Markus Neteler
Fondazione E. Mach - CRI
Italy, markus.neteler@iasma.it

GRASS GIS and Sextante

Quarte Giornate Italiane di gvSIG
19-21 April 2011, Udine, Italy

SEXTANTE Overview

By Victor Olaya

- SEXTANTE ("Sistema EXTremeño de ANálisis TErritorial" in Spanish)
- **GIS library written in Java**: an extensive set of geoprocessing modules.
- Developed under the auspices of the government of the Spanish autonomous region of Extremadura
- has evolved into an **all-purpose solution** and continues to cover new fields of application, such as ecology and archaeology
- Usable as extension in many open source Java GIS (such as gvSIG, uDig or OpenJUMP)

Functionality

- Hundreds of modules provide raster and vector data processing tools, tabular data analysis and diagrams
- Speciality: **WPS support** and link to the **GRASS GIS geoprocessing modules**

http://www.sextantegis.com/

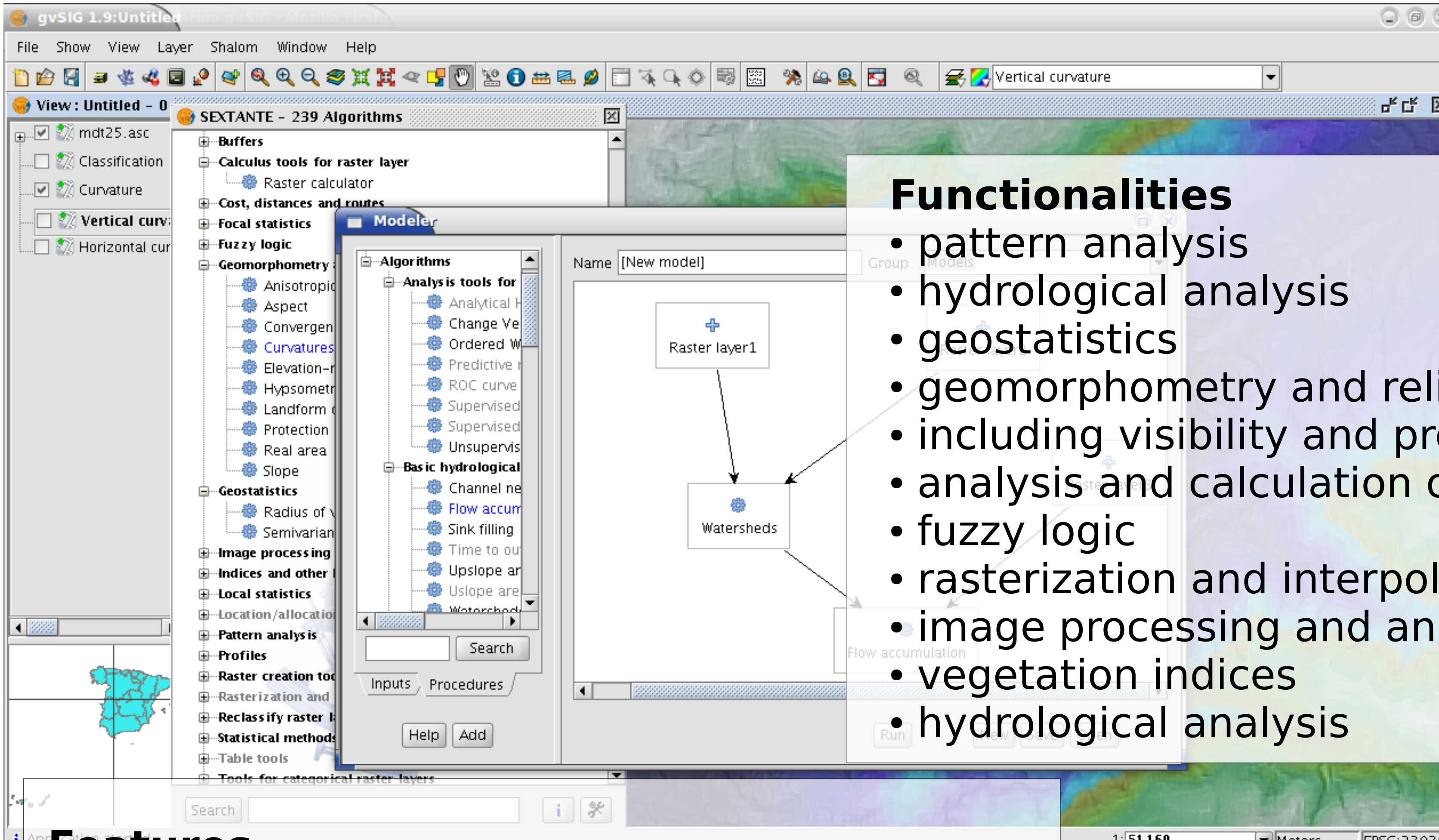
SEXTANTE History

By Victor Olaya

The SEXTANTE project was launched in **2004** with the main goal of developing a GIS solution specially designed for the needs of regional goverment foresters.

- **first version** based on the German software **SAGA** with 190+ algorithms
- in the following years **gvSIG** became a full fledged GIS, including new features such as support for Web services
- Sextante was migrated to gvSIG in order to enrich its functionality especially for analysis
- The import/export routines and other from the management layer are used from gvSIG to avoid duplication

SEXTANTE Overview



Functionalities

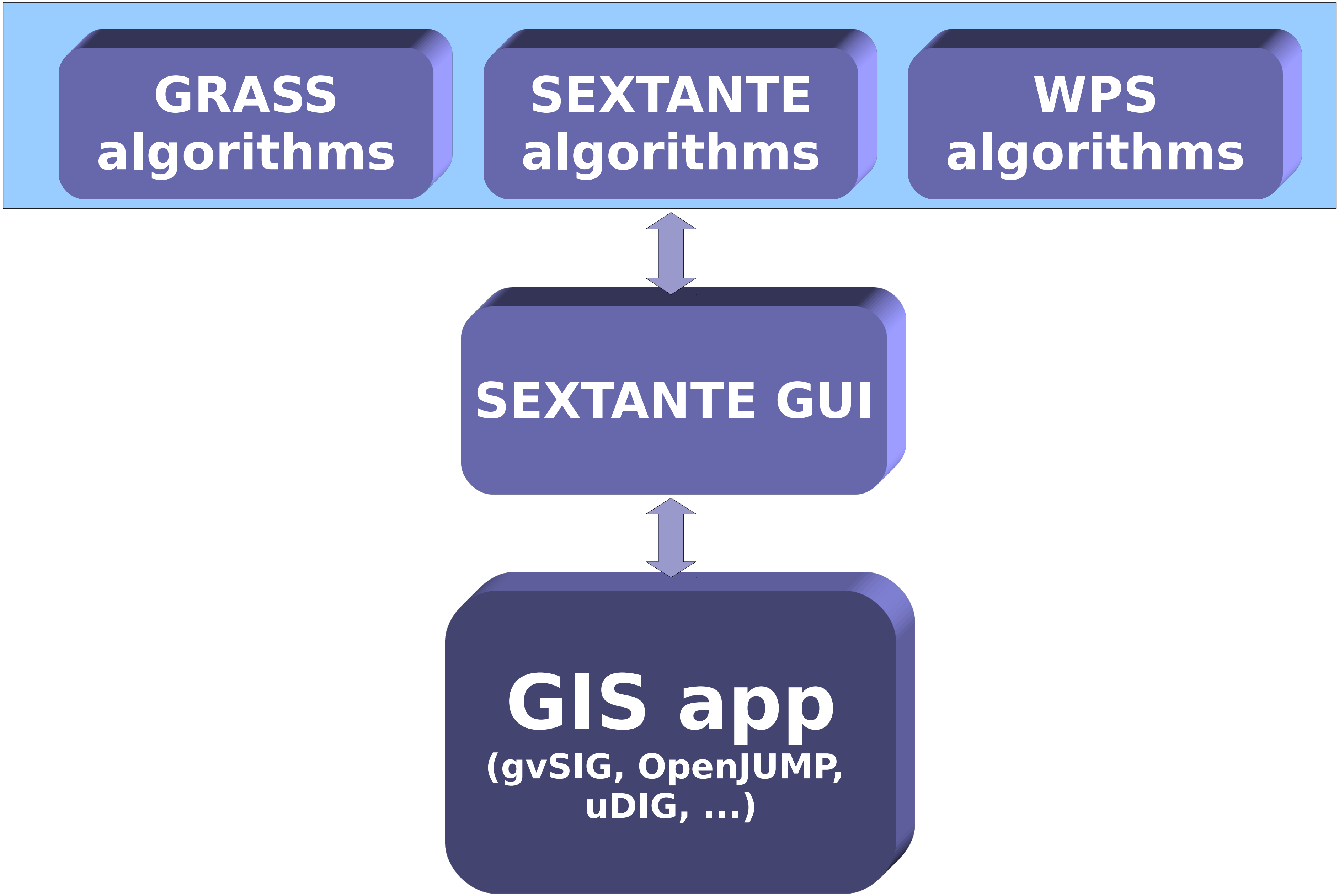
- pattern analysis
- hydrological analysis
- geostatistics
- geomorphometry and relief analysis,
- including visibility and profiles
- analysis and calculation of raster layers
- fuzzy logic
- rasterization and interpolation
- image processing and analysis
- vegetation indices
- hydrological analysis

Features

- Graphical user interface and command line
- geoprocessing manager
- a batch processing manager
- a model generator (modeller)
- history of commands executed by the user so that the processes can be repeated easily.

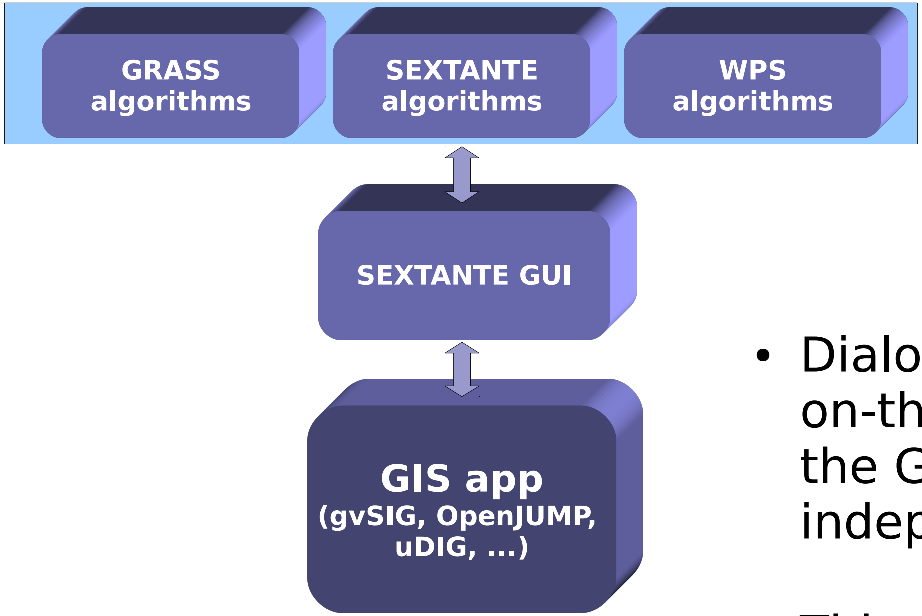
SEXTANTE Architecture

By Victor Olaya



SEXTANTE Architecture

By Victor Olaya



- Dialogs for executing algorithm are created on-the-fly from algorithm requirements, so the GUI and the processes are completely independent.
- This guarantees that all dialogs follow the same criteria and have a similar appearance, making it easier for users to understand them

SEXTANTE – GRASS Integration: How it works

By Victor Olaya

- Each call to a GRASS command is wrapped as a SEXTANTE algorithm
- Such call can be used in any of the graphical components of SEXTANTE
- Each user-seen algorithm involves calling several GRASS commands:
  - Importing data into GRASS into an „on-the-fly“ session
  - Processing of data
  - Exporting and opening results in the GIS app (gvSIG etc)

```
v.edit --interface-description
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE task SYSTEM "grass-interface.dtd">
<task name="v.edit">
        <description>
                Edits a vector map, allows adding, deleting and modifying selected vector features.
        </description>
        <keywords>
                vector, editing, geometry
        </keywords>
        <parameter name="map" type="string" required="yes" multiple="no">
                <description>
                        Name of vector map to edit
                </description>
```

Help

SEXTANTE
- Basic concepts
  - Introduction
  - SEXTANTE toolbox
  - Batch processing
  - Models
  - Command line
  - History
  - Installing grass...
- GRASS
  - Raster (r.*)
  - Vector (v.*)
- Algorithms
  - Basic hydrological analysis
  - Basic tools for raster layers
  - Buffers
  - Calculus tools for raster layer
  - Cost, distances and routes
  - Focal statistics
  - Fuzzy logic
  - Geomorphometry and terrain analysis
  - Geostatistics
  - Image processing
  - Indices and other hydrological parameters
  - Local statistics
  - Location/allocation
  - Pattern analysis
  - Profiles
  - Raster categories analysis
  - Raster creation tools
  - Rasterization and interpolation
  - Raster layer analysis
  - Reclassify raster layers
  - Statistical methods
  - Table tools
  - Tools for line layers
  - Tools for point layers
  - Tools for polygon layers
  - Tools for vector layers
  - Topology
  - Vectorization
  - Vegetation indices
  - Visibility and lighting

SEXTANTE

NAME

v.extrude - Extrudes flat vector object to 3D with defined height.

