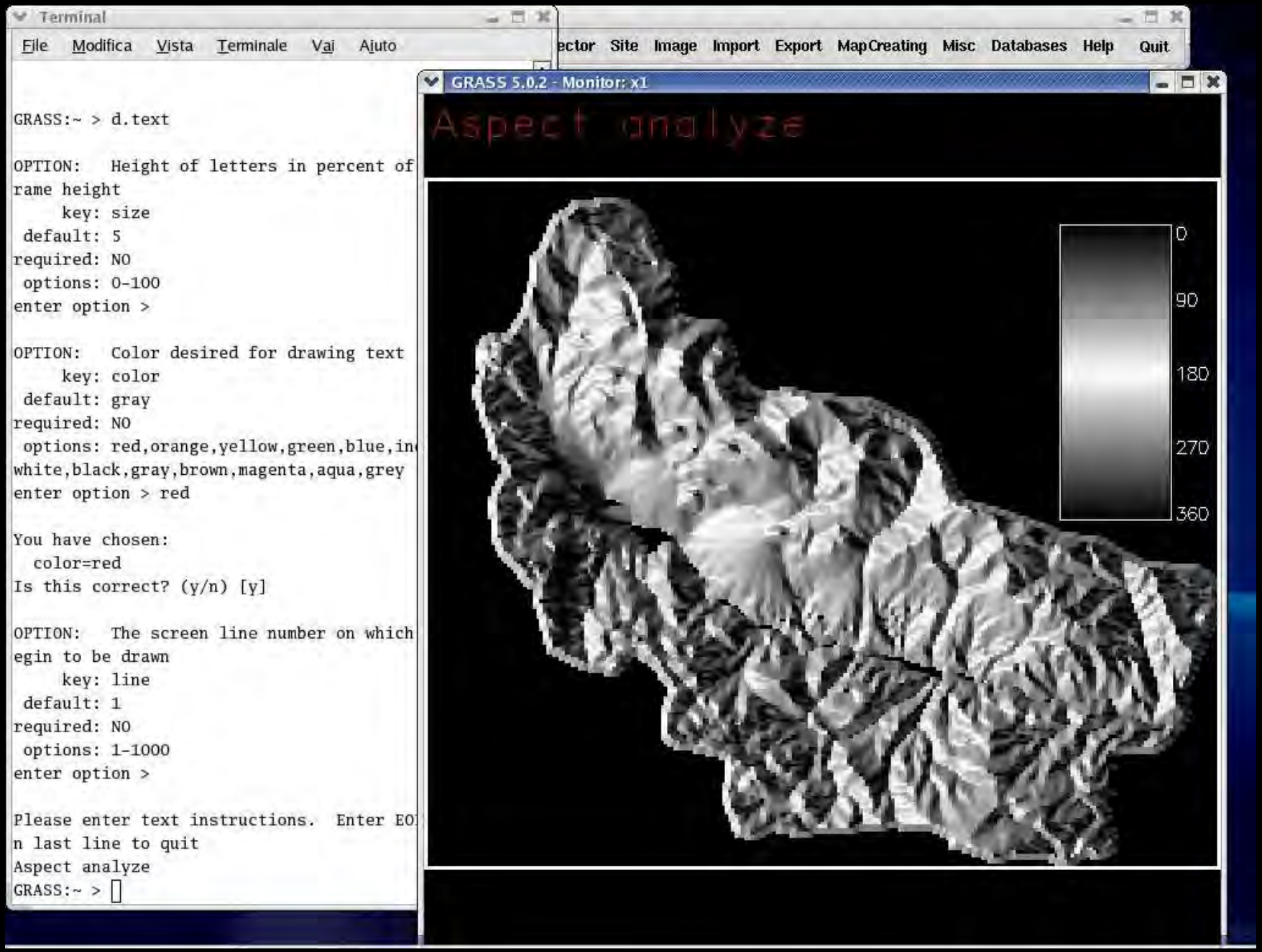
Grass: Terrain data analysis (Profile)



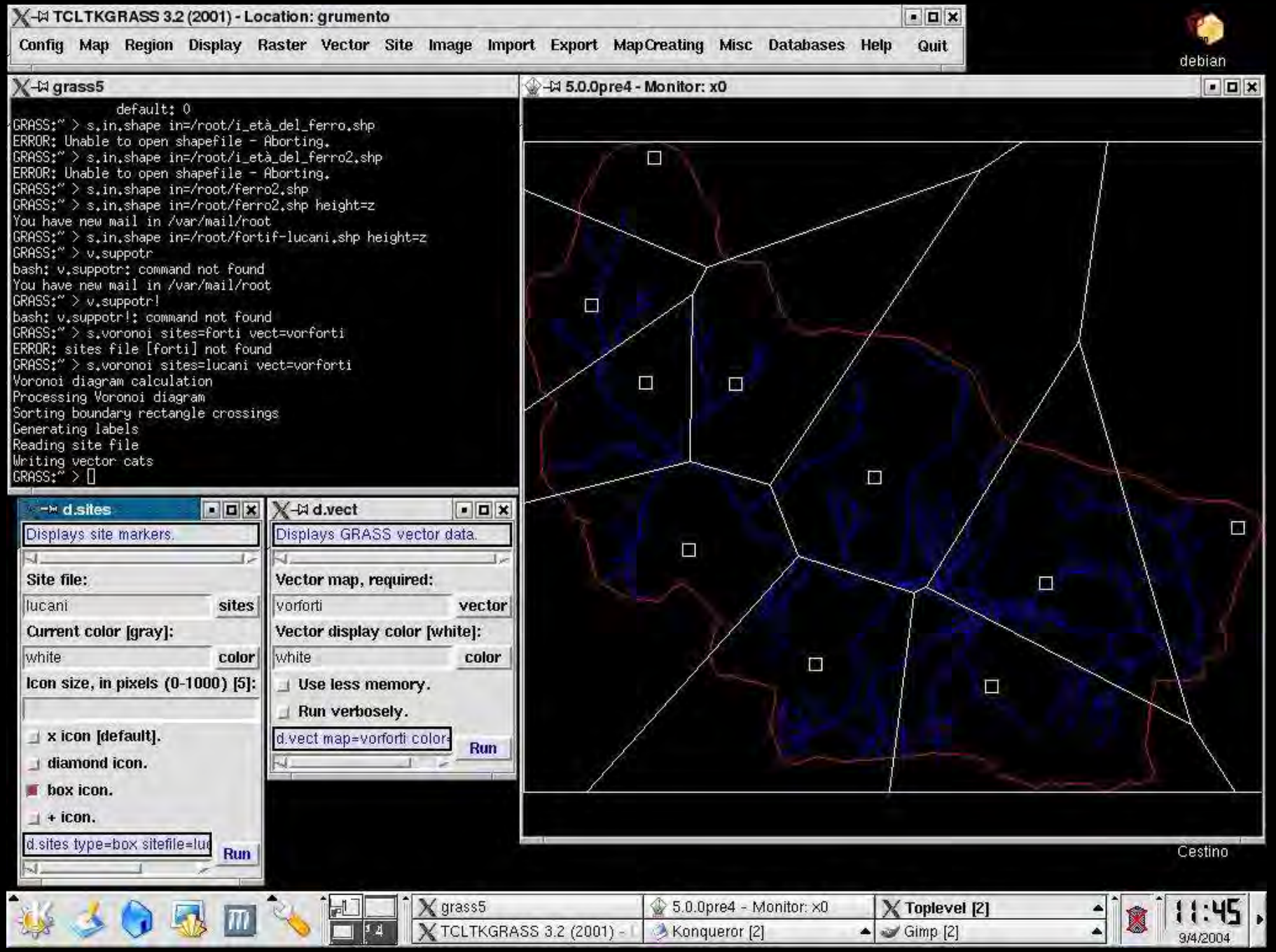
Grass: Terrain data analysis (Viewshed)



Grass: Terrain data analysis (Aspect)

