



GRASSY GIS

H. S. Rai

hs@raiandrai.com

September 23, 2007



Abstract

This will introduce to a beginner, the use of GIS, which mean “Geographic Information System”, using excellent software named GRASS. The creation of data, visualisation of data, and brief of analysis will be covered.

1. Introduction

Geographic Information System is increasingly effecting our domain of knowledge by proving its worthiness in the areas where it has not till showed its usefulness. GIS is not just a map making tool, it is nowadays being applied in remarkable ways. From Agriculture, Defence and Intelligence, Ecology, Environment Conservation, Public Utilities like Electricity, Water to Emergency services, Government revenue records, Forestry, Mining and Telecommunication.

2. Target Audience

One, who just want to show roads and streets connecting to his / her house to Bus Station, or some one who want to know the extent of pollution created by a polluting industry, or just to find shortest path between two points of interest.

One who want to start using GIS, for his personal, official, or commercial use.

3. Pre-requisite

The readers are expected to have basic knowledge of computer. Use of file manager, GUI, and very basic knowledge of CLI.

It is assumed that access to GNU / Linux system is there, on which GRASS is installed.

4. Starting GRASS

GRASS stands for Geographic Resources Analysis Support System.

SPEARFISH data set is used to introduce GRASS software, this dataset contains raster, vector and point data of South Dakota, USA.