KEYWORDS

vector, geometry, 3D

SYNOPSIS

v.extrude
v.extrude help
v.extrude [-**t**] **input**=*name* **output**=*name* [**zshift**=*float*] [**elevation**=*name*] [**height**=*float*] [**hcolumn**=*name*] [**type**=*string*[,*string*,...]] [**layer**=*integer*] [--**overwrite**] [--**verbose**] [--**quiet**]

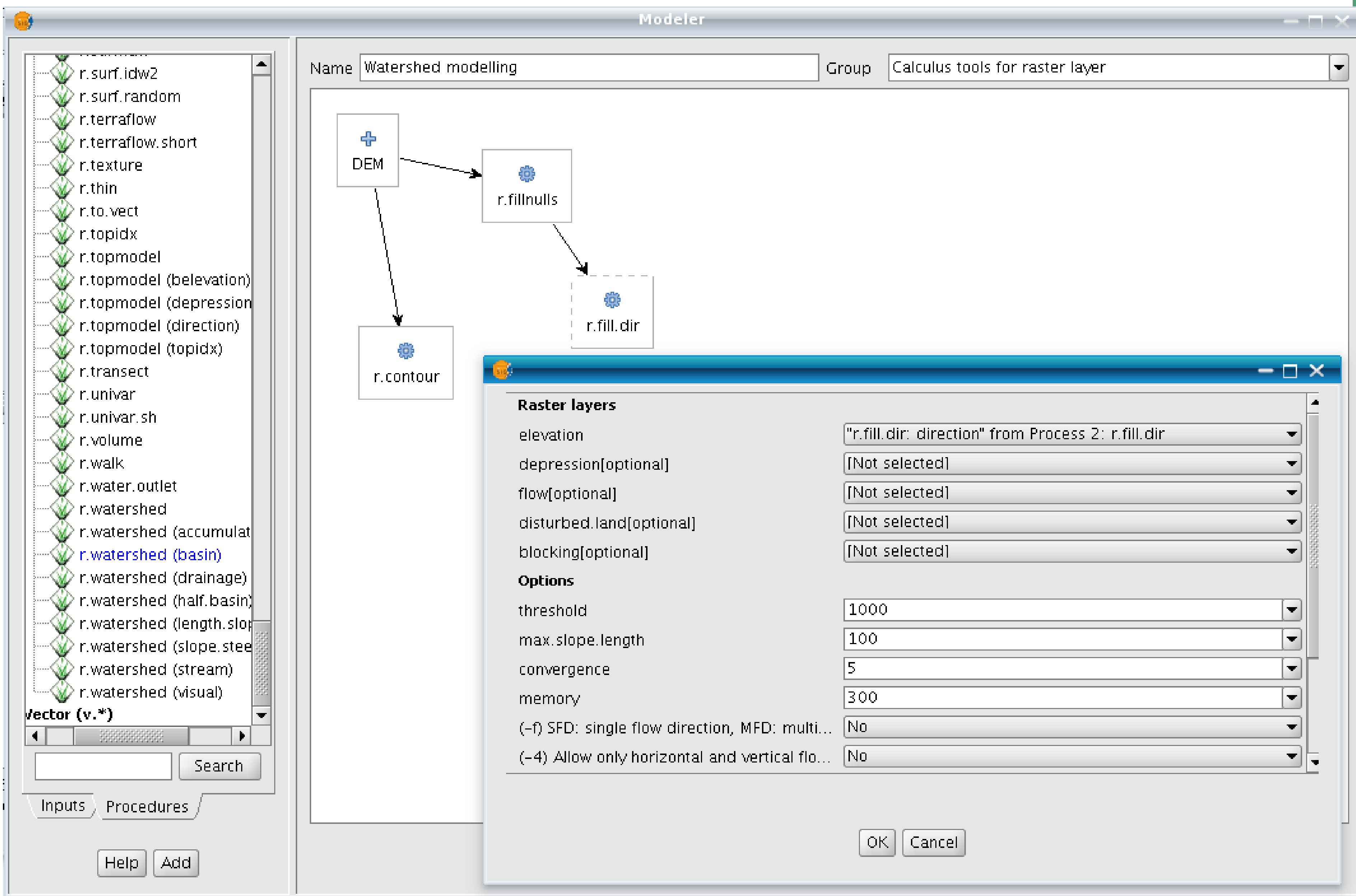
Flags:

-t
Trace elevation
--overwrite
Allow output files to overwrite existing files
--verbose
Verbose module output
--quiet
Quiet module output

Parameters:

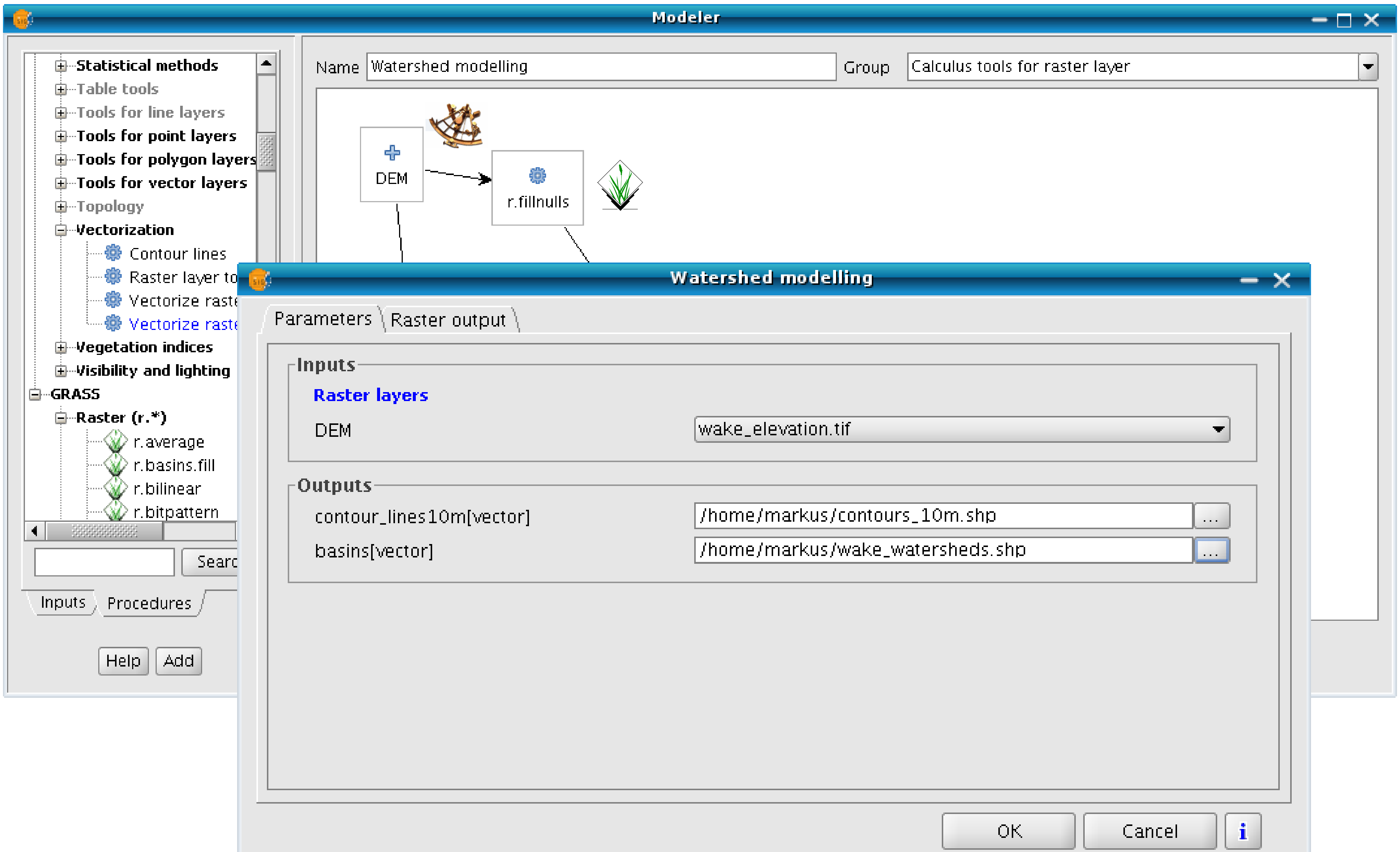
input=*name*
Name of input 2D vector map
output=*name*
Name of resulting 3D vector map
zshift=*float*
Shifting value for z coordinates
Default: *0*
elevation=*name*
Elevation raster for height extraction
height=*float*

SEXTANTE – GRASS Integration: Modeller

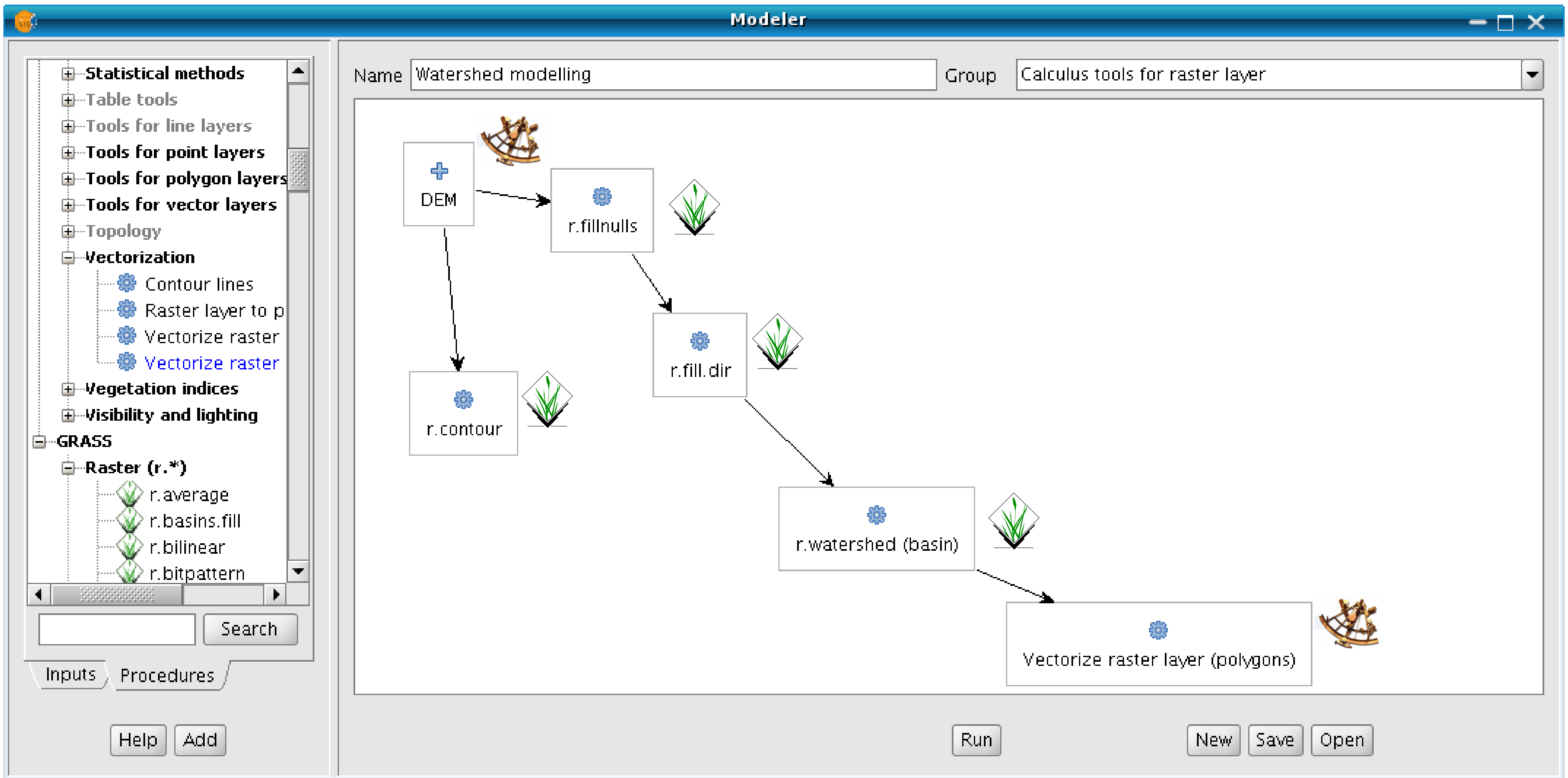


Markus Neteler, 2011: GRASS GIS and Sextante
Quarte Giornate Italiane di gvSIG, Udine, Italy

SEXTANTE – GRASS Integration: Modeller



SEXTANTE – GRASS Integration: Modeller



Note: Partially functional in gvSIG OADE 2010, more to come in (near) future...

GRASS GIS:
Geographic Resources Analysis Support System

Free Software GIS (“software libero”):

- Developed since **1982**, under GPL since 1998
- GRASS master Web: **http://grass.osgeo.org**
- *Portable:* Versions for GNU/Linux, MS-Windows, Mac OSX, etc
- Sample data for download (free North Carolina dataset)
- Mailing lists in various languages
- Commercial support available

The early days of open source GIS: pre-Internet times...


construction engineering research laboratory

United States Army Corps of Engineers

Technical Report N-154
May 1983

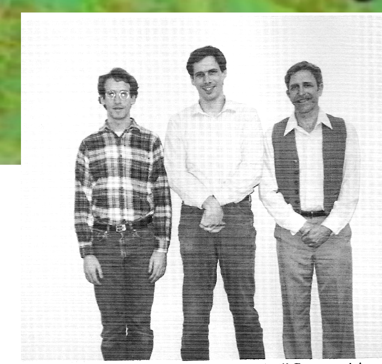
FORT HOOD GEOGRAPHIC INFORMATION SYSTEM:
PILOT SYSTEM DEVELOPMENT AND USER INSTRUCTIONS

by
William D. Goran
William E. Dvorak
Lloyd Van Warren
Ronald D. Webster

CERL

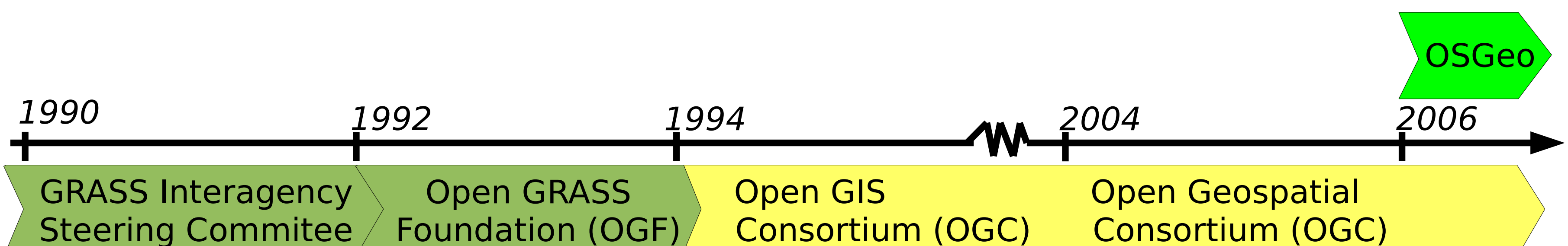
Approved for public release; distribution unlimited.