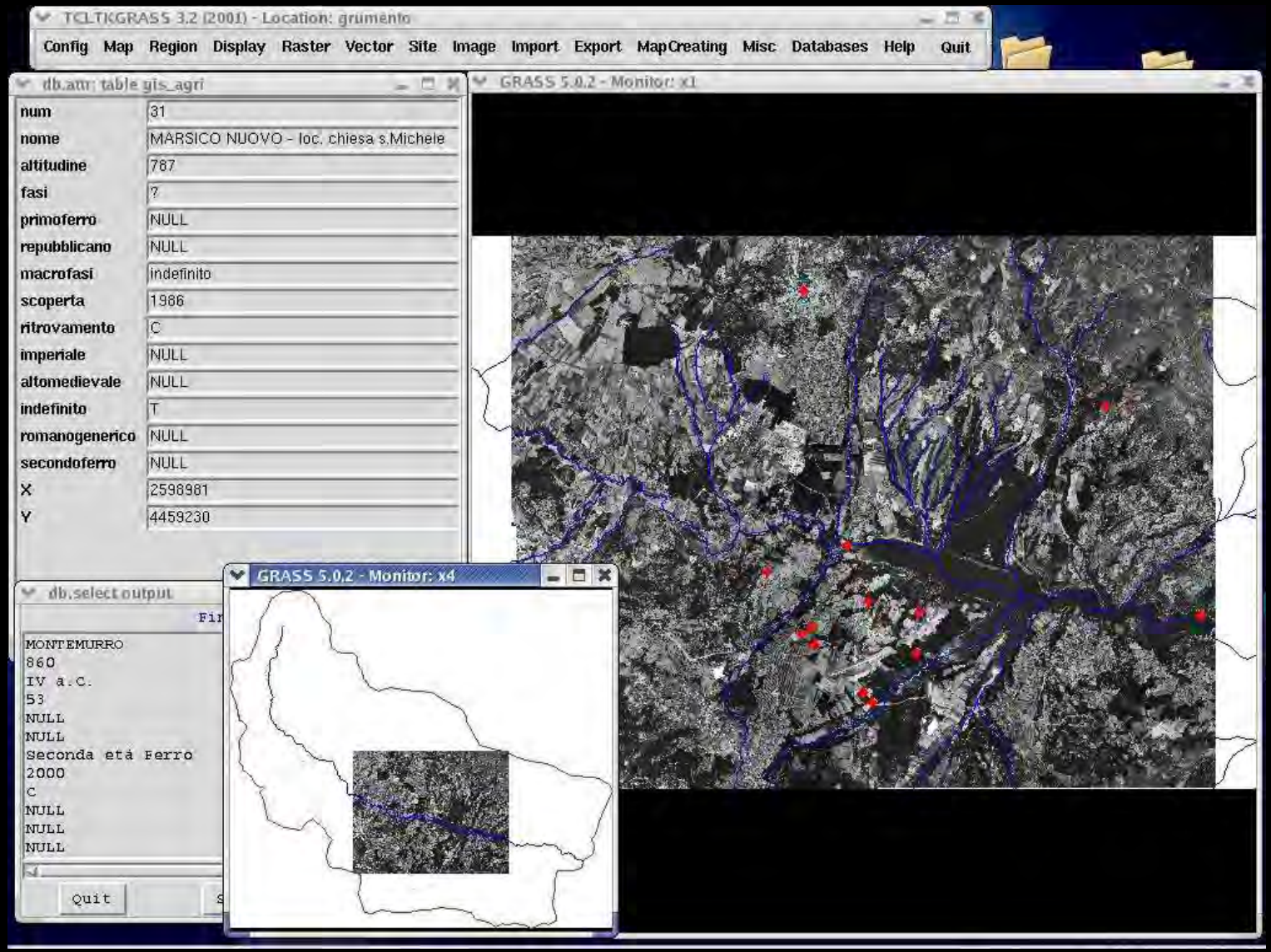


Grass: Terrain data analysis (Voronoi)

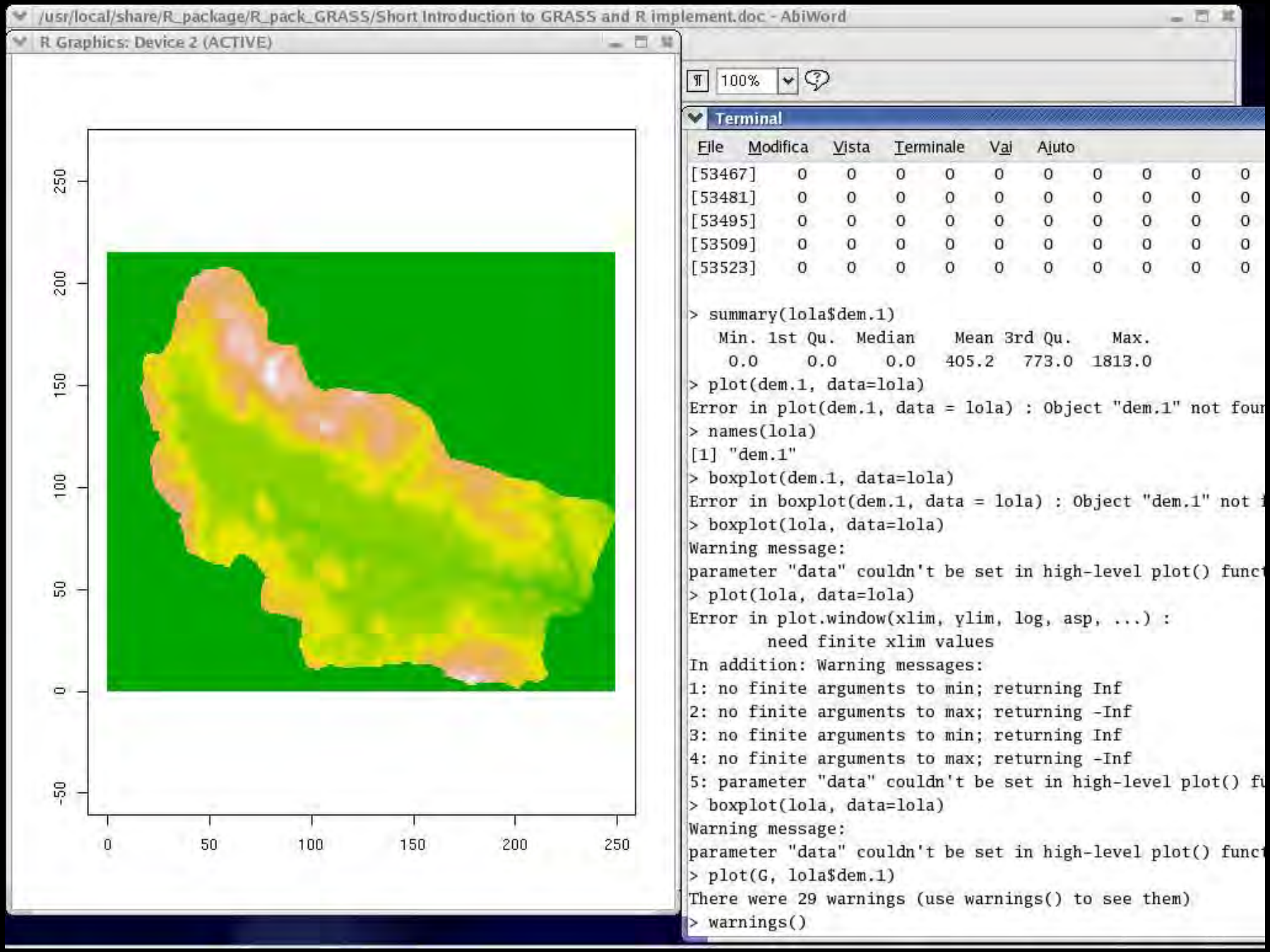


One of the most promising potentialities of Grass is the capacity to comunicate with outsourced databases like MySQL and statistical packages like “R”.

