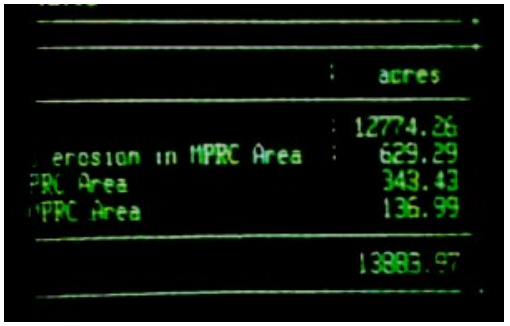
Markus Neteler & GRASS Development Team
Fondazione E. Mach – CRI, Italy
http://gis.cri.fmach.it
http://grass.osgeo.org

GRASS GIS 7: your reliable geospatial number cruncher

FOSS4G 2014, Portland (OR), USA
8 - 13 Sept 2014

GRASS GIS 7 User interface

What you think it is...



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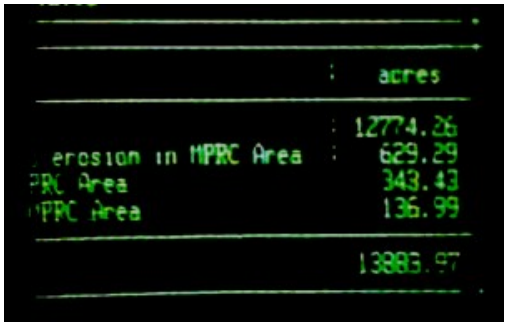
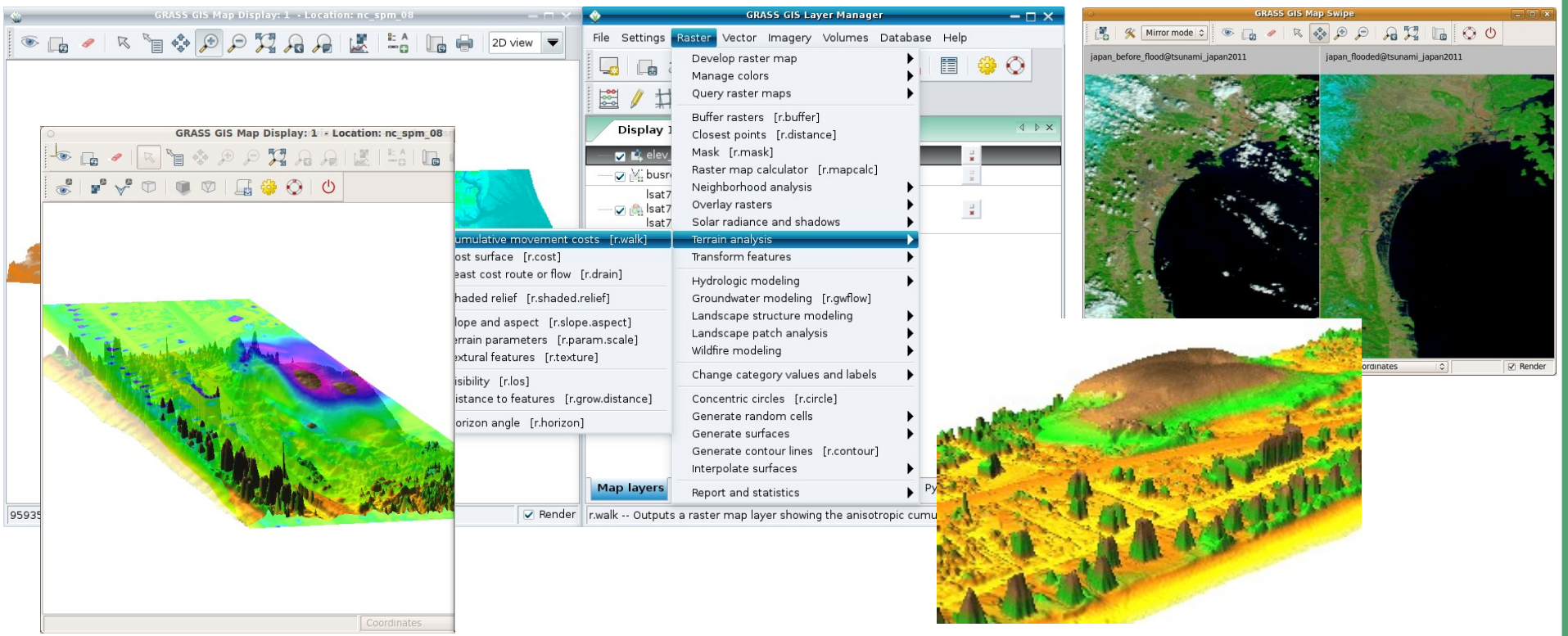
GRASS GIS 7 User interface

What you think it is...



What it really is...



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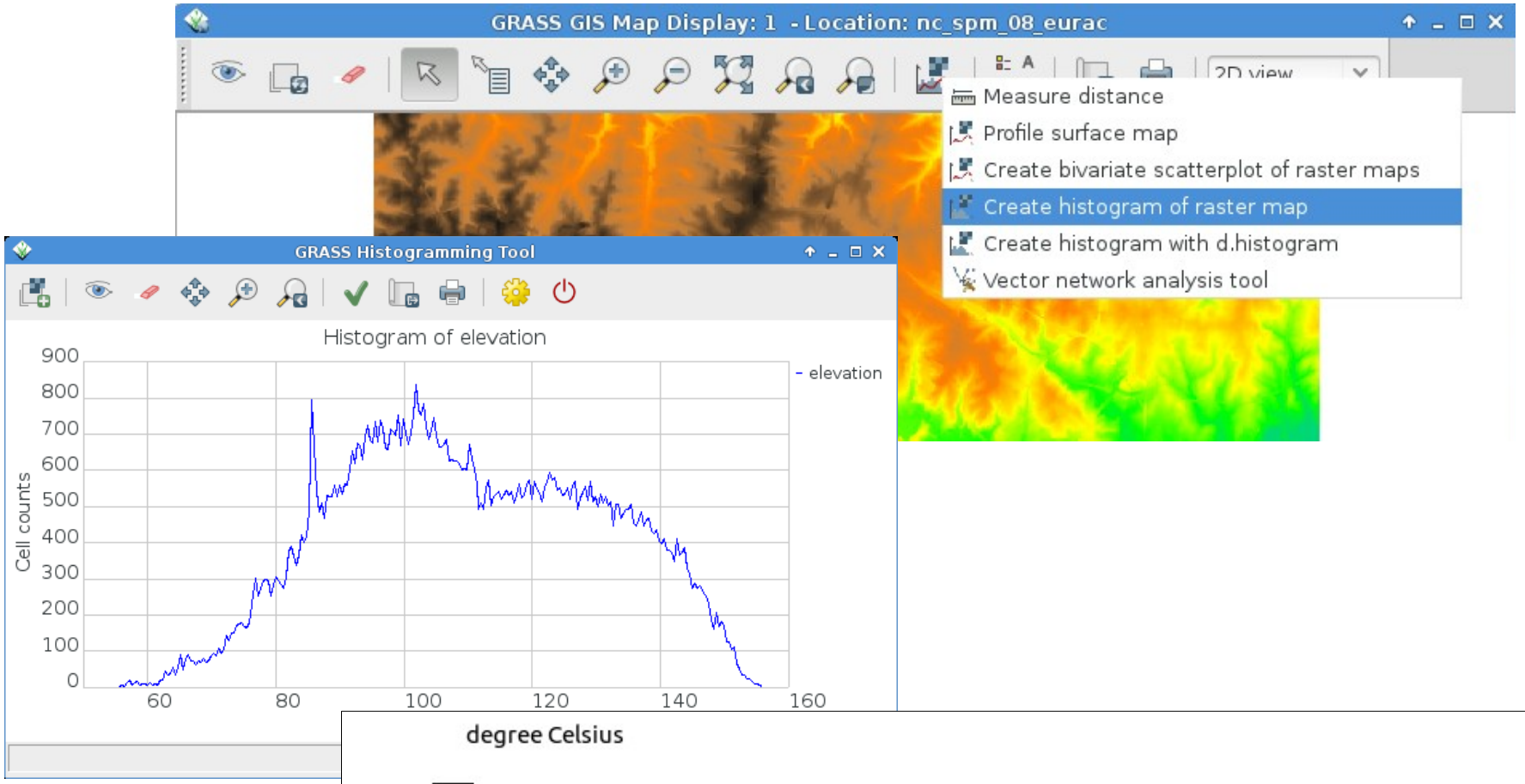
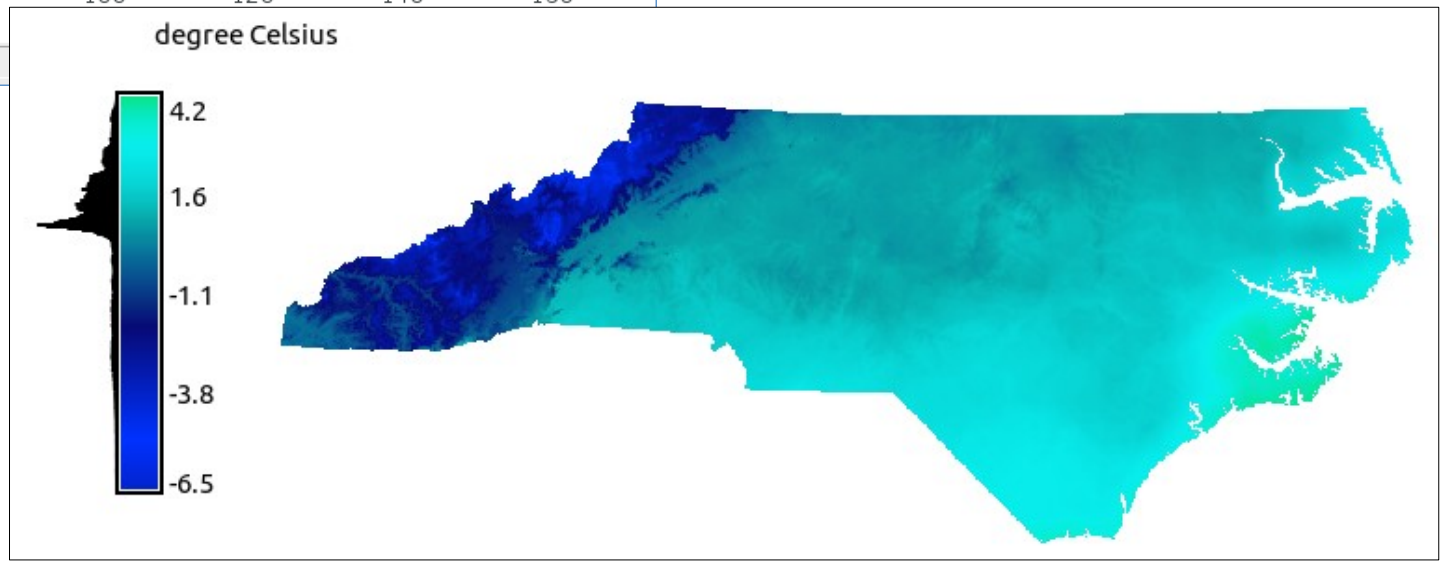
GRASS 7: Map histogram tool





Additionally:
Histogram in legend

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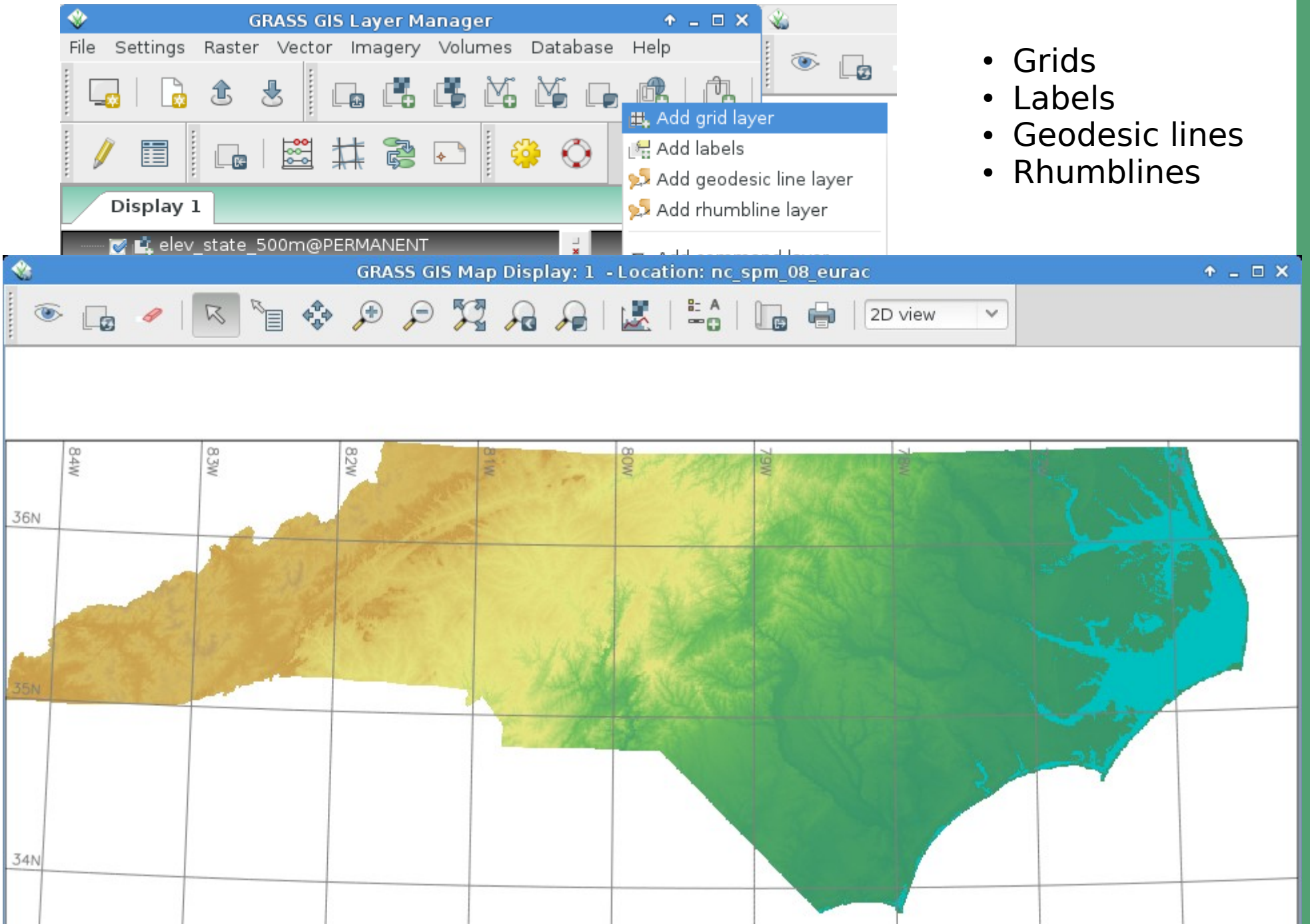
GRASS 7: Adding a grid to the map view



