



# GRASS-News

The Newsletter of the GRASS Project

Volume 1, August 2004

## Editorial

by Martin Wegmann

Dear GRASS user,

Welcome to the first volume of *GRASSNews*, the Newsletter of the *GRASS-Project*.

This is an effort to expand the publicity of GRASS and its capabilities. The Newsletter does not aim at being comparable to a scientific publication but shall extend the level of FAQ, manuals, and mailing-lists. *GRASSNews* aims at a quarterly release, but this will depend on the amount of submitted articles and might be shorter or longer. Every GRASS user is encouraged to submit articles, news etc. Every submission will be recognized by the editorial board and reviewed only to ensure the quality of articles.

In general, this newsletter aims at covering various topics from "getting started with GRASS" *novice-section* up to "How to become a developer". Each Newsletter, however, will be different in its content depending on the articles submitted. Various topics

shall be covered; broad categories are listed below:

- GRASS in action
  - articles targeting GRASS novices
  - presentation of GRASS capabilities e.g. modeling, animation, spatial statistics
  - presentation/description of new/note-worthy GRASS modules (rather technical)
- GRASS development
  - articles targeting developer
  - forthcoming GRASS capabilities
  - summary of GRASS development, discussions
- Various topics
  - new GRASS related publications
  - Interviews, misc.
  - upcoming events, news & news about past meetings etc.

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  - presentations of non-GRASS GIS/RS related programs

*GRASSNews* is inspired by the R newsletter <sup>1</sup> and I appreciate their help with getting this project off the ground. The R Editorial Board contributed the base of the GRASS newsletter by providing the Latex/sty file and answering some organisational questions.

Hopefully you will enjoy the first Newsletter and perhaps you will be encouraged to throw a glance at

GRASS if you have not used it before, to submit an article for the next volume, or to have a closer look behind the scenes and become involved with GRASS development.

with best regards, Martin Wegmann

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## Historical Notes

GRASS (Geographic Resources Analysis Support System) GRASS has been under continuous development since 1982 and has involved a large number of federal U.S. agencies, universities, and private companies. The core components of GRASS and the management of the integration efforts into GRASS releases were accomplished by the U.S. Army - Construction Engineering Research Laboratory (USA-CERL) in Champaign, Illinois. USA-CERL completed its last release of GRASS as version 4.1 in 1992, and provided five updates and patches to this release through 1995. USA-CERL also wrote the core components of the GRASS 5.0 floating point version.

From "GRASS Mini-HOWTO" (Nov. 1997)<sup>2</sup>: In the early 1980s the U.S. Army Corps of Engineers' Construction Engineering Research Laboratory (USA/CERL) in Champaign, Illinois, began to explore the possibilities of using Geographic Information Systems to conduct environmental research, assessments, monitoring and management of lands under the stewardship of the U. S. Department of Defense. Part of the motivation for this action was new responsibility for the environment encoded into the National Environmental Policy Act of the late 1970s.

Bill Goran of USA/CERL conducted a survey of available GISs, assuming that he could find several systems capable of environmental analysis, from which he could select one or more to recommend for use by CERL and perhaps others in the Department of Defense. However, he was surprised to find no GIS that satisfied his needs. What started as a selection process turned into a design exercise for his own GIS development program. USA/CERL hired several programmers, and began by writing a hybrid raster-vector GIS for the VAX UNIX environ-

ment. This made the team one of the first to seriously develop GIS for UNIX. Though they still faced challenges with different versions of UNIX, they developed procedures of coding in ANSI standard UNIX, avoiding "tweaking" the code toward any particular vendor-specific flavor of UNIX.

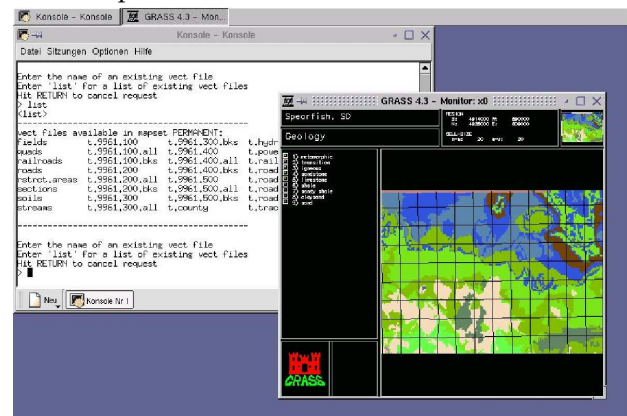


Figure 1: That's how GRASS 4.3 looked like in 1999. With kind permission of *Linux Magazin*

## L. Van Warren's historical note

I was visiting your wonderful website and wanted to add a few historical details. I was the founding software architect of GRASS. When I was an engineering student at the University of Illinois I was hired by Bill Goran of the Corps of Engr. Research Laboratory (CERL) to create the first version. It started with a capability to overlay various kinds of raster GIS data and do Boolean combinations on layers of that data. I delivered the first version in 1982. The document describing that work was published later in CERL Technical Report N-154, May 1983. A short

<sup>1</sup><http://www.r-project.org>

<sup>2</sup><http://www.tldp.org/HOWTO/GIS-GRASS/>

historical note. Around 1981 at the University of Illinois I had lunch with a CERLite named William Dvorak who was also a student. At this lunchtime meeting William said he was graduating and leaving the project, but thought it might be possible to use Boolean algebra to construct and answer questions about maps created from remote sensing data. His insight was both a brilliant and historical one. Using a yacc parser I constructed the first version of such a program and called the program combinate. I do not know how long this name survived. The user could type in expressions and see them evaluated on multiple layers of maps. The first example I did combined elevation, landsat and watershed data of Fort Hood, in Kileen, Texas. That was a pretty big deal back then... The same idea later appeared a few years later in an image synthesizer built by Ken Perlin that made its way through SIGGRAPH circles. The GRASS images were some of the first to combine these two kinds of data in the same image. Pat Kane, now of Motorola, implemented a hidden surface algorithm to show elevation and landcover type in 3D simultaneously. I do not think that code was added to the early version of GRASS. After this, Jim Bozek, now of IBM, added a menu driven user interface and a musician whose name I have forgotten built the first version of a distance-from operator which produced beautiful images. In 1983 I left Champaign for the University of Utah and recommended as my replacement an engineering friend of mine, Dan Goriesky, who later went to work for the Naval Weapons Center at China Lake. Later I was the technical director for a project sponsored by National Geographic called the Earth from Space. It was the prototype of the nice image you use for tracking developers. Starting in 1983 Jim Westervelt added many other capabilities to the system and was an early champion of making GRASS a comprehensive product. I hope this adds to any history of GRASS that you currently have. I have an extra copy of the CERL report if it is of historical value. I am glad to see GRASS being distributed under the GNU public license. That is a fitting tribute to its multi-authored legacy.

Best Regards, Van

L. Van Warren MS CS, MS AE [www.wdv.com](http://www.wdv.com)  
March 2003

## GRASS releases

- 1982 Fort Hood Information System (FHIS) (Vax 11/780)
- 1983 Installation Geographic Information System (IGIS) (SUN-1 Microcomputer)

- 1984 GRASS (SUN-1 and Masscomp)
- 1985 GRASS 1.0, GRASSnet established (GRASShopper archive 1991-95, GRASSList archive 1996-today)
- 1986 GRASS 1.1; receives "Exemplary Systems in Government Award" from URISA
- 1987 GRASS 2.0; first issue of GRASSClippings, GRASS video narrated by William Shatner (Captain Kirk of Star Trek)
- 1988 GRASS 3.0; Army R&D Achievement Award (Webster, Goran, Shapiro, Westervelt)
- 1989 GRASS 3.1; First release available on Internet ([uxc.cso.uiuc.edu](http://uxc.cso.uiuc.edu))
- 1991 GRASS 4.0 released through Internet - popularity grows with universities, business and government agencies. Vector Library changed significantly from the library used in GRASS 3.1
- 1993 (Spring) GRASS 4.1 released through Internet - Federal Lab Consortium - Award for Excellence in Technology Transfer
- 1995 GRASS 4.1.5 port to Linux: Yung-Tsung Kang, Michigan State University
- 1995 internal 5.0fp with floating point raster data implementation. US-CERL withdrawal from GRASS
- 1997 GRASS 4.2 Baylor University - The first "GRASS Research Group" takes control of GRASS Development from USA-CERL.Extended sites format. This first new GRASS 4.2 release in 4 years adds numerous programs. Popularity increases with academic community.
- 1998 GRASS 4.2.1 Markus Neteler, University of Hannover, Germany (team applied 243 fixes and 50 new modules to former 4.2)
- 1999 GRASS 4.3 released (based on 4.2.1V22 with a few more fixes)
- 1999 GRASS 5.0 Baylor University and Markus Neteler
- 2001 The GRASS Development Team, now headquartered at ITC-irst (Trento, Italy) released:
  - GRASS 5.0.0 stable released 5 September 2002
  - GRASS 5.0.3 released 6 November 2003
  - GRASS 5.3.0 released 5 May 2004
  - GRASS 5.7.0 released 17 June 2004

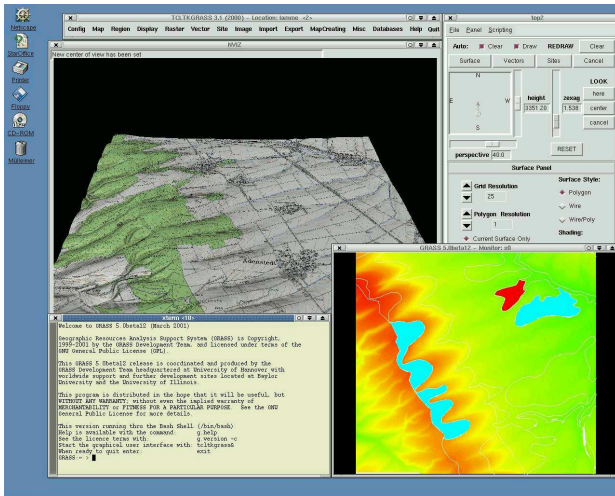


Figure 2: Screenshot of GRASS 5.0 beta version

## GRASS 5.3.0 release

Released 5 May 2004

A new release of GRASS has been published. This is a "technology preview" release from the 5.3 development series, which is undergoing testing in preparation for creation of the stable 5.4 branch (see the GRASS Development Roadmap (fig. 1)). GRASS 5.3 is already in reliable daily production use at many locations worldwide.