MySQL database integrated with Grass GIS:
database linked terrain data

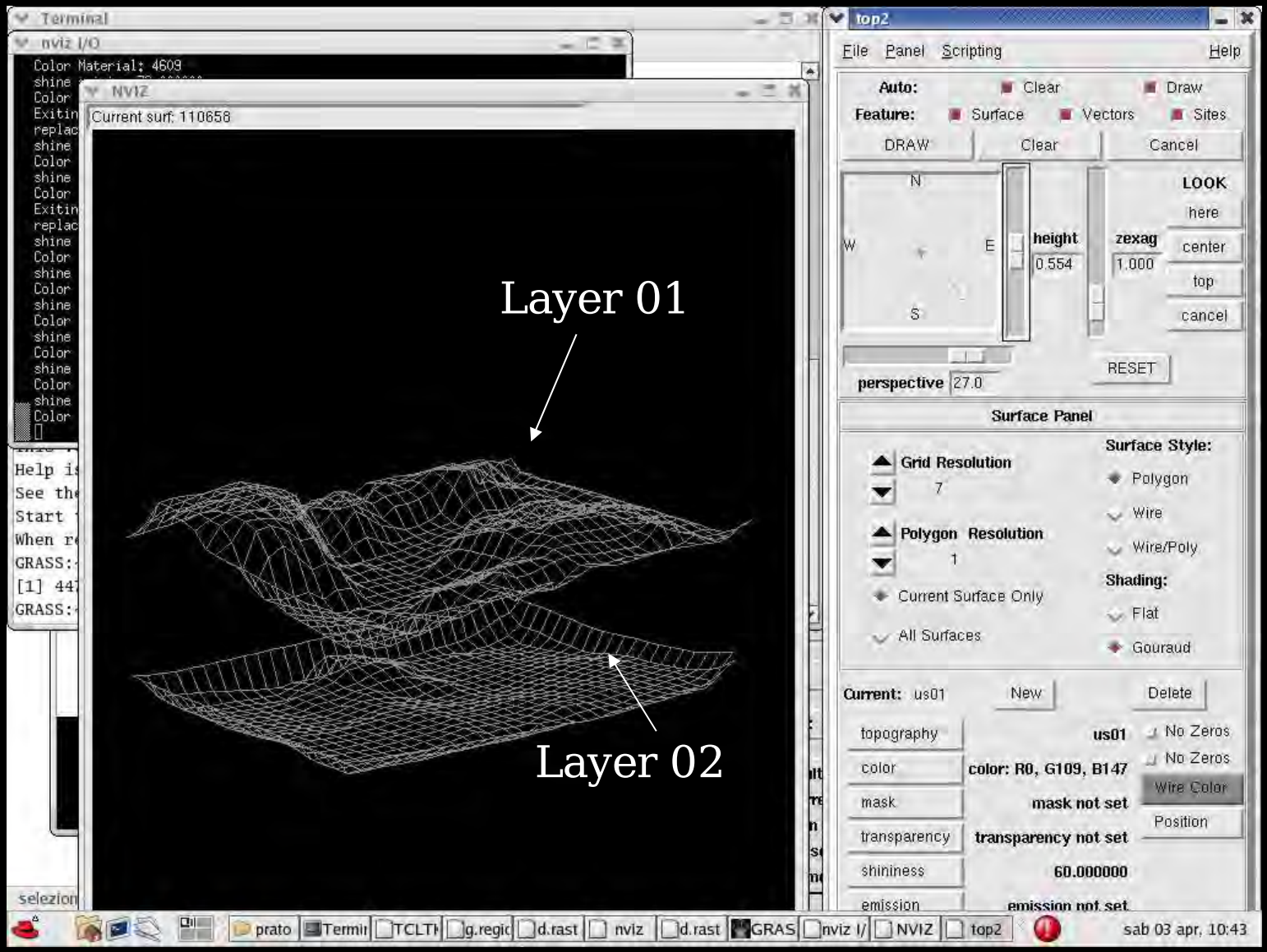


“R” data analysis language integrated with Grass GIS: Statistical analyze of terrain data

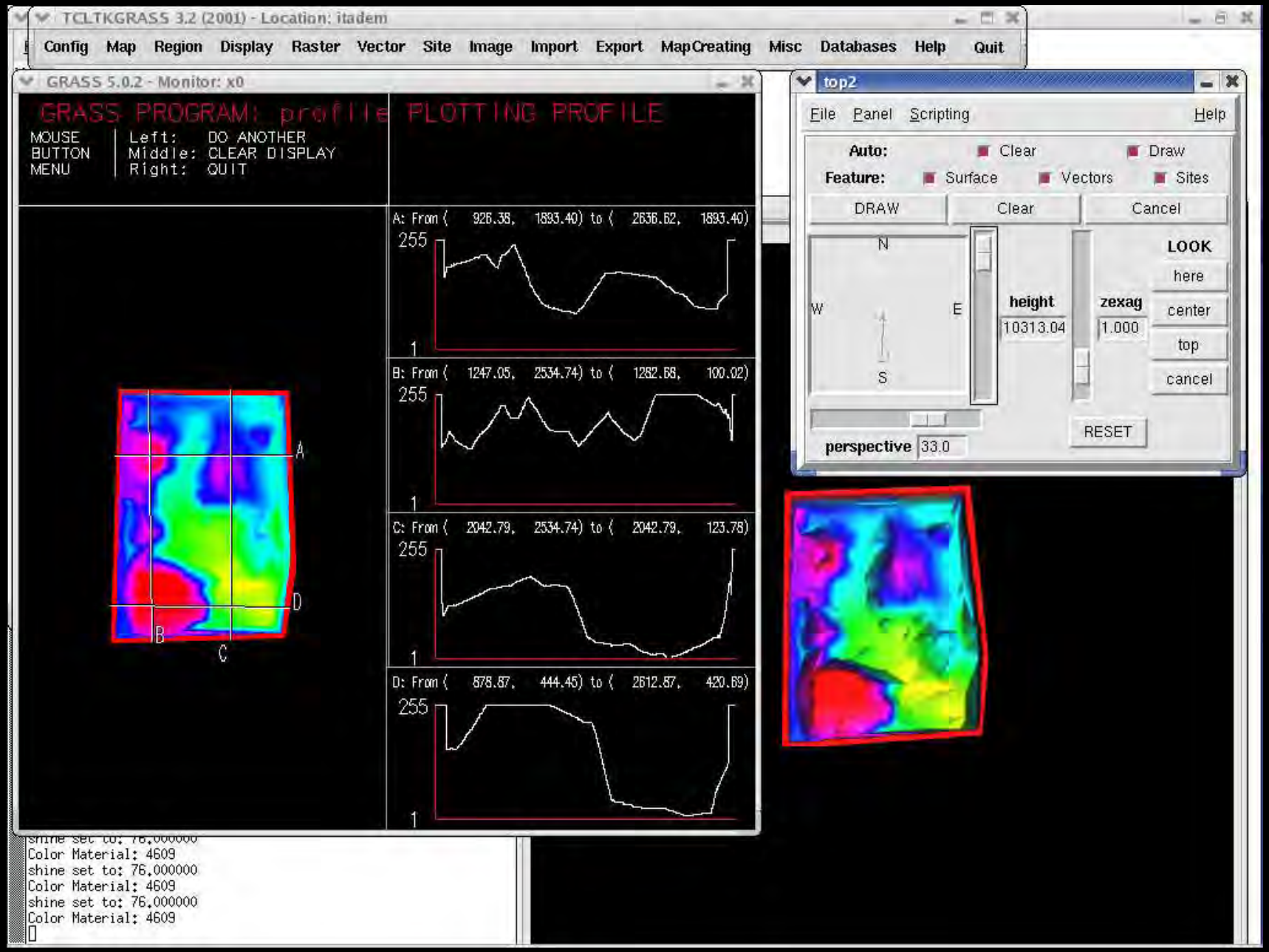


Grass on site

Grass offers not only various possibilities for territorial research, it´s applicable also for processing and management of archaeological excavations. Here you can see the same kind of analyses we've just seen for the landscape.