- Grids
- Labels
- Geodesic lines
- Rhumblines

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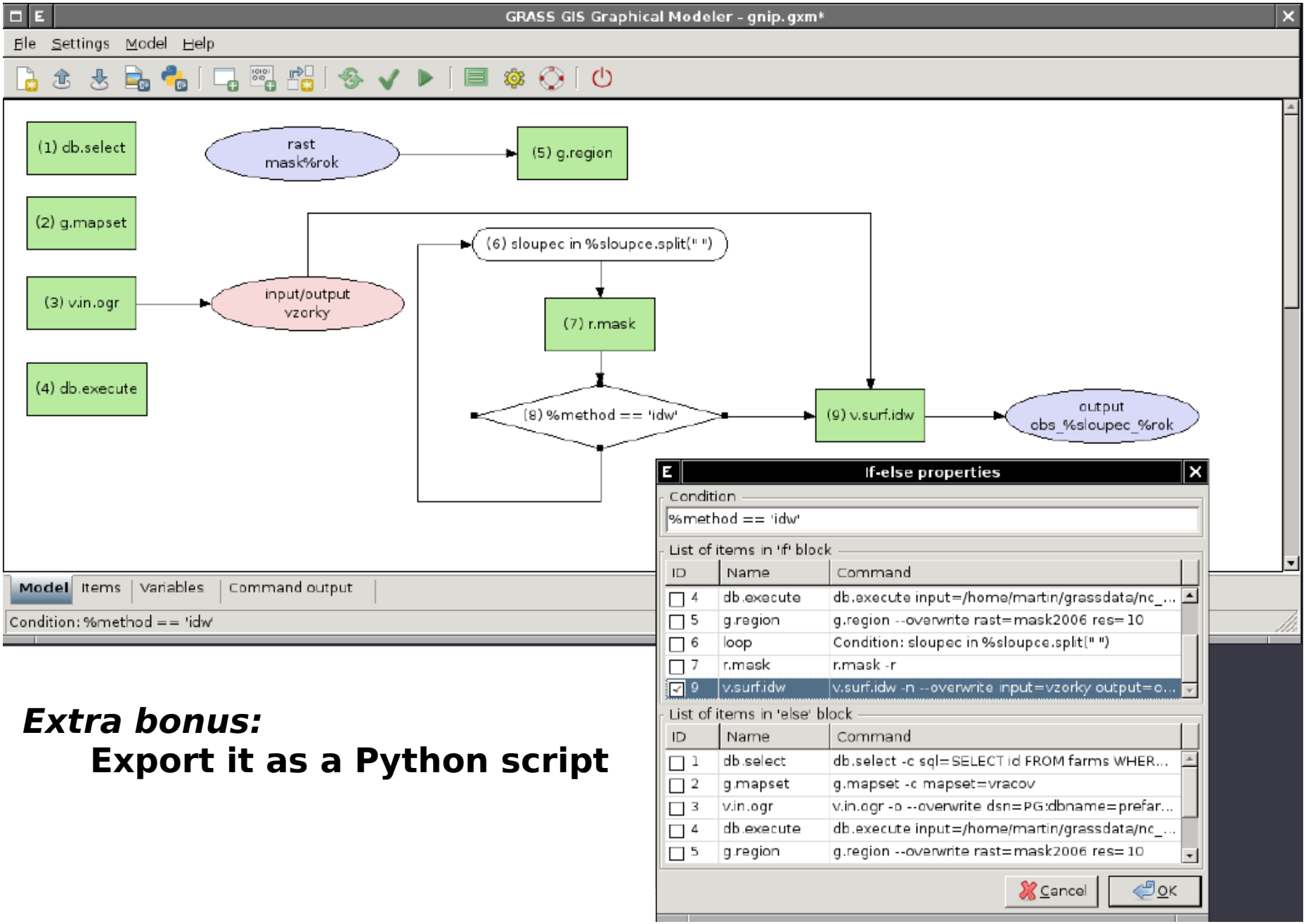
GRASS 7: New Geospatial Modeller



Extra bonus:

Export it as a Python script

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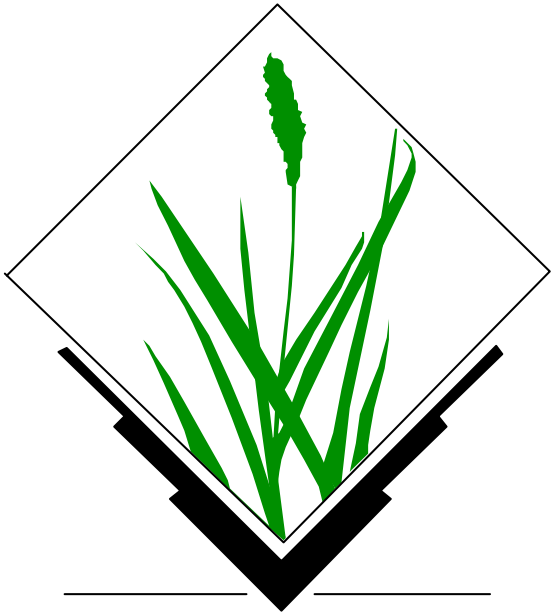
Vector data processing



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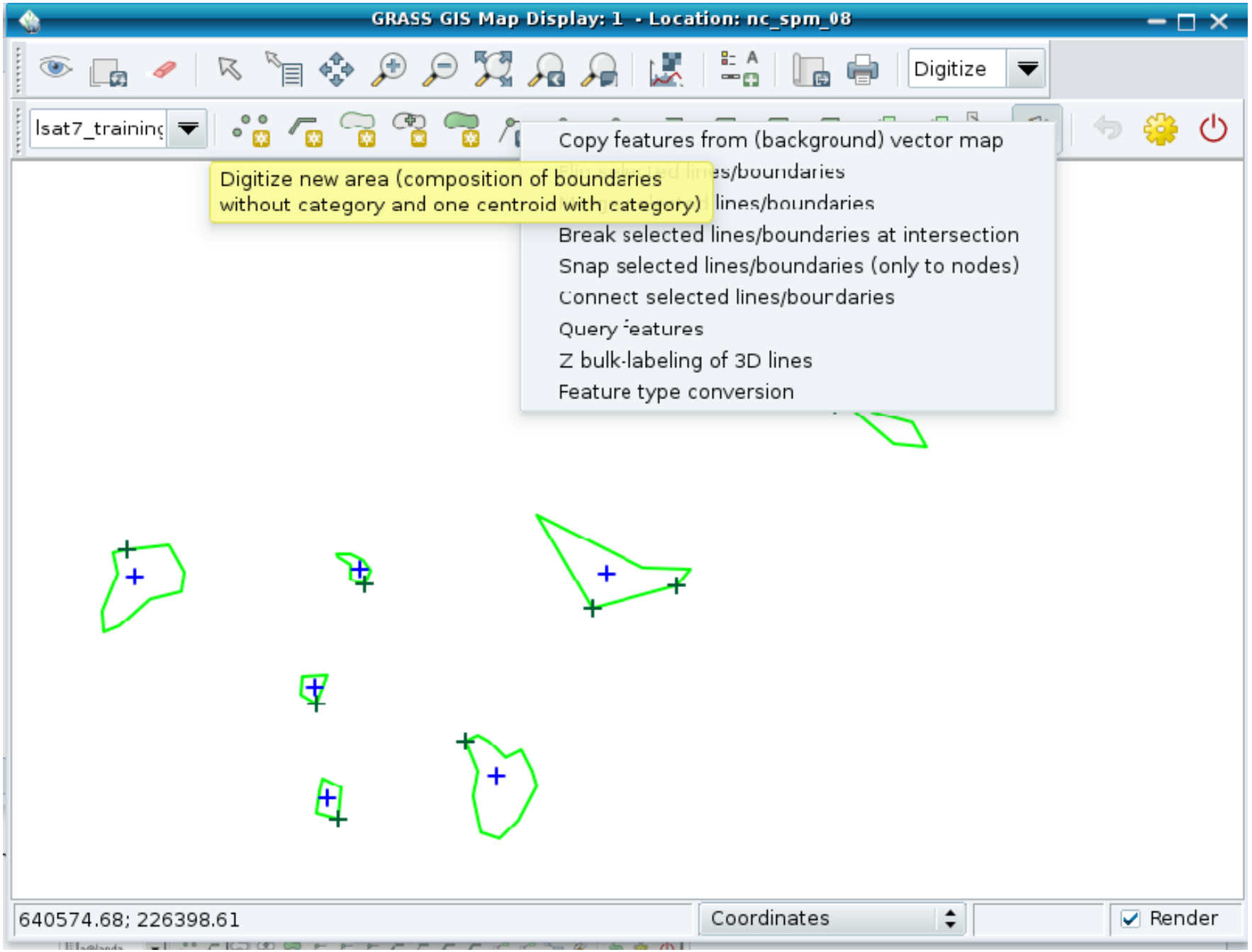
GRASS 7: Topological Vector Digitizer



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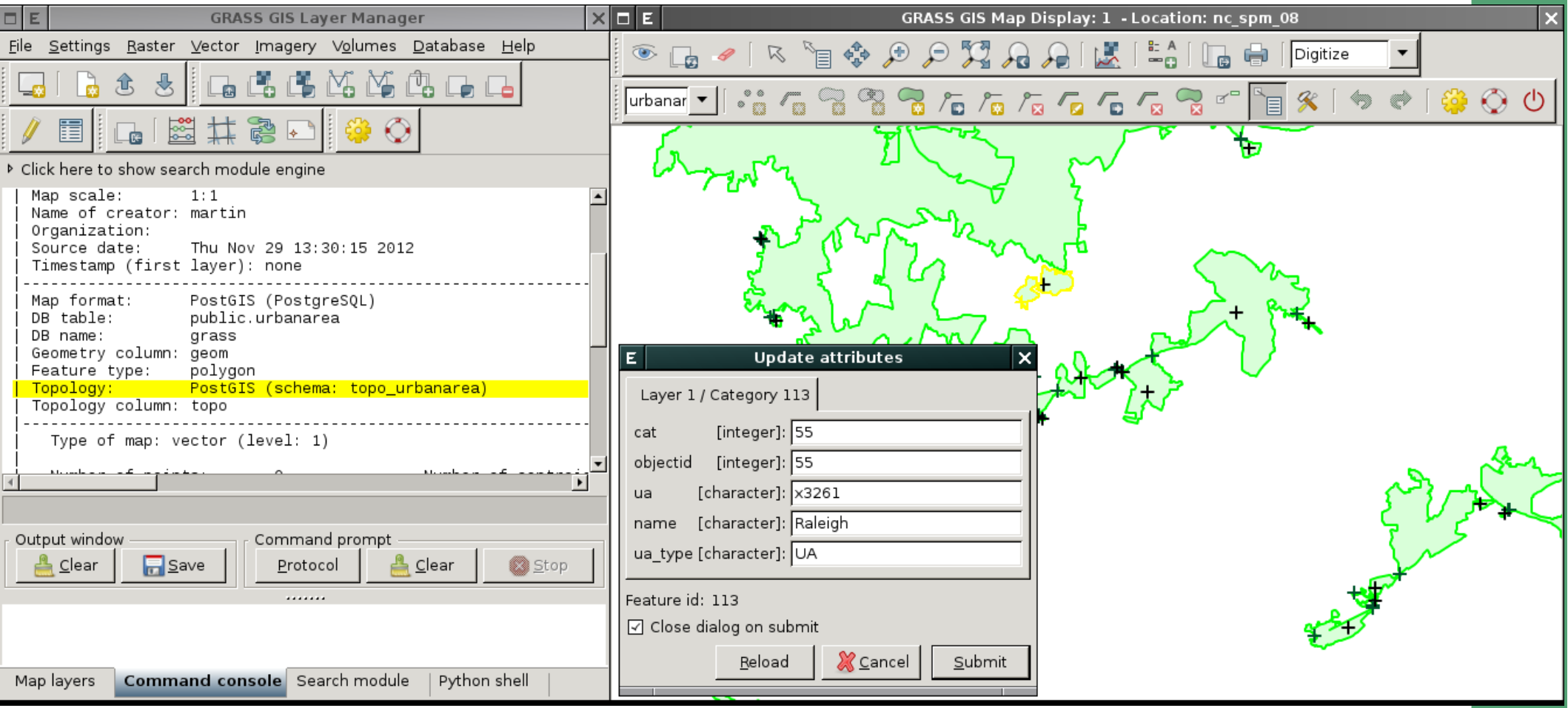
GRASS 7: Topological Vector Digitizer in PostGIS 2 (under development)

Programmer: Martin Landa



http://grass.osgeo.org/grass70/manuals/v.out.postgis.html

http://grasswiki.osgeo.org/wiki/PostGIS_Topology

Cofunded by Municipality of Trento, Italy

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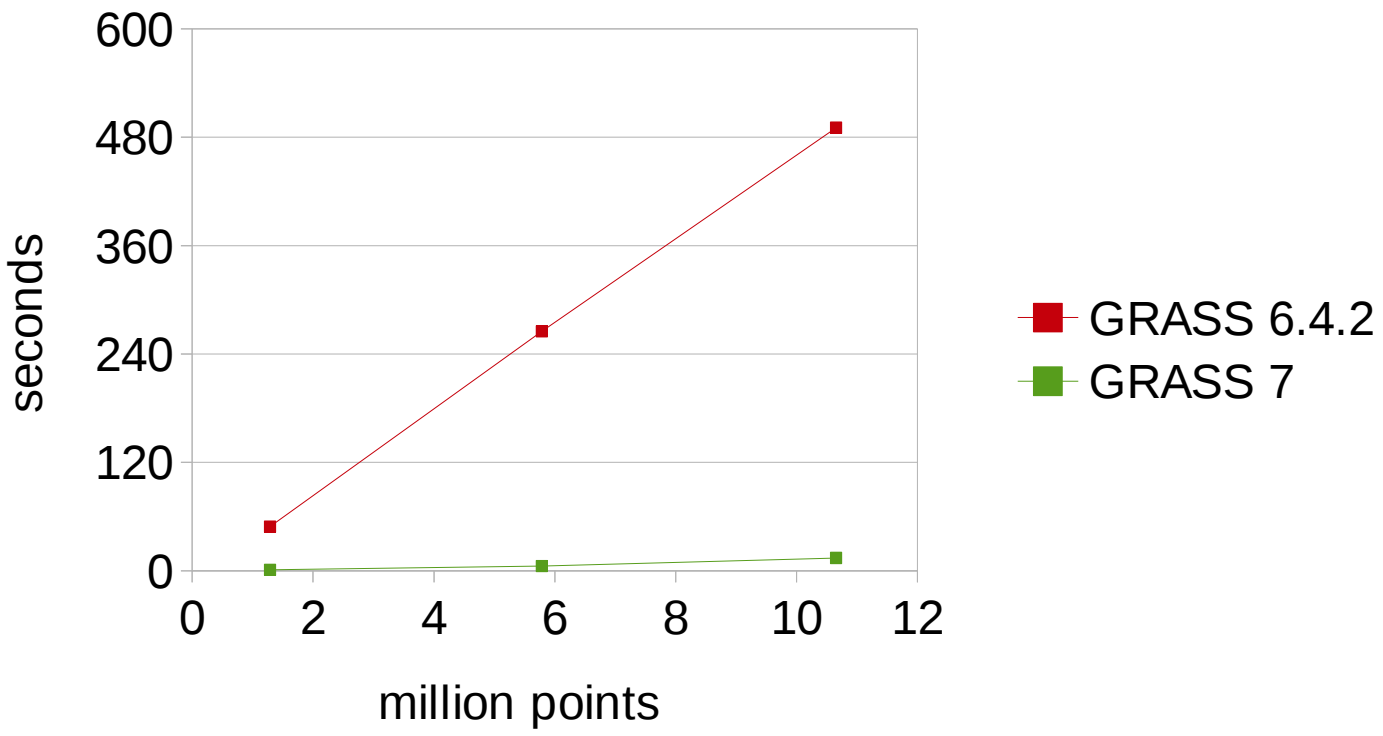
News in GRASS 7's Vector Topology

Spatial query example

Query of vector point maps

GUI: click on vector map, what is there?