The Geographic Resources Analysis Support System, commonly referred to as GRASS GIS, is a Geographical Information System (GIS) used for data management, image processing, graphics production, spatial modelling, and visualization of raster, vector and sites data. It is open source Free Software released under the GNU General Public License (GPL).

### Platforms supported by GRASS:

GNU/Linux, Sun Solaris (SPARC/Intel), Silicon Graphics Irix, Mac OS X/Darwin, Microsoft Windows with Cygwin, HP-UX, DEC-Alpha, AIX, BSD, iPAQ/Linux and other UNIX compliant platforms (32/64bit).

### Software download:

<http://grass.itc.it>, <http://grass.ibiblio.org> and various mirror sites

The new source code is available now, and selected binary distributions for major operating

For more in detailed informations concerning the development of GRASS please visit [http://grass.itc.it/grass\\_releases.html](http://grass.itc.it/grass_releases.html).

The 5.3.0 and the 5.7.0 branch are under concurrent development and both versions have been released in 2004. The release announcement of these two releases can be found on page 4 and 6.

GRASS-Project

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[grass5\\_AT\\_grass.itc.it](mailto:grass5_AT_grass.itc.it)

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systems will be published shortly. For details on GRASS software capabilities please refer to <http://grass.itc.it/general.html>.

### What's new in GRASS 5.3.0

5.3.0 represents a significant improvement in functionality over 5.0.3 (the most recent release in the old 5.0 stable series) and includes many bugfixes. Selected major changes are outlined below. For a more comprehensive list of changed modules see the Developers' Notes; the full ChangeLog is also available.

#### Datum Transformation

Re-projection of GPS and satellite-derived data into a national co-ordinate system often requires datum transformation, otherwise shifts in the data of the order of several hundred metres can occur. The GRASS re-projection modules `r.proj`, `v.proj` and `s.proj` now support datum transformation. This is built on top of the implementation in the PROJ.4 library. If you are not sure whether your existing locations in the database contain enough information to perform datum transformations, please re-run `g.setproj`, which has been improved.

#### Shared library support

Using the configure option `--enable-gmake=no` (this will become the default for 5.4 when it is reliable on all supported platforms) makes use of a new build mechanism which compiles the core GRASS libraries

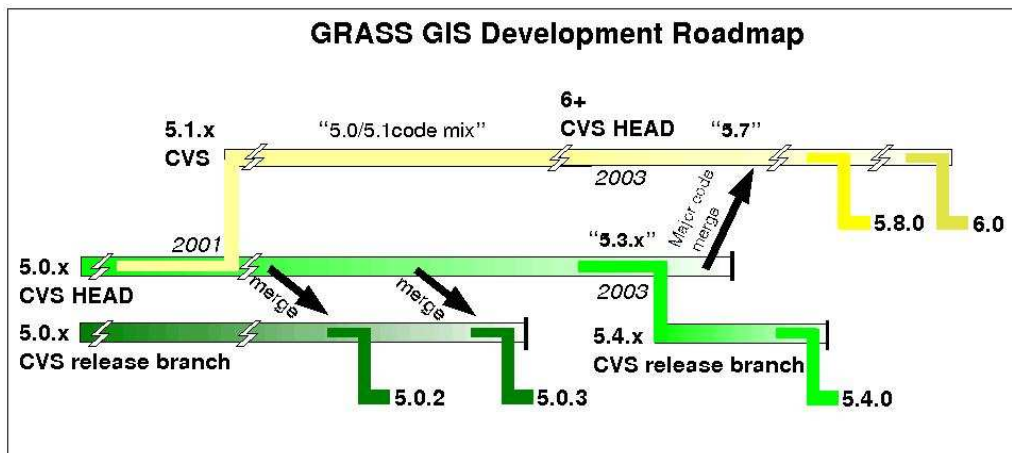


Figure 1: Roadmap of GRASS development.

as shared by default. This results in a much smaller size for the installed binaries. Not yet fully compatible with Mac OSX and Cygwin.

### External PROJ.4 library support

Users can avail of the latest updates to the projections and datums supported by the RemoteSensing.org PROJ.4 library by compiling GRASS against it. This is the default; note that PROJ.4 must be installed before GRASS. Using the `--with-proj=no` configure option will result in the old version of PROJ.4 contained within the GRASS sources being used instead.

### New tcltkgrass Graphical User Interface menu structure

Additional commands are also supported via the GUI. `g.help` is still there, but an enhanced task-oriented GUI is now also available to guide novice users through typical GIS tasks

### Improvements to 3-D Visualisation

Updates to the `nviz` 3-D visualisation tool include experimental loading and saving of `3d.view` files from the GRASS database, off-screen rendering and implementation of many planned features for which 'stub' functionality only has existed up to now. In addition the new module `d.nviz` allows automated creation of fly-through animations in `nviz`. Improved Inverse distance weighted interpolation An improved algorithm in `s.surf.idw` indexes sites and allows greatly improved performance when the region resolution and number of sites are both very large.

### Experimental LIDAR processing tools

`s.bspline.reg`, `s.correction`, `s.edgedetection`, `s.growing`, `s.to.qrast` (not compiled by default)

### Experimental hydrology and sediment transport simulation tools

`r.sim.sediment`, `r.sim.water` (not compiled by default)

### Experimental large-scale watershed computation

`r.terraflow`

### G3D 3-D Raster Voxel tools enabled

The 3-D raster processing tools are fully enabled in this release of GRASS. This includes the modules `g3.region`, `g3.list`, `g3.remove`, `g3.rename`, `g3.setregion`, `r3.colors`, `r3.in.ascii`, `r3.in.grid3`, `r3.in.v5d`, `r3.info`, `r3.mapcalc`, `r3.mask`, `r3.mkdspf`, `r3.null`, `r3.out.ascii`, `r3.out.v5d`, `r3.showdspf`, `r3.timestamp`, `r3.to.sites`, `g3.createwind`, `s.to.rast3`, `s.vol.idw` and `s.vol.rst`

### MATLAB import and export

GRASS can now import and export rasters from the MATLAB binary '.mat' format. The relevant modules are `r.in.mat` and `r.out.mat` (not compiled by default)

### Raster time series Statistical Analysis

`r.series` can be used to create an output raster map where each cell value is a statistical function (average, count, median, mode, minimum, maximum, `stddev`, sum, variance, diversity, slope or offset) of

the values of the corresponding cells in all the input raster maps. Please see r.series article on page 11 for further details. (not compiled by default)

### Vis5D Output

r3.in.v5d and r3.out.v5d already exist to allow data conversion between Vis5D and GRASS G3D format. Now in addition 2-D raster and vector data can be output to a Vis5D model (for further enhanced visualisation) using the new modules r.out.v5d.topo and v.out.v5d.map. g.region.v5d sets the region from a Vis5D file (not compiled by default).

### TrueColor Support

All the core display modules (d.\*) now support 24-bit colour.

### More reliable raster import

Technical changes and bugfixes to the r.in.gdal raster import module mean that by default it will operate reliably with all recent and older versions of GDAL.

### Other new modules

Miscellaneous new modules include d.3d.views, d.info, d.out.png, d.sites.icons, i.tasscap.tm7, m.cogo, r.grow2, r.out.gdal, r.texture, r.univar2, s.cellstats, s.kernel and s.sv2svfit (not all compiled/installed by default).

### Note on changes in datum transformation functionality for locations using the 'nad27' and 'nad83' datums

Released versions of GRASS 5.0.x from 5.0.0pre4 onward (i.e. up to and including 5.0.3) have included the capability to perform NAD27<->NAD83 datum conversions. This was done using the published NADCON conversion tables, if and only if the line 'datum: nad27' appeared in the PROJ\_INFO file for one location and 'datum: nad83' in the other. Even if datum transformation parameters were specified

(e.g. dx, dy, dz) they were ignored and the NADCON tables used. In GRASS 5.3 any datum transformation parameters present in the PROJ\_INFO file will be used. These are likely to be less accurate than the NADCON transformation (unless g.setproj is re-run for the location and the NADCON parameters specifically selected). Many more datum transformation options are available in this release of GRASS and g.setproj should be re-run if in any doubt that the location is using the most up-to-date datum parameters.

### Why is 5.4.0 not yet released?

The developers want to ensure that 5.4.0 is a stable release. GRASS development relies on people willing to help. This 5.3.0 release is a candidate for becoming the 5.4.0 release. It can only be made stable if it enjoys a lot of testing. Please give it a spin. Report bugs to the GRASS bugtracker. Don't hesitate to report a bug which you find in the new release.