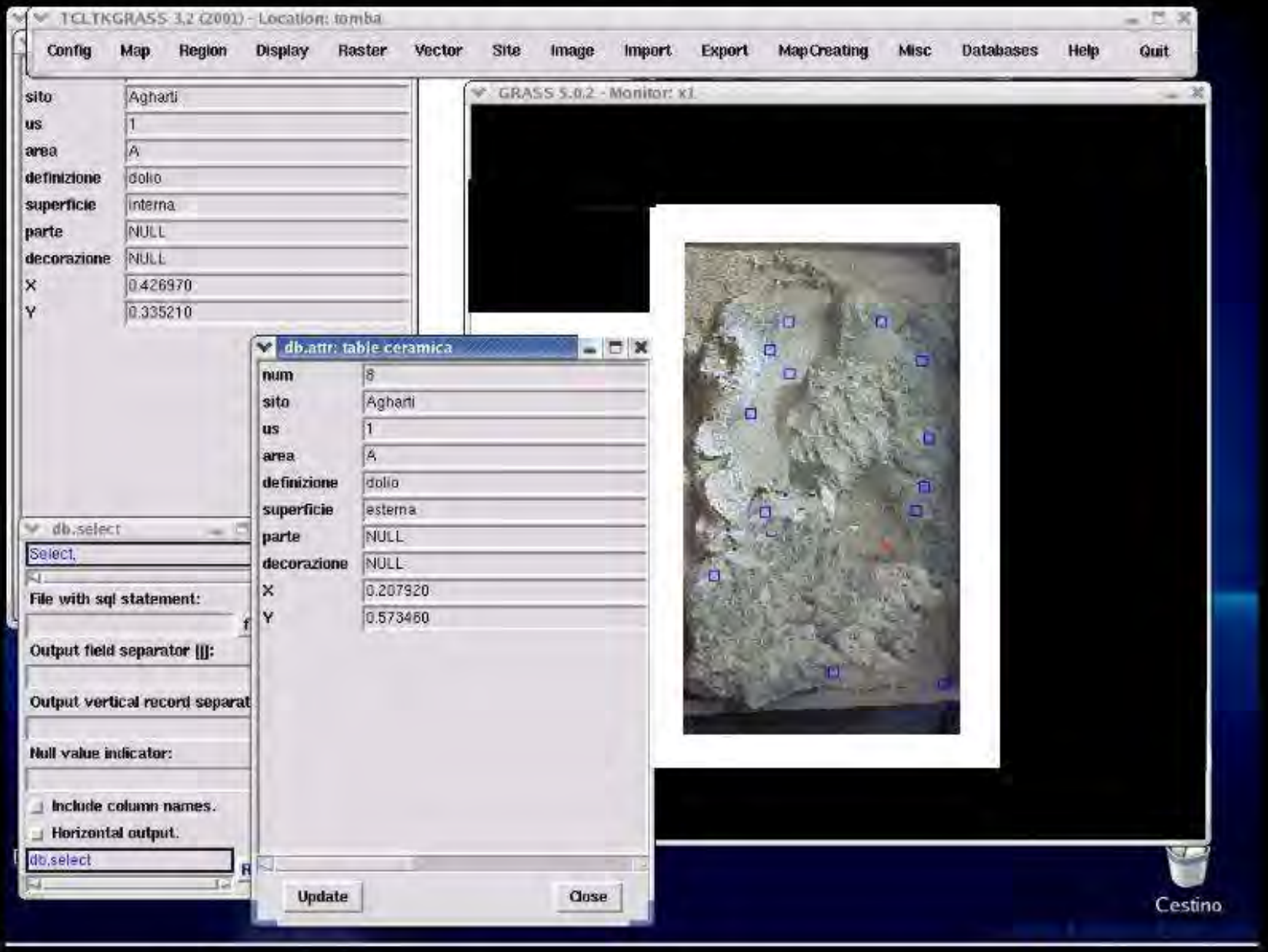


Grass on site



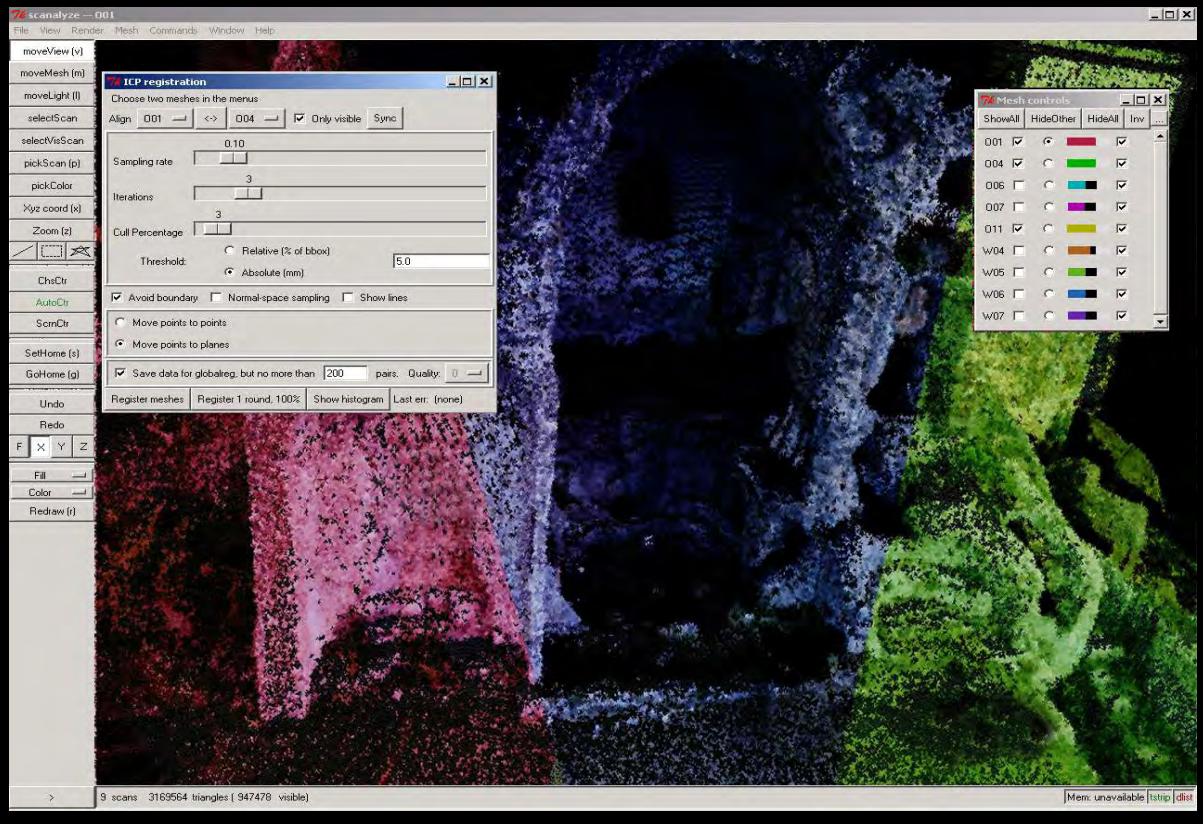
Different sections of one layer

Grass on site



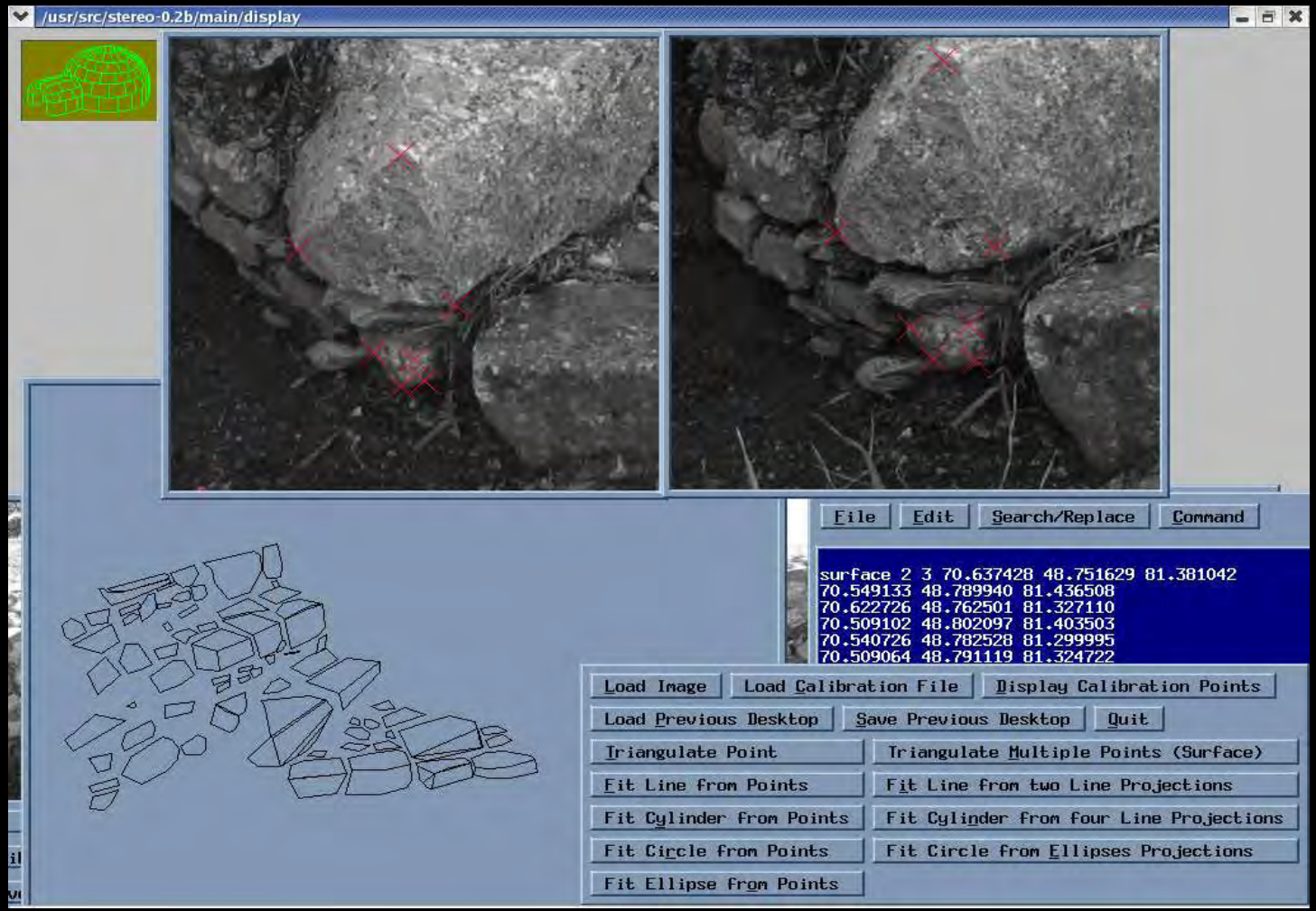
MySQL database integrated with Grass GIS:
database linked excavation data

Here you can see a screenshot of **Scanalyze** running on a Windows platform. Scanalyze is an application for viewing, editing, aligning, and merging Laserscanner data. It has been developed and continuously improved from the Computer Graphics Laboratoryof the Stanford University since the 1990ties. You can process triangle meshes or range images encoded as rectangular arrays of points. Scanalyze is using his own file-format called *.ply, but there exist already data conversion modules for exemple for Cyberware, 3D Scanners Ltd., and Cyra Technologies scanners. In the upper right corner of the screen you can see a list of the scans, visible as false color pointclouds and displayable in different resolutions. On the left you find the menu for aligning pairwise single scans (through an ICP *Iterated Closest Point* algorithm). Furhter Scanalyze offers different capabilities of displaying, clipping and reducing polygon meshes, or filling of holes in range data, that we havent tested as yet.