1987: William Shatner narrates ...



CERL's Michael Shapiro, Jim Westervelt, and Bill Goran, recipients of the 1st GAIA Award (photo by Brenda Johnson, USACERL, 3/90).

1978: MOSS
1982: GRASS GIS



GRASS GIS: Functionality

geospatial data integration

- import and export of data in various formats, coordinate systems transformations and **projections**, transformations between raster and vector data, **2D/3D spatial interpolation** and approximation

2D/3D raster data processing

- 2D and 3D map algebra, surface and volume geometry analysis, topographic parameters and landforms, flow routing and **watershed** analysis, line of sight, **insolation**, cost surfaces, shortest path, buffers, landscape ecology measures, correlation, covariant analysis, expert system (Bayes logic)

2D/3D vector data processing

- multi-attribute vector data management, **topological** digitizing, overlay, buffers, vector **network analysis**, spatial autocorrelation, summary statistics, multivariate spatial interpolation and approximation, Voronoi polygons, triangulation, **SQL**

image processing

- processing and analysis of **multispectral** aerial and satellite data, image rectification and **orthophoto** generation, principal and canonical component analysis, smap classification and edge detection, radiometric correction

visualization

- 2D display of raster and vector data with zoom and pan, 3D visualization of surfaces and **volumes** with vector data, 2D and 3D animations, hardcopy postscript maps,

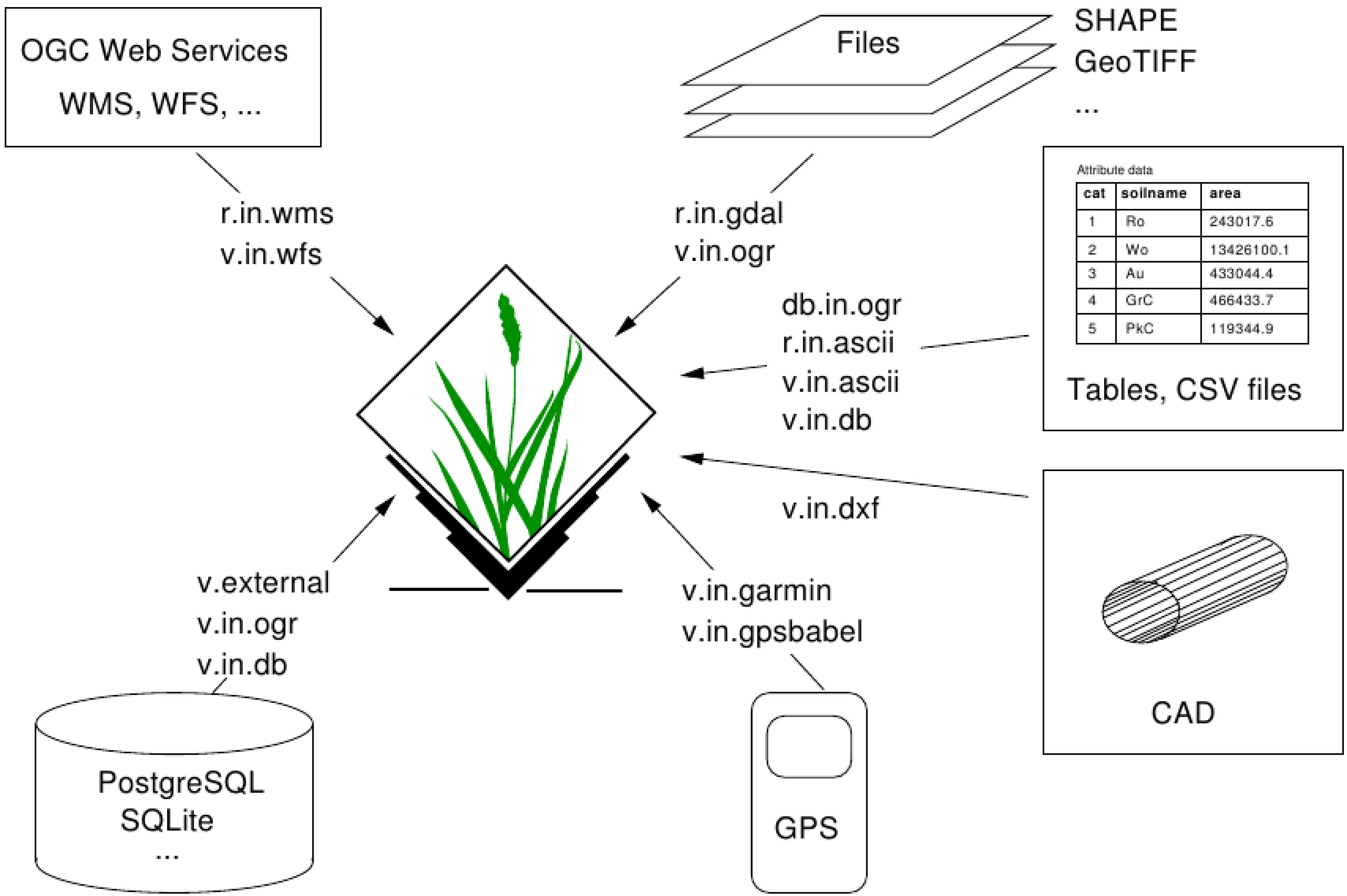
modeling and simulations

- hydrologic, erosion and pollutant transport, fire spread, temporal data support, time stamp for raster and vector data, raster **time series** analysis

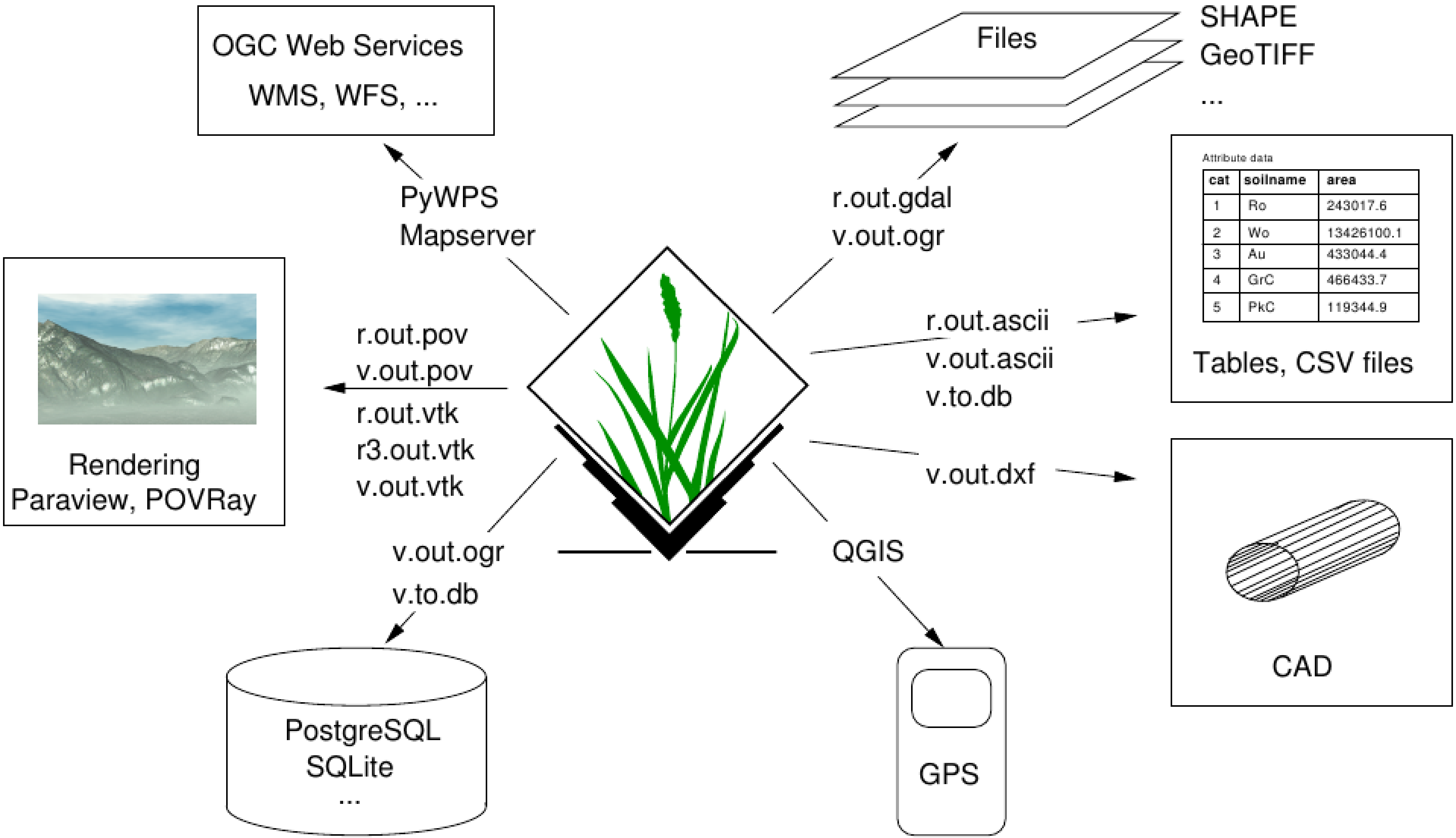
links to Open Source tools

- QGIS, R-stats, gstat, **ZOO-WPS**, Paraview, GPS tools, GDAL/OGR, PostgreSQL, MySQL, gvSIG-Sextante, ...