If you are interested in joining the developers team, and/or share algorithms or ideas with the GRASS community, contact us! <http://grass.itc.it/grassdevel.html>

### Concurrent Development Series 5.7

Major changes and improvements to the vector engine and attribute management system have been implemented in the 5.7.x line, which is very usable today and will become the next major production series as 5.8.x. At present development is taking place concurrently on both the 5.3.x and 5.7.x lines, but once the stable release of 5.4.0 is made, all development effort will transfer to 5.7.x. Please have a look at the 5.7.0 release announcement on page 6.

We are always looking for both testers and developers to help us maintain and accelerate this development cycle.

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## GRASS 5.7.0 release

Released 17 June 2004

After more than two years of development the first official release of the next generation implementation

of GRASS has been published (see the GRASS Development Roadmap (fig: 1 on page 5)).

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tem, commonly referred to as GRASS GIS, is a Geographical Information System (GIS) used for data management, image processing, graphics production, spatial modeling, and visualization of raster, vector and sites data. It is open source Free Software released under the GNU General Public License (GPL).

## Platforms supported by GRASS

GNU/Linux, Sun Solaris (SPARC/Intel), Silicon Graphics Irix, Mac OS X/Darwin, Microsoft Windows with Cygwin, HP-UX, DEC-Alpha, AIX, BSD, iPAQ/Linux and other UNIX compliant platforms (32/64bit).

## Software download

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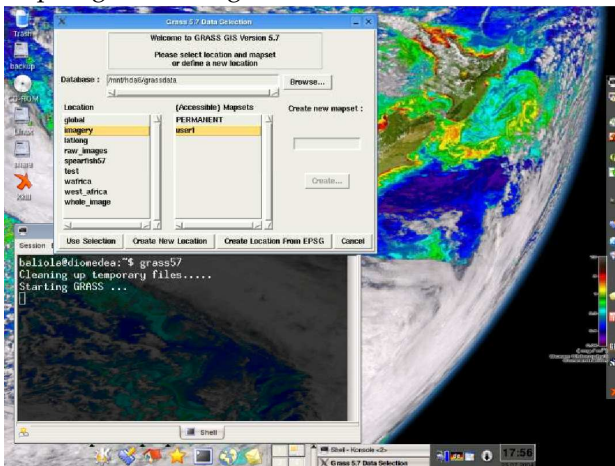


Figure 1: New start-up screen of GRASS 5.7.0

## What's new in GRASS 5.7.0

### Geometry management

GRASS 5.7.0 comes with a completely overhauled vector engine which is extended to manage 2D and 3D topological vector data. The new internal vector data format is portable between 32bit and 64bit platforms. In addition, a new spatial indexing system accelerates data access. Vector data from other GIS software can be imported (allowing for topological data clean-up) as well as live-linked into the

GRASS database. The new Directed Graph Library provides support for vector network analysis. Vector map overlays, intersections and extraction of features are implemented.

### Attribute management

The new vector engine includes full and flexible integration of database management systems (DBMS) for attribute management (currently PostgreSQL, MySQL, DBF, and ODBC are supported). SQL statements are used to manage attributes. Graphical updating of vector attributes has been implemented as well.

### User interface

A graphical user interface (GUI) for every module is now generated on the fly. A new display manager has been implemented, which is supplemented by an updated version of the classic 'tcltkgrass' GUI menu structure. NVIZ, the included visualization package, is enhanced to display 3D vector data. Additionally, a completely new graphical tool for digitizing has been implemented. (fig. 2)

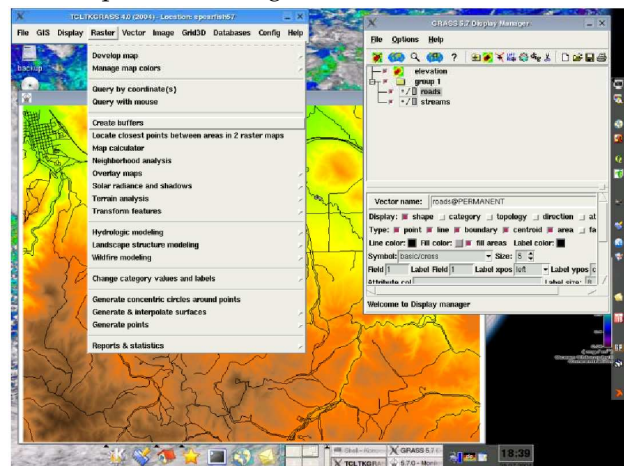


Figure 2: New graphical user interface of GRASS 5.7.0

### Multi-session

Users can now run concurrent GRASS 5.7 sessions. It is also possible to run GRASS 5.3.x and 5.7.0 in parallel in the same LOCATION.

### Generating new GRASS LOCATIONS

New LOCATIONS with automatically set projection information can be generated by EPSG code number from the start-up screen. Within a GRASS session,

LOCATIONS can be automatically created from existing datasets (raster data as well as vector data, see fig. 1).

## Data Import/Export

GRASS 5.7.0 is integrated with the GDAL/OGR library to support an extensive range of raster and vector formats. OGC-conformal Simple Features vector data are converted into the topological GRASS format; conversely, export into Simple Features is also possible.

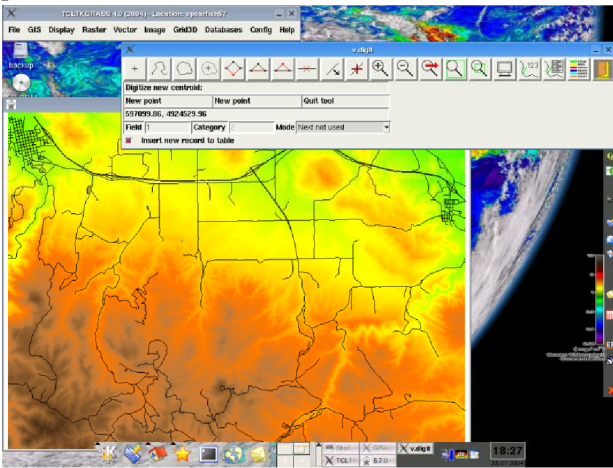


Figure 3: Vector and raster digitizing in GRASS 5.7.0

## Enhancements included from 5.3.0

This release bundles the new vector capabilities with all the improvements from GRASS 5.3.0 (e.g. support for datum transformation, use of external PROJ4 and GDAL/OGR libraries, shared libraries making binary distributions significantly smaller, G3D 3-D Raster Voxel tools). The raster capabilities of 5.7.0 are identical with those of 5.3.0 (please see article on page 4).

For a more comprehensive list of changed modules see the ChangeLog. For a complete list of command in GRASS 5.7.0, see HTML manuals.

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# Global dataset of bathymetry and topography

## Import and display in GRASS

by M. Hamish Bowman

### Introduction

The National Oceanic and Atmospheric Administration (NOAA) of the United States provides global gridded relief data for the entire planet at high resolution. This article will show how this type of data may be imported and visualised in GRASS GIS. All commands are given for GRASS 5.3.0 or newer, and most are also available through the GRASS Tcl/Tk menu system although not provided here.

### Obtaining the data

The gridded global datasets are in the public domain and freely downloadable and distributable, although user-distributed data is unsupported. An exception is the land-topography data of Australia in the GLOBE 1.0 dataset, which is copyrighted to AUSLIG and may not be redistributed without prior consent.

Combined bathymetric and topographic datasets are available at 2' (3.7 km) and 5' (9.3 km) resolution, and global land-topography is available at 30" (1 km) resolution. In this article, we will explore the ETOPO2 combined bathymetric and topographic global dataset.

NOAA's National Geophysical Data Center hosts the data on their website:

<http://www.ngdc.noaa.gov/mgg/global/global.html>

The raw ETOPO2 gridded relief data may be



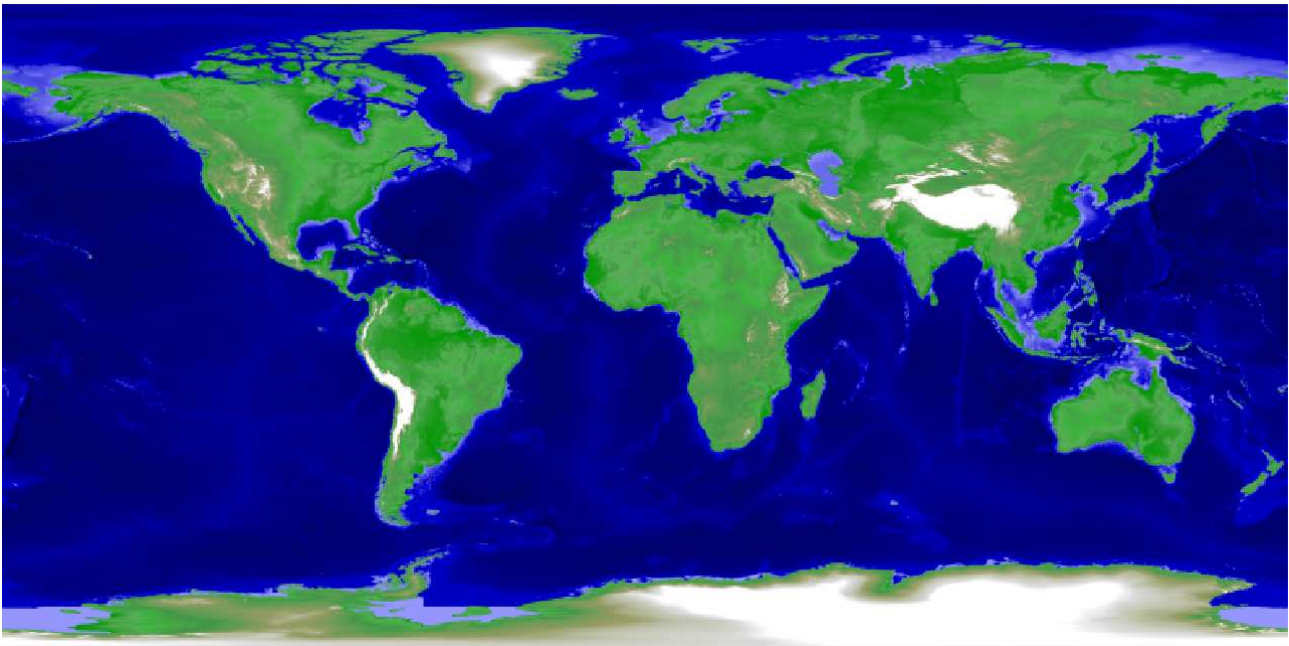


Figure 1: Global bathymetry and topography.

downloaded here:

<http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO2/>

In this case we will download the little-endian version, ETOPO2.dos.bin (111mb). Alternatively, you might prefer to try the ETOPO5 dataset (18mb), or the 30" GLOBE 1.0 land-topography dataset (307mb). It is interesting to note that the GLOBE 1.0 dataset was created in the late 1990's using GRASS 4.1.4 for final assembly. GRASS support files are available for download from the GLOBE webpage.