Photogrammetrical reconstraction with **Stereo**

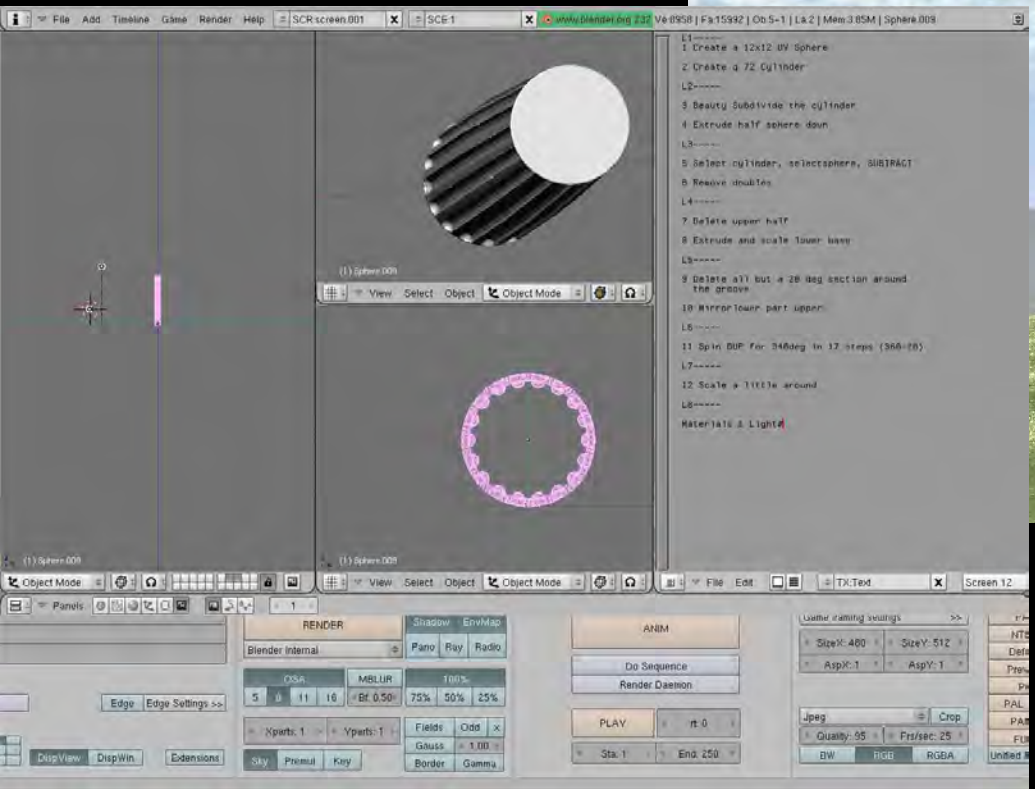
Stereo is an a ccurate 3d measurement software for large (gray-scale tiff / targa) stereo images, in order to produce CAD drawings, comparable with Photomodeler©. First of all it aims at high qualiy, but the current version stereo-0.2b is still a little bit unstable, because its creator, Paul Sheer, has left the project in 1997. We tested the software with quite good results, how you can see in the next pictures. We hope that its problems will be resolved in the near future, by the ITC-irst, which wants to develop it further and integrate it into Grass.



Photogrammetrical reconstraction with **Stereo**

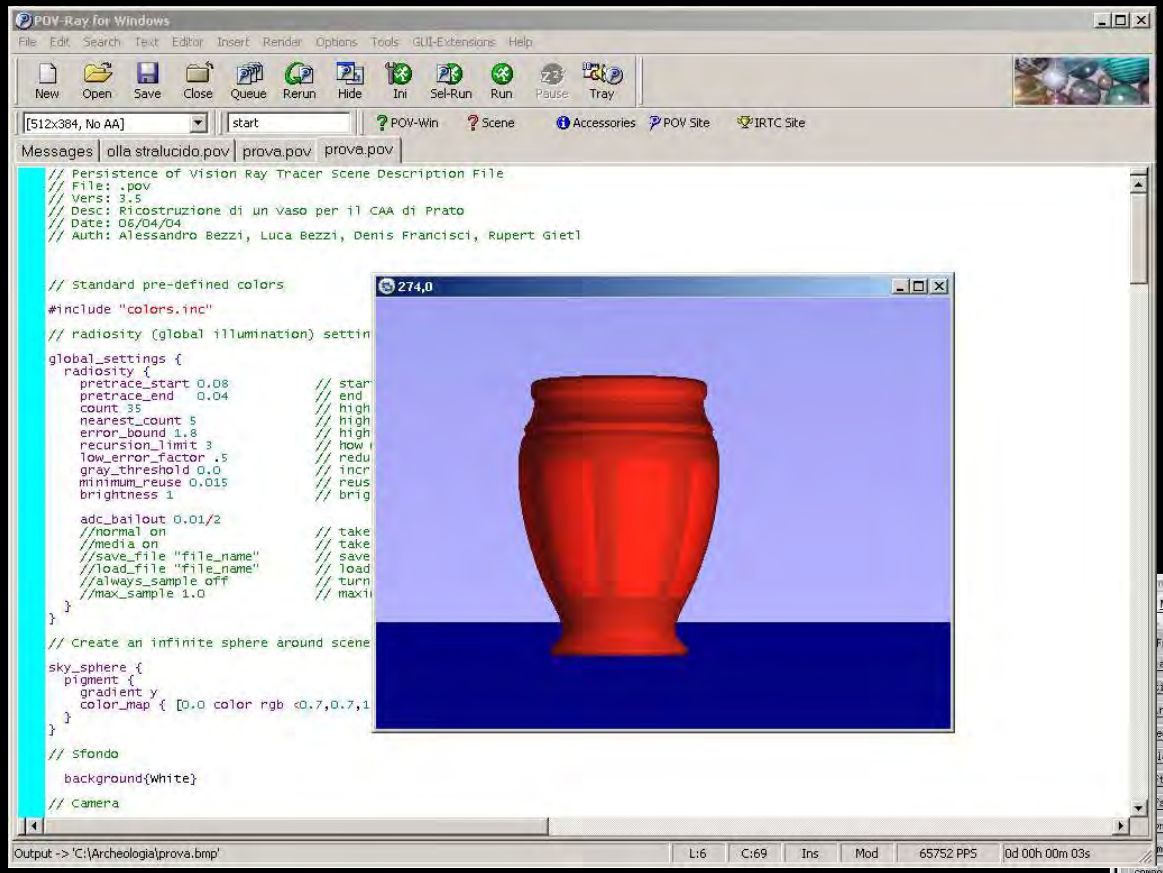
Blender offers a very familiar graphical user interface (GUI) for 3D-Studio Max© users. It is one of the most used open source software and it's supported by a large comunity of programmers. This garanties a continuous updating and the development of new tools and exctensions, like BlenderCAD.

3D Reconstruction with **Blender**

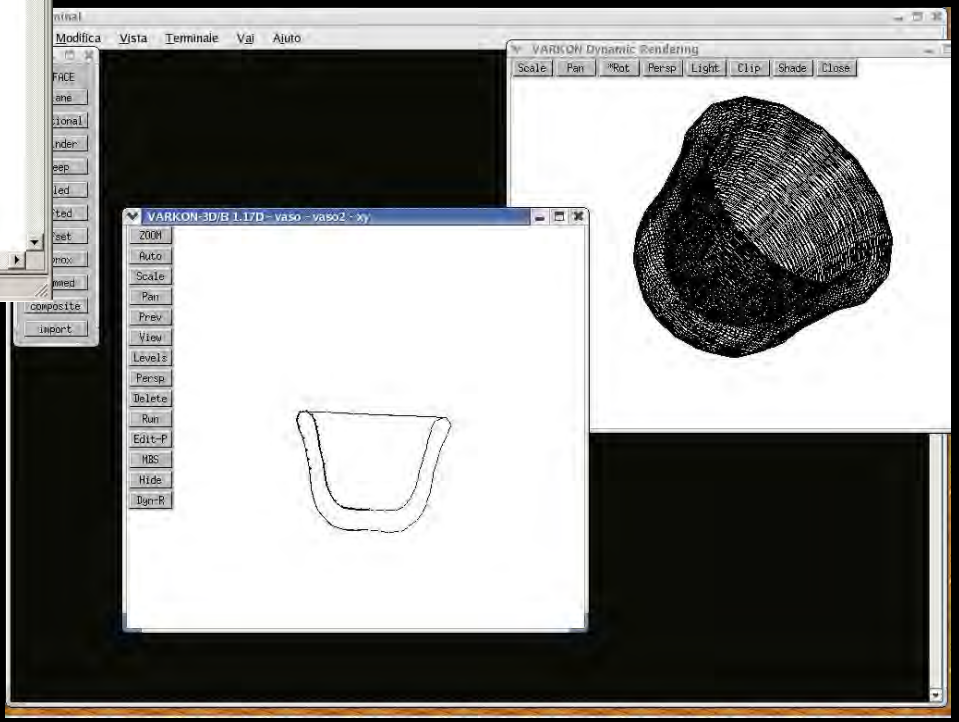


Screenshots kindly offered by **S. Selleri**

PovRay is a powerfull 3D graphic software, but its command based interface may be quite difficult to handle for common users. We can say the same about **Varkon**: a complete 3D CAD software, but not yet so user frendly.