CLI: v.what east_north=east,north



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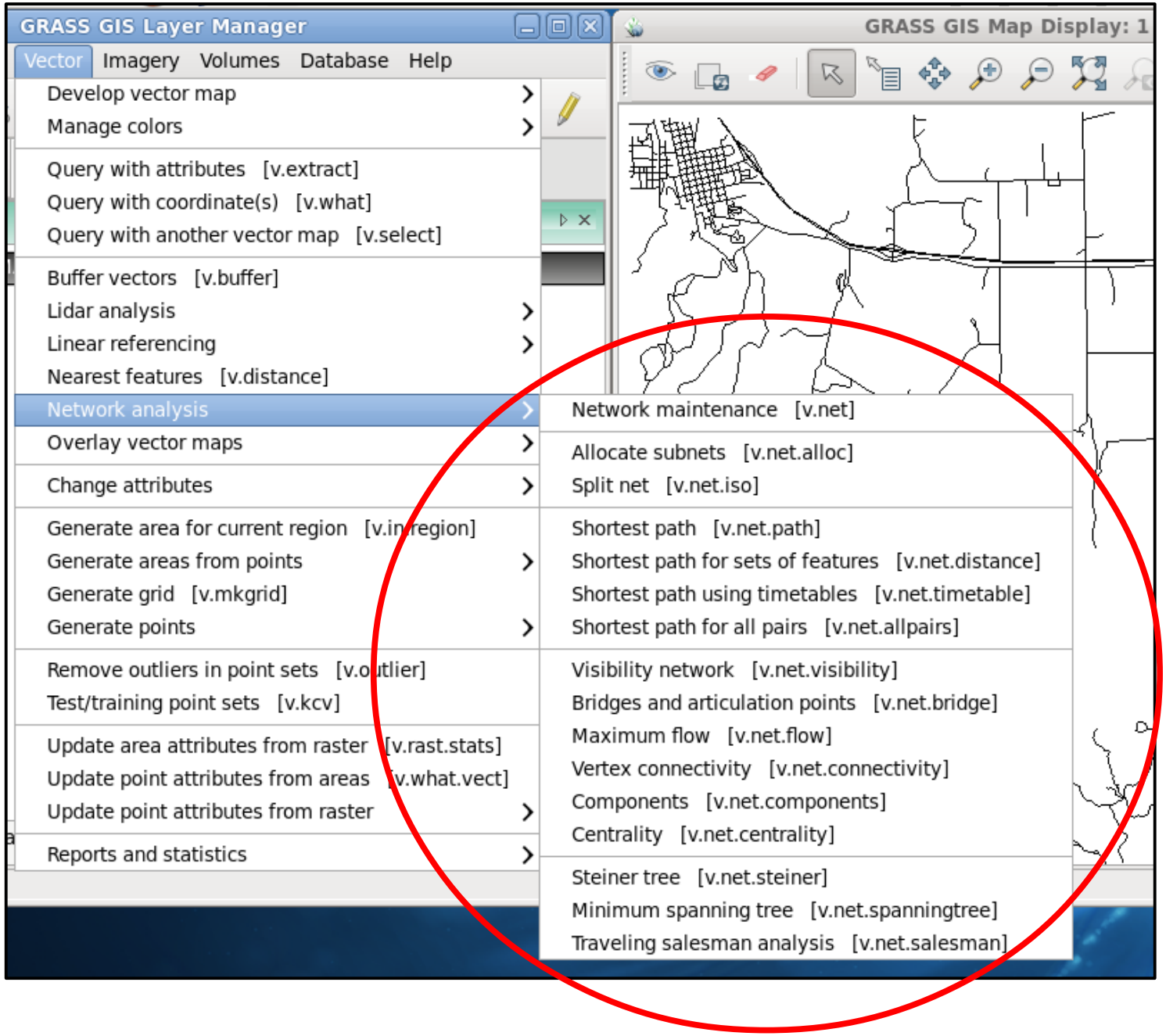
Vector network analysis in GRASS



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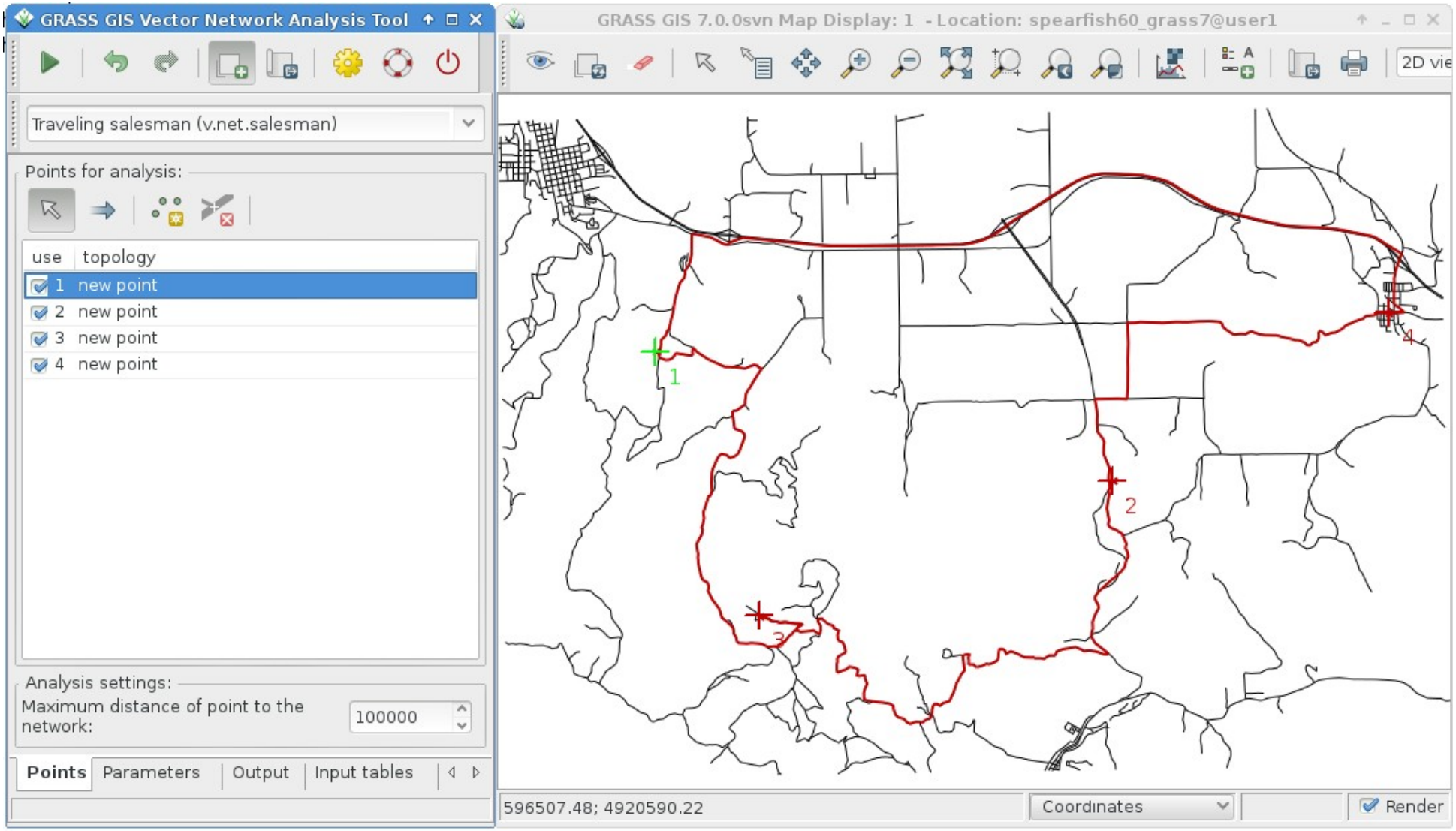
Vector network analysis in GRASS

Example travelling salesman problem, 4 points to visit with optimal path



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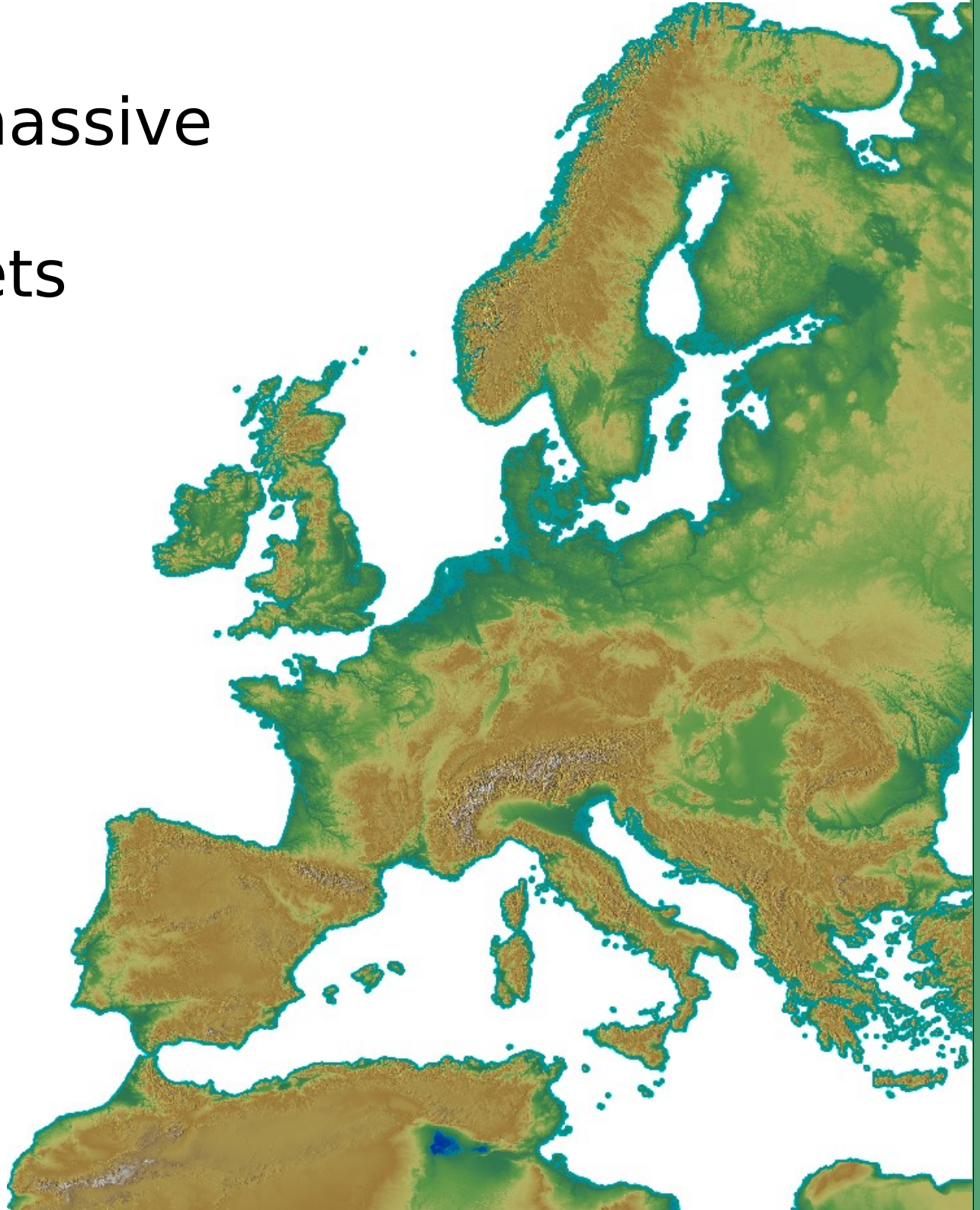
Support for massive spatial datasets in GRASS GIS



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GRASS 7: Support for massive datasets

What is massive?

Massive is relative to

- Hardware resources
- Software capabilities
- Operating system capabilities

Limiting factors

-  RAM
-  Processing time
- ✔ Disk space
- ✔ Largest supported file size

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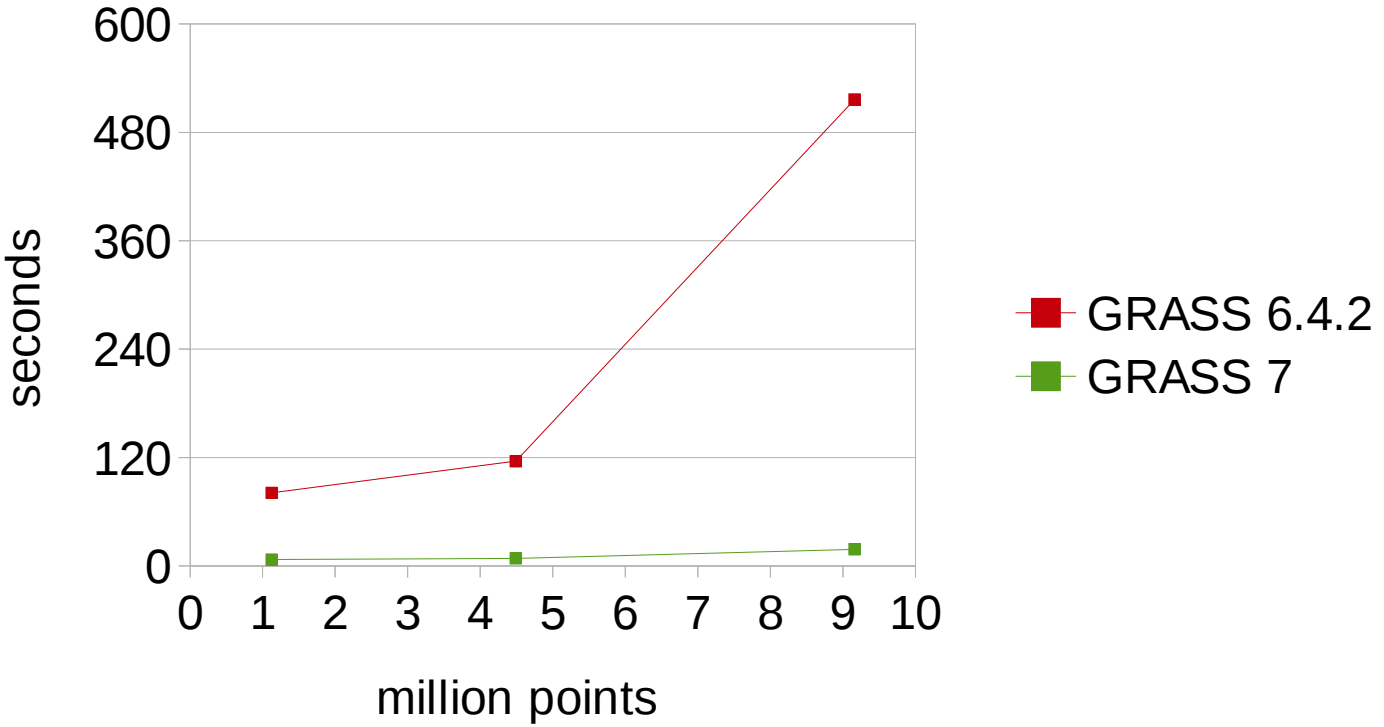
GRASS 7: Support for massive datasets

Cost surfaces: *r.cost*



Other speed figure:
PCA of 30 million pixels in 6 seconds on this small presentation laptop...