An update to the GLOBE dataset is due soon, presumably incorporating cleaned SRTM data once it becomes available.

## Importing into GRASS

After creating a new Latitude-Longitude location and mapset, the `r.in.bin` module is used to load the data.

```
GRASS:~ > r.in.bin input=ETOPO2.dos.bin \
  title="2' worldwide relief (3.7 km-sq)" \
  output=etopo2 bytes=2 -s rows=5400 \
  cols=10800 n=90N s=90S e=180E w=180W
```

Next we use the `r.info` module to check that the import went as expected.

```
GRASS:~ > r.info etopo2
```

Note that the GRASS region is defined as the outside extent of the grid cells, not the centers of the outside cells, as in many other systems. Here, we

check that the map's resolution was set correctly at 0:02, i.e. zero degrees and two minutes, indicating that the map bounds and array size parameters were set correctly in `r.in.bin`.

## Displaying the map

After starting a display monitor with `d.mon`, the map can be viewed using the `d.rast` module. If you have been doing other work in the mapset, you may have to reset the region bounds first with `g.region`. The resulting image can be seen in figure 1.

```
GRASS:~ > d.mon x0
GRASS:~ > g.region rast=etopo2
GRASS:~ > d.rast etopo2
```

If you zoom in using `d.zoom`, be aware that you may have to reset the region's resolution with `g.region`. This is unnecessary in newer versions of GRASS.

```
GRASS:~ > g.region -p
GRASS:~ > g.region res=0:02 -a
```

You can use `d.legend` to add a colorbar legend.

```
GRASS:~ > d.legend map=etopo2 -f color=white \
  at=10,75,2,5
```

A more natural color scale may be added using `r.colors`.

```
GRASS:~ > r.colors map=etopo2 rules=terrain
```

After resetting the color table, you will need to redraw the display monitor.

```
GRASS:~ > d.redraw
```

The predefined terrain color rules were designed for a continental shelf situation where the ocean fades into the abyss at 500m depth. When working with data covering the full depth of the ocean floor, we will need to enter the rules manually or modify the existing rules file. To enter the rules manually, use the following command:

```
GRASS:~ > r.colors map=etopo2 color=rules
```

Followed by whatever rules you choose. See the `r.colors` help page for more information. You can also tweak the existing rules file by editing the simple text file it is stored in using your favorite text editor.

```
GRASS:~ > g.findfile element=colr file=etopo2 \
# look for the 'file=' line
GRASS:~ > nedit ~/gdata/world/etopo2/colr/etopo2
```

Here we need to change -500 to -10000 on the third and fourth lines to tag that depth as the transition to a dark blue (colors are given after the elevation as RED:GREEN:BLUE on a scale from 0 to 255). The color table can be quickly reset using `r.colors` if anything goes wrong.

## Hardcopy output

You can save a hardcopy of the image with the `d.out.png` script or to a PostScript file for printing with the following `ps.map` command:

```
GRASS:~ > g.region res=0:10
GRASS:~ > ps.map -r out=global_relief.ps << EOF
raster etopo2
grid 30
  numbers 1 blue
  end
mapinfo
  where 9 6.75
  end
end
EOF
```

If you would like to create a shaded relief image, you can use `'shade.rel.sh scale=m'` in GRASS 5.3 or the `r.shaded.relief` module in GRASS 5.7.

## 3D visualisation and fly-throughs using NVIZ

To view the map in full 3D we will use the NVIZ visualisation software. At the time of this writing, it is necessary to scale the map into equal dimensions before loading into NVIZ. That is, we need the map to be scaled 1:1:1 in the XYZ, not degrees:degrees:meters. To do this we use the GRASS map calculator, `r.mapcalc`.

```
GRASS:~ > r.mapcalc \
"etopo2_scaled=etopo2/(60*1852.0)"
```

This does not copy the color table, so we will need to define a simple one at the new vertical scale.

```
GRASS:~ > r.colors etopo2_scaled col=rules << EOF
0% black
-0 blue
+0 0:100:0
100% white
EOF
```

As the map is very large, you might want to change the region resolution to half a degree or zoom in on an area of interest.

```
GRASS:~ > g.region res=0:30 -a
```

We can now start NVIZ.

```
GRASS:~ > nviz etopo2_scaled
```

If you want to use the more refined terrain colors from the original elevation map, select Panel→Surface from the NVIZ control panel menu and, at the bottom of the window, select 'color:' from the Surface Attribute menu. Select 'New Map' and choose the unscaled `etopo2` elevation map. For more detail on the final output, you may want to set the polygon resolution to 1 or 2 after making all other adjustments. You can save a hardcopy image from the File→Image Dump menu on the NVIZ control panel.

The `d.nviz` module in GRASS 5.7 can be used to quickly create 3D fly-through movies with NVIZ. Some nice examples of this by Bob Covill can be found in the Image Gallery at the Tekmap Consulting website:

<http://www.tekmap.ns.ca>

## Further exploration

There is very good topographic data freely available for the planet Mars as well as Earth, and it can be loaded into the GIS in a similar manner. Figure 2 shows a rendering of Olympus Mons, the largest volcano in the solar system, created in NVIZ using this data.

The Mars Orbiter Laser Altimeter (MOLA) elevation data can be found at the Mars Global Surveyor website:

<http://pds-geosciences.wustl.edu/missions/mgs/megdr.html>

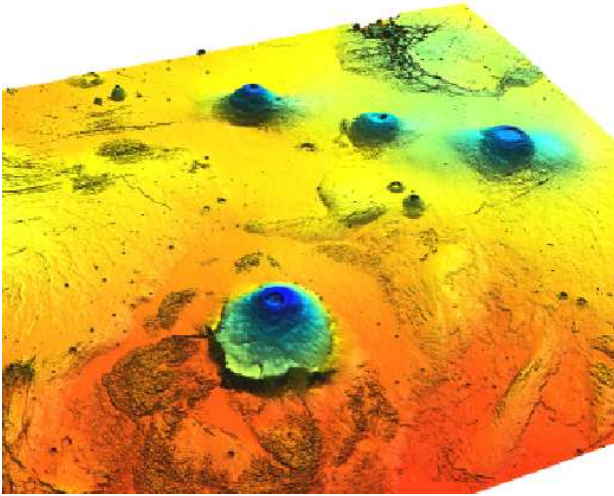


Figure 2: Olympus Mons topography from Mars Global Surveyor/MOLA data. 10x vertical exaggeration

After downloading the 1/32 degree topographic dataset (133mb), import into GRASS with:

```
GRASS:~ > r.in.bin input=megt90n000fb.img \
  title="MGS/MOLA Gridded Data, 1/32 degree" \
  output=mars_mola_32 -b bytes=2 rows=5760 \
  cols=11520 n=90N s=90S e=180E w=180W
```

If required, reset the resolution after zooming:

```
GRASS:~ > g.region res=0.03125 -a \
  # 1/32 = 0.03125
```

For NVIZ, scale with:

```
GRASS:~ > r.mapcalc \
  "mars_scaled=mars_mola_32/59271.4"
```

Where  $59271.4 = (2\pi * radius\_mars)/360$

## In Conclusion

GRASS provides a powerful and versatile platform for loading, displaying, and analyzing many forms of topographic, satellite, and other scientific data. In addition to the traditional GIS tasks of qualitative and quantitative analysis of maps, the user can quickly and easily produce quality graphics for presentation or publication after learning the basics. The advent of high quality Free data and Free software together create a special synergy and new opportunities for experts and everyday users alike to expand our understanding of the greater world, both individually and collectively.

Have fun!

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# r.series: Raster time series analysis

by Martin Wegmann & Glynn Clements

## Introduction

**r.series** is designed to provide a tool for a time series analysis. It is officially implemented in GRASS since 5.3.0, prior to this release *r.series* had to be added manually. Raster data can be analysed using **r.series**, after having changed vector to raster data, vector data can be used as well.

## Features

The following features can be computed over time:

- count
- mode, sum, median, mean, max, min

- variance and standard deviation
- diversity
- tendency (*slope*) of a time series using linear regressions
- point of intercept with the ordinate (*offset*) of the linear regression

## The algorithm

The algorithms used are the same as in *r.neighbors*. Note that for the deviation and standard deviation  $N$  and not  $N-1$  is used. Diversity is the number of distinct values in the time series. Please refer to a statistics book for detailed explanation of the algorithms used.