PovRay



Varkon

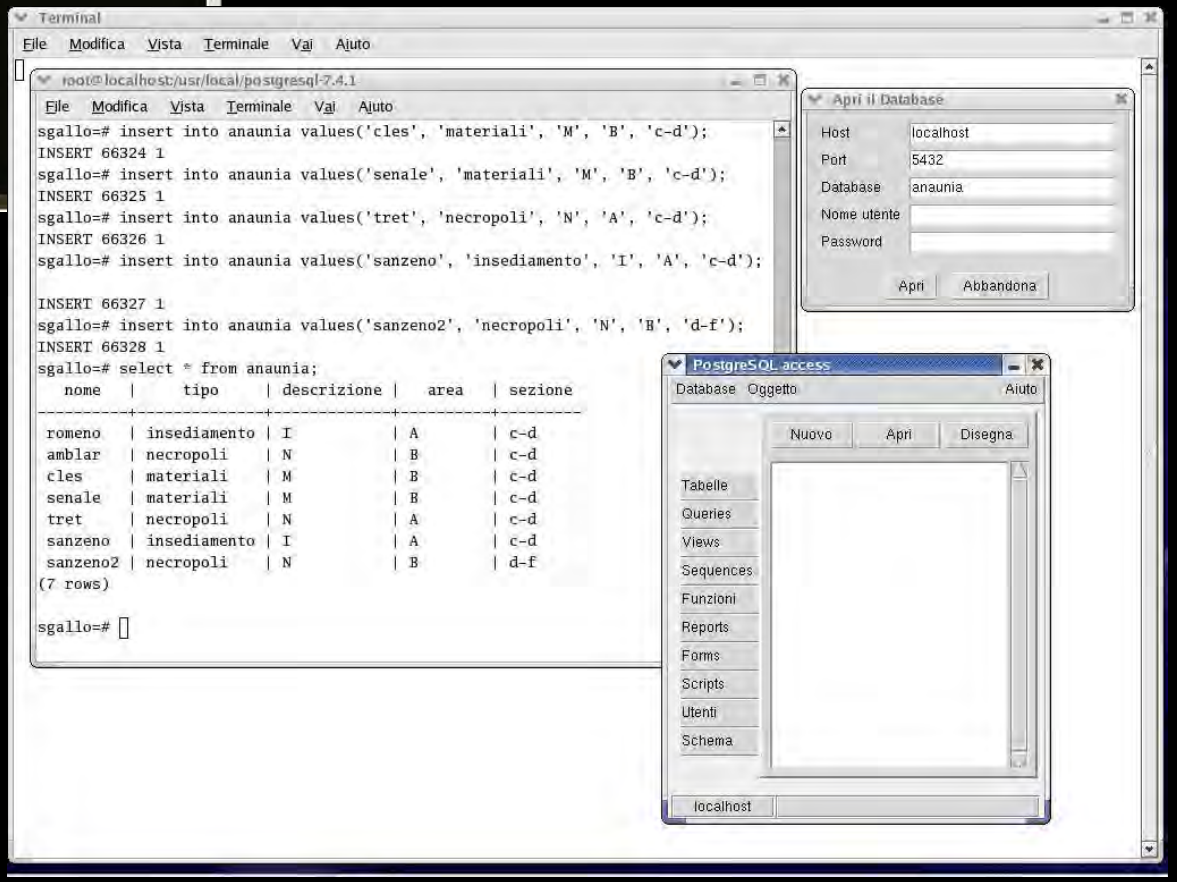
Data management

Databases (**MySQL**, **PostgreSQL**, **ODBC**,...)

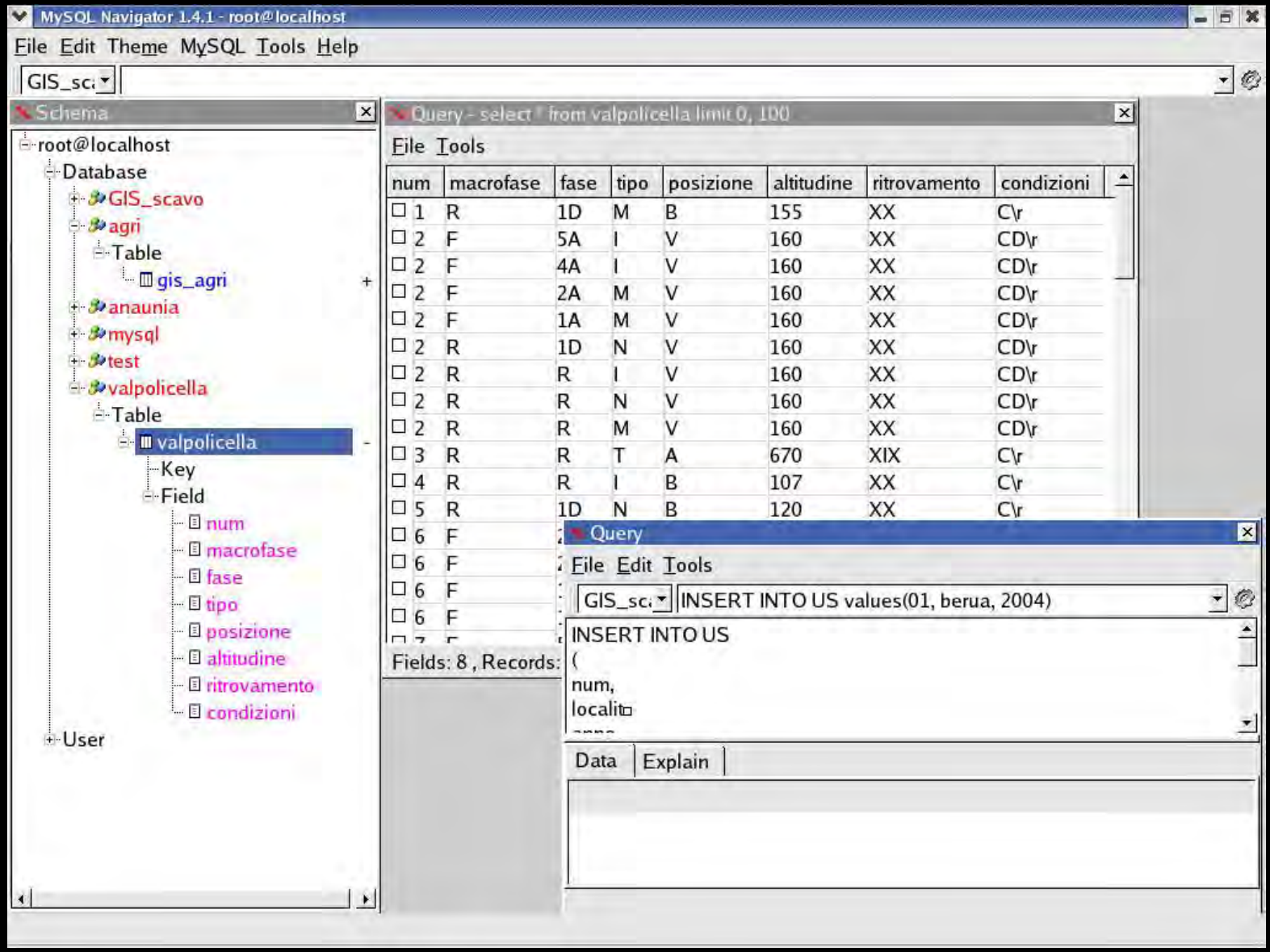
```
root@localhost:/usr/local/mysql
File  Modifica  Vista  Terminale  Vai  Aiuto
mysql> insert into valpo
    -> set descrizione=villaggio;
ERROR 1054: Unknown column 'villaggio' in 'field list'
mysql> insert into valpo
    -> SET
    -> ;
ERROR 1064: You have an error in your SQL syntax.  Check the manual that corresponds to your MySQL server version for the rig
ht syntax to use near '' at line 2
mysql> update valpo
    -> set descrizione=villaggio where numero=1;
ERROR 1054: Unknown column 'villaggio' in 'field list'
mysql> update valpo
    -> set descrizione="villaggio" where numero="1";
Query OK, 1 row affected (0.09 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> select * from valpo;
+--------+-----------+------+------+-----------+------------+----------+------------+-------------+
| numero | macrofase | fase | tipo | posizione | altitudine | data     | condizioni | descrizione |
+--------+-----------+------+------+-----------+------------+----------+------------+-------------+
|      1 | R         | 1D   | M    | B         |        155 | XX       | C          | villaggio   |
|      2 | F         | 5A   | I    | V         |        160 | XX       | CD         | NULL        |
|      2 | F         | 4A   | I    | V         |        160 | XX       | CD         | NULL        |
|      2 | F         | 2A   | M    | V         |        160 | XX       | CD         | NULL        |
|      2 | F         | 1A   | M    | V         |        160 | XX       | CD         | NULL        |
|      2 | R         | 1D   | N    | V         |        160 | XX       | CD         | NULL        |
|      2 | R         | R    | I    | V         |        160 | XX       | CD         | NULL        |
|      2 | R         | R    | N    | V         |        160 | XX       | CD         | NULL        |
|      2 | R         | R    | M    | V         |        160 | XX       | CD         | NULL        |
|      3 | R         | R    | T    | A         |        670 | XIX      | C          | NULL        |
|      4 | R         | R    | I    | B         |        107 | XX       | C          | NULL        |
|      5 | R         | 1D   | N    | B         |        120 | XX       | C          | NULL        |
|      6 | F         | 2A   | I    | A         |        815 | XX       | C          | NULL        |
|      6 | F         | 2A   | M    | A         |        815 | XX       | C          | NULL        |
|      6 | F         | 1A   | I    | A         |        815 | XX       | C          | NULL        |
|      6 | F         | 1A   | M    | A         |        815 | XX       | C          | NULL        |
|      7 | F         | 5A   | I    | A         |        166 | XX       | C          | NULL        |
```