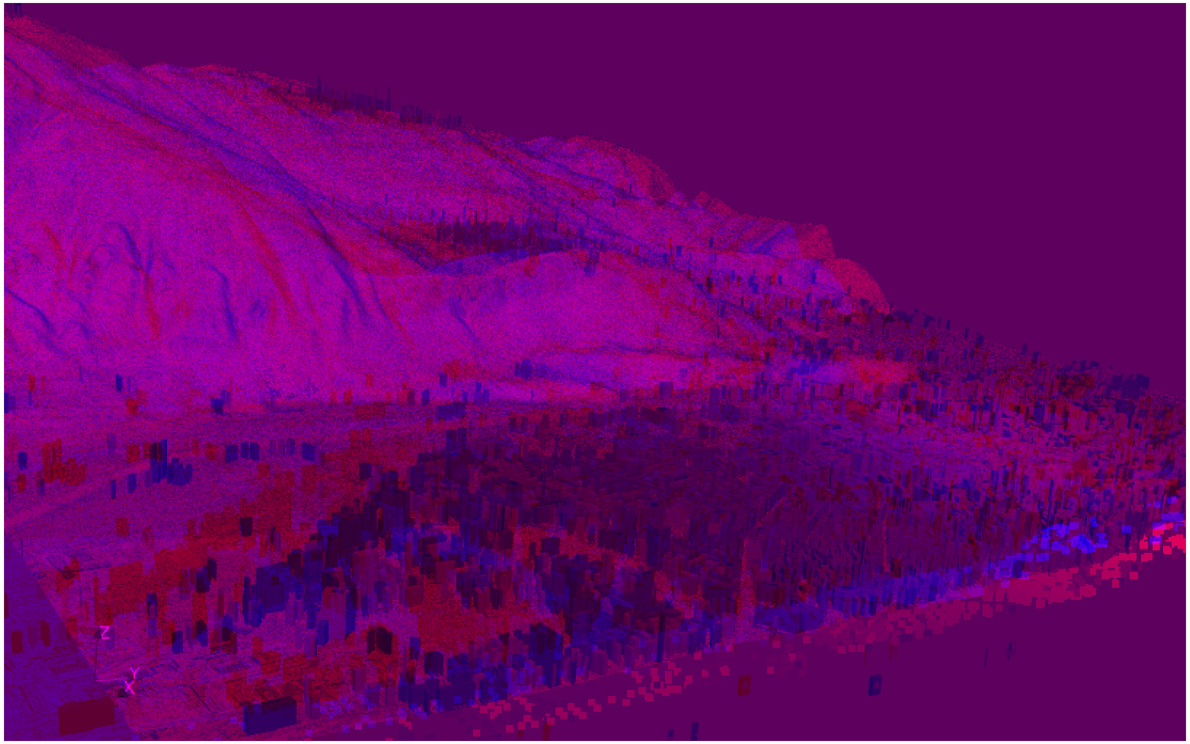
GRASS GIS: Interoperability – Import

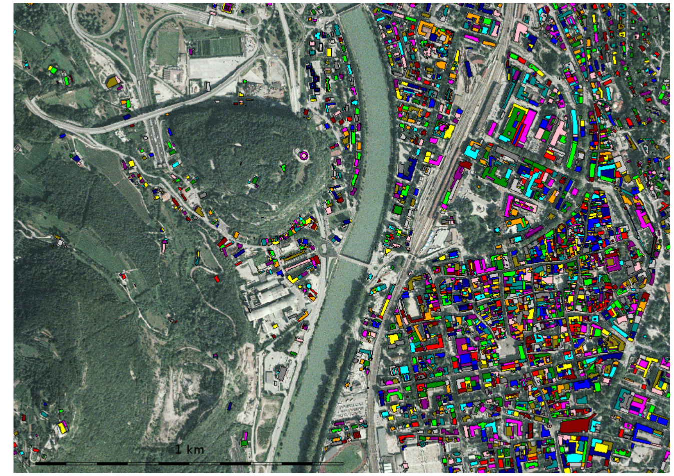


GRASS GIS: Interoperability – Export



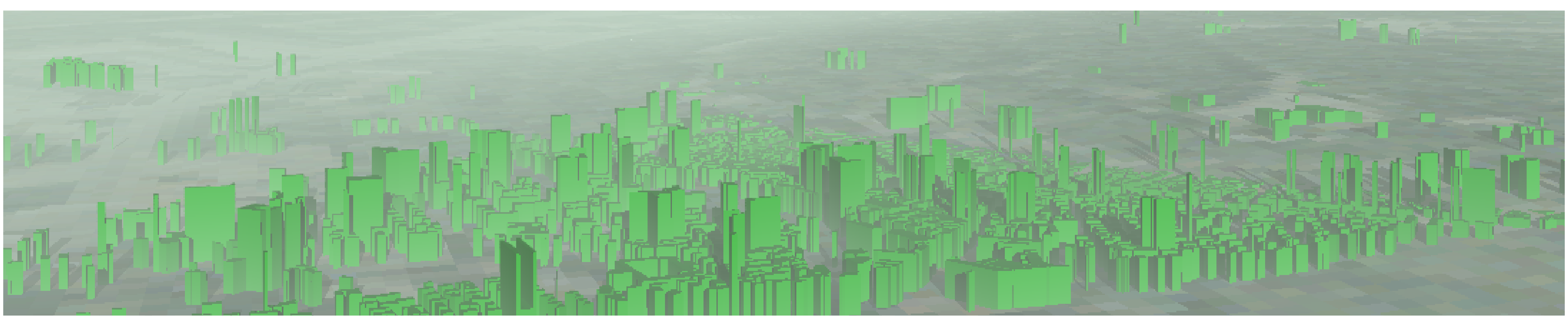
Visualization: GRASS data export to Paraview and Povray





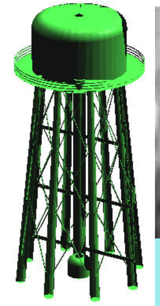
Stereo rendering in **Paraview** (www.paraview.org)

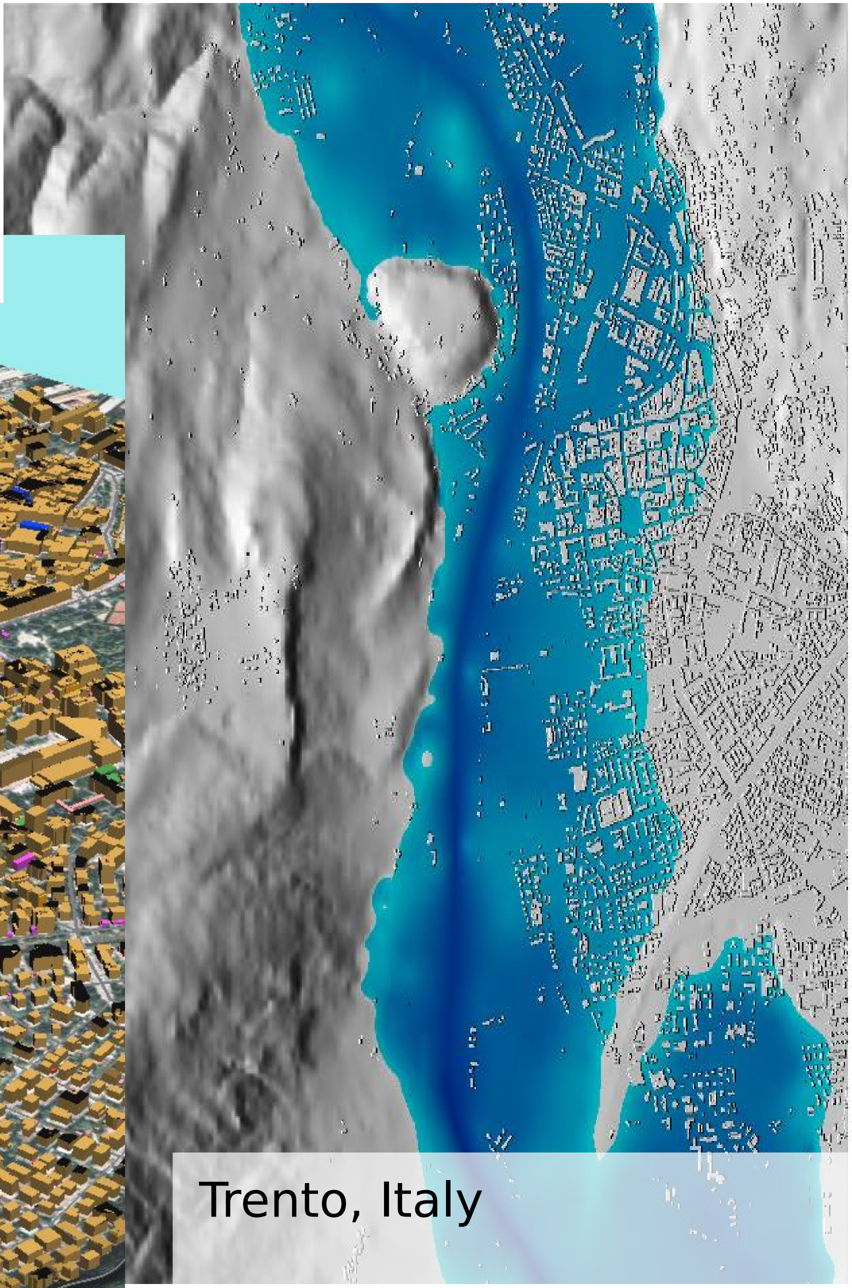
Povray rendering (www.povray.org): adding clouds and haze



GRASS: Raster and 3D vector

Elevation model combined with extruded 3D buildings; also true 3D vector supported