## Command line

From the command line *r.series* is started by the command **r.series**. In GRASS versions 5.3.0 this results in a series of prompts. The raster with the oldest date, followed by raster files of subsequent dates, have to be entered.

```
GRASS:~ > r.series
```

```
OPTION:  Names of existing raster files
         key: input
required: YES
multiple: YES
```

```
Enter the name of an existing raster file
Enter 'list' for a list of existing raster files
Hit RETURN to cancel request
> 971
<971>
```

```
Enter the name of an existing raster file
Enter 'list' for a list of existing raster files
Hit RETURN to accept the default
> 981
```

```
[...]
```

```
Enter raster file name
Enter 'list' for a list of existing raster files
Hit RETURN to cancel request
> ts_series
```

```
OPTION:  Aggregate operation
         key: method
required: YES
         options: average,median,mode,minimum,maximum,
                 stddev,sum,variance,diversity,slope,offset
>
```

The *aggregate operation* requires the definition of a method. Only one method can be defined at a time. Available options are listed in the *Feature* section. The available *r.series* commands can be obtained by using the common *-help* flag:

```
> r.series --help
```

```
Description:
  Makes each output cell value a function
  of the values assigned to the
  corresponding cells in the input
  raster map layers.
```

```
Usage:
  r.series [-qn] input=name[,name,...] output=name
           method=name
```

```
Flags:
  -q  Run quietly
```

```
-n  Propagate NULLs
```

Parameters:

```
input  Names of existing raster files
output  Name of the new raster file
method  Aggregate operation
         options: average,count,median,mode,
                 minimum,maximum,stddev,sum,
                 variance,diversity,slope,offset
```

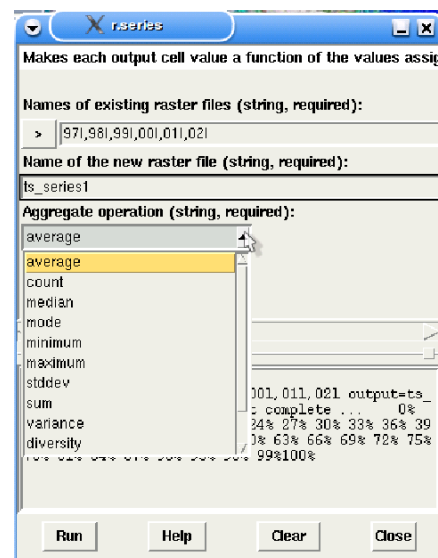


Figure 1: The graphical user interface for **r.series** in GRASS 5.7.0.

The flags *-q* makes **r.series** run quietly; *-n* will propagate *NULLs*. The latter flag might be useful if the area of interest is a subset of various raster images of which just some cover the whole area. Missing input values would result in the final **r.series** pixel being blank when adding the latter flag. Per default, the computation of average, min, etc. handles missing values by ignoring the *NULL* value. In this case, the linear regression analysis does not ignore the existence but the value. Linear regression analysis needs at least two pixel values without *NULL* values, otherwise the operation will be aborted. By choosing the *-n* flag, the user would receive a resulting images where just pixels with non-*NULL* values in all images are displayed.

Since GRASS 5.7.0 **r.series** has a graphical interface which can be accessed through the *Tcltkgrass 4.0* GUI or by typing *r.series* which will display the user interface (fig. 1). The same feature as presented above can be chosen through this interface, which is self-explanatory.

## An example: Time series of a savanna landscape

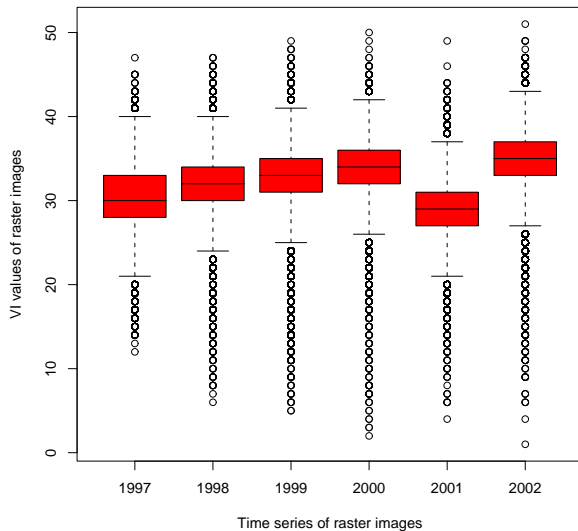


Figure 2: Boxplot of Vegetation Index values plotted against time.

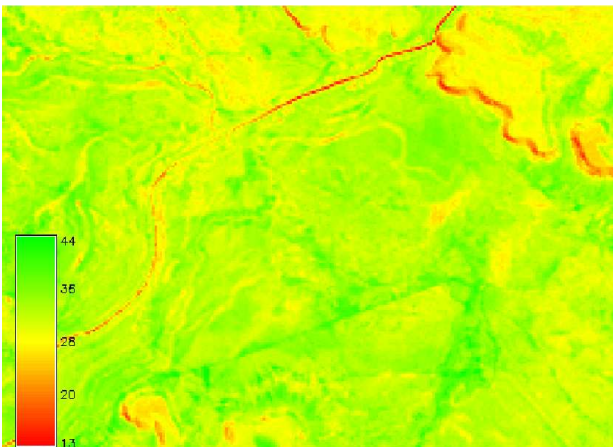


Figure 3: Average of a time series covering 5 years. Green areas indicate a high positive slope, red areas stand for a negative tendency over time.

Five raster images of a savanna landscape are used to visualise the functionality of **r.series**. Boxplots of all raster pixel values (derived from a vegetation index) of 5 images are displayed in figure 2. An overall tendency can not be seen but a quite large scatter can be. Displaying this data pixelwise rather than imagewise results in more detailed information concerning the variation. The average of pixel val-

<sup>3</sup><http://www.r-project.org/>

ues over time is shown in figure 3. High average values are represented by green colours; low average values show up in red. The savanna landscape does not include large elevational differences but a branch of an escarpment is visible in the top-right corner. Moreover, a river crosses the image from the top right edge to the left edge. In the centre few cross-fence effects are visible. The river embodies high and low average values due to its ephemeral character in some parts. The cross-fence effects are shown as sharp edges of red to green areas caused by different grazing regimes.

As second example we analysed the tendency (slope) of these 5 images over time. It can hardly be recognised in the boxplot, yet is very distinguishable in the graphical linear regression analysis (fig. 4). Green colours indicate an increasing tendency over time; red colours depict a decrease of vegetation index values over time. Especially changes in the grazing regimes are especially evident. Some paddocks show up with no tendency where the vegetation values of others are declining over time.

These two very brief examples hopefully show the potential of *r.series* for landscape analysis and can be used in a straightforward manner inside GRASS.

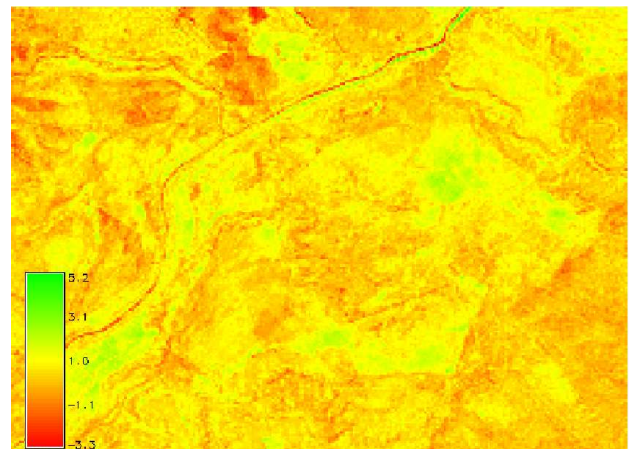


Figure 4: Trend (slope) of a time series covering 5 years. Green areas indicate a high positive slope, red areas stand for a negative tendency over time.

## Future developments

This functionality inside GRASS is pretty recent. Requested in October 2002, officially released in the 5.3.0 version on 15th May 2004, but available for testing since summer 2003. More functionality can be achieved by using R<sup>3</sup> and analysing time series data inside this sophisticated statistical programme. Nevertheless, functionality like a multivariate autocorrelation (equivalent to the *acf()* function inside

R) or robust fitting of linear regressions (equivalent to the `rlm()` function inside R) may be implemented. Further proposals and help in programming are highly welcome.

GRASS-Project

<http://grass.itc.it> and its mirrors  
[grass5\\_AT\\_grass.itc.it](http://grass5_AT_grass.itc.it)

*you need to be subscribed in order to send mail onto this list!*

## Interview with Moritz Lennert

Helping GRASS with documentation  
Spring 2004

by Gonzalo Fernández-Victorio Arévalo ([phasmi-dae\\_at\\_yahoo.com](mailto:phasmi-dae_at_yahoo.com))

*Could you provide some insight about yourself and your background?*

I am 30 years old, German, but have been living in Belgium for 10 1/2 years. I am not married but live with my partner Annabelle. Our son Leo (fig. 7) was born on March 24th. I studied geography at the Free University of Brussels (ULB) here in Belgium, graduating in 1998. Since then I've worked on different research contracts at the university, but also with a small non-profit organisation on local development in a poor neighbourhood of Brussels. A few years ago, I came to the GNU/Linux world out of pure curiosity without any hacking background, but quite rapidly converted to the free software paradigm. I actually consider using free software as much a practical as a political issue.