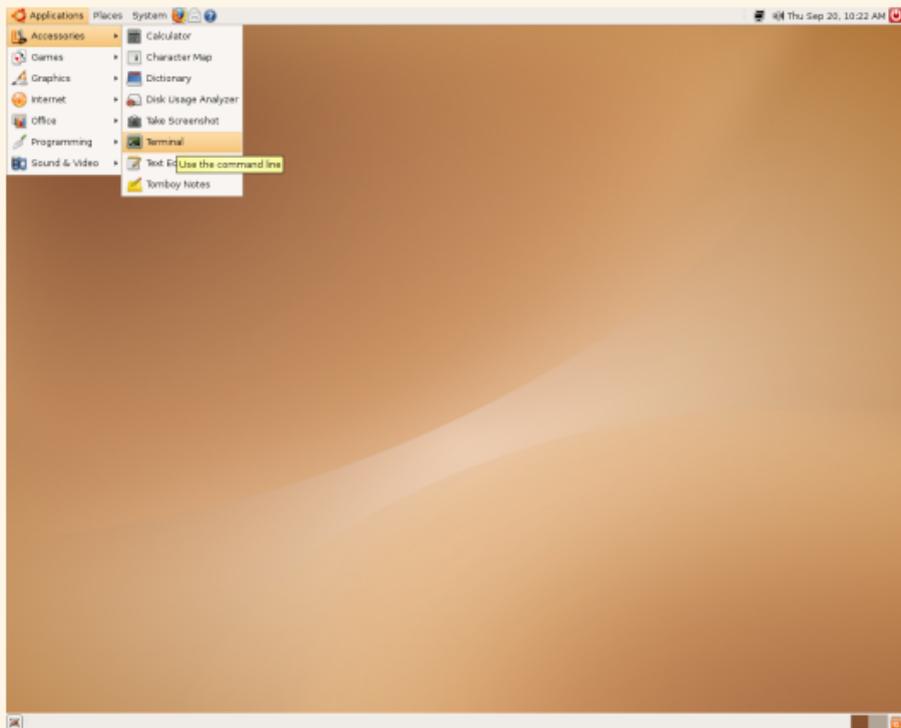


Figure 1: Launching Terminal

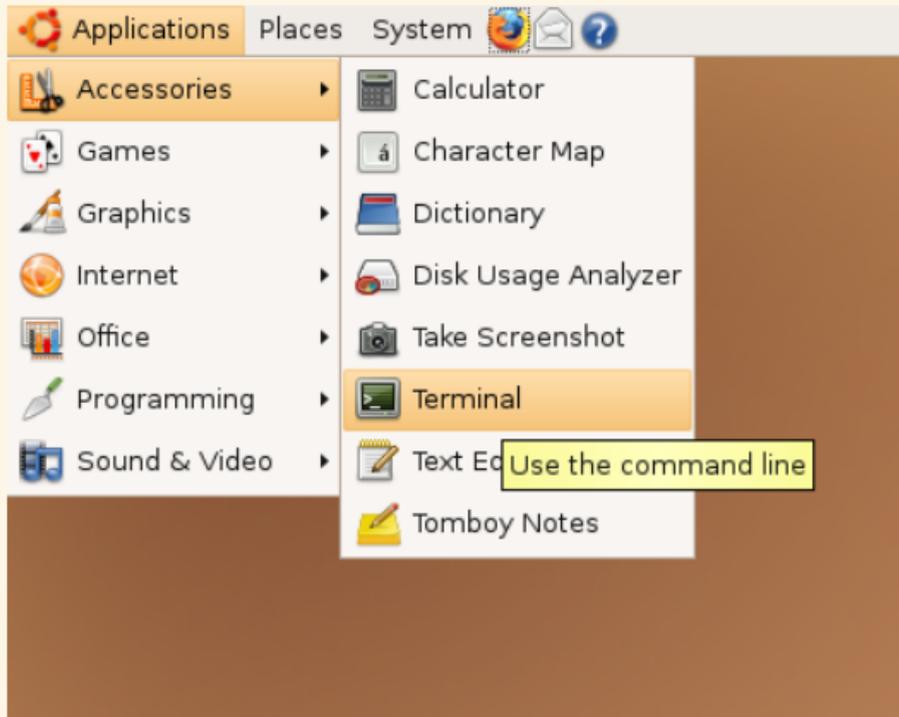