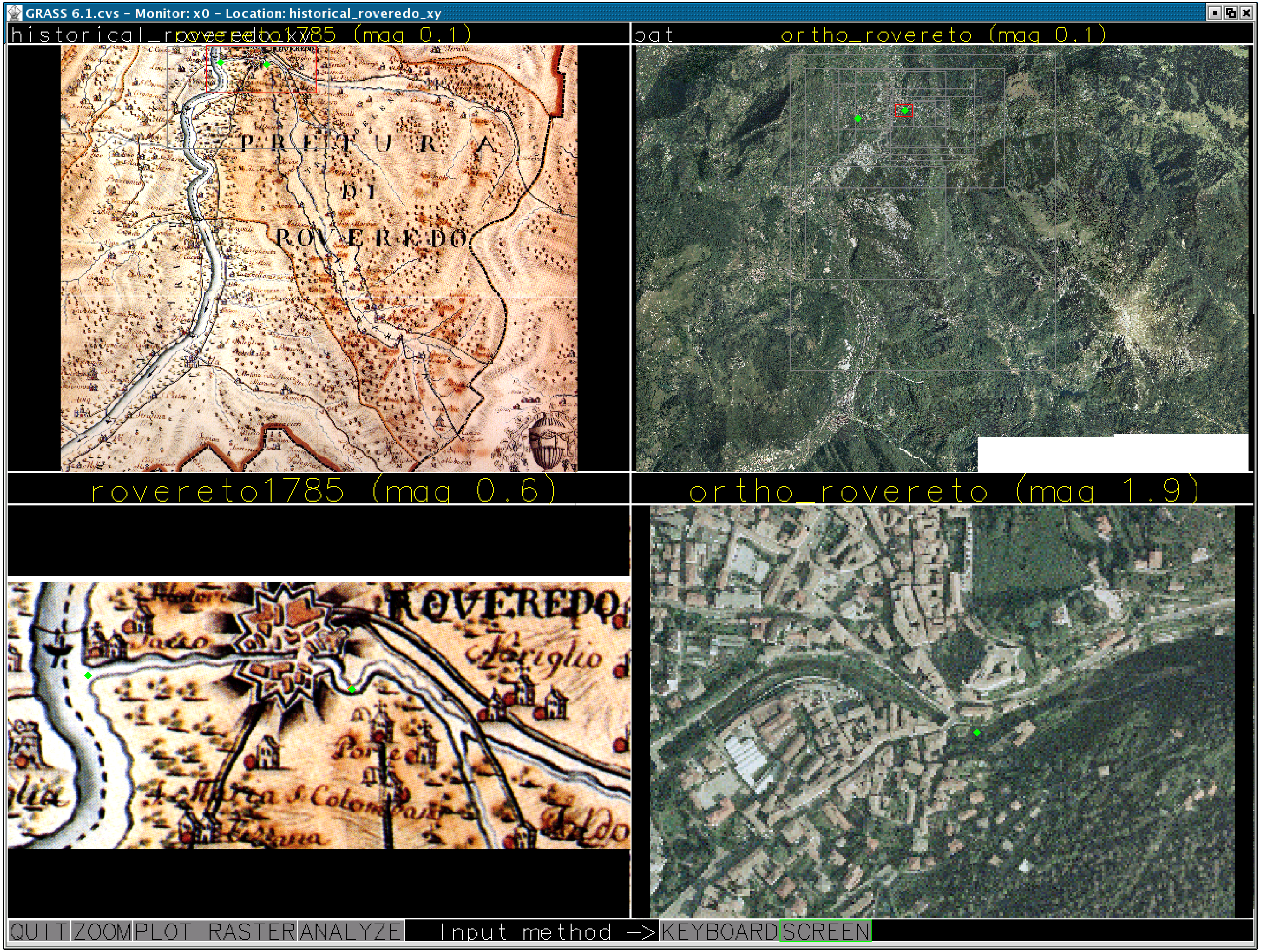




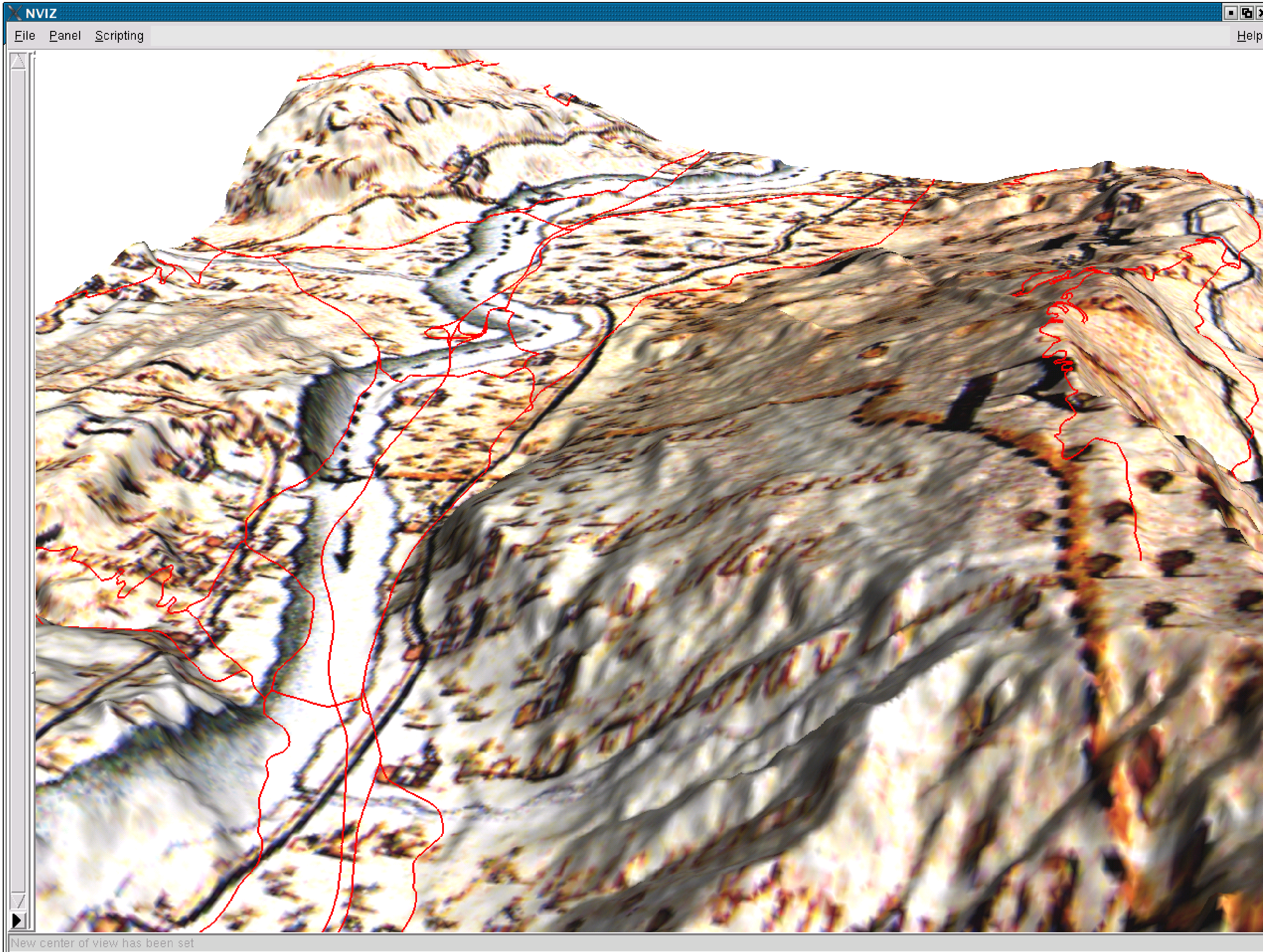
Trento, Italy

Optional: KML export for virtual globes

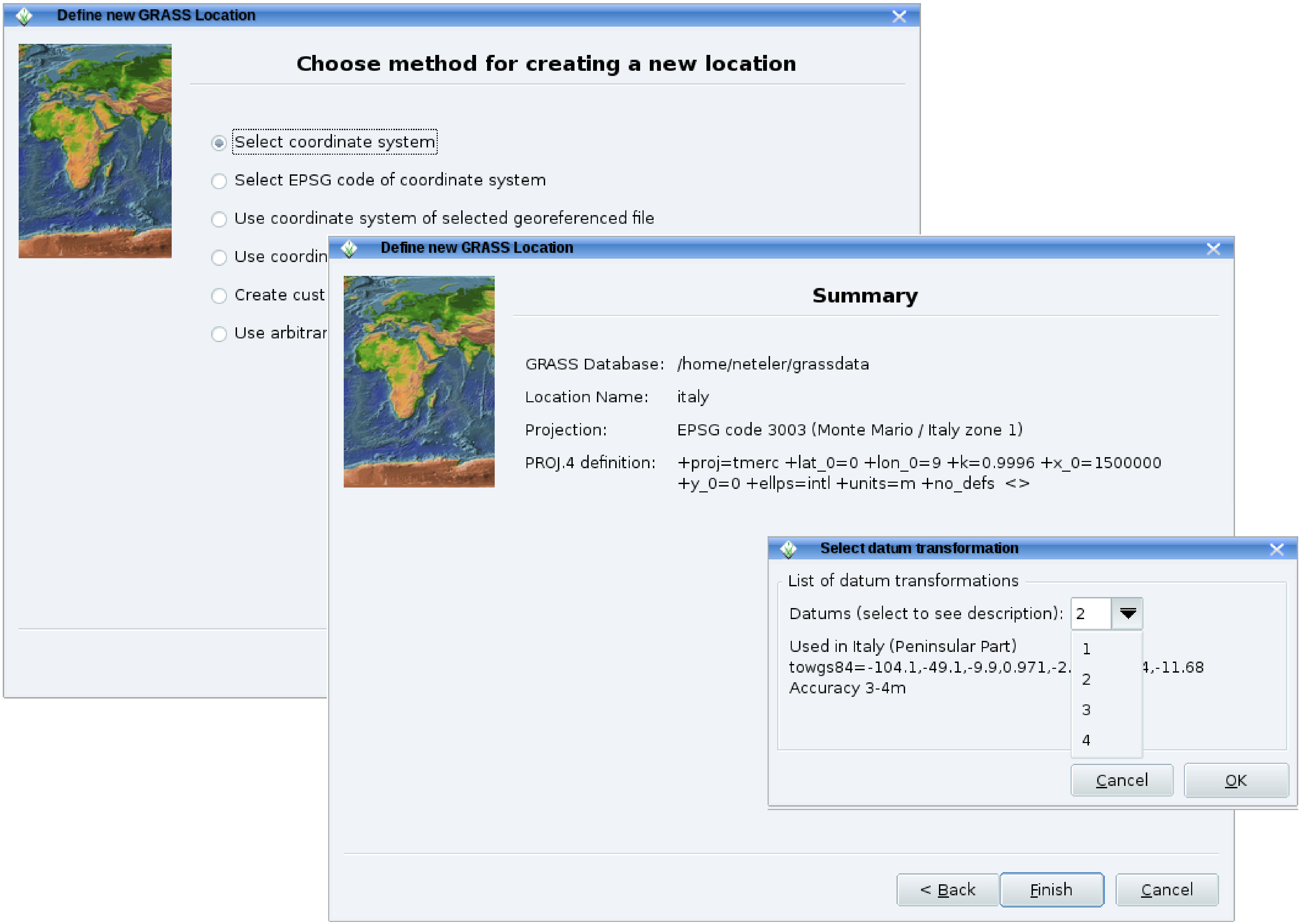
GRASS: geocoding of historical maps



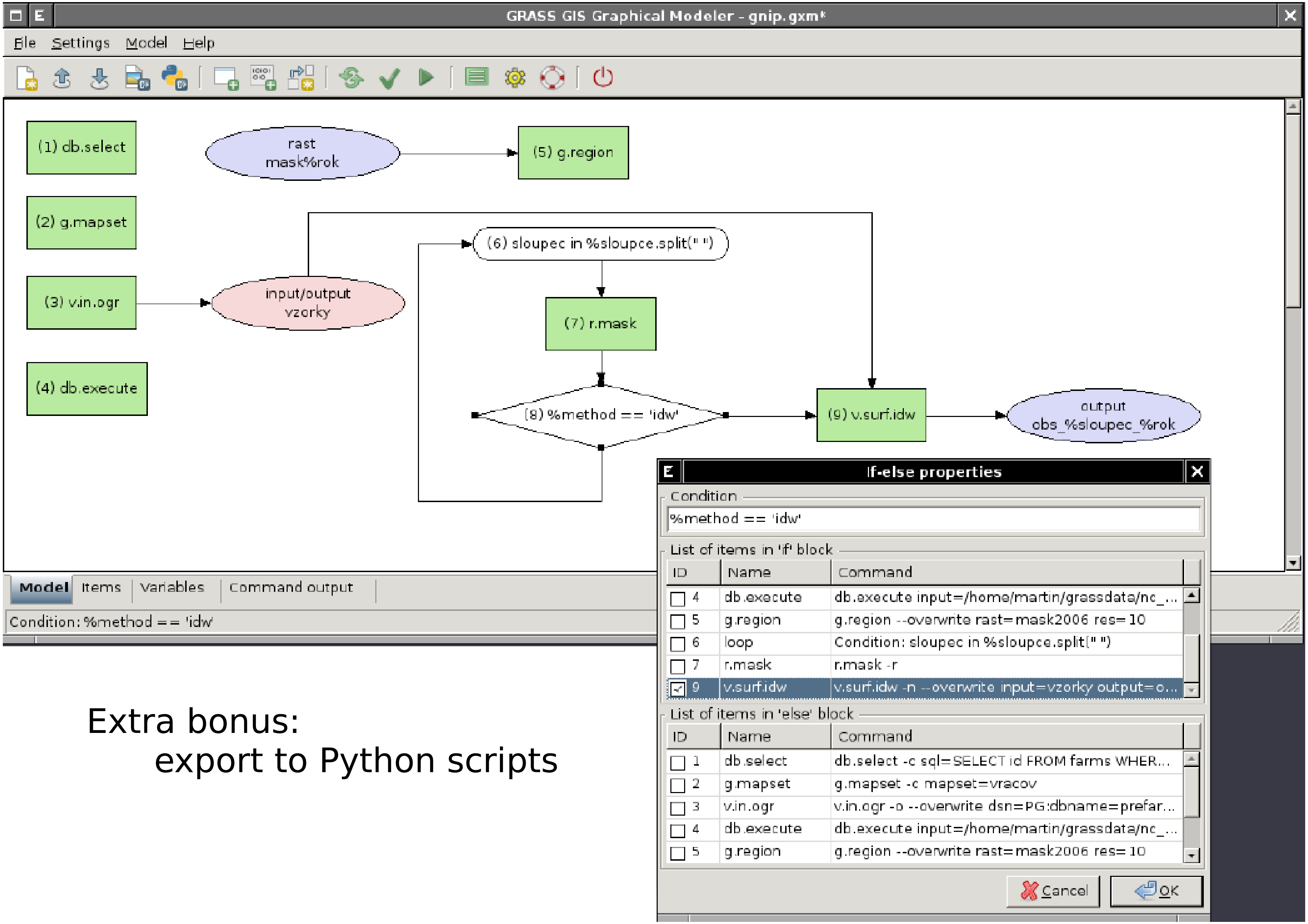
GRASS: geocoding of historical maps



GRASS: Project database (Location) wizard

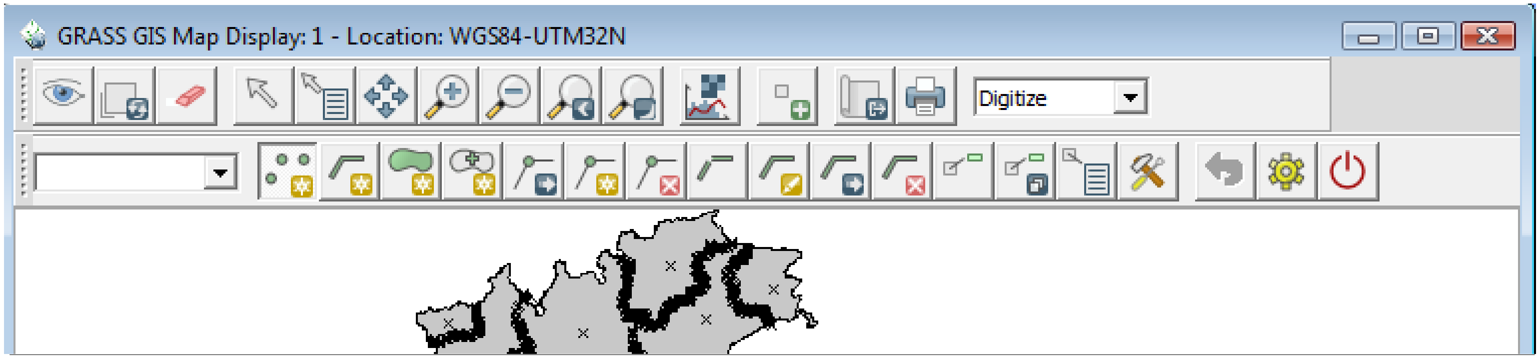


GRASS: Geospatial modeller

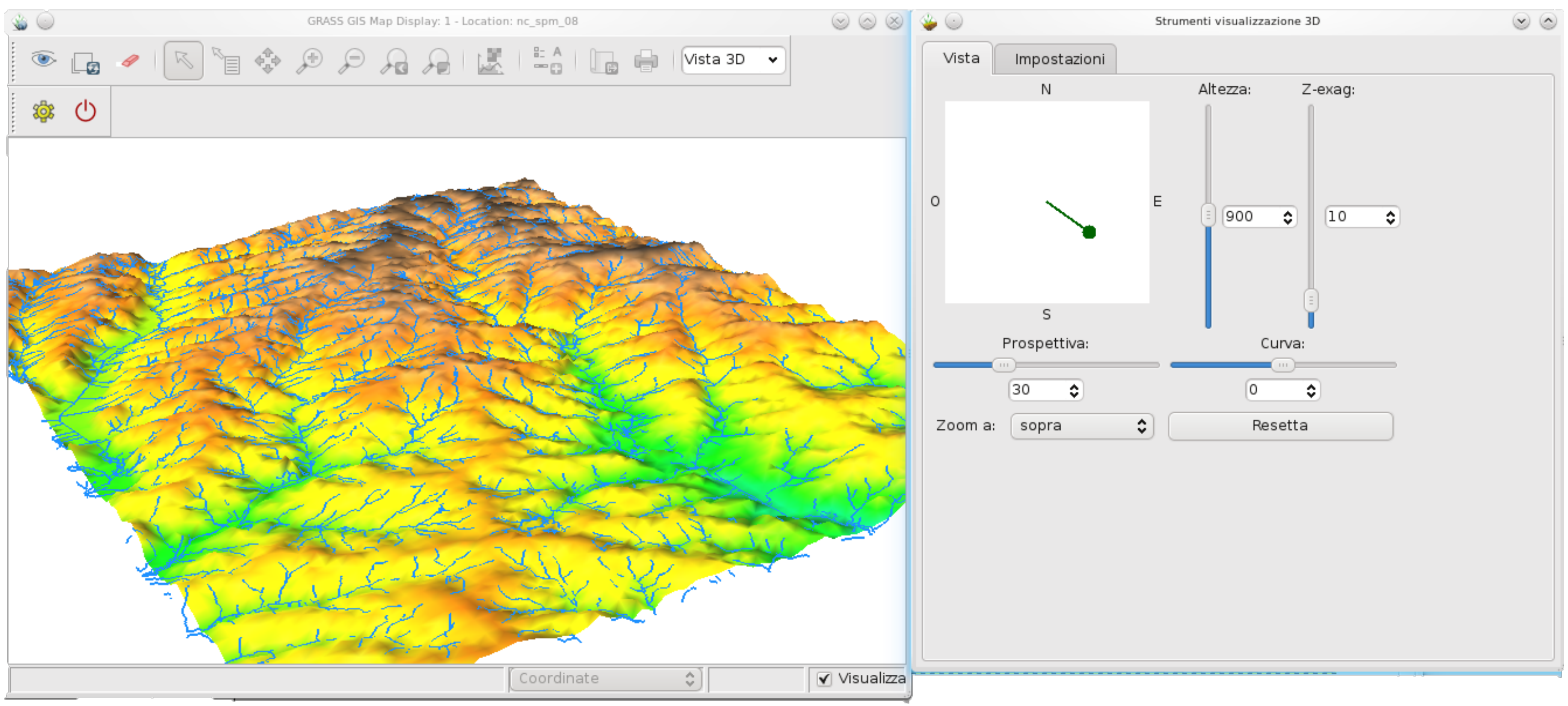


Extra bonus:
export to Python scripts

More GRASS GIS Features



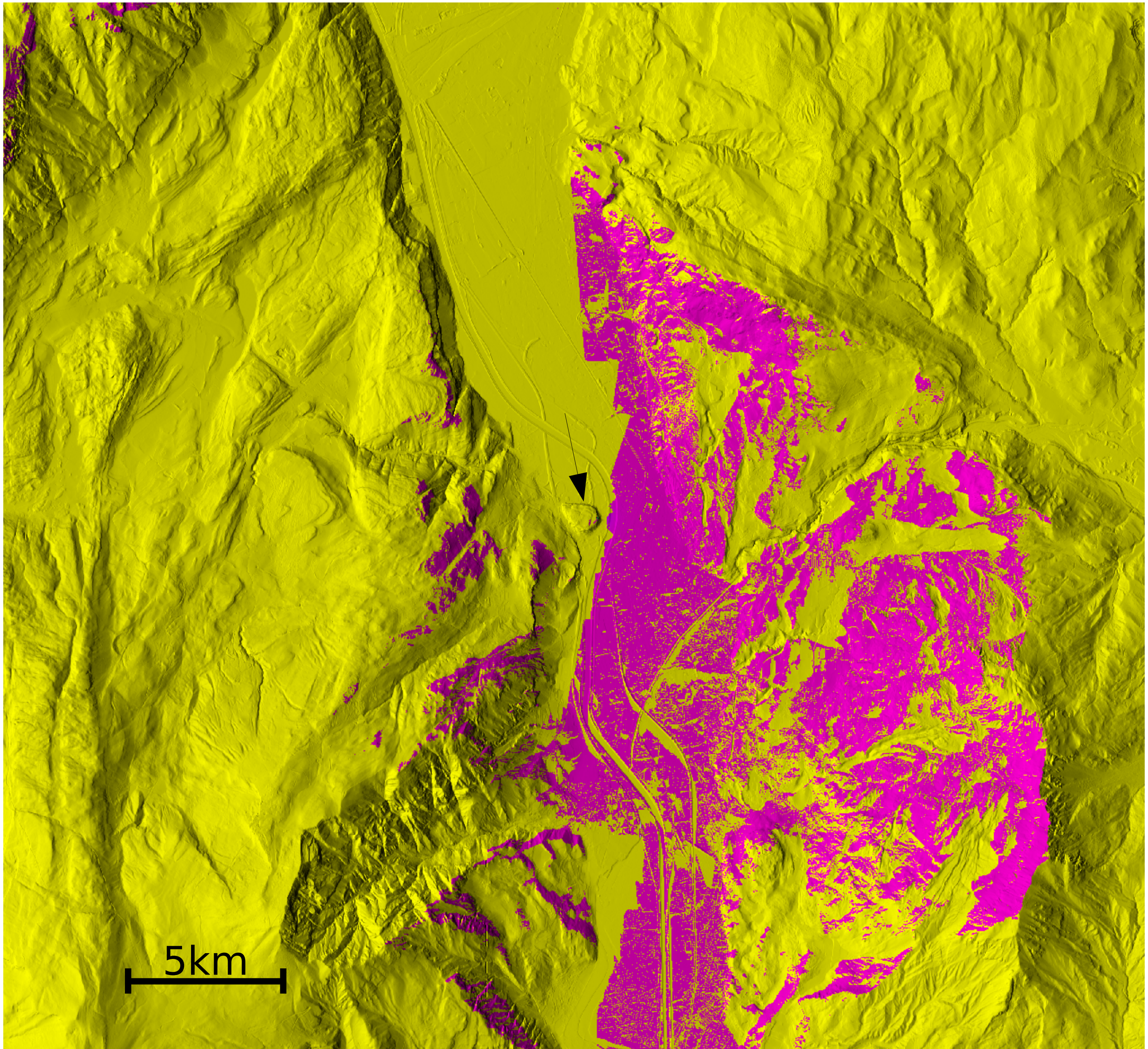
Topological Digitizer



OpenGL based 3D viewer: nviz 3D

Viewshed analysis with GRASS

New, extremely fast viewshed algorithm (yet in GRASS-Addons): **r.viewshed**



Comparison on a 5m Lidar based DEM (left map) – calculation time:

- common command:
  r.los: 4.5h

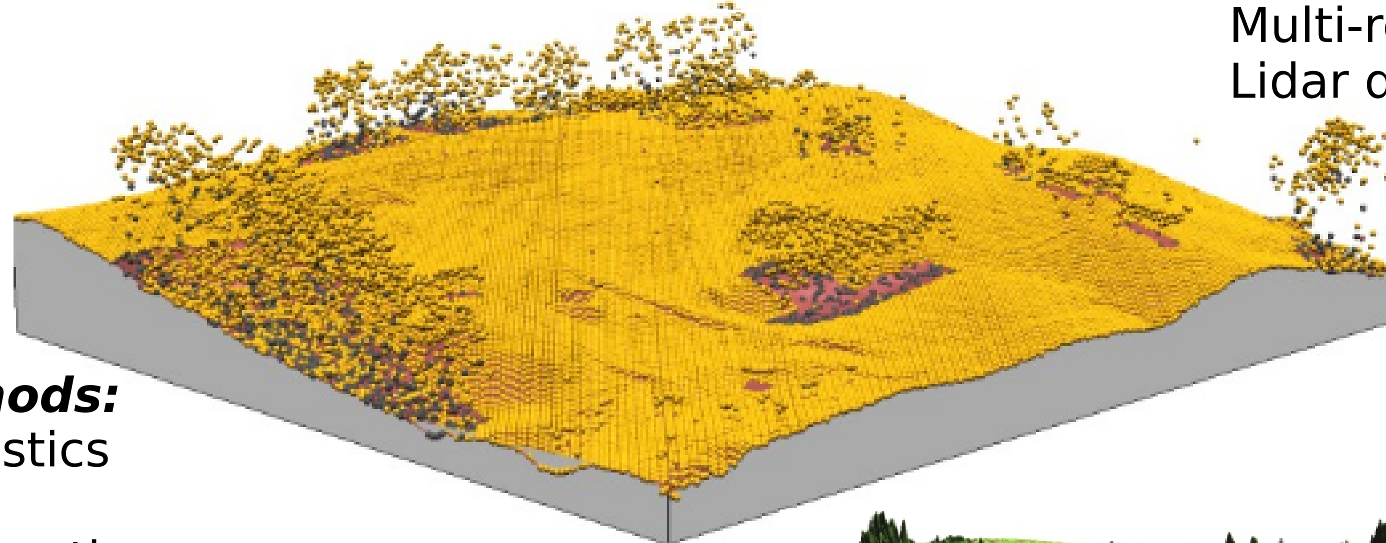
- rewritten:
  r.viewshed: 18 sec

Viewsheds include Earth curvature

Viewshed from Dos Trento

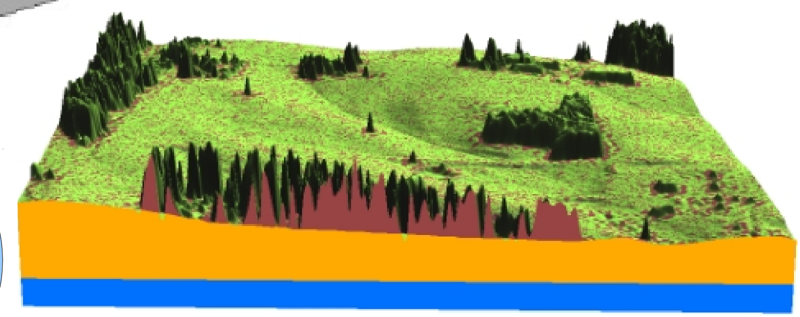
Lidar data analysis in GRASS GIS

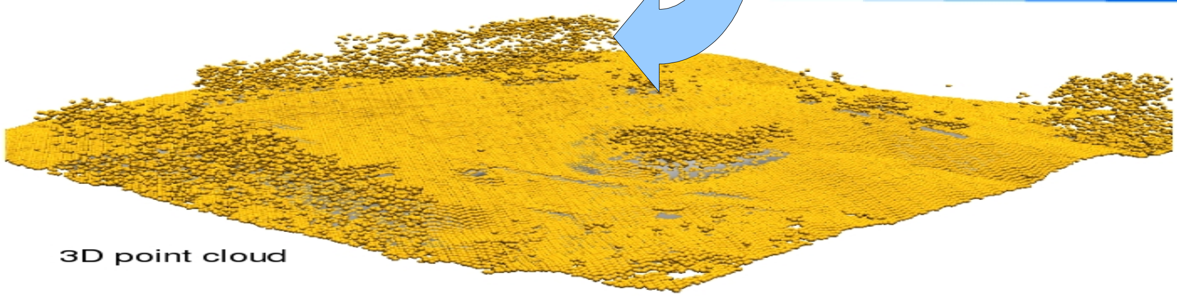
Multi-return
Lidar data



Available Methods:
- cell based statistics
- binning
- spatial approximation
- smoothing

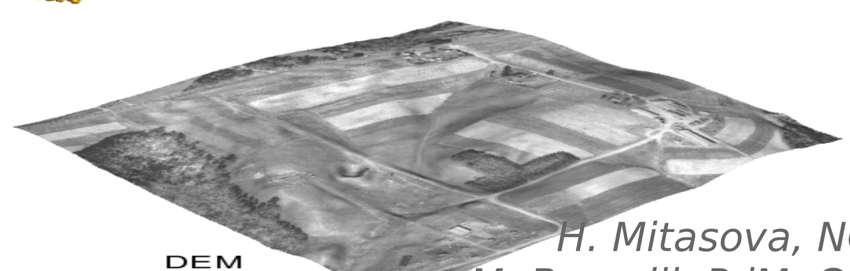
Use cases:
- topographic analysis
- Feature extraction (Separation DEM/DSM)





3D point cloud

DSM



DEM

H. Mitasova, NCSU
M. Brovelli, PdM, Como

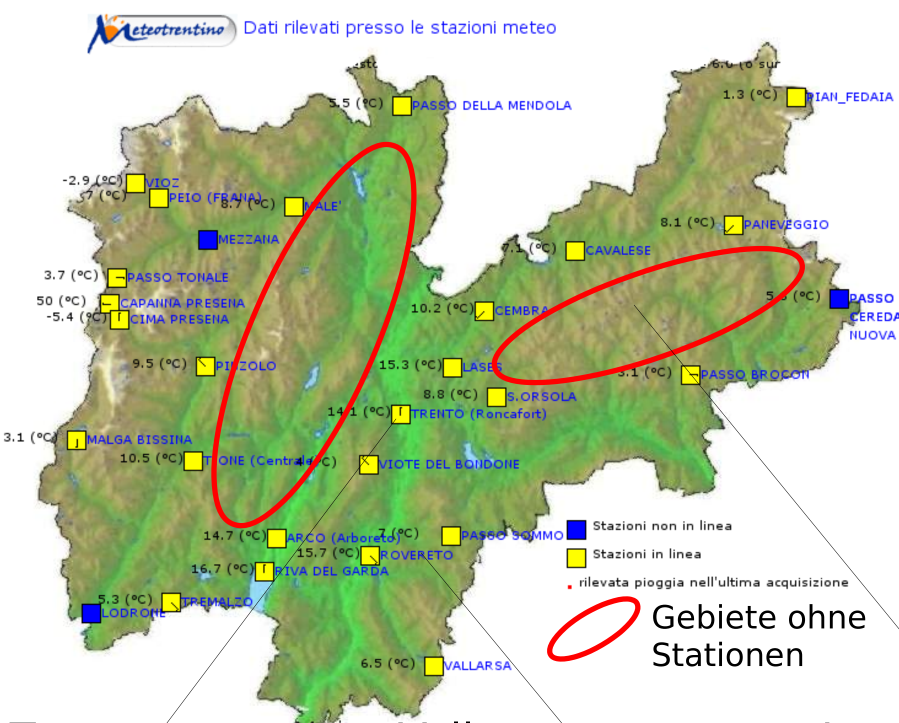
Short DEMO

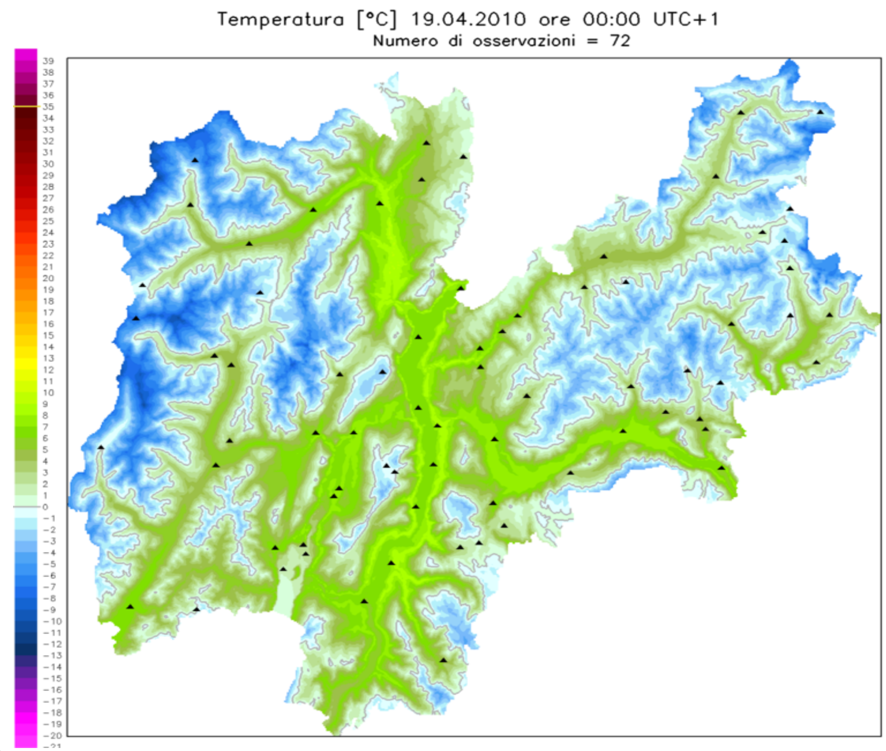
Tiger mosquito project @ Fondazione E. Mach

Using GFOSS at its best...