Figure 1: Moritz with his son

*How did you come to GRASS and what is your use of it?*

I first stumbled upon GRASS while still using MS Windows and looking for a free alternative to ArcView which most of my colleagues use. But I finally started to use GRASS professionally in 2000 when I was working on a study of international migrations. I was doing all my work in GNU/Linux and

so I wanted to do the same for the cartography (of which some was impossible to do in ArcView, BTW), both for philosophical and for practical reasons. I finally created a very personal but efficient solution to what I had to do by combining GRASS with R<sup>4</sup> and the Bash shell. Since then other solutions have appeared such as Thuban<sup>5</sup> and Quantum GIS<sup>6</sup>, so when someone is looking for a simple mapping / interactive viewing tool, I would recommend that. However, GRASS does offer a lot of possibilities, especially in combination with other tools such as the shell, but also R or PostgreSQL<sup>7</sup>. And it allows quite a lot of flexibility in terms of cartography, once you go through the effort of understanding how it works.

*What do you miss (if anything) from GRASS?*

First of all, I would have to say that so much is changing in GRASS at the moment with the foreseen transition to 5.7 that some of the main issues are being addressed. For example, vector handling (which is very important for me) is fundamentally transformed in 5.7 and makes life much easier. The display manager is even more sophisticated with direct export to PS or PDF format or even to a printer, thus allowing a more user-friendly GUI approach. Something I personally miss quite a lot is the possibility to "automatically" classify the data in categories, i.e. a module which would allow me to say that I want a division in 5 classes using, for example, a natural breaks algorithm and which would then automatically reclassify (or display) my map according to this new classification. This is actually becoming possible by using cartographic viewers such as QGIS for which Radim wrote a GRASS plug-in. I hope that Thuban will have something similar soon.

An interactive cartography module would be nice, but I can live with the current system where I export GRASS maps into vector drawing programs

<sup>4</sup><http://www.r-project.org/>

<sup>5</sup><http://thuban.intevation.org/>

<sup>6</sup><http://qgis.sourceforge.net>

<sup>7</sup><http://www.postgresql.org>

<sup>8</sup><http://sketch.sourceforge.net/>

such as sketch<sup>8</sup> (Ed.: now called Stencil) not to create a nice layout. (Actually, some of my colleagues working with ArcView often do the same, even though ArcView contains its own cartography layout tool, so maybe keeping them separate is not such a bad idea.) One issue which is not easy to grasp for first-time users is projection handling. I think some help (such as, for example, a small data set integrated into the distribution) could be useful. The new feature of being able to choose an EPSG projection number to automatically create a location based on that is a big step forward. Another solution would be to use automatic projection recognition as available in GDAL and OGR in order to create the location automatically based on data (already implemented in `r.in.gdal`<sup>9</sup>). This could lead to something like a first screen giving the option of creating a location (and the GRASS database directory) by hand or automatically from existing data. I think this would significantly lower the barrier of entry. But for all these propositions, someone would have to do the job ;-)

*Your biggest (IMO) contribution to GRASS has been the GRASS tutorial, and in particular, "GRASS in 10 minutes - Quick Intro for Newbies"<sup>10</sup>. How did the idea come?*

The GRASS tutorial came out of the translation of Markus Neteler's "GRASS-Handbuch"<sup>11</sup>. The initial idea was to publish the book online as such. However, the translation process took quite some time and so some of the information was outdated. In addition, Markus and Helena Mitasova published their book "Open Source GIS: A GRASS GIS Approach"<sup>12</sup>, so we did finally have a solid book on GRASS usage (even though it is quite expensive). So the idea came up to use the material of the translation of the handbook and create an online tutorial. I am not quite sure if the term "tutorial" is actually correct, maybe something like "user manual" would be more precise. The chapter "GRASS in 10 minutes - Quick Intro for Newbies" is probably what comes closest to a real tutorial.

I decided to write it while reading yet another discussion on the mailing lists concerning the trouble newcomers have with getting started. I have no idea whether this chapter does the job, or even whether anybody looks at it, so some feedback about it would be great. The first rough draft of the entire tutorial is almost finished. Only the chapters on hardcopies

and on special topics still need writing (any volunteers are very welcome !). But most of the chapters could do with a thorough reading and correction. I haven't been active in the last months because of quite a lot of pressure at work, but we should aim at getting a more or less definite version out as soon as possible. The next step would then probably be to write a similar newbie chapter for 5.7.

*Last year you performed a survey about the use of GRASS<sup>13</sup>. One of the more demanded wishes in the responses<sup>14</sup> (just behind vector and database capabilities that hopefully we're starting to have, and the never-ending story about GUI) was documentation. But when I contacted you for this interview, you seemed to not consider yourself a developer. What about a contributor? Why don't "we" give value to documentation, even to the point of considering it a "second task"?*

First of all my reaction was meant more in the direction of "why you didn't ask one of the main developers (or the project leader) for the first interview". I would agree that documentation writing is an essential part of developing an application and as such I could be considered a "developer". The big advantage of documentation is that almost anyone who has used GRASS could write some of it. In that sense, I would not consider myself one of the experts who knows the entrails of GRASS as a programmer would, but "just" as an informed user. In view of the fact that documentation writing is accessible to most of us, I had actually hoped for more feedback from the GRASS users mailing list and a few volunteers who would actively contribute. Some people manifested their interest, and some have helped with a few parts and with corrections, but there was no follow-up, which is probably partly my fault since I did not insist enough ;-)

*You seem to have grown up in Europe. Are you concerned about software patents in Europe? What do you think about ?*

Yes, I am concerned about software patents in Europe since if Europe falls, the world falls in the sense that currently Europe is the only economic block which could resist the logic of a global application of US legislation. The European parliament has voted against software patents, but the issue is not over as it went through the European Council<sup>15</sup> who ac-

<sup>9</sup>[http://grass.itc.it/gdp/html\\_grass5/html/r.in.gdal.html](http://grass.itc.it/gdp/html_grass5/html/r.in.gdal.html)

<sup>10</sup>[http://grass.ibiblio.org/gdp/grass5tutor/HTML\\_en/p272.html](http://grass.ibiblio.org/gdp/grass5tutor/HTML_en/p272.html)

<sup>11</sup><http://grass.itc.it/gdp/handbuch/index.html>

<sup>12</sup><http://mpa.itc.it/grassbook/>

<sup>13</sup><http://grass.itc.it/pipermail/grass5/2002-March/004841.html>

<sup>14</sup>[http://grass.itc.it/announces/grass\\_questionnaire\\_2002\\_synthesis.html](http://grass.itc.it/announces/grass_questionnaire_2002_synthesis.html)

<sup>15</sup><http://swpat.ffii.org/news/recent/index.en.html>

cepted a “compromise” which reinstated almost the exact same proposition the parliament voted against. So now it’s back to the parliament. But for me the issue is larger than just software patents. I believe that patents as a whole are losing their role of incentive for innovation and are becoming a means of protecting monopolies. Design has become a more important source of income than actual production and the rich countries are using tools such as patents, glob-

alized through the TRIPs agreement, to ensure that other countries cannot compete with them.

*Would you like to say anything else?*

I think I’ve probably already written too much... :-)

But: Thanks to the GRASS developers for such a great tool !

# Quantum GIS

## Features and Future

*Gary E. Sherman*

## Introduction

Quantum GIS (QGIS) is an Open Source Geographic Information System. The project was born in May of 2002 and was established as a project on SourceForge in June of the same year. There are currently 11 developers with CVS access, and a number of developers without CVS access who contribute to QGIS. Much of the discussion relating to development takes place on the #qgis IRC channel (irc.freenode.net) which is a friendly place to chat about QGIS.

QGIS currently runs on most Unix platforms and OS X. QGIS is developed using the Qt toolkit (<http://www.trolltech.com>) and C++. Work is underway to produce a MS Windows build of QGIS, as well as a version for Qt-embedded capable pocket PCs.

QGIS aims to be an easy-to-use GIS, providing common functions and features. The initial goal was to provide a GIS data viewer. As such, it provides functions for panning and zooming, various symbolization options for both vector and raster data, and an overview that easily provides a reference while zoomed in beyond full extent. QGIS has reached the point in its evolution where it is being used by many for their daily GIS data viewing needs.

QGIS supports a number of raster and vector data formats, with new support easily added using the plugin architecture.

## Current Features

QGIS currently has a number of tools for visualizing GIS data and support for a variety of GIS data stores, both raster and vector.

## Supported Formats

All support for vector data types in QGIS is accomplished using plugins called *data providers*. A data provider is a shared library that acts as middleware between the data store and QGIS. With this architecture, any vector data store can be supported in QGIS by writing a plugin using the data provider API.

Supported data types in QGIS version 0.4 include:

1. Rasters, including GeoTiff, Tiff with world file, ArcInfo grid, and others supported by GDAL
2. Preliminary support for GRASS rasters
3. Vectors, including shapefiles, PostGIS, Map-Info
4. GRASS vector via plugin
5. Delimited text (event theme) via plugin
6. GPS data via plugin

## Tools and Plugins

QGIS has the usual GIS tools for map navigation and exploring features. Some of the more interesting tools are those provided by both core plugins and user contributed plugins.

A core plugin resides inside the QGIS source tree and is maintained by the QGIS development team. A user contributed plugin is an external plugin that is not part of the QGIS core. Core plugins are expected to be generally useful to a wide audience. Special purpose and experimental plugins are kept outside of the main QGIS code base and are subject to their own release schedules. The QGIS community site (<http://community.qgis.org>) serves as the repository for user-contributed plugins.