Figure 2: Launching Terminal: Close up

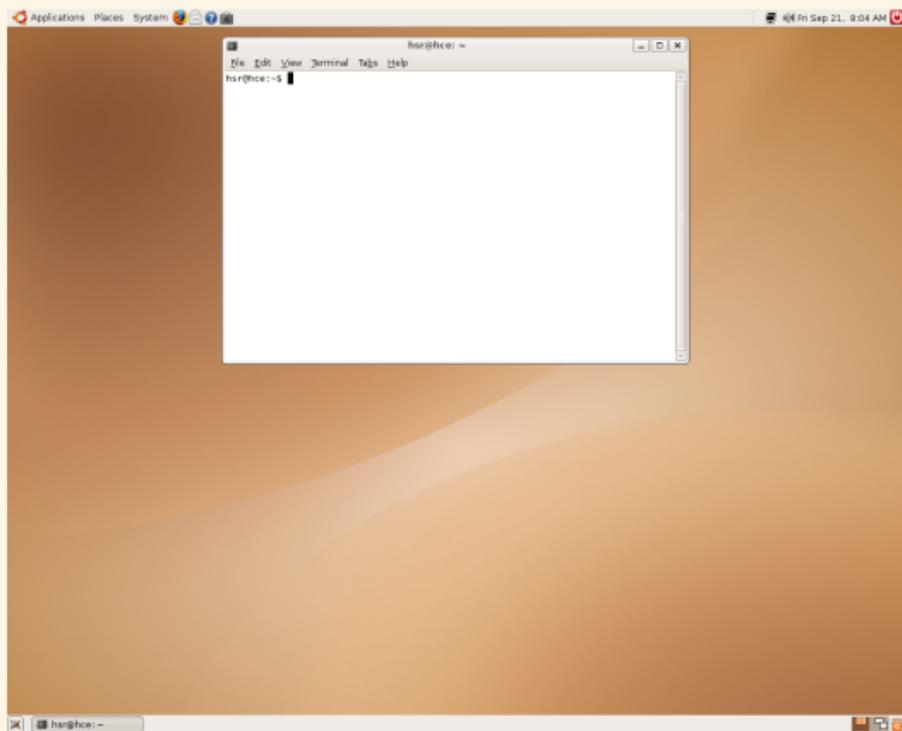
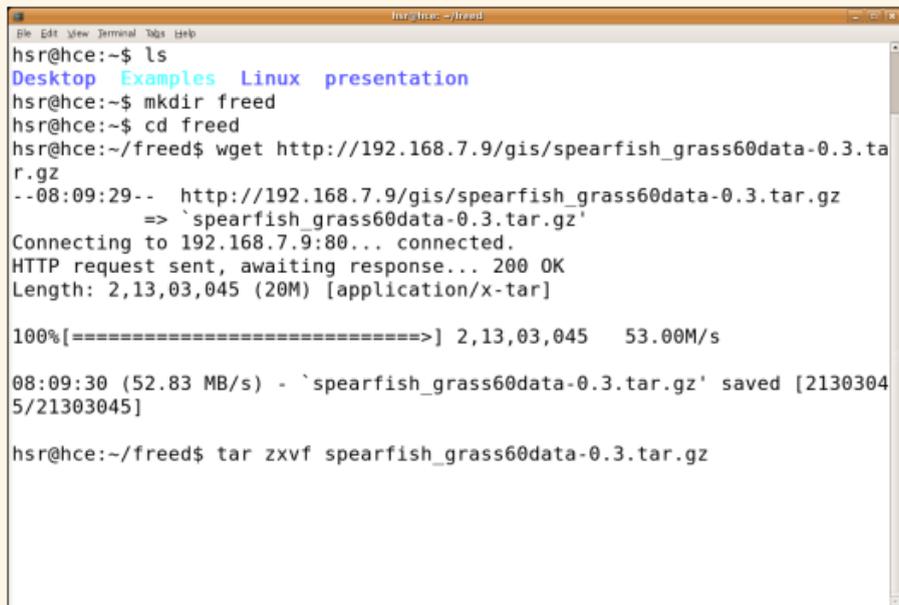