Scarse meteo-stations or dense MODIS LST maps?

Interpolation of meteo data likely complicated due to complex alpine relief: Data density and micro-climatic effects

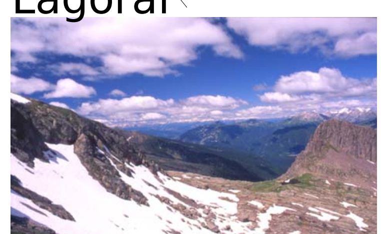




Trento

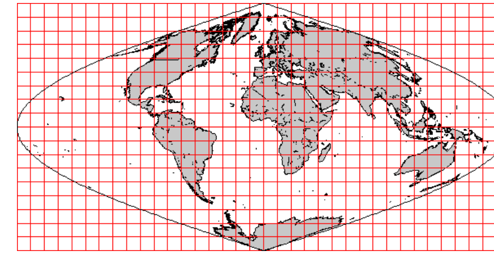
Vallarsa

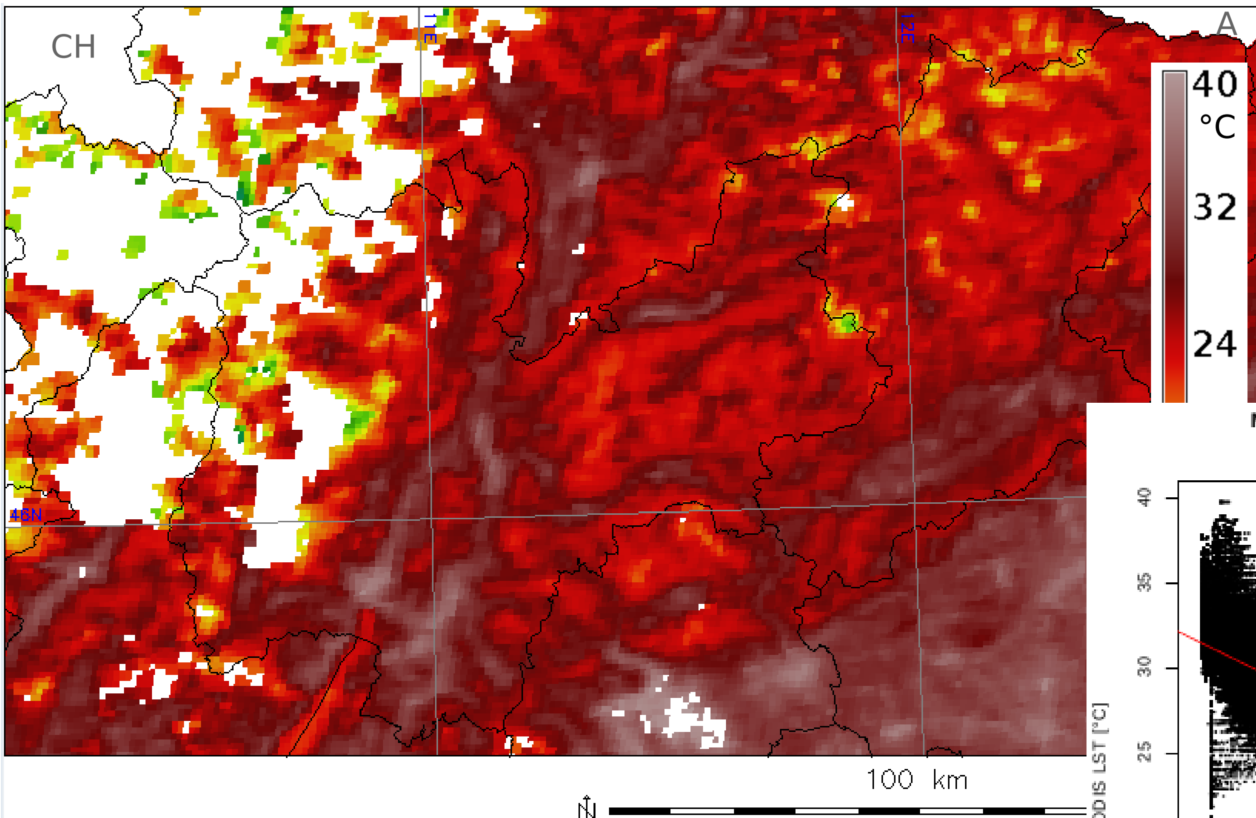
Lagorai



Official temperature map from meteo model (number of stationens variable, data access limited)

Overcoming the clouds problem in satellite based land surface temperature data





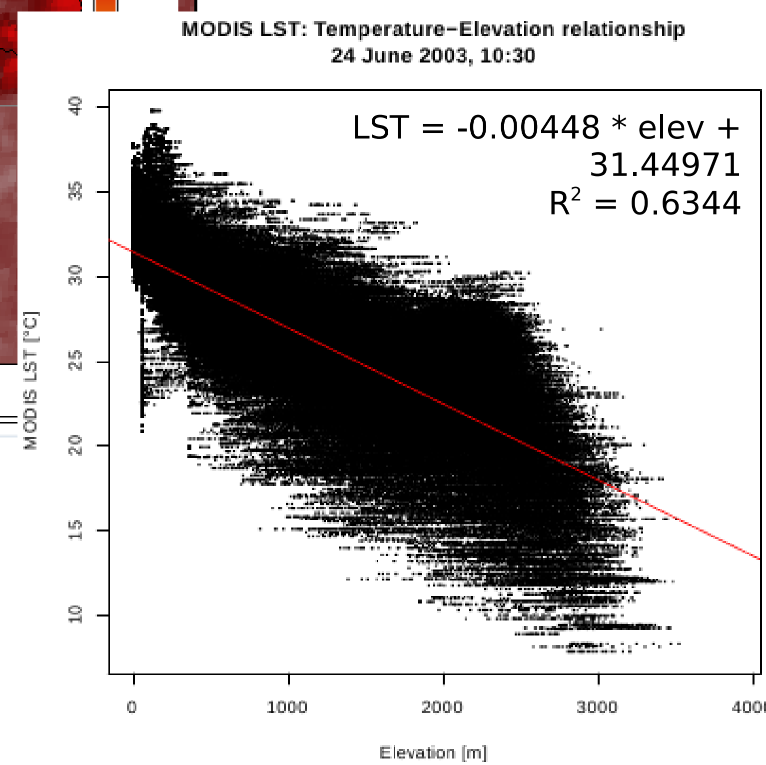
MODIS LST/Terra, 24 June 2003, 10:30 solar time

Missing pixels due to clouds, aerosol, haze, ...

Approach:

Relationship temperature - elevation: gradient method

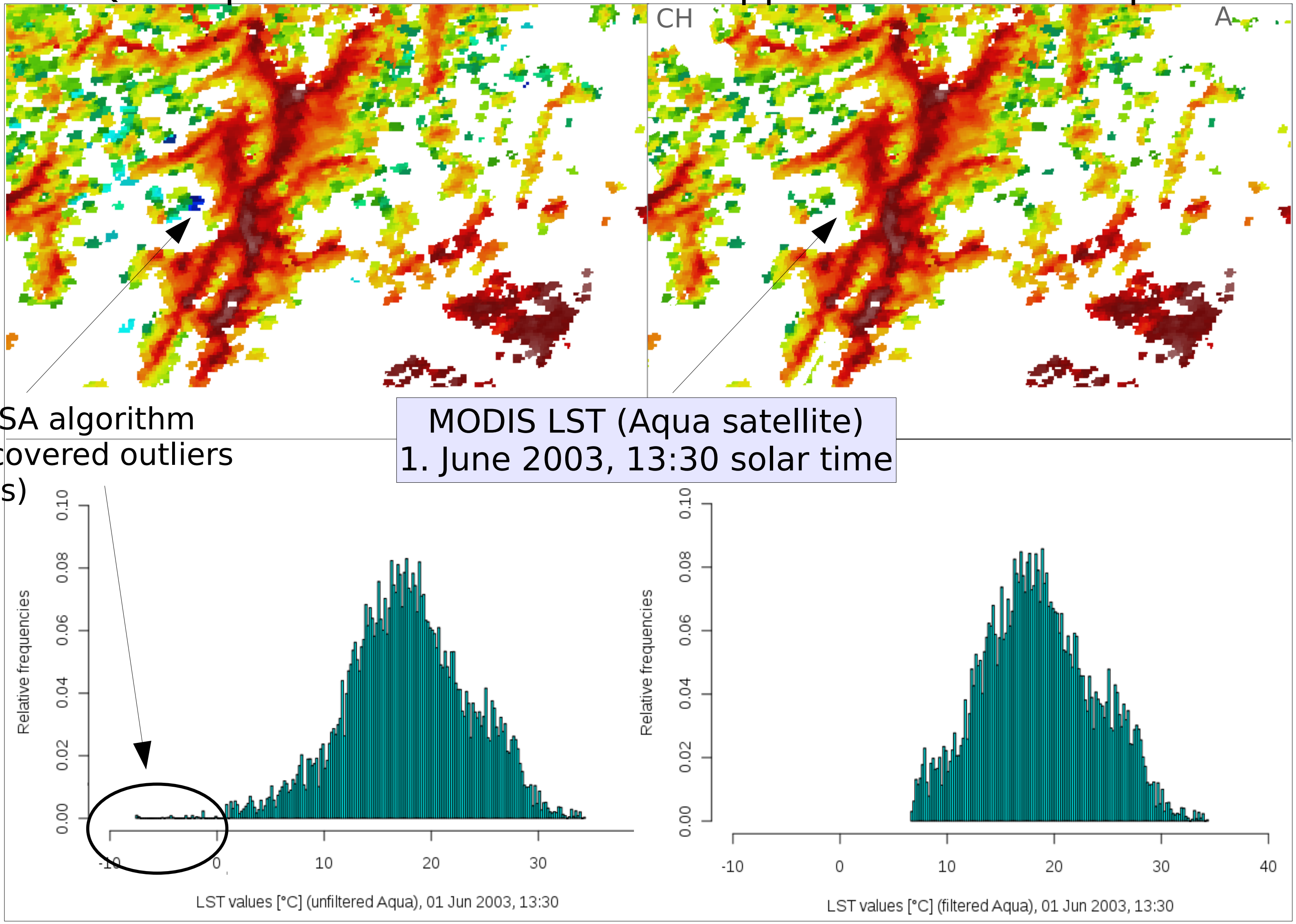
Elevation model → LST



Results of MODIS LST reconstruction

Original MODIS LST map,
QA map used as filter

Second and third filter step
applied to MODIS map



By NASA algorithm
undiscovered outliers
(clouds)

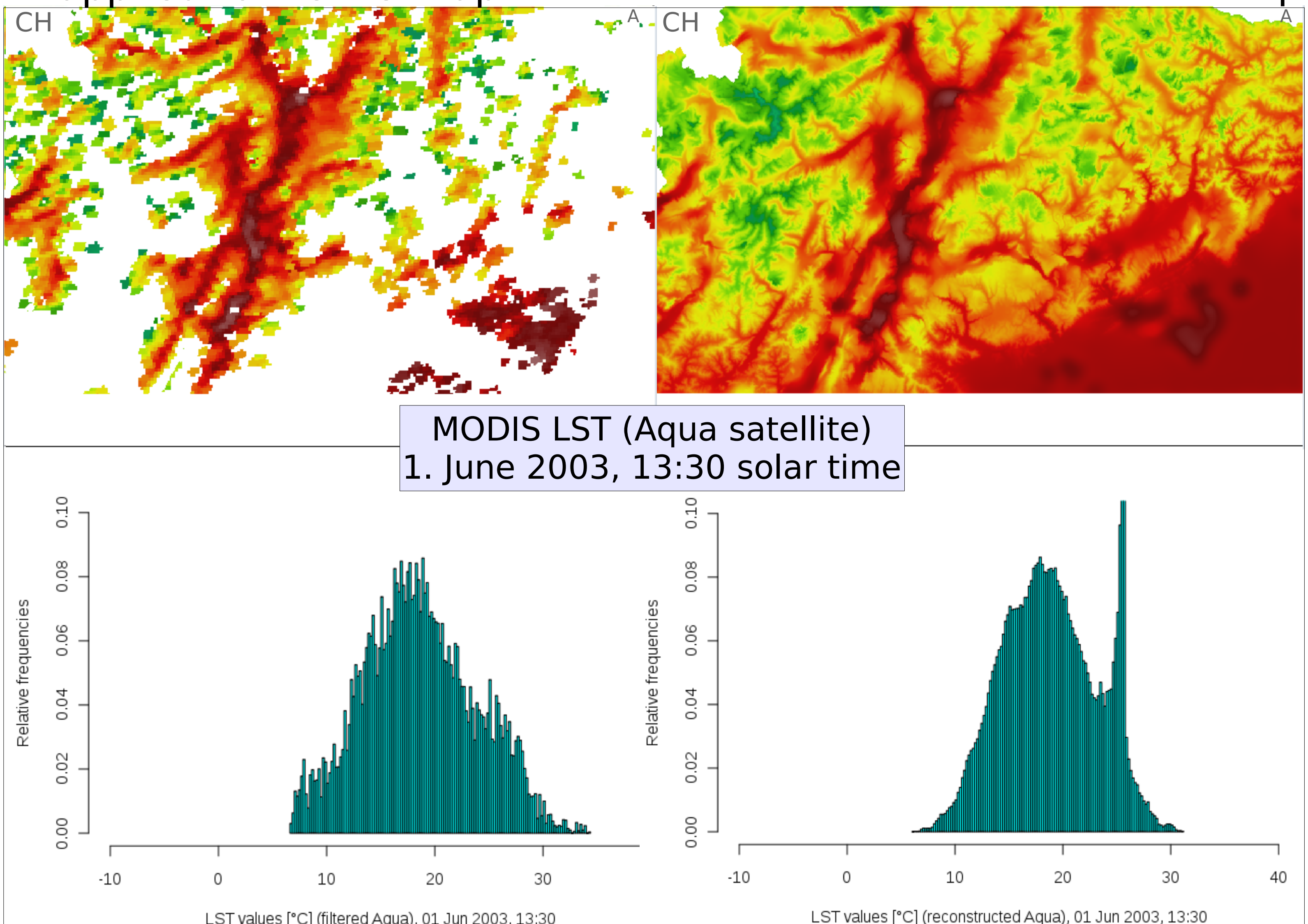
MODIS LST (Aqua satellite)
1. June 2003, 13:30 solar time