Some of the current plugins available for QGIS 0.4 include:



- GRASS data provider, which adds support for GRASS vector data sets;
- SPIT, the Shapefile to PostGIS Import Tool provides a means to import shapefiles into a PostGIS enabled PostgreSQL database;
- Delimited text plugin provides ability to create a layer from delimited text containing x and y values;
- GPS tools plugin imports GPS data in Garmin Dump, GPX and LOC formats;
- PostGIS geoprocessing tool uses the PostGIS extensions to buffer point, line, or polygon features;
- North arrow;
- Copyright labeler;
- Graticule creator;
- Http Server providing simple map serving capabilities;
- Launcher which allows arbitrary scripts and applications to be launched from within QGIS.

Creating new plugins is a relatively simple process, carried out by means of a simple shell script which then creates a "template" that can be built upon. At present, developing a plugin requires a working knowledge of C++. The plugin API provides great potential for extending QGIS and integrating it with other Open Source tools.

## Internationalization

QGIS is greatly enhanced by fairly active group of developers, and by several translators who work to provide QGIS in additional languages. Currently there are complete translations for English, German, Swedish and Brazilian Portuguese. In addition, incomplete translations exist for Chinese and Russian. Translation is carried out using the Qt linguist application.

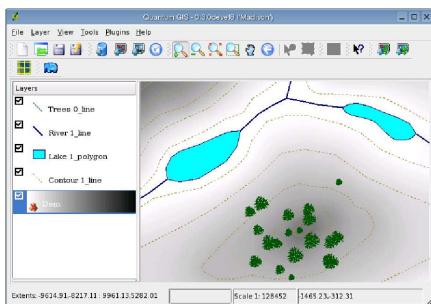


Figure 1: Viewing GRASS Vectors and a DEM Using QGIS

## Viewing GRASS Data in QGIS

Using the GRASS vector plugin and a patched GDAL library, GRASS data can be viewed in QGIS. The following components are required to view GRASS vectors and rasters in QGIS:

1. Functioning GRASS installation (Version 5.7)
2. QGIS source code (Version 0.4 release or current CVS version - <http://qgis.org>)
3. Radim Blazek's GDAL patches for GRASS ([http://qgis.org/gdal\\_grass\\_patch.tar.gz](http://qgis.org/gdal_grass_patch.tar.gz))
4. GDAL source code (Version 1.2.0 - <http://www.remotesensing.org/gdal>)

GDAL must be patched to resolve a library conflict and allow the raster and vector data to happily coexist in QGIS. Detailed information on building QGIS with GRASS support can be found at [http://community.qgis.org/grass\\_plugin](http://community.qgis.org/grass_plugin).

Once the GRASS plugins are built and the plugin is loaded by QGIS, two new toolbar icons appear: one for raster and one for vector layers.

Typically, QGIS should be started from the grass57 shell when working with GRASS layers. Otherwise, the environment must be setup manually prior to running QGIS. More information on starting QGIS with GRASS support can be found at <http://mpa.itc.it/radim/qgis>.

Figure 1 shows QGIS displaying GRASS vectors and a DEM from the g51test-12 test data set.

## Future

When the QGIS project was started, it was obvious that creating a full-featured GIS from scratch was an enormous undertaking. In fact, the project was started not to build a rich analytical feature set from the ground up, but to provide easy-to-use visualization while ultimately leveraging existing algorithms and systems.

The future goals of QGIS include these core areas:

- Support for projections (using PROJ4);
- Labeling engine and printing support for map production;
- Digitizing tools to facilitate basic spatial data capture;
- Further integration with GRASS, including the ability to run GRASS modules from within QGIS;

- Full featured support of PostGIS/PostgreSQL layers (editing, spatial operations, layer definition subsets);
- Raster tiling (raster catalogs);
- 3-D visualization;
- Create new functionality by fostering and encouraging third-party plugins.

Contributions to QGIS are welcome, particularly those facilitating the further integration of GRASS with QGIS.

*Gary E. Sherman*

*Micro Resources*

<http://qgis.org>

[sherman \(AT\) mrcc com](mailto:sherman(AT)mrcc.com)

## GRASS related Publications

### Articles

#### **The spread of the Chinese mitten crab (*Eriocheir sinensis*) in Europe; the predictive value of an historical data set**

**Herborg et al. (2003)**

The Chinese mitten crab, *Eriocheir sinensis* (H. Milne Edwards), is an invasive species that lives as an adult predominantly in freshwater but migrates seawards to breed. It has spread via ballast water and/or intentional introduction to Continental Europe, Southern France, U.S.A. (San Francisco Bay), and the United Kingdom. Analysis of detailed historic data from the outbreak in Europe was digitised and analysed using Geographical Information Software. This revealed that there were two separate invasions in Northern Europe and Southern France, with an average range expansion during the peak period of 562 km/year from 1928-1938 (Northern Europe) and 380 km/year from 1954-1960 in Southern France. Size class distribution data from the lower estuary of the River Elbe (Germany) (1932-1936) illustrate migration patterns to and from the estuary over the year. Marking experiments determined that the mean rate of downstream migration for adults was 11.5 km/day (SD 3.54; n=7), up to a maximum of 18.1 km/day. The carapace width of upstream-migrating animals increased by 3 mm/100 km. The peak period for upstream migration was March to July, followed by the downstream season from July to September. This data set, extracted from historic references, represents one of the most complete pictures of the life cycle and spreading behaviour of this alien invader.

#### **Predicting grey squirrel expansion in North Italy: a spatially explicit modelling approach**

**Lurz et al. (2001)**

There is growing concern about the spread of the North American grey squirrel (*Sciurus carolinensis*) in northern Italy, which was introduced into Piedmont in 1948. They have since spread across the Po plain covering an area of approximately 450 km<sup>2</sup> and continue to expand their range. In parallel to what has been observed in Britain and Ireland, grey squirrels replace the native red squirrel (*S. vulgaris*) and damage poplar (*Populus*) plantations through bark-stripping. Spatially explicit population dynamics models have been successfully used to predict the spread of grey squirrels in East Anglia, England. We extended a previous approach employing a sensitivity analysis where life history and other demographic inputs are generated using Latin Hypercube Sampling from the known ranges of each input parameter, and applied it to Italy using field data collected in Piedmont. The analysis indicated that reproductive output was the most important factor determining total population size present in Piedmont. The structure and composition of woodland habitats around the introduction site suggested that initial grey squirrel expansion would have been slow and subject to emigration rates from the available habitat blocks. A comparison of the 1996 survey results with model predictions indicated that a mean litter size of three young gave the best fit with the observed distribution, and we use this to predict future grey squirrel spread. We also present a 'worst case' scenario in which grey squirrels experience improved reproductive success due to the availability of high quality habitats beyond the Po plain. In both cases they could disperse along existing continuous woodland corridors into France between 2039-2048. The case of the grey squirrel highlights the problems of implementing conservation conventions and the resulting conflicts between wildlife management, public per-

ception, and local political support and the narrow time frame that is available to control alien species effectively before it is too late. If allowed to spread, grey squirrels have the potential of becoming a European forest pest species and are likely to replace the native red squirrel in large parts of its range.

### **Modelling the consequences of duck migration patterns on the genetic diversity of aquatic organisms: a first step towards a predictive tool for wetland management.**

**Lurz et al. (2002)**

We have developed a spatially explicit modelling framework that links duck migration patterns with gene transport. The model is individual-based and simulates the journey of a duck from migration start locations through stopover sites to breeding or wintering sites. We investigate two different migration strategies: 'hopper' (where the bird makes many stopovers) and 'jumper' (where the bird makes few stopovers). The migration model is linked to a genetics model calculating gene frequency changes based on propagule deposition for potential duck landing sites along the European migration pathways. We present the results of a sensitivity analysis relating flight characteristics of several duck species to the resulting pattern of potential gene spread. The modelling framework is designed to develop hypotheses on the likely impact of duck migration on genetic diversity of aquatic organisms, and the predictions are discussed in relation to future empirical research and subsequent model development.

### **Modelling the distribution of the red and grey squirrel at the landscape scale: a combined GIS and population dynamics approach.**

**Rushton et al. (1997)**

1. An integrated Geographical Information System (GIS)-Spatially Explicit Population Dynamics Model (SEPM) for investigating the dynamics of red squirrel *Sciurus vulgaris* and grey squirrel *S. carolinensis* populations in different landscapes is described. 2. Using the model, we simulated processes of reproduction, mortality and dispersal in individual populations of squirrels in habitat blocks identified within a GIS. We modelled dispersal as a process whereby individual animals moved between blocks of habitat separated by areas of unsuitable habitat. An interference model simulating the effects of competition between the grey and red squirrels was incorporated where both species occupied the same habitat blocks.

3. The model was used to investigate the spread of grey squirrels and its impact on the distribution of red squirrels in Norfolk, UK, where historical information on the decline in the red squirrel and the expansion of the grey squirrel were available. 4. We examined the effect of a range of life history scenarios differing in terms of adult mortality, juvenile mortality, fecundity, habitat carrying capacity and maximum dispersal distances. Model predictions were closest to the observed expansion of the grey squirrel and decline in the red squirrel when mortality was lower and fecundity higher than the averages recorded for the grey squirrel in the United Kingdom.