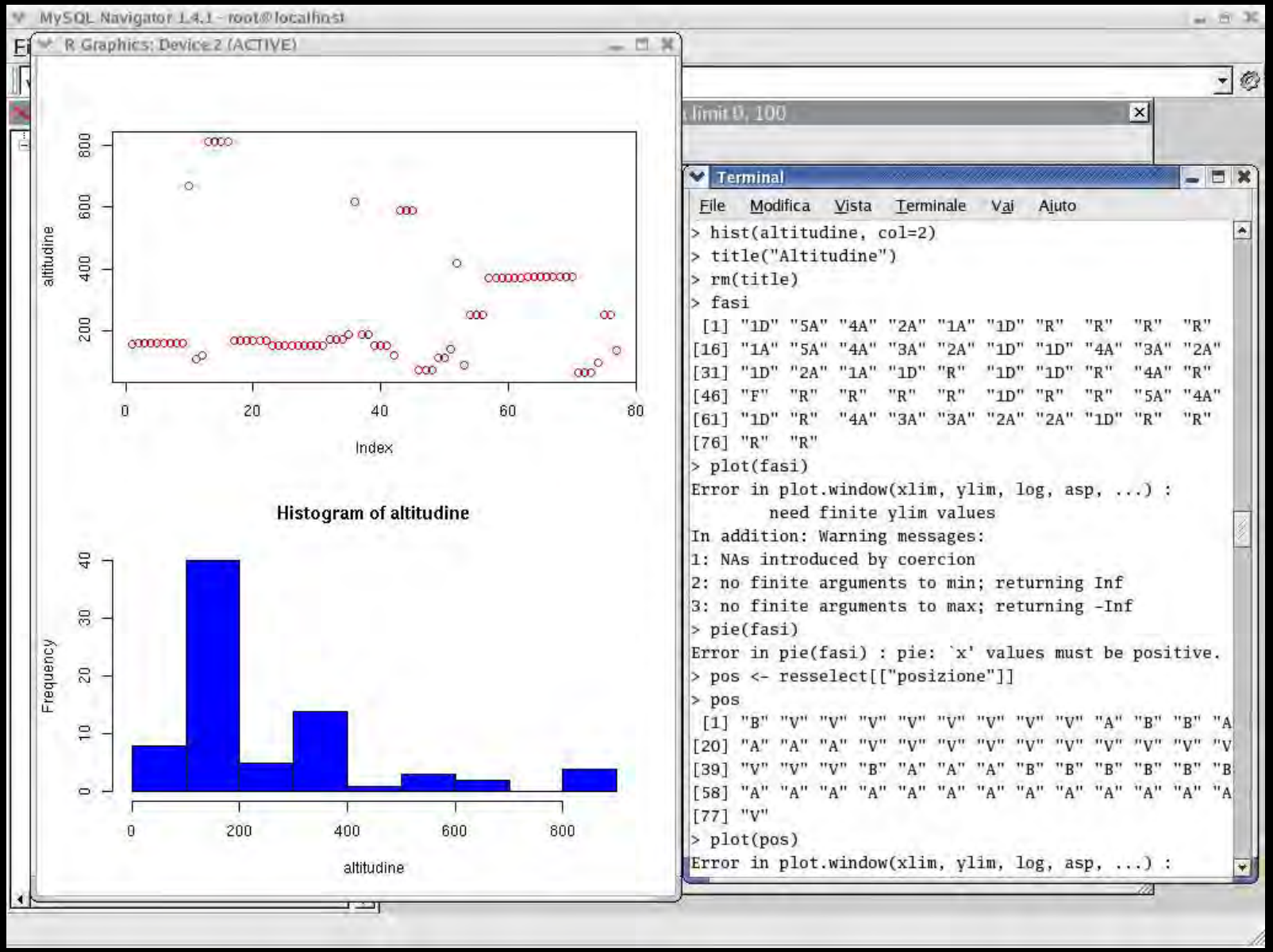
MySQL and PostgreSQL are two database servers based on the widespreaded SQL language. Both of them can comunicate with Grass and “R”. They can manage a big amount of data and this characteristic is very advantageous to serve many clients at the same time, like in a webGIS. SQL language allows simple and sofisticated queries.



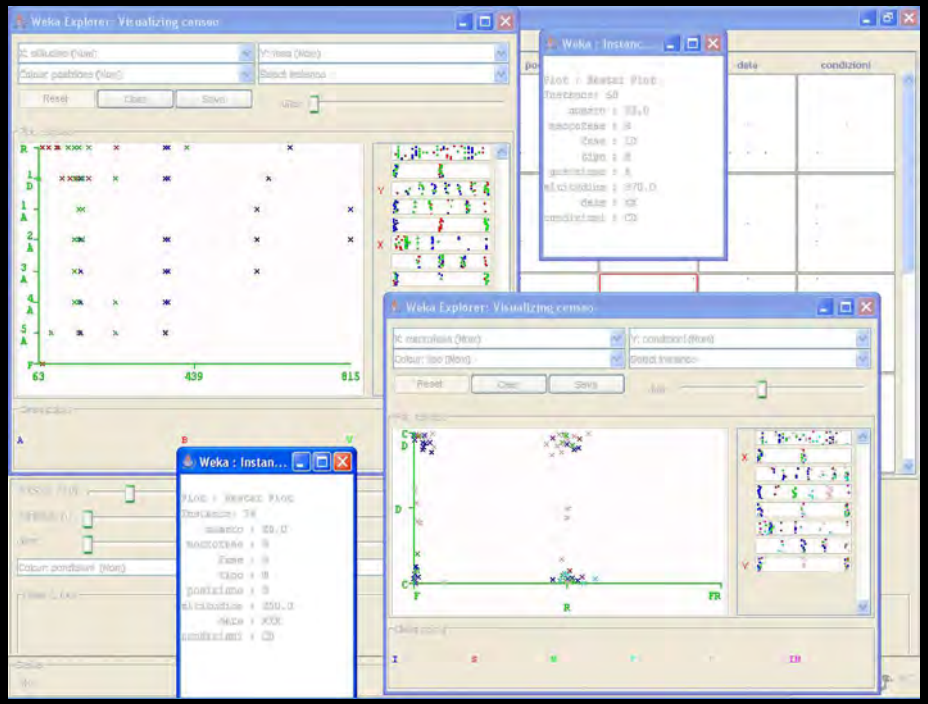
PostgreSQL and MySQL have various user interfaces like MySQL Navigator, which you can see in this screenshot, or PHPMyAdmin, Agatha, PGAcces, PHPPGAdmin and others...