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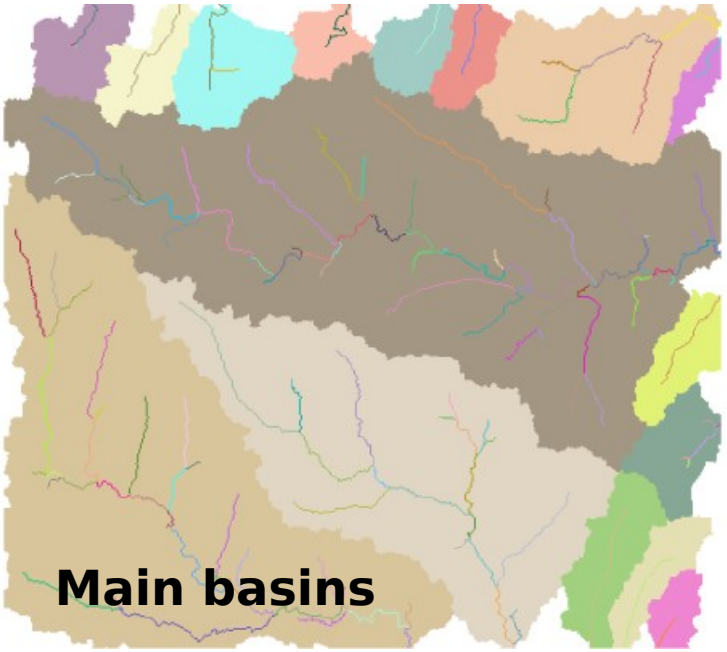
New tools for hydrological modelling



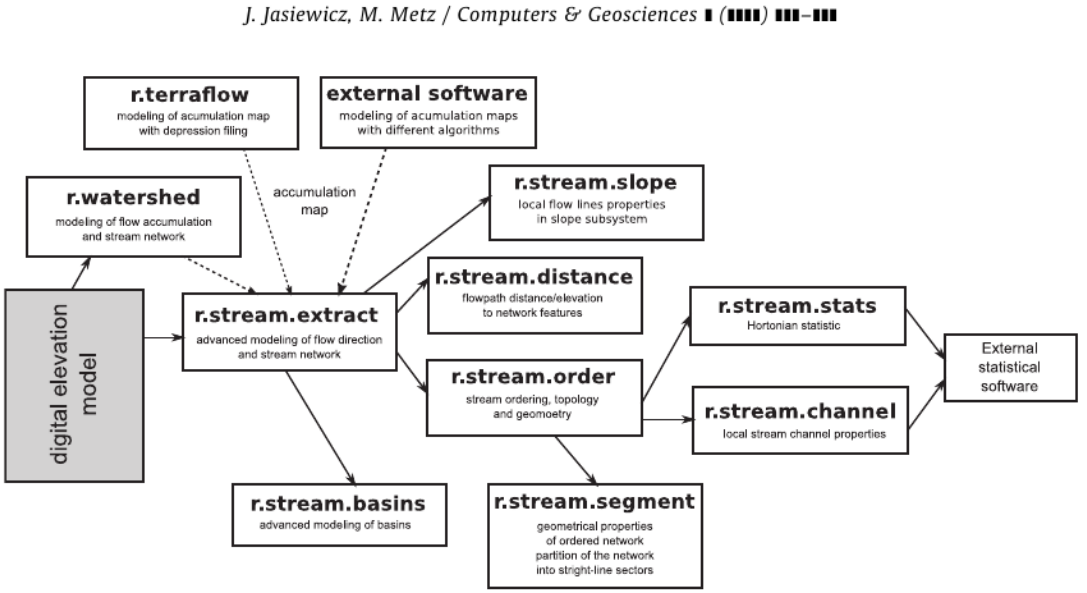
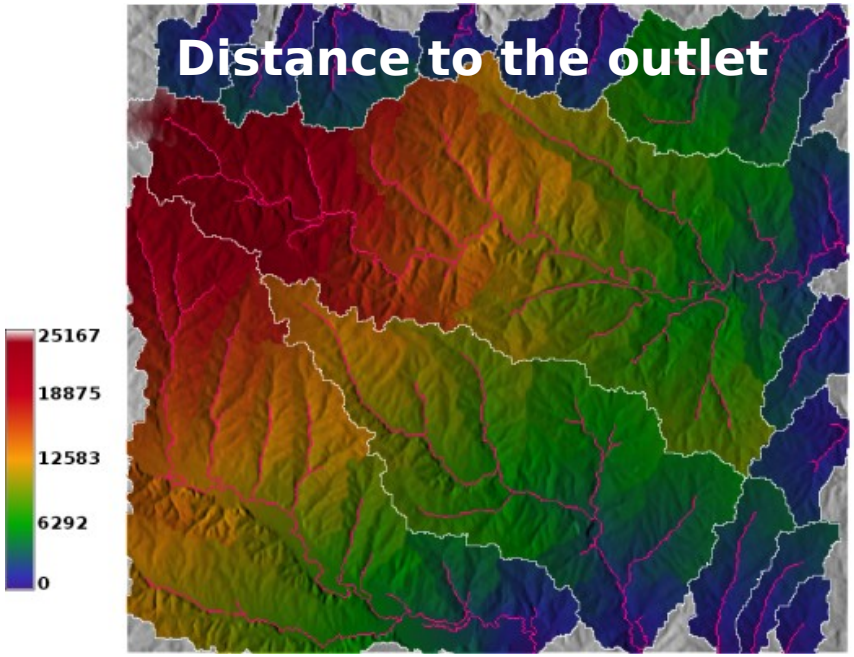
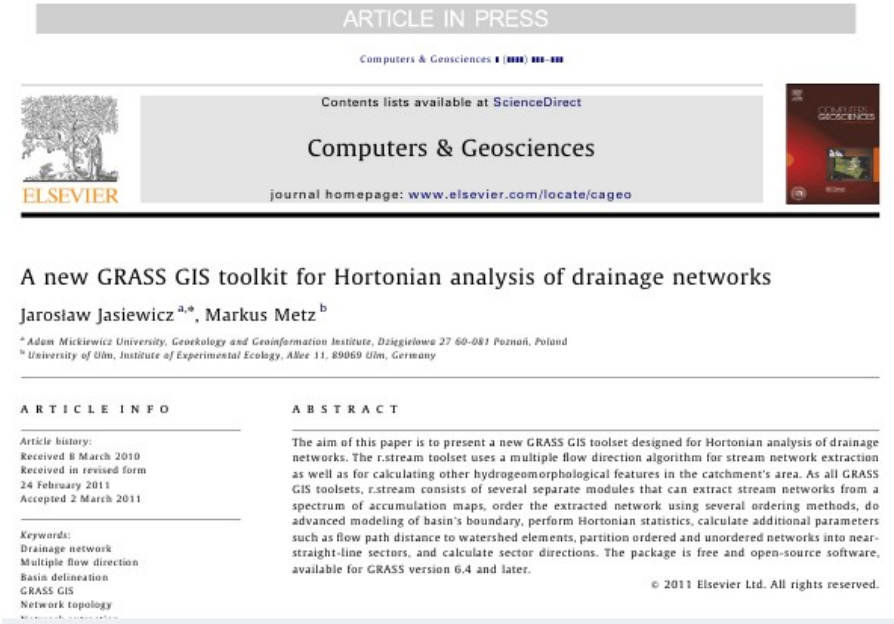


Fig. 2. The structure of the r.stream toolset and data flow between particular modules and external software.

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ELSEVIER

A new GRASS GIS toolkit for Hortonian analysis of drainage networks

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GRASS GIS
Network topology

ABSTRACT

The aim of this paper is to present a new GRASS GIS toolset designed for Hortonian analysis of drainage networks. The r.stream toolset uses a multiple flow direction algorithm for stream network extraction as well as for calculating other hydrogeomorphological features in the catchment's area. As all GRASS GIS toolsets, r.stream consists of several separate modules that can extract stream networks from a spectrum of accumulation maps, order the extracted network using several ordering methods, do advanced modeling of basin's boundary, perform Hortonian statistics, calculate additional parameters such as flow path distance to watershed elements, partition ordered and unordered networks into near-straight-line sectors, and calculate sector directions. The package is free and open-source software, available for GRASS version 6.4 and later.

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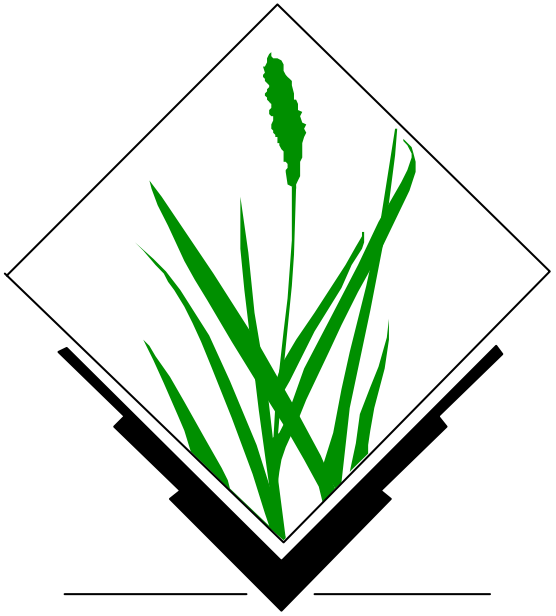
Programming own applications with GRASS GIS 7



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New GRASS 7 Python API

http://grass.osgeo.org/wiki/GRASS_and_Python

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GRASS and Python

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- Development
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- GRASS Help
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- Help

Toolbox

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- Permanent link

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Introduction to Vector classes — Python library documentation documentation - Konqueror

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http://grass.osgeo.org/grass71/manual/

Google

Python library documentation documentation » PyGRASS documentation »

previous | next | modules | index

Introduction to Vector classes

Details about the architecture can be found in the GRASS GIS 7 Programmer's Manual: GRASS Vector Library

Instantiation and basic interaction.

```
>>> from pygrass.vector import VectTopo
>>> municip = VectTopo('boundary_municp_sqlite')
>>> municip.is_open()
False
>>> municip.mapset
''
>>> municip.exist()  # check if exist, and if True set mapset
True
>>> municip.mapset
'user1'
```

Open the map with topology:

```
>>> municip.open()

get the number of primitive:
```

Previous topic
Introduction to Raster classes

Next topic
Interface to GRASS GIS modules

Quick search

Go

Enter search terms or a module, class or function name.

New GRASS 7 Python API

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ISPRS International Journal of **Geo-Information**

ISSN 2220-9964

www.mdpi.com/journal/ijgi

Article

Pygrass: An Object Oriented Python Application Programming Interface (API) for Geographic Resources Analysis Support System (GRASS) Geographic Information System (GIS)

Pietro Zambelli [1,*], Sören Gebbert [2] and Marco Ciolli [1]

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[2] Thünen Institute of Climate-Smart Agriculture, Bundesallee 50, Braunschweig 38116, Germany; E-Mail: soerengebbert@googlemail.com

* Author to whom correspondence should be addressed; E-Mail: pietro.zambelli@ing.unitn.it; Tel.: +39-46-128-2696.

Received: 1 January 2013; in revised form: 21 January 2013 / Accepted: 21 February 2013 / Published: 11 March 2013

Abstract: PyGRASS is an object-oriented Python Application Programming Interface (API) for Geographic Resources Analysis Support System (GRASS) Geographic Information System (GIS), a powerful open source GIS widely used in academia, commercial settings and governmental agencies. We present the architecture of the PyGRASS library, covering interfaces to GRASS modules, vector and raster data, with a focus on the new capabilities that it provides to GRASS users and developers. Our

http://dx.doi.org/10.3390/ijgi2010201

All former shell scripts have been rewritten to Python in GRASS GIS 7:

→ re-use as example!

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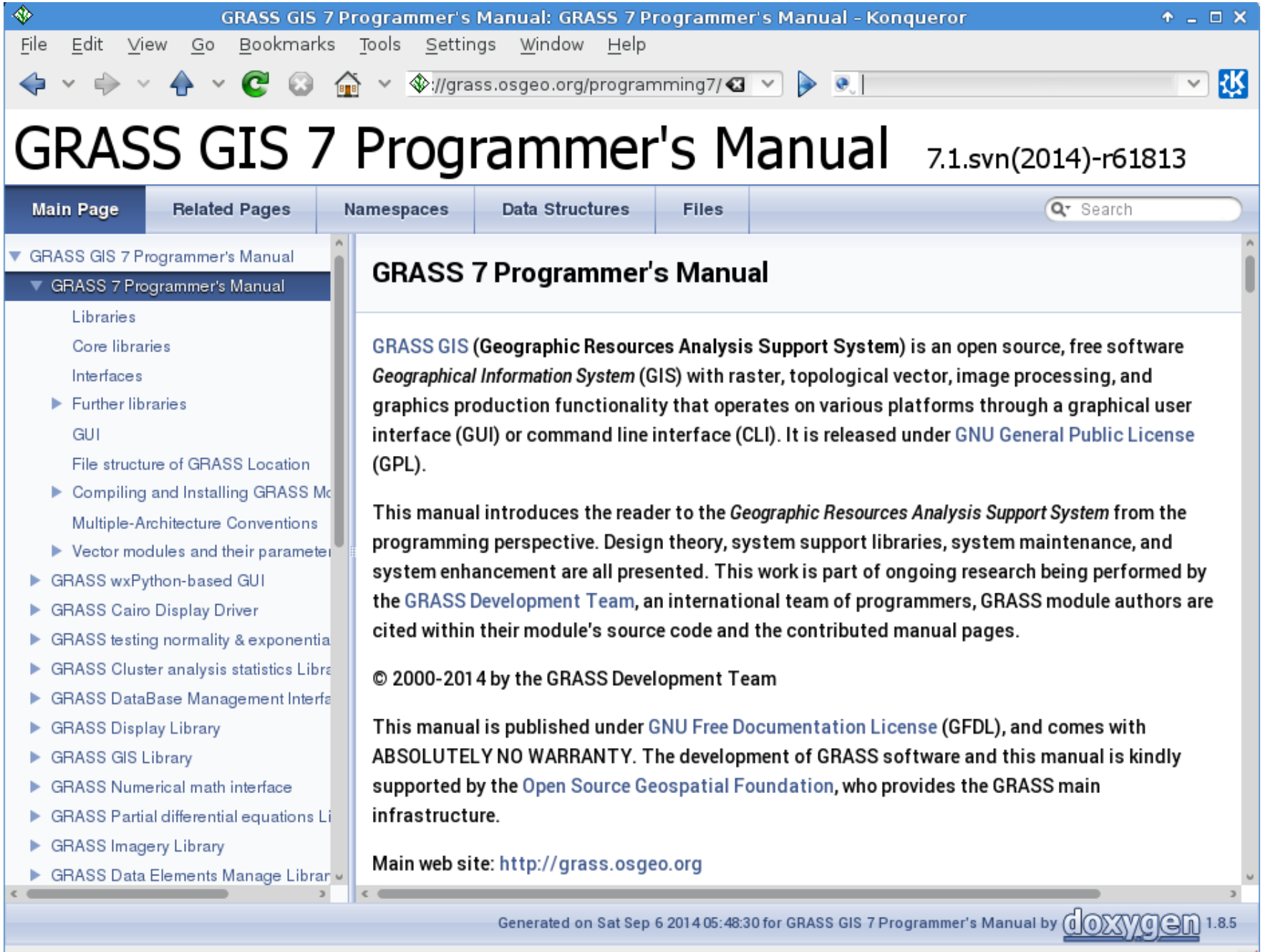
GRASS 7 Programmer's manual

http://grass.osgeo.org/programming7/



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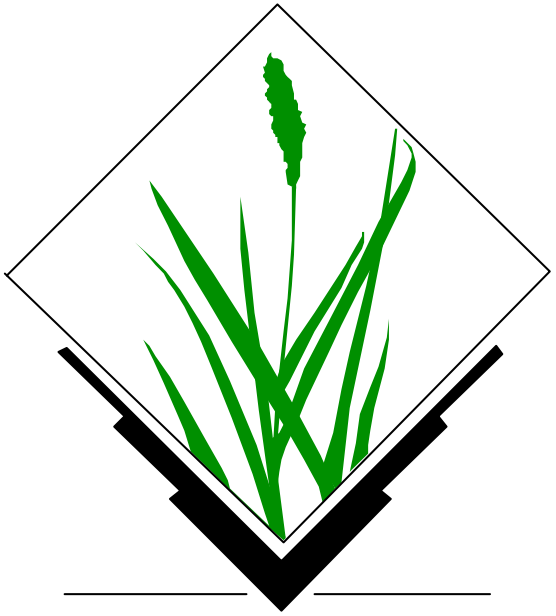
GRASS GIS as Open Source GIS backbone:

Connecting to other software packages



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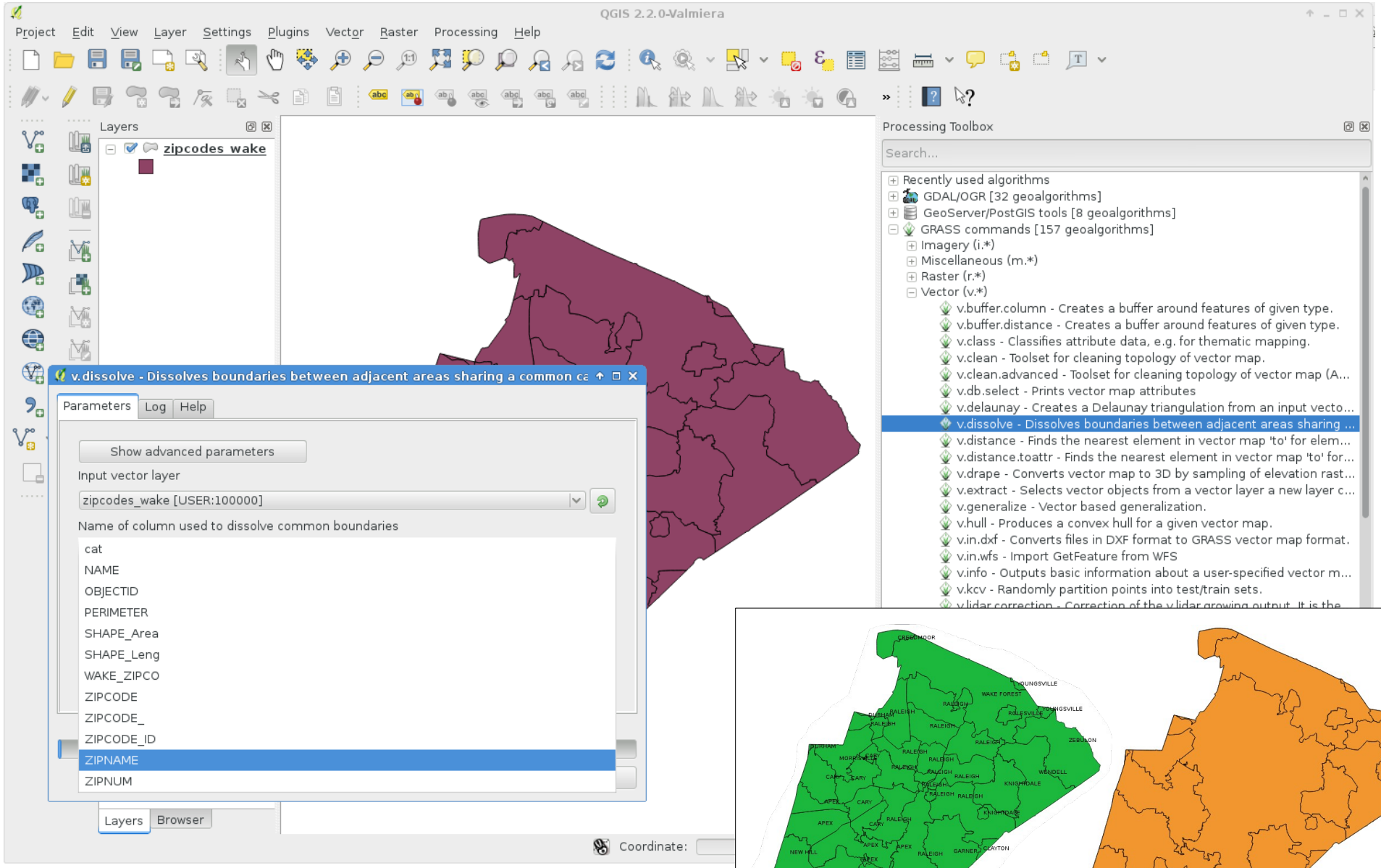
GRASS and QGIS Integration: Processing



Dissolving geometry by string column attributes: *Processing* calls GRASS GIS in a virtual session which delivers the result back (here: SHAPE file)

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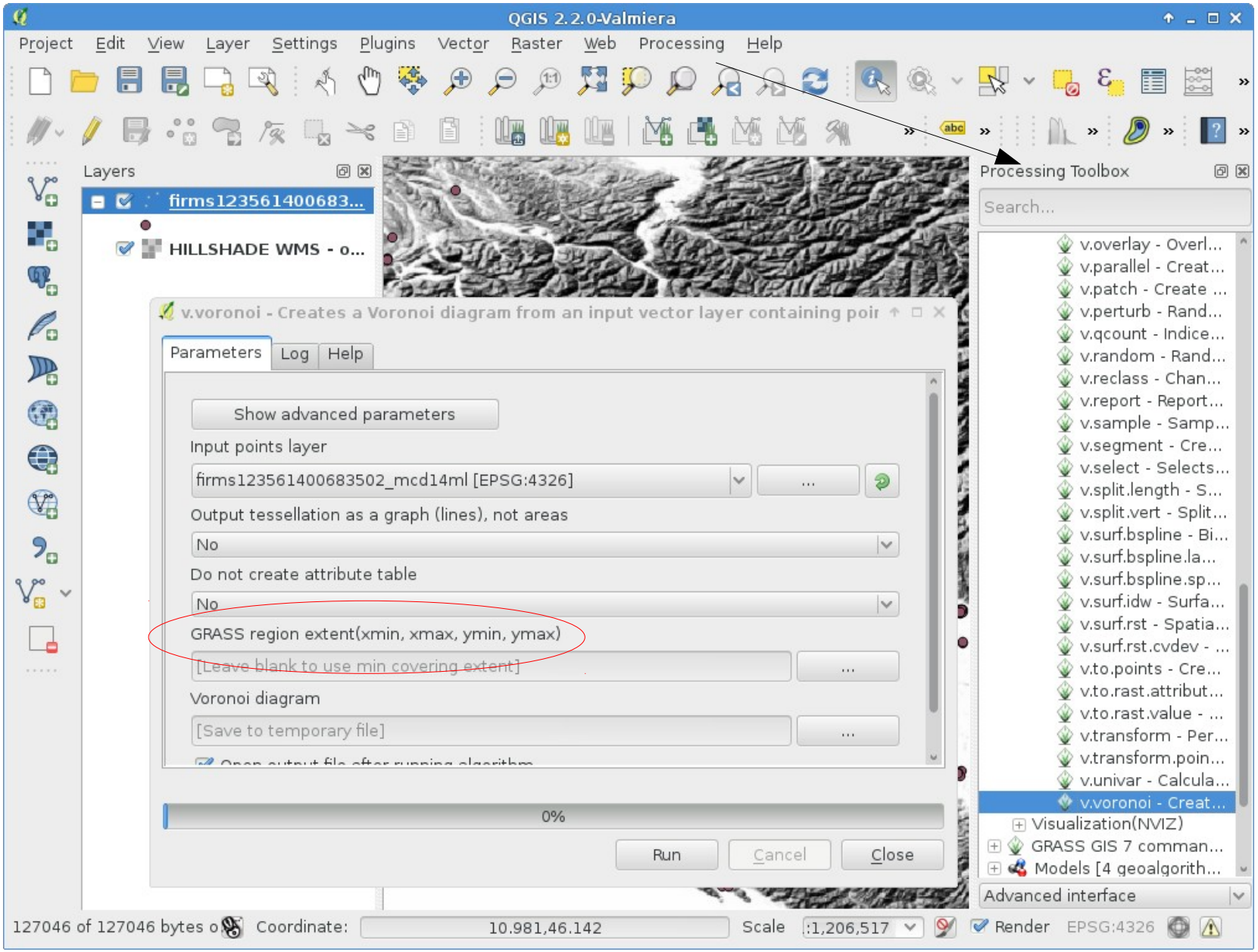
Integration of GRASS GIS with QGIS, PostGIS, OGC

Geoprocessing of an external wildfire point layer:
PostGIS or WFS -> QGIS → Processing → GRASS GIS



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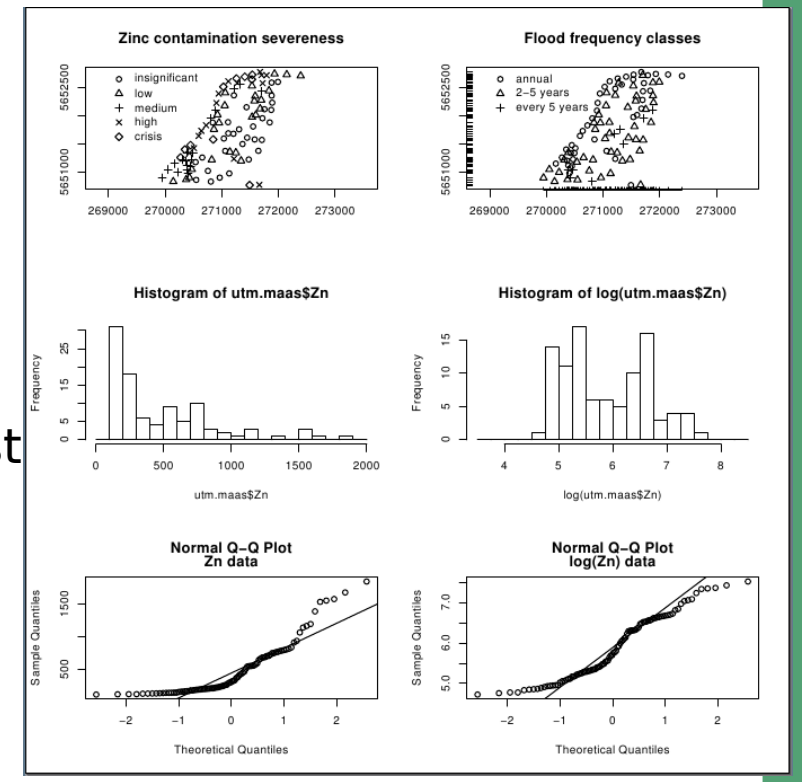
GRASS and R Integration




```
GRASS 7.0.svn (nc_spm_08_grass7):~ > R

R version 3.0.1 (2013-05-16) -- "Good Sport"
Copyright (C) 2013 The R Foundation for Statist
Platform: x86_64-redhat-linux-gnu (64-bit)

> library(spgrass6)
Loading required package: sp
Loading required package: XML
GRASS GIS interface loaded with GRASS version: GRASS 7.0.svn (2013)
and location: nc_spm_08_grass7
>
> myrast <- readRAST6(c("geology", "elevation"), cat=c(TRUE, FALSE))
> myvect <- readVECT6("roads")
...
> writeRAST6(myrast, "elev_filt", zcol="elev")
...
```

http://grass.osgeo.org/wiki/R_statistics

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GRASS 7: Native WPS Support


```
r.grow --wps-process-description
```

Web Processing Service

```
<?xml version="1.0" encoding="UTF-8"?>
<wps:ProcessDescriptions xmlns:wps="http://www.opengis.net/wps/1.0.0"
xmlns:ows="http://www.opengis.net/ows/1.1"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wps/1.0.0
 http://schemas.opengis.net/wps/1.0.0/wpsDescribeProcess_response.xsd"
 service="WPS" version="1.0.0" xml:lang="en-US">
        <ProcessDescription wps:processVersion="1" storeSupported="true" statusSupported="true">
                <ows:Identifier>r.grow</ows:Identifier>
                <ows:Title>Generates a raster map layer with contiguous areas grown by one cell.</ows:Title>
                <ows:Abstract>The manual page of this module is available here: http://grass.osgeo.org/grass70/manuals/html70_use
                <ows:Metadata xlink:title="raster" />
                <DataInputs>
                        <Input minOccurs="1" maxOccurs="1">
                                <ows:Identifier>input</ows:Identifier>
                                <ows:Title>Name of input raster map</ows:Title>
                                <ComplexData maximumMegabytes="2048">
                                        <Default>
                                                <Format>
                                                        <MimeType>image/tiff</MimeType>
                                                </Format>
                                        </Default>
                                        <Supported>
                                                <Format>
                                                        <MimeType>image/tiff</MimeType>
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                                                        <MimeType>application/geotiff</MimeType>
```

http://grasswiki.osgeo.org/wiki/WPS

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Image processing

Improved modules:

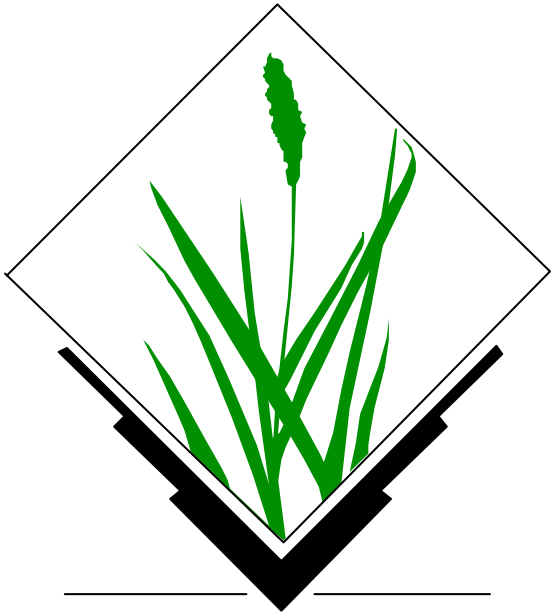
Georectification

Orthorectification

Atmospheric correction

Terrain correction

Landsat cloud detection



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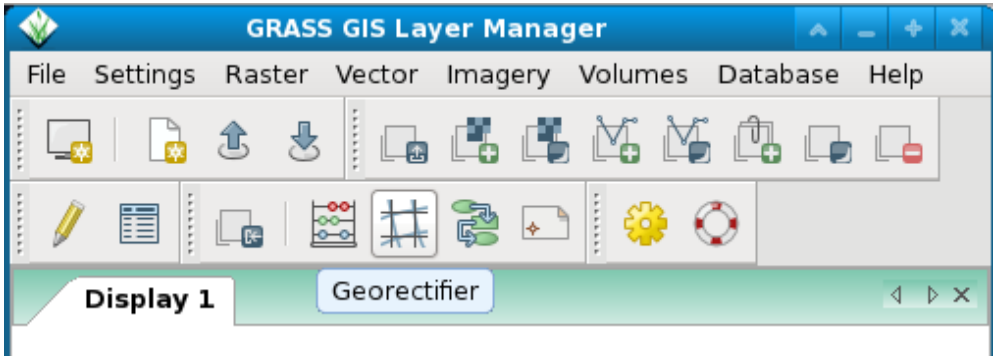
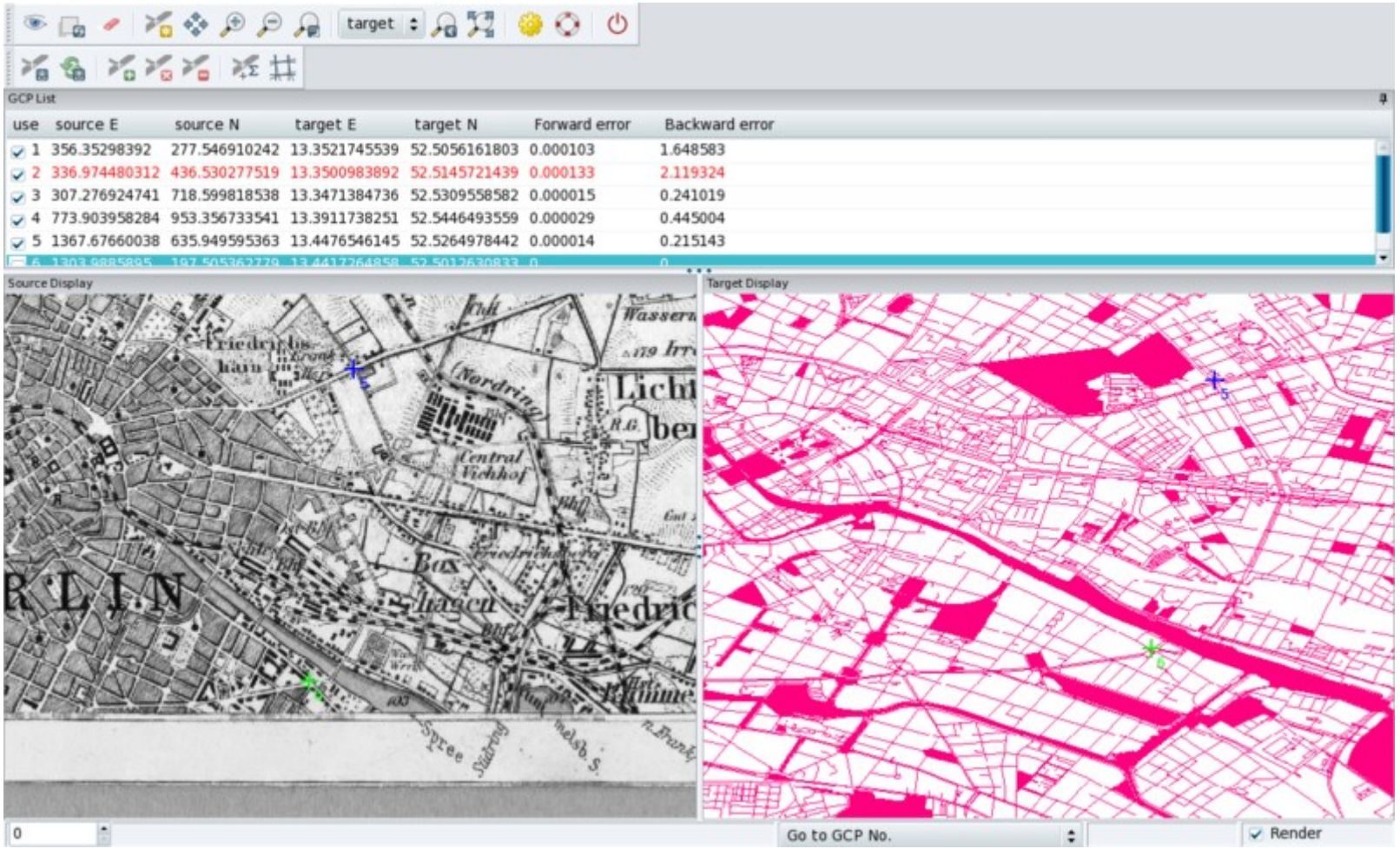
GRASS 7: New geocoding tool

Image/Map rectifier

For raster (imagery, historic scans) and vector maps





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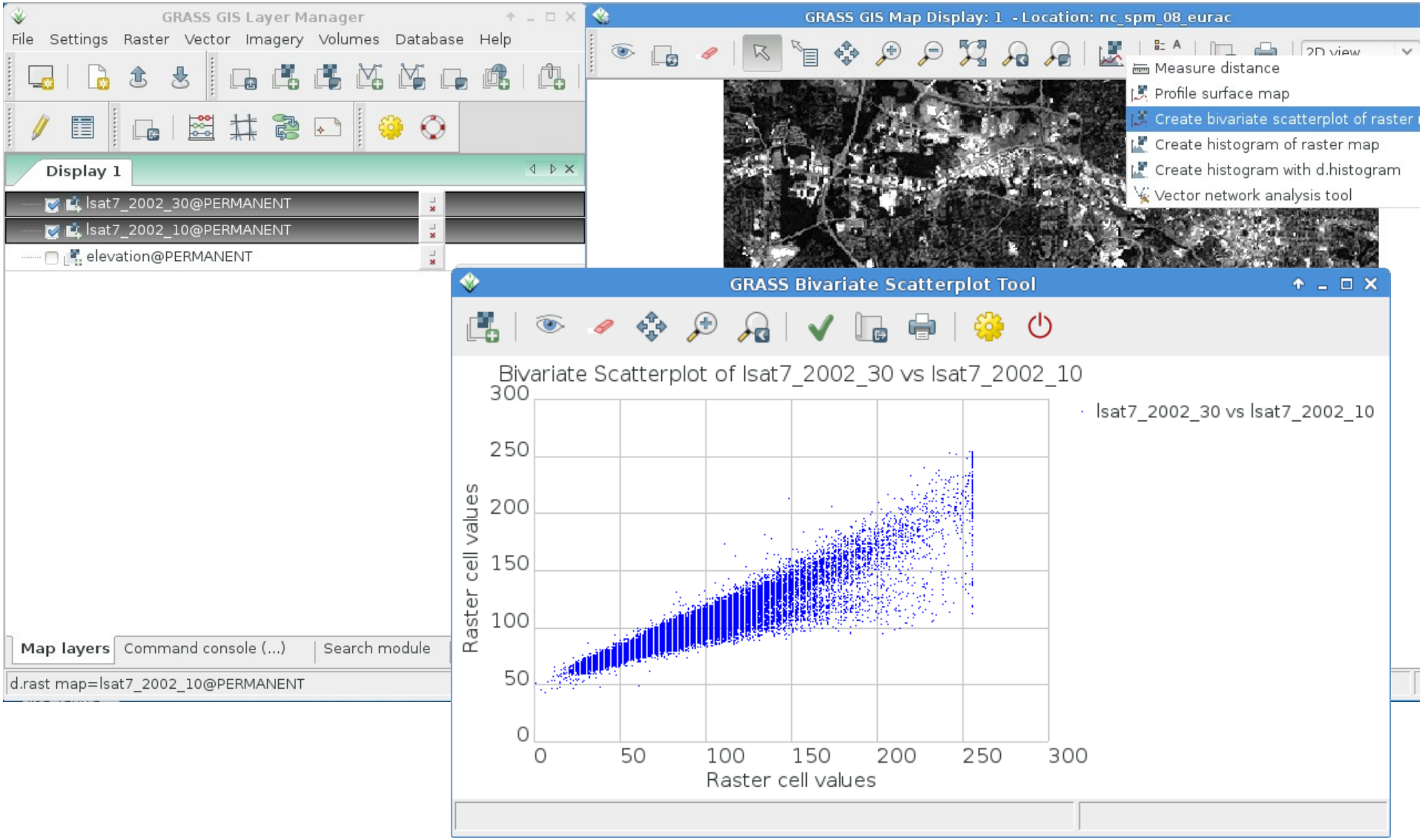
GRASS 7: New bivariate Scatterplots

LANDSAT 7 2002 **channels 1 and 3** of Wake county, NC



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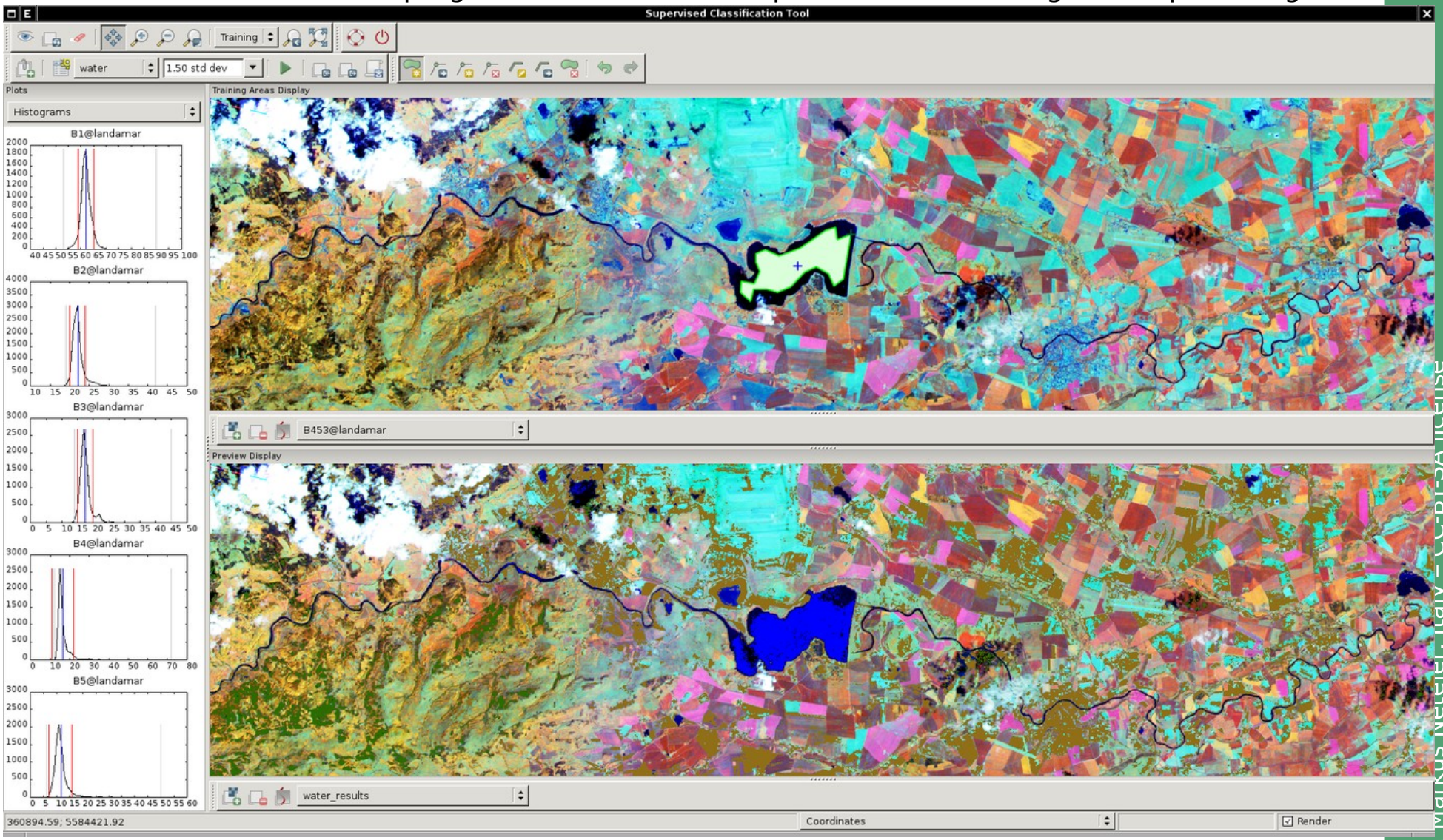
GRASS 7: Supervised image classification

http://geo.fsv.cvut.cz/~landa/publications/2012/ogrs2012/poster/figures/



Tool for supervised classification of imagery data.

Generates spectral signatures for an image by allowing the user to outline regions of interest.