Neteler, M. 2010: Remote Sensing, 2(1), 333-351

Results of MODIS LST reconstruction

Second and third filter step applied to MODIS map

Reconstructed MODIS LST map



Neteler, M. 2010: Remote Sensing, 2(1), 333-351

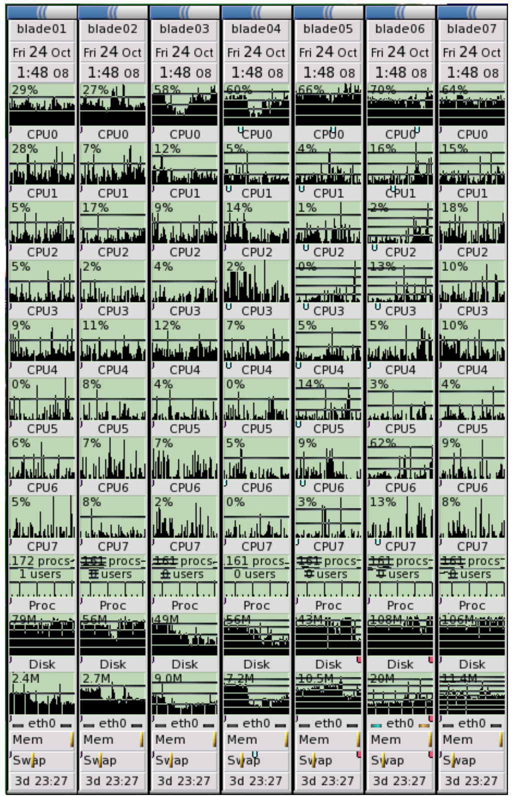
Parallelised GIS Processing

Infrastructure: FEM-GIS Cluster

- 12 single-blades and 2 double-blades
- In total 300 nodes with 600 Gb RAM
- Circa 2 Tflops/s
- Linux operating system, blades headless

- **GRASS GIS and R-stats**
- Queue system for job management (Grid Engine)

- Processing of all 11,000 maps in parallel: one map per node
- Computational time: 3 weeks with LST-algorithm V1.1

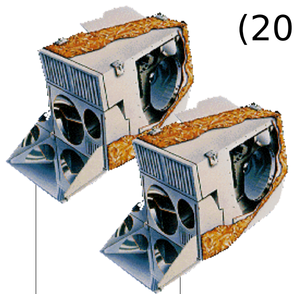


GRASS GIS

LST Applications: Tiger mosquito survival

***Aedes albopictus* survival maps from reconstructed Daily MODIS Land Surface Temperature maps**

Terra-MODIS LST
(2000-today)

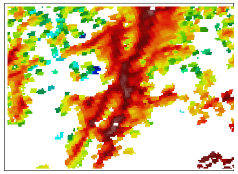


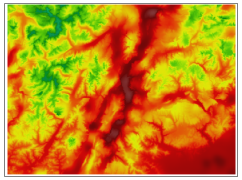
Aqua-MODIS
LST
(2002-today)

GIS based
MODIS LST
reconstruction

Daily LST maps

01:30
10:30
13:30
22:30
solar
time





GIS based map analysis

January temperature thresholds (2001-2009)

Annual temperature thresholds (2001..2009)

Growing Degree Days (2003..2009)

Neteler, Roiz, Castellani, Rizzoli, in review.

LST Applications: Tiger mosquito survival today...

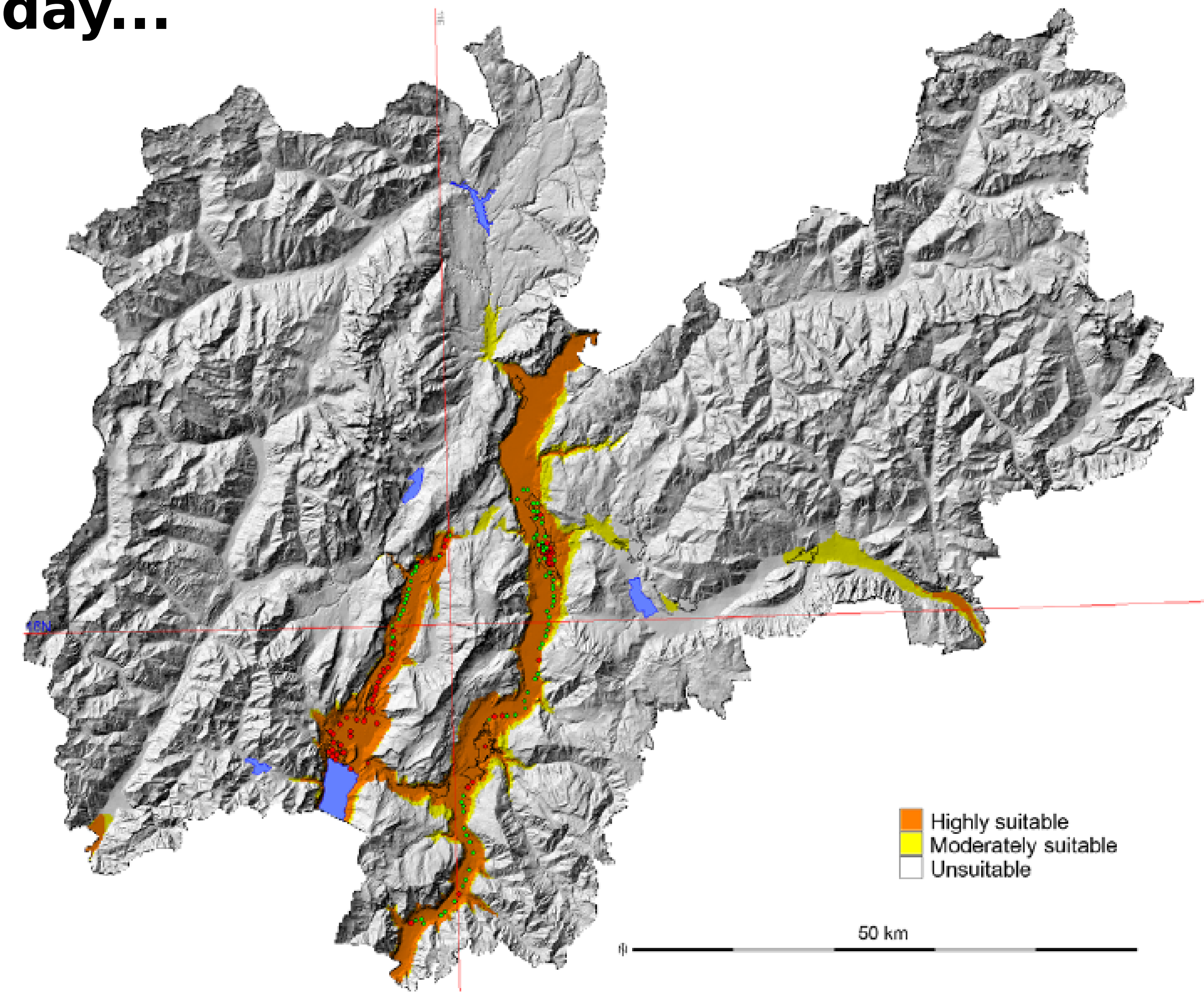


Figure 3. Potential and current distributional areas of *Ae. albopictus.* Overlap of both indicators ($JanT^{mean}$ LST $>=0$°C and $AnnT^{mean}$ LST $>=11$°C) were plotted for the period 2001–09 and integrated in a final map with 3 categories (see methods). Red spots represent the presence and green spots the absence of *Ae. albopictus*.

Roiz D., Neteler M., Castellani C., Arnoldi D., Rizzoli A., 2011: Climatic Factors Driving Invasion of the Tiger Mosquito (Aedes albopictus) into New Areas of Trentino, Northern Italy. PLoS ONE. 6(4): e14800

LST Applications: Tiger mosquito survival in 2050 (A2 scenario)

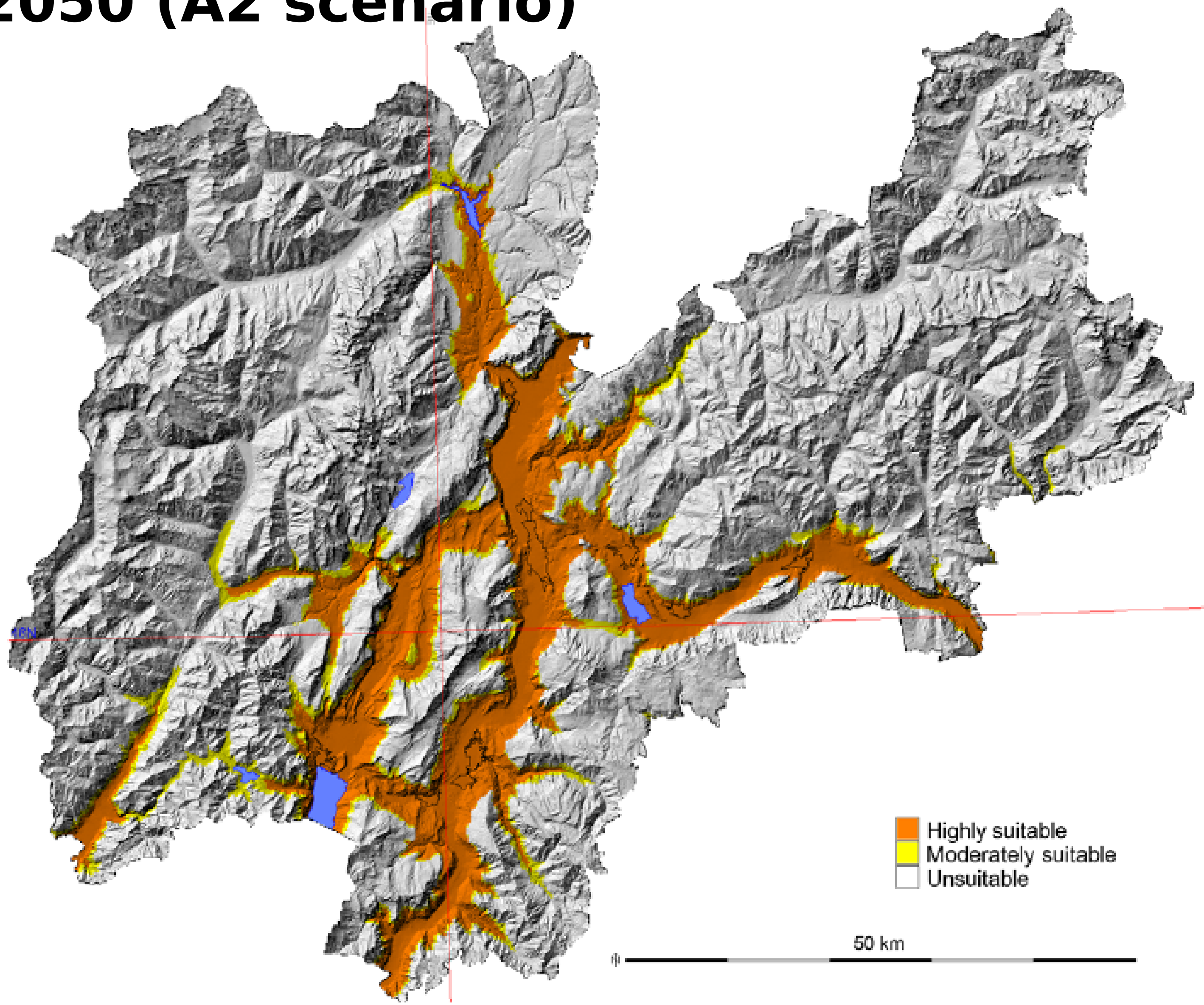


Figure 4. Potential distribution *of Ae. albopictus* in an A2 scenario for 2050 (see text). Overlap of both indicators (JanT^{mean} LST +1.5°C and AnnT^{mean} LST +1°C) were plotted for the study period and integrated in a final map with 3 categories (see methods).
doi:10.1371/journal.pone.0014800.g004

Roiz D., Neteler M., Castellani C., Arnoldi D., Rizzoli A., 2011: Climatic Factors Driving Invasion of the Tiger Mosquito (Aedes albopictus) into New Areas of Trentino, Northern Italy. PLoS ONE. 6(4): e14800

Conclusions

- Sextante and GRASS provide complementary functionality
- The integration is becoming smooth
- gvSIG user can now easily use GRASS' capabilities without changing their environment
- Powerful toolsets for empowered people!

Special thanks to...

- Victor Olaya (Sextante and core GRASS interface)
- Benjamin Ducke (Sextante-GRASS integration)
- Regione Autonoma Friuli Venezia Giulia (support for my presentation)

Markus Neteler
Fondazione E. Mach (FEM)
Centro Ricerca e Innovazione
GIS and Remote Sensing Unit
Via E. Mach, 1
38010 S. Michele all'Adige, Italy
http://gis.cri.fmach.it
http://www.osgeo.org

OSGeo
Your Open Source Compass