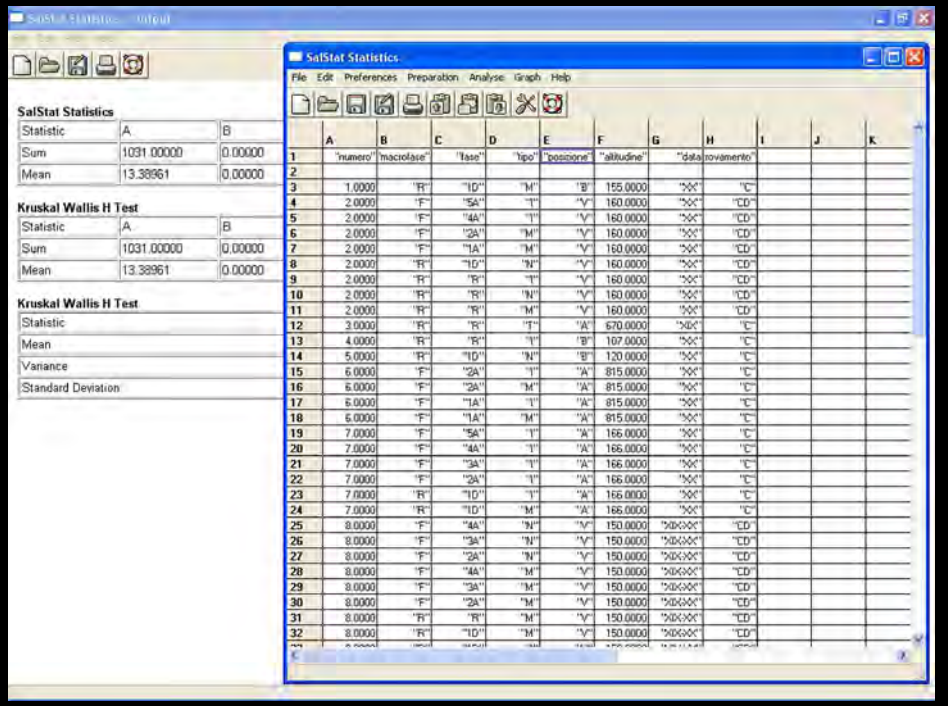


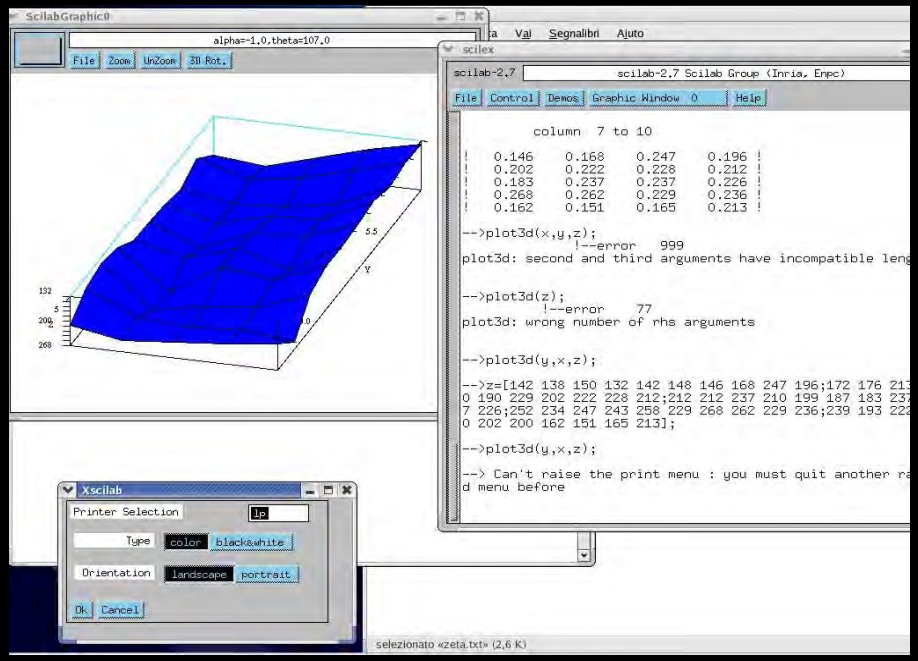
Statistical analysis is well supported by several open source applications. The most important of them is "**R**". In this pictures you can see some diagrams which R created quering a MySQL database.

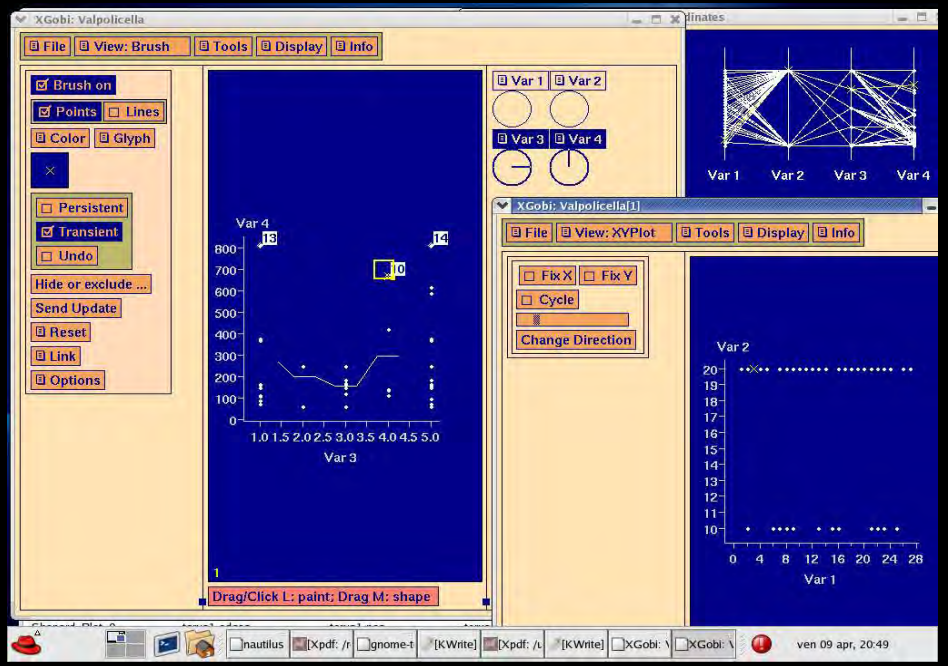


Other packages for statistics are softwares like **Weka**, **Salstat**, **Scilab**, and **Xgobi**

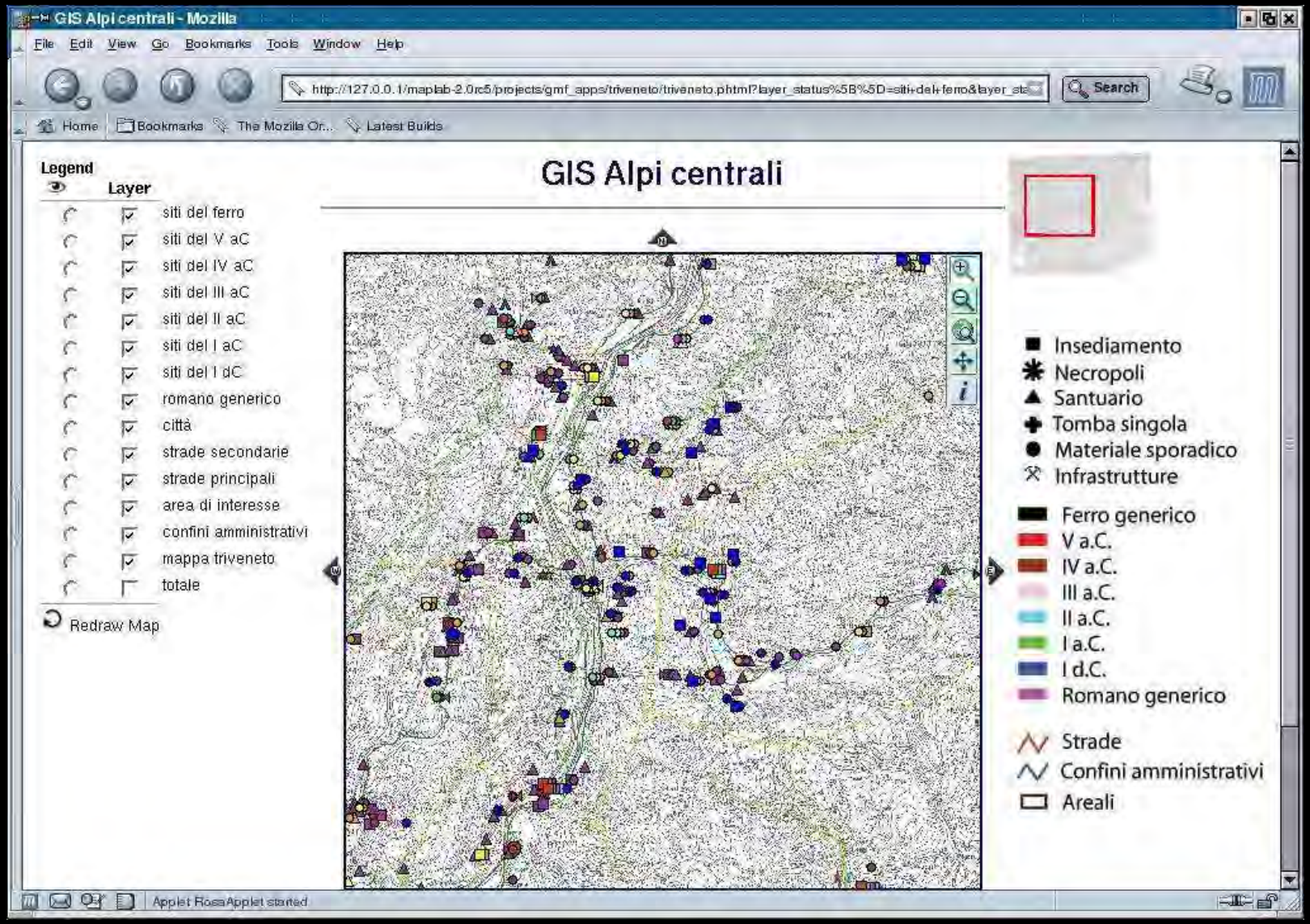








Presentation & (Web-)Publishing WebGIS (**MapServer**, **MapLab**)



It's our belief that WebGIS is the future of spreading archaeological information. If GIS is an indispensable tool for harvesting and managing of archaeological data, WebGIS can be the future link between this data and the science community. MapLab is a graphical tool for that aim. It's optimized for the creation of web mapping applications based on MapServer.

We believe that open source have three decicive advantages:

- first off all software can be modified optimized by it's users,
- it's supported by thousends of programmers all over the world and
- it's accessible for everyone.

Its biggest disadvantages are:

- some software packages aren't yet very user friendly
- the missing request and participation from professional users, in our discipline, slows the developement and improvement of adapted solutions,
- many users (Archaeologists) still have a psycological barrier to renounce their usual software packages and to try new ways.

We hope that our contribute can help to reduce this barrier and to open our discipline for this unique opportunity.

Special thanks to:

Markus Neteler, Cesare Furlanello, Steno Fontanari, Stefano Menegon
(ITC-irst)

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