Figure 3: Terminal window on Desktop

A terminal window titled "hsr@hce:~/freed" showing a sequence of commands and their outputs. The user lists files, creates a directory named "freed", and changes to it. Then, they use "wget" to download a tar.gz file from a remote server. The terminal shows the progress of the download, including connection status, request details, and a 100% completion bar. Finally, the user runs "tar zxvf" to extract the downloaded file.

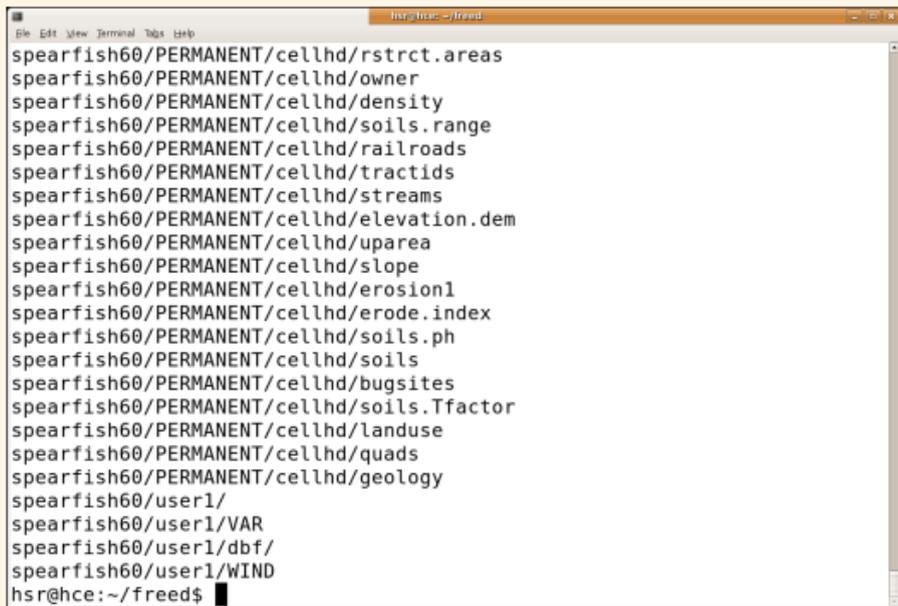
```
hsr@hce:~$ ls
Desktop  Examples  Linux  presentation
hsr@hce:~$ mkdir freed
hsr@hce:~$ cd freed
hsr@hce:~/freed$ wget http://192.168.7.9/gis/spearfish_grass60data-0.3.tar.gz
--08:09:29-- http://192.168.7.9/gis/spearfish_grass60data-0.3.tar.gz
              => `spearfish_grass60data-0.3.tar.gz'
Connecting to 192.168.7.9:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2,13,03,045 (20M) [application/x-tar]

100%[=====>] 2,13,03,045  53.00M/s

08:09:30 (52.83 MB/s) - `spearfish_grass60data-0.3.tar.gz' saved [21303045/21303045]

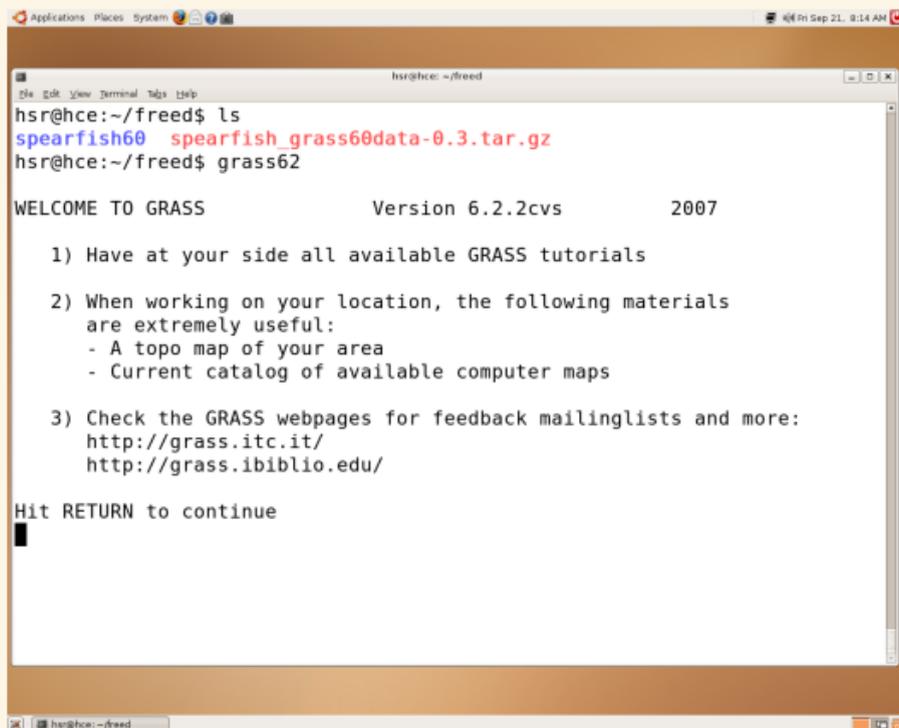
hsr@hce:~/freed$ tar zxvf spearfish_grass60data-0.3.tar.gz
```

Figure 4: Spearfish Data

A terminal window titled "hsr@hce:~/freed" displays a list of files and directories. The files are organized into several categories: cellhd (cellular data), user1 (user data), and VAR (variable data). The cellhd files include various maps and data sets such as rstrct.areas, owner, density, soils.range, railroads, tractids, streams, elevation.dem, uparea, slope, erosion1, erode.index, soils.ph, soils, bugsites, soils.Tfactor, landuse, quads, and geology. The user1 directory contains sub-directories dbf/ and WIND. The terminal prompt is hsr@hce:~/freed\$.

```
hsr@hce:~/freed
spearfish60/PERMANENT/cellhd/rstrct.areas
spearfish60/PERMANENT/cellhd/owner
spearfish60/PERMANENT/cellhd/density
spearfish60/PERMANENT/cellhd/soils.range
spearfish60/PERMANENT/cellhd/railroads
spearfish60/PERMANENT/cellhd/tractids
spearfish60/PERMANENT/cellhd/streams
spearfish60/PERMANENT/cellhd/elevation.dem
spearfish60/PERMANENT/cellhd/uparea
spearfish60/PERMANENT/cellhd/slope
spearfish60/PERMANENT/cellhd/erosion1
spearfish60/PERMANENT/cellhd/erode.index
spearfish60/PERMANENT/cellhd/soils.ph
spearfish60/PERMANENT/cellhd/soils
spearfish60/PERMANENT/cellhd/bugsites
spearfish60/PERMANENT/cellhd/soils.Tfactor
spearfish60/PERMANENT/cellhd/landuse
spearfish60/PERMANENT/cellhd/quads
spearfish60/PERMANENT/cellhd/geology
spearfish60/user1/
spearfish60/user1/VAR
spearfish60/user1/dbf/
spearfish60/user1/WIND
hsr@hce:~/freed$
```