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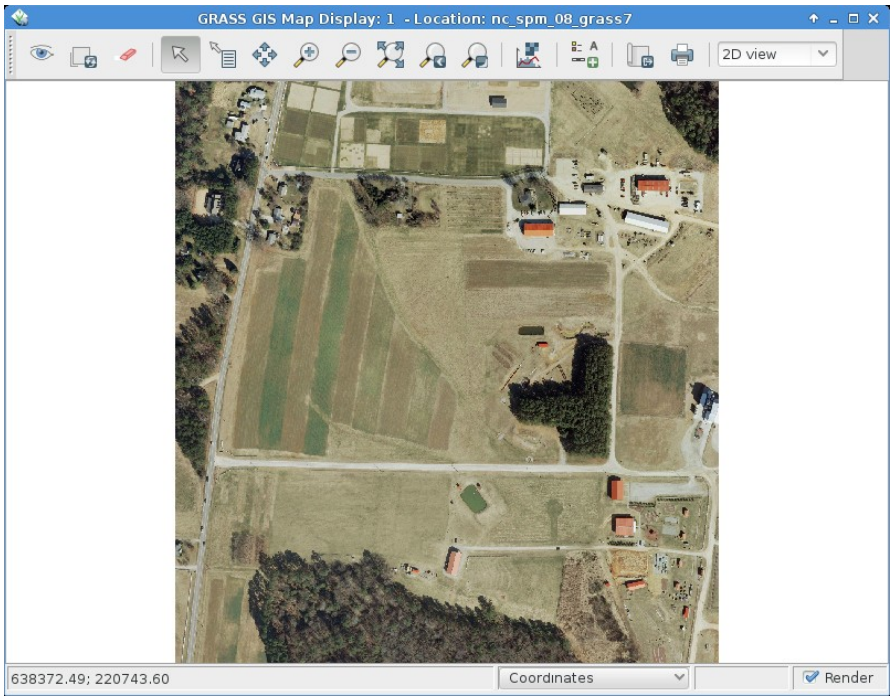
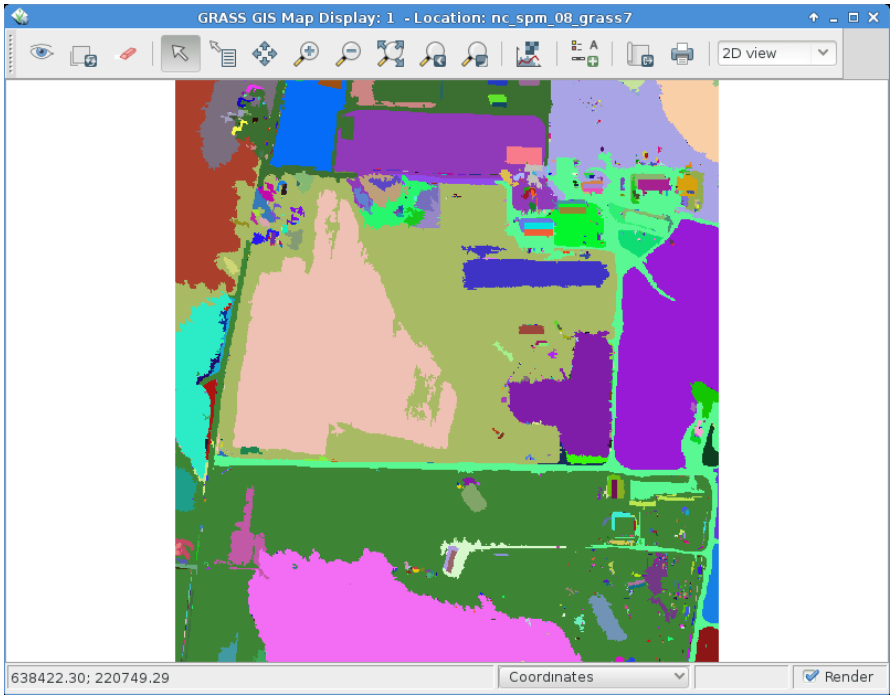
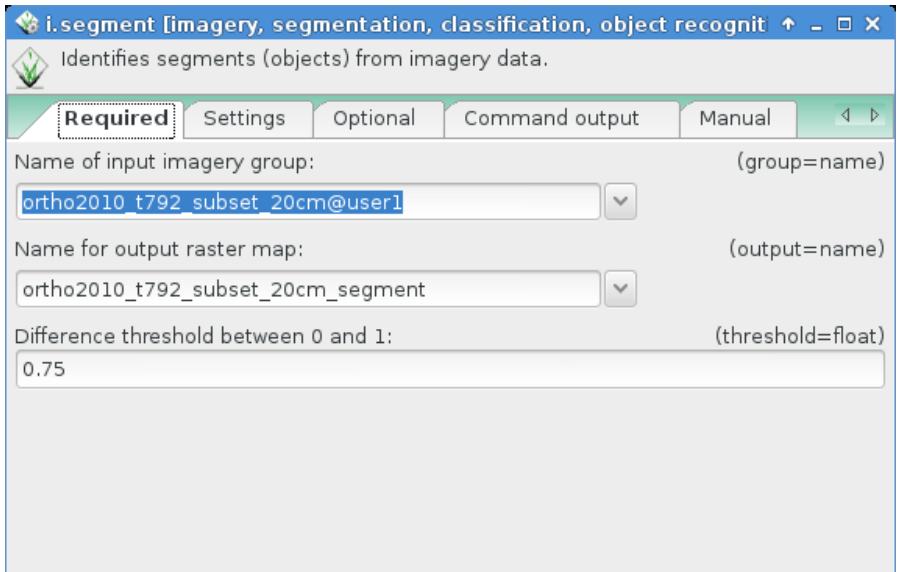
GRASS 7: Unsupervised image classification

i.segment - Identifies segments (objects) from imagery data.







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GRASS 7: New cool stuff: massive data processing

- Since **2005** GRASS GIS is running **natively** on 64bit CPUs
- GRASS GIS 7 also offers Large File Support on 32bit Windows

- Installed on Grids and TOP500 supercomputers (AKKA Umeå, ENEA Frascati, Aurel Bratislava, ...)
- Runs on Linux, AIX, Solaris, freeBSD, netBSD, ...
- Various ways of parallelization

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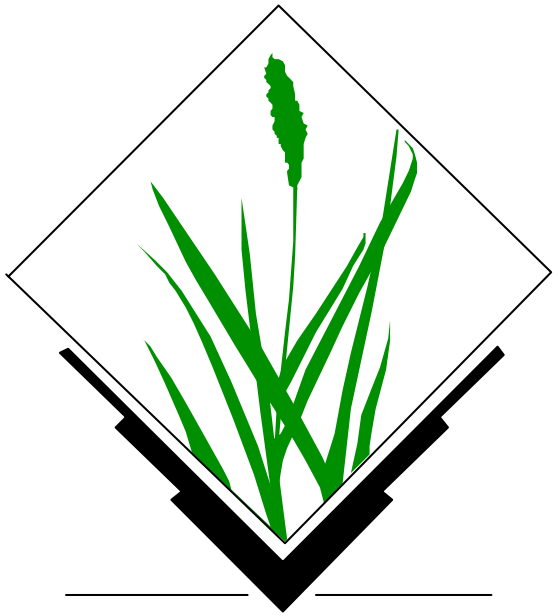
GRASS GIS 7 Temporal Framework: Time-series support



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New Space-Time functionality in GRASS 7

Temporal data processing in GRASS GIS

The temporal GIS framework in GRASS introduces three new datatypes that are designed to handle time series data:

- *Space time raster datasets* (strds) are designed to manage raster map time series. Modules that process strds have the naming prefix *t.rast*.
- *Space time 3D raster datasets* (str3ds) are designed to manage 3D raster map time series. Modules that process str3ds have the naming prefix *t.rast3d*.
- *Space time vector datasets* (stvds) are designed to manage vector map time series. Modules that process stvds have the naming prefix *t.vect*.

Temporal data management in general

List of general management modules:

- t.connect
- t.create
- t.remove
- t.register
- t.unregister
- t.info
- t.list
- t.rast3d.list
- t.vect.list
- t.vect.db.select
- t.sample
- t.support
- t.topology

Export/import conversion

- t.rast.export
- t.rast.import
- t.rast.out.vtk
- t.rast.to.rast3
- r3.out.netcdf
- t.vect.export

Statistics and gap filling

- t.rast.gapfill
- t.rast.univar

Querying and map calculation

- t.rast.list
- t.rast.extract
- t.rast.gapfill
- t.rast.mapcalc
- t.rast3d.extract
- t.rast3d.mapcalc
- t.rast3d.univar
- t.vect.extract
- t.vect.import
- t.vect.observe.strds
- t.vect.univar
- t.vect.what.strds

Aggregation

- t.rast.aggregate.ds
- t.rast.aggregate
- t.rast.series

Space time datasets are stored in a temporal database. SQLite3 or PostgreSQL are supported as SQL database back end. Connection settings are performed with t.connect. As default a sqlite3 database will be created in the PERMANENT mapset that stores all space time datasets and registered time series maps from all mapsets in the location.

Gebbert, S., Pebesma, E., 2014. *TGRASS: A temporal GIS for field based environmental modeling*. Environmental Modelling & Software 53, 1-12. (DOI)

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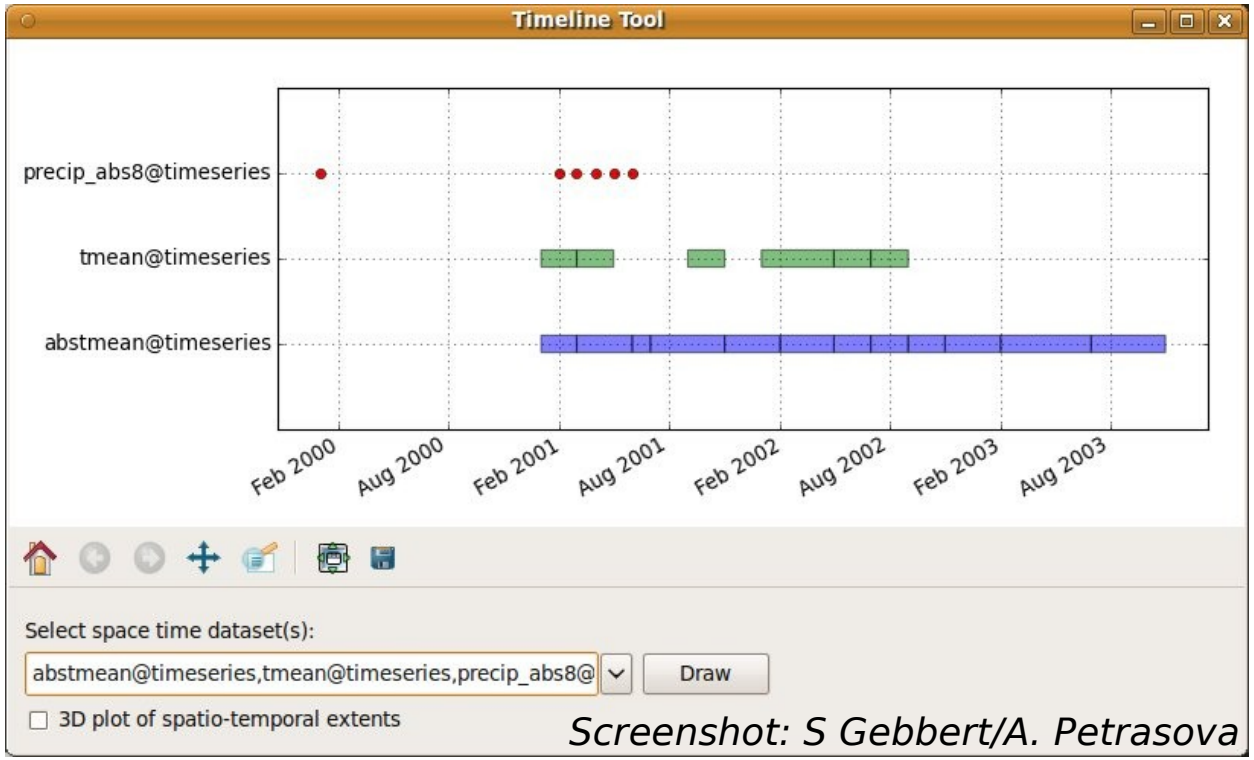
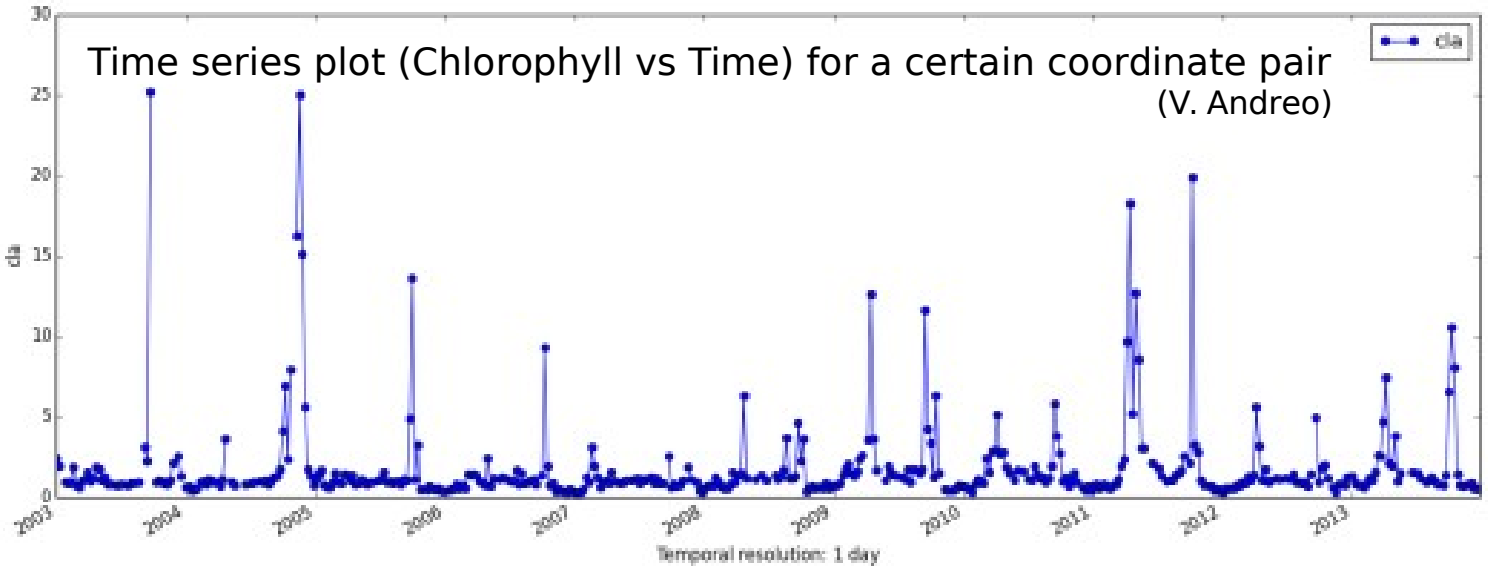
New Space-Time functionality in GRASS 7



Screenshot: S Gebbert/A. Petrasova



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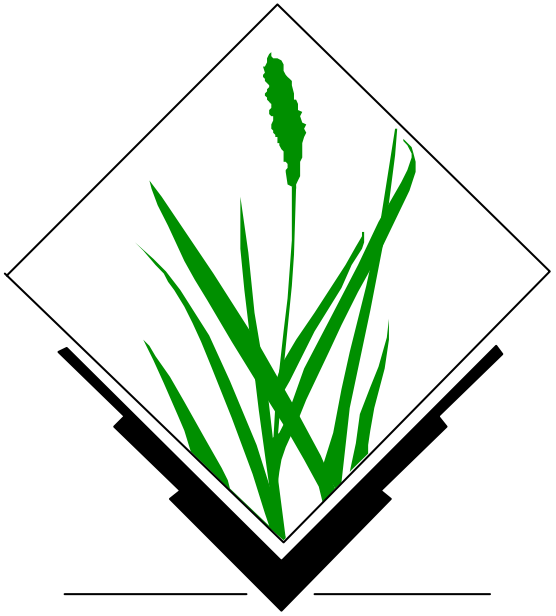
Visualization



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GRASS 7: New animation tool for time series

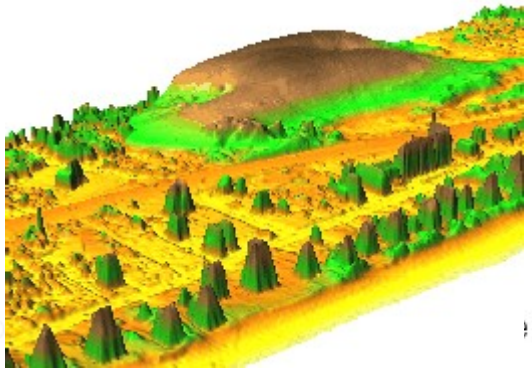
The **Animation Tool** is a *wxGUI* component for animating a series of GRASS raster maps or a space time raster dataset (created by t.* modules).