### **Conserving red squirrels (*Sciurus vulgaris*): mapping and forecasting habitat suitability using a Geographic Information Systems Approach.**

**Gurnell et al. (2002)**

A model of habitat suitability linked to a Geographic Information System was developed for the red squirrel (*Sciurus vulgaris*) in 2800 ha of Thetford Forest, East England, to assess red squirrel population numbers in relation to forest management. We defined each forest sub-compartment or parcel of land in terms of its tree species and age between 1995 and 2015, and categorised each parcel of land as low, moderate, or high red squirrel suitability. Resident squirrels may live in more than one habitat patch, providing the distance between patches is within the foraging range of the animals and the land between the patches does not act as a barrier to foraging movements. Moreover, squirrels require a minimum area (home range area) of suitable habitat that will provide them with sufficient food resources. To examine these two factors, we explored 120 different model scenarios using three different distances to link patches together and four different sized minimum areas, termed minimum linked areas (MLA), that would hold resident red squirrels, at five year intervals between 1995 and 2015. As an overall measure of suitability, we summed all the MLAs in the reserve for high plus moderate suitability, which we have called the total linked area (TLA), and forecast how this may change in the future. We show that TLA will increase from 39 demonstrating that the reserve will get better for red squirrels over this time. We also demonstrate how changes in forest management would further increase TLA to 82 suitability model operating at the scale of an individual forest, coupled with a GIS and based on an understanding of the species' ecology, provides an objective way to assess the impact of forest management prescriptions on red squirrel populations.

## The application of GIS-modelling to mustelid landscape ecology.

**Gough and Rushton (2000)**

Landscapes are mosaics of habitat patches. The composition, configuration and connectivity of these elements changes in space and time as a result of 'natural' and human disturbance. Landscapes provide the ecological template for the life history and behavioural processes that determine animal spacing patterns. An understanding of the effects of landscape dynamics on mammal distributions is therefore vital if populations are to be managed effectively. Members of the Mustelidae present a considerable practical and theoretical challenge because of the great range of morphological, behavioural, and ecological variation within the family. Habitat use data have been gathered only for a small number of Mustelidae species, and most studies have been conducted with few individuals at small spatial scales and over relatively short time spans. Consequently, our knowledge of the landscape ecology of mustelids is very limited. Modelling can provide a strong conceptual framework for investigating mustelid-habitat relationships. We review the potential of different modelling approaches for analysing the influence of landscape dynamics on the distributions of mustelids.

## Modelling the effects of mink and habitat fragmentation on the water vole

**Rushton et al. (2000)**

1. The decline of the water vole *Arvicola terrestris* in the UK has been attributed to the spread of the introduced American mink *Mustela vison*. Understanding the causes and dynamics of this decline is vital to water vole conservation. We investigated the dynamics of water voles in relation to habitat fragmentation and mink predation using an individual-based spatially explicit model of population dynamics on the River Windrush, Oxfordshire, UK. 2. A sensitivity analysis was undertaken using values for life-history parameters drawn from known ranges using Latin hypercube sampling. Partial correlation coefficients were used to estimate how the predicted size of water vole population and extinction were determined by the life-history parameters. The model was then validated by comparing model predictions with observed distributions of water voles. 3. The effects of mink predation and habitat fragmentation on the future viability of water vole populations on the River Windrush were analysed after artificially manipulating habitat fragmentation on the river and running the model in the presence and absence of mink predation. 4. The match between predicted

and observed distributions was significantly related to home range requirement and high reproductive success. At low fragmentation, home range requirement was the most important influence on the number of populations. Reproductive output, as well as adult and juvenile mortality, became increasingly important with increased fragmentation. At high levels of fragmentation, demographic stochasticity had a large influence on population size. 5. We deduce that the importance of demography in determining population persistence will depend on the level of fragmentation. Additionally, life-history parameters that are crucial to the viability of water vole populations can only be identified in the context of the landscape in which populations are found. 6. The extinction of water vole on the River Windrush became more likely as habitat fragmentation and mink predation increased. Mink predation effectively doubled the probability of extinction over that arising from fragmentation alone. 7. These simulations indicate that extant populations on the Windrush are now so fragmented that populations may not be viable even in the absence of mink predation. We assessed the extent of habitat restoration necessary to ensure population persistence on the River Windrush and considered developments of the model for use in water vole conservation.

## Modelling bird distributions - a combined GIS and Bayesian rule-based approach

**Tucker et al. (1997)**

Models to predict the breeding distribution of three species of birds in north-east England are described. The models use readily available data from the ornithological literature on the habitat preferences and life-history characteristics of the birds, together with satellite (land cover) and physiographic data. These data are linked via Bayesian decision-rules, and model predictions calculated at the landscape scale using a raster-based Geographic Information System. Log-linear regressions of the predicted suitability of the landscape for the birds with observed sets of nest records were statistically significant for all three species. The robustness of the models to the effects of nonindependence of predictor (habitat) variables on Bayesian predictions was investigated using a perturbation method, which gave minor improvements to the accuracy of the predictions. The value of this modelling approach as a method of utilising published autoecological data to predict the landscape distribution of birds is discussed.

## Books

### Open Source GIS: A GRASS GIS Approach. 2nd Edition

Neteler and Mitasova (2004)

Since the first edition of Open Source GIS: A GRASS GIS Approach was published in 2002, GRASS has undergone major improvements. This second edition includes numerous updates related to the new development; its text is based on the GRASS 5.3 version from December 2003. Besides changes related to GRASS 5.3 enhancements, the introductory chapters have been re-organized, providing more extensive information on import of external data. Most of the improvements in technical accuracy and clarity were based on valuable feedback from readers.

Open Source GIS: A GRASS GIS Approach, Second Edition, provides updated information about the use of GRASS, including geospatial modeling with raster, vector and site data, image processing, visualization, and coupling with other open source tools for geostatistical analysis and web applications. A brief introduction to programming within GRASS encourages new development. The sample data set used throughout the book has been updated and is available on the GRASS web site. This book also includes links to sites where the GRASS software and on-line reference manuals can be downloaded and additional applications can be viewed.

Open Source GIS: A GRASS GIS Approach, Second Edition is designed for a professional audience, composed of researchers and practitioners in government and industry. This book is also suitable as a secondary text for graduate-level students in geomatics,

computer science and geosciences.

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## Recent and Upcoming Events

### GIS-GRASS User Conference 2004

#### Free and Open Source Software for Geoinformatics

Bangkok, Thailand, Sept 12-14, 2004

The Free/Libre and Open Source Software (FOSS) for Geoinformatics: GIS - GRASS Users Conference will be held in Bangkok, Thailand, 12-14 September 2004. An extended successor to a long series of GRASS-GIS Users Conferences (last held on September 2002

in Trento, Italy), the series will be in Asia for the first time. The conference joins GRASS developers and users worldwide to foster closer relations and to share ideas for improving software and applications. (Unlike at closed-source software users meetings, anyone can turn findings of this meeting into new code and improved applications.) The Bangkok conference will cover all aspects of FOSS for Geoinformatics in addition to GRASS itself. Thus the aim of the conference is twofold: (a) exchange of experiences between GRASS users and developers and (b) provide first-hand information on FOSS capabilities for developing national/local spatial data infrastructures, with emphasis on Asian countries. One unique

aspect of the conference will be the INSTALLFEST. Bring your computer (or buy one in Bangkok), install GRASS and other geoinformatics software, and begin to use it - all at the conference! Venue and Organizers The conference is being organized by the Faculty of Engineering, Chulalongkorn University, Thailand, with support from several other institutions. The Organizing Committee includes prominent experts in FOSS for Geoinformatics.

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## GRASS support

If you like to contribute to the GRASS development you can

- write manual pages for modules and scripts <sup>16</sup>
- test new GRASS releases and report bugs
- provide scripts to the script repository set up by Michael Barton <sup>17</sup>
- fix bugs and minimize the wish list by programming (ANSI-C)

### Modules without man-pages

Following GRASS 5.3 modules do not yet have a manual html page:

d.colorlist, d.fix.ortho, m.futil,  
m.strip99s, r.colors.paint, r.composite,  
r.his, r.in.doq, r.in.dted, r.in.gridatb,  
r.in.png, r.in.tang, r.in.utm,  
r.out.gridatb, r.out.png, r.out.tga,  
r.rvi.prediction, r.weight.new,  
s.territory, tcltkgrass, v.distance,  
v.dump, v.in.atlas, v.mk\_stats,  
v.out.atlas, v.out.mapinfo, v.out.mif,  
v.patch.scs, v.rm.dangles

Following GRASS 5.3 scripts do not yet have a manual html page:

demo.scripts, demo.sh, d.monsize,  
d.rast.leg, d.rast.leg2, d.rast.rescale,  
d.redraw, fig2grass, g3.createwind,  
g3.list, g3.remove, g3.rename,  
g.html2man, g.mlist, g.mremove, grass2fig,  
i.image.mosaic, intens.sh, i.spectral,  
i.tasscap.tm4, i.tasscap.tm5, i.tm.dehaze,  
ps.add.pagesize, ps.map.barscale,  
r.avgstats, r.edge.dig, r.in.globedem,  
r.mpatch, r.out.bil, r.reclass.area,  
r.regression.line, r.to.pg, shade.clr.sh,  
s.reclass, v.area2line, v.cutregion.sh,  
v.cutter.attr, v.in.mapgen.sh, v.line2area,  
v.out.xfig, v.region.sh

Further information how a man-page has to structured can be found at

[http://grass.itc.it/gdp/html\\_grass5/](http://grass.itc.it/gdp/html_grass5/)

Please send your contribution to a GRASS developer.

### Recent wishes & bugs

Please visit <http://intevation.de/rt/> for wishes and bugs and send your contribution to a GRASS developer.

<sup>16</sup>[http://grass.itc.it/gdp/html\\_grass5/missing.html](http://grass.itc.it/gdp/html_grass5/missing.html)

<sup>17</sup>[http://www.public.asu.edu/~cmbarton/grass\\_scripts.htm](http://www.public.asu.edu/~cmbarton/grass_scripts.htm)

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Andrey Mitas

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**Acknowledgements**

Various reviewers & the R News Project