Figure 5: Decompressing SpearFish Data

A terminal window titled "hsr@hce: ~/freed" is shown. The user has executed the following commands: `ls`, `spearfish60 spearfish_grass60data-0.3.tar.gz`, and `grass62`. The terminal output displays the GRASS version information and a list of instructions for users. The instructions include: 1) Have at your side all available GRASS tutorials; 2) When working on your location, the following materials are extremely useful: - A topo map of your area; - Current catalog of available computer maps; 3) Check the GRASS webpages for feedback mailinglists and more: <http://grass.itc.it/> and <http://grass.ibiblio.edu/>. The prompt "Hit RETURN to continue" is followed by a cursor.

```
hsr@hce:~/freed$ ls
spearfish60 spearfish_grass60data-0.3.tar.gz
hsr@hce:~/freed$ grass62

WELCOME TO GRASS                Version 6.2.2cvs                2007

1) Have at your side all available GRASS tutorials

2) When working on your location, the following materials
are extremely useful:
- A topo map of your area
- Current catalog of available computer maps

3) Check the GRASS webpages for feedback mailinglists and more:
http://grass.itc.it/
http://grass.ibiblio.edu/

Hit RETURN to continue
█
```

Figure 6: Launching GRASS

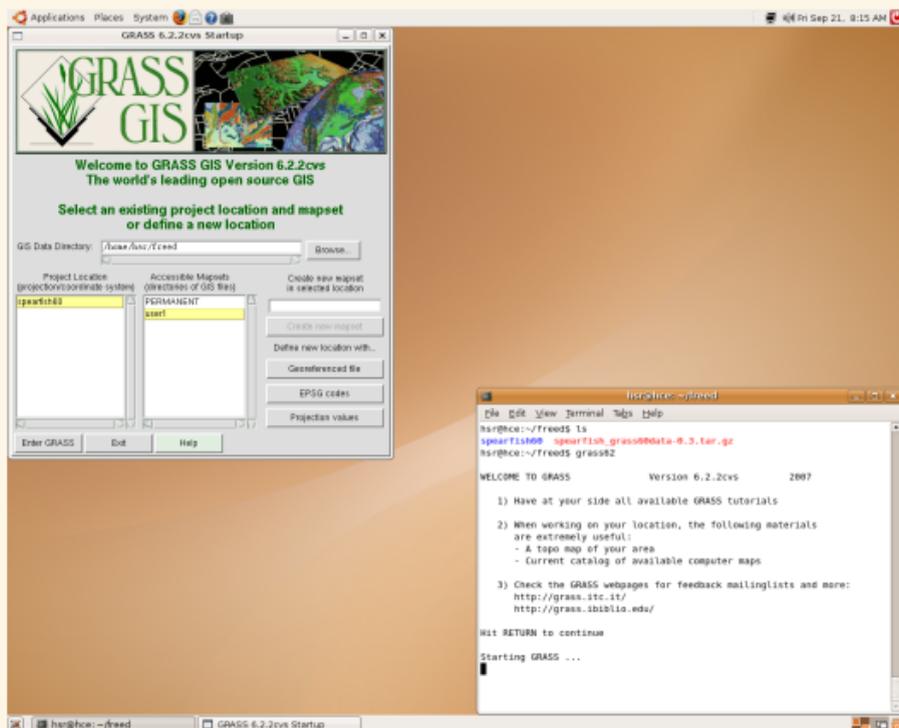


Figure 7: Startup on Desktop

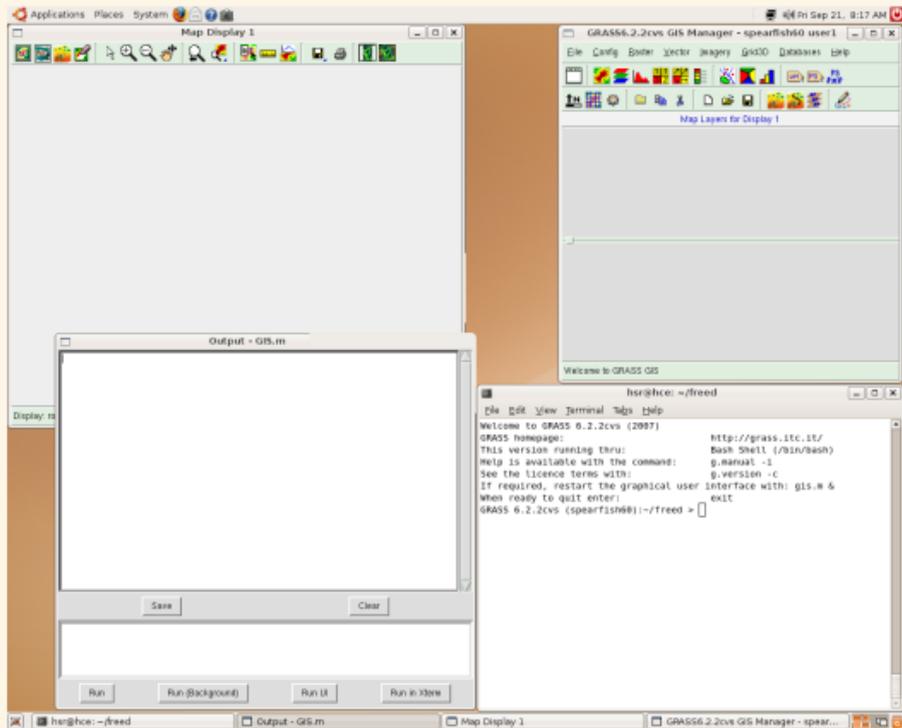


Figure 8: GRASS on Desktop

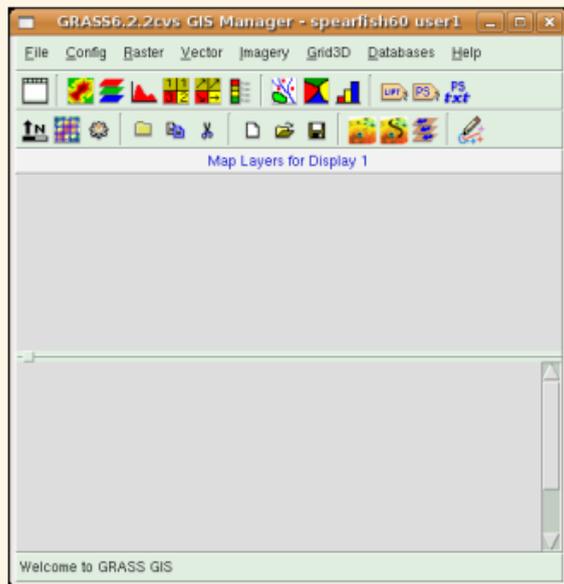


Figure 9: GIS Manager



Figure 10: Adding Raster Map

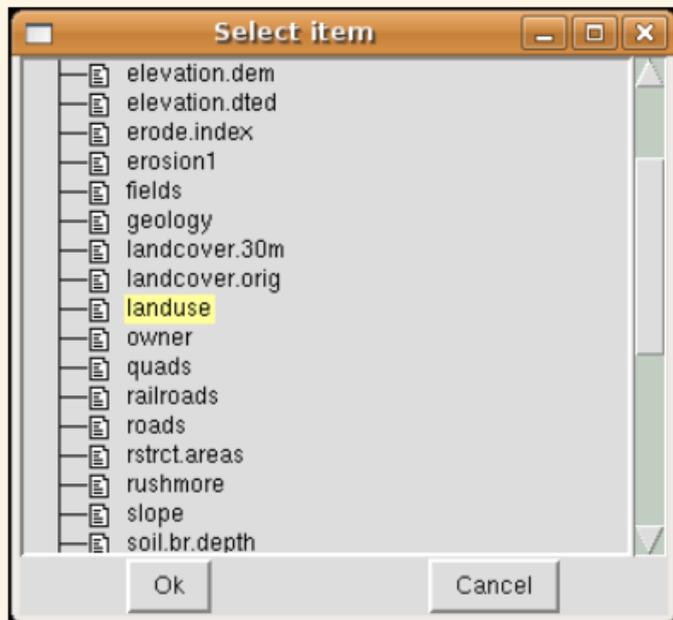


Figure 11: Selecting Map

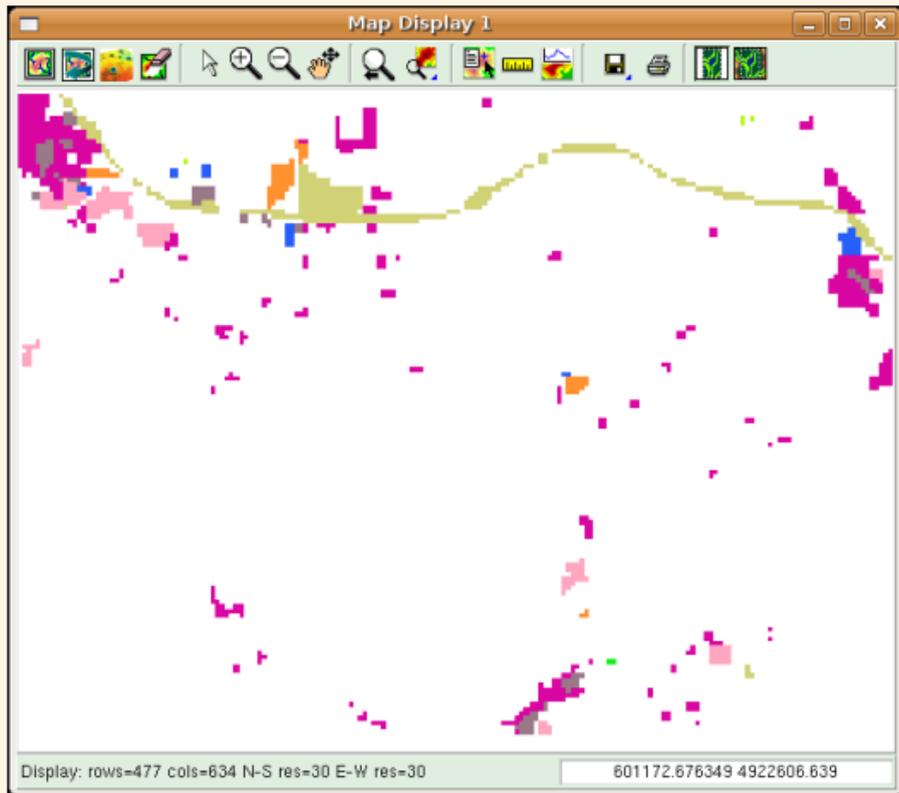


Figure 12: Displaying Map

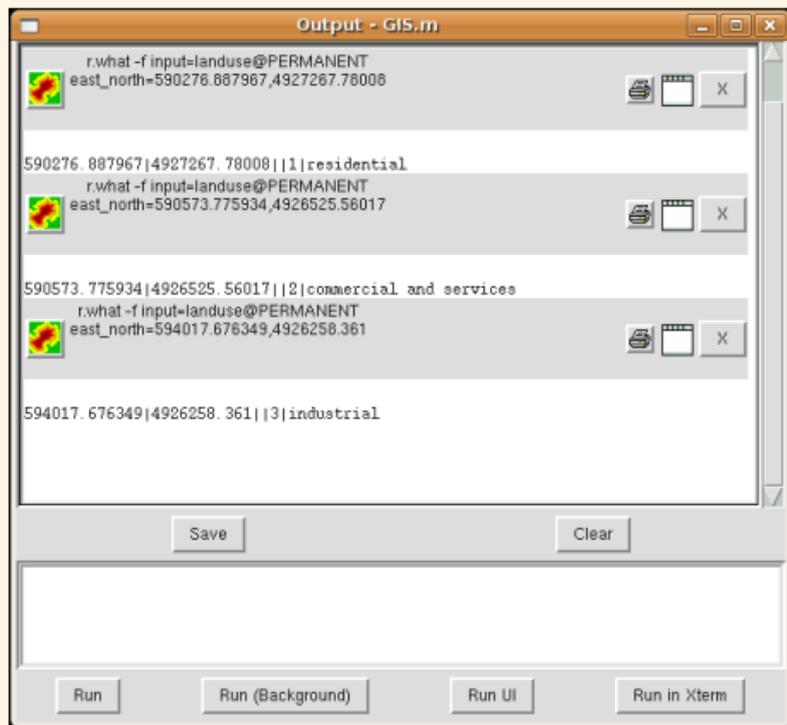


Figure 13: Query Result

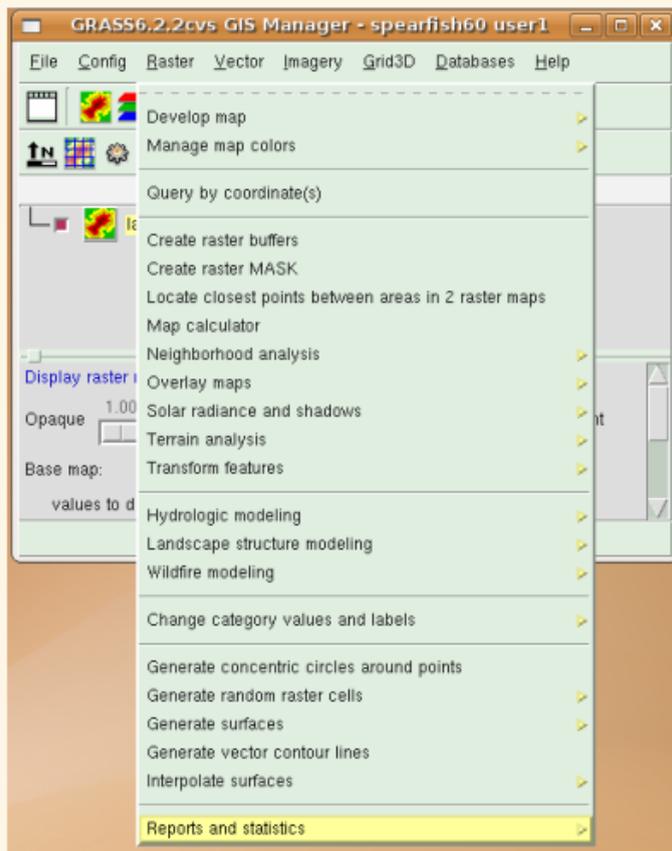


Figure 14: Reporting

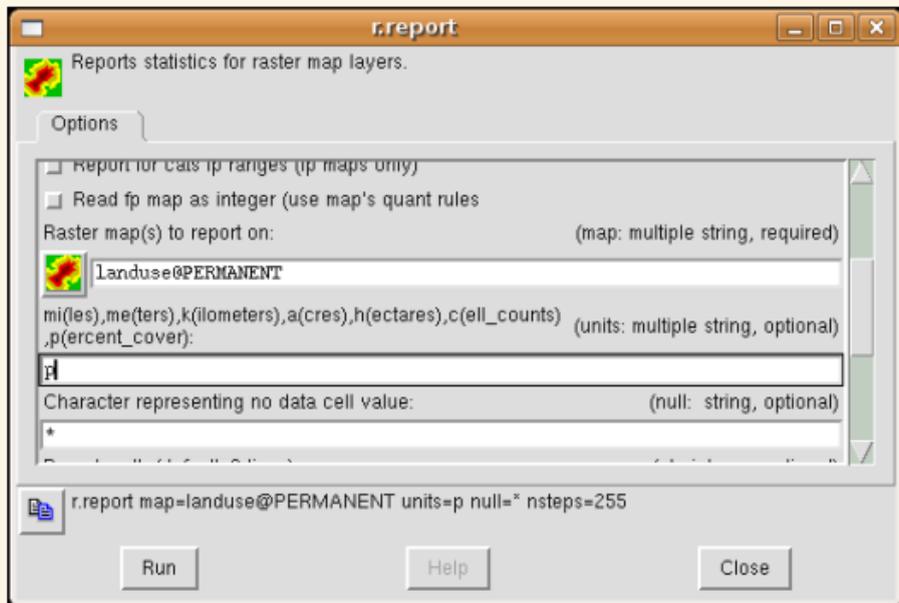


Figure 15: Report Options