Animation Tool allows you to:

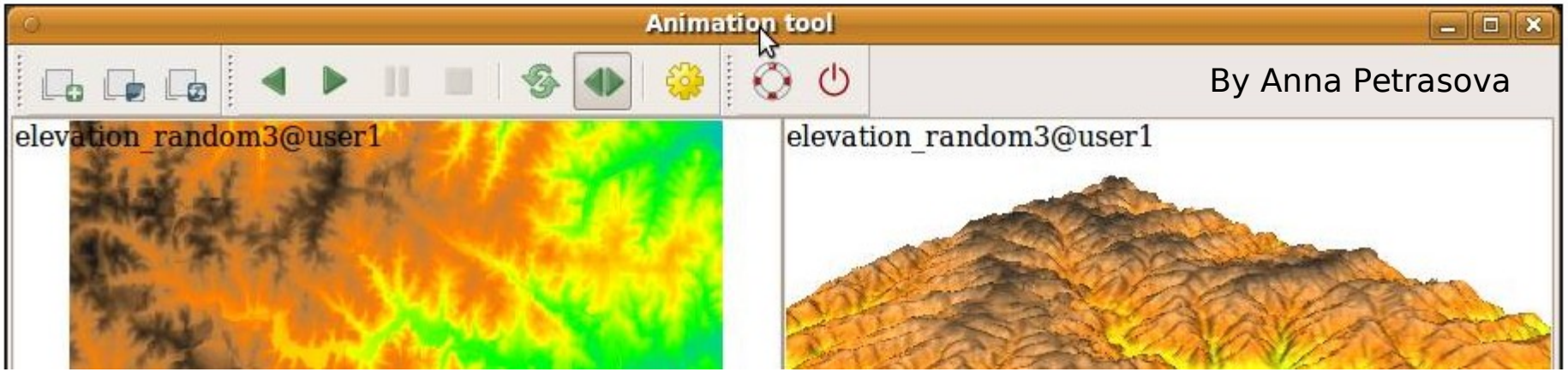
- display up to 4 synchronized animations
- control the animation speed
- interactively change active frame using a slider
- visualize space time datasets with unequally spaced intervals
- animate 3d view (partially implemented)

3D view animation enables to animate raster (as an elevation map or a color map) or vect
m.nviz.image is used. To display 3D view animation follow these steps:

- open GRASS GUI, load maps and start 3D view
- set view, light and other parameters as you like
- save workspace file
- add new animation in Animation Tool, choose 3D view mode
- choose data (series of maps or space time dataset) used for animation
- set workspace file
- choose parameter (parameter of m.nviz.image) to animate (e.g. color_map)



Nagshead LiDAR time series: dune moving over 9 years (NC, USA)



http://grass.osgeo.org/grass70/manuals/g.gui.animation.html

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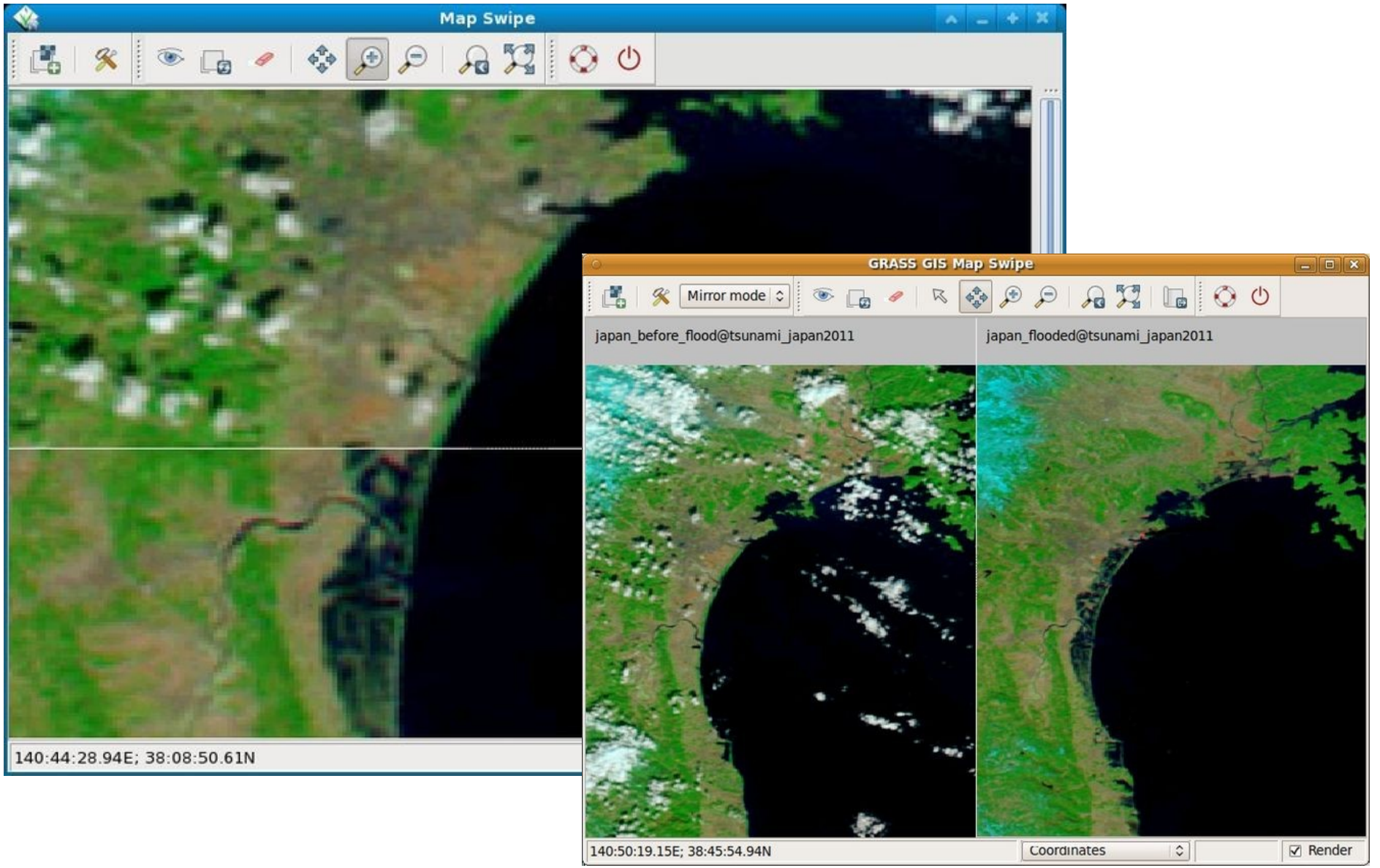
New Map swiping tool for multitemporal maps



Pre and post disaster images of the tsunami in Japan in 2011
(MODIS images taken on February 26 and March 13, 2011)

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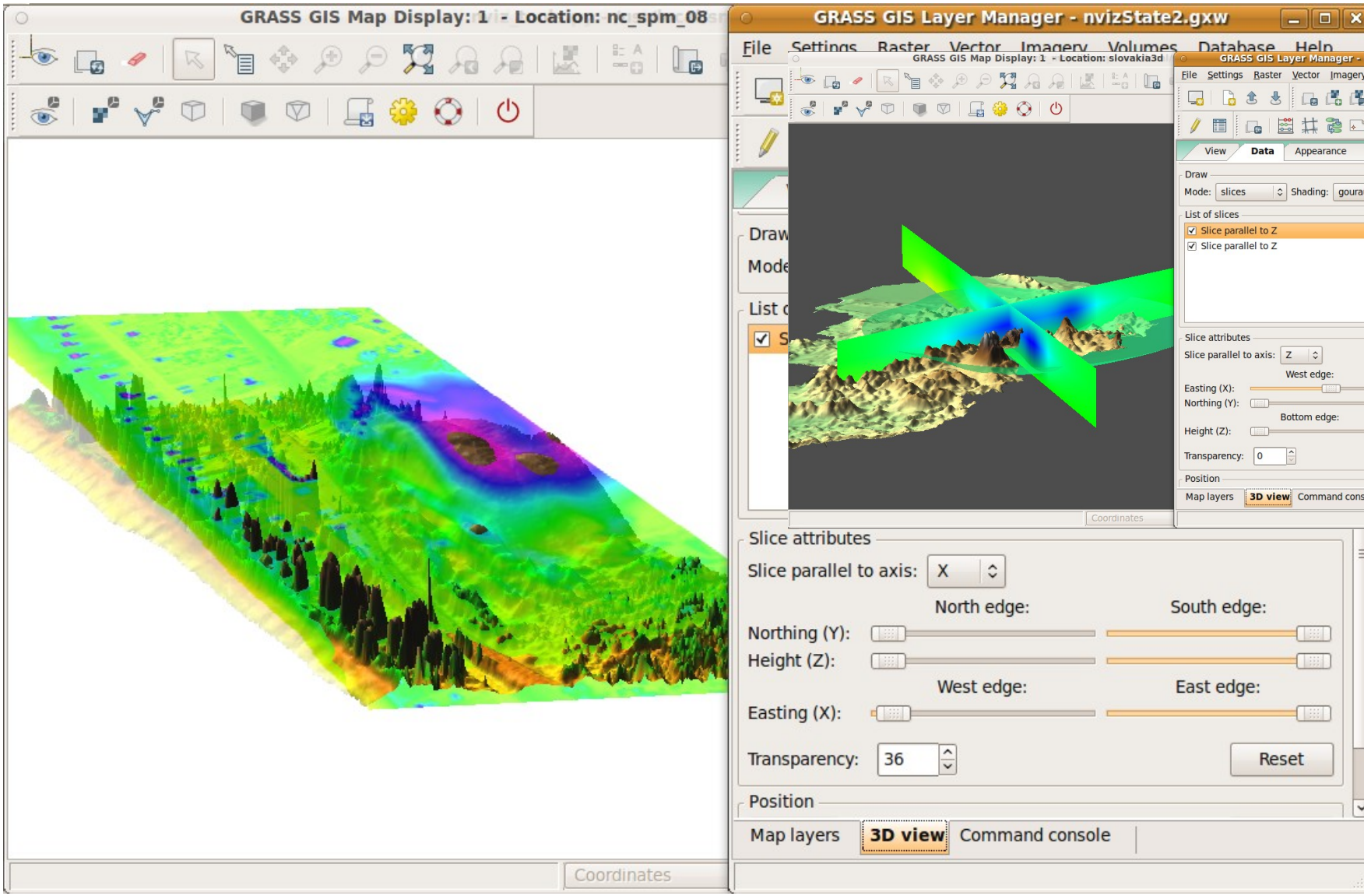
GRASS 7: New visualization tool: wxNVIZ



Programming/screenshot:
Anna Petrasova

http://grasswiki.osgeo.org/wiki/WxNVIZ

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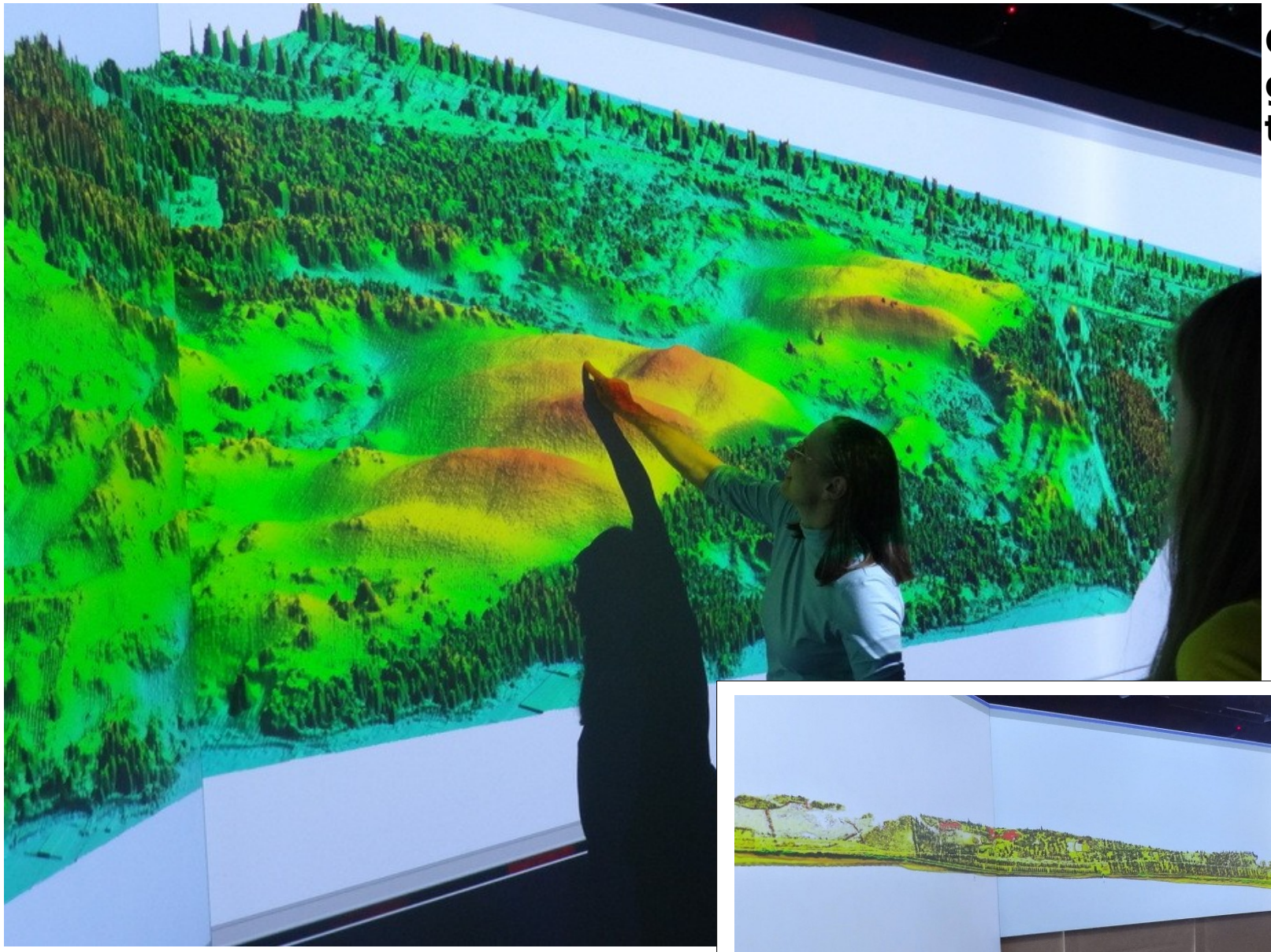
New vizualization methods(NC state university)



GRASS GIS goes theatre

LiDAR derived DSM: 100k x 50k pixels

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GRASS GIS as a platform for sustainable Open Science

GRASS GIS software offers to you:

- **Reproducibility:** Open source is the natural habitat for science and research
- **Return of Investment**:
  Example *r.mapcalc*: available since 1985, continuously developed, user can still run old scripts in latest GRASS GIS 7

https://www.openhub.net/p/grass_gis

- **Auto-documentation**: map and command history preserved “forever”
- **Reliability**: Testing and quality control system (in progress) integrated into the software itself
- **Longevity for Open Science**: code integrated into GRASS “survives” even if original authors would not continue

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Where is the stuff?

GRASS GIS 7 Software:

Free download for MS Windows, MacOSX, Linux and source code:

http://grass.osgeo.org/download/

Addons (user contributed extensions):

http://grasswiki.osgeo.org/wiki/GRASS_AddOns

Free sample data:

Rich data set of North Carolina (NC)

... available as GRASS GIS location and in common GIS formats

http://grass.osgeo.org/download/sample-data/

User Help:

Mailing lists (also in different languages):

http://grass.osgeo.org/support/

Wiki:

http://grasswiki.osgeo.org/wiki/

Manuals:

http://grass.osgeo.org/documentation/manuals/

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http://grass.osgeo.org

http://trac.osgeo.org/grass/wiki/Grass7/NewFeatures

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Coming soon: GRASS GIS 7!

THANKS

OSGeo
Your Open Source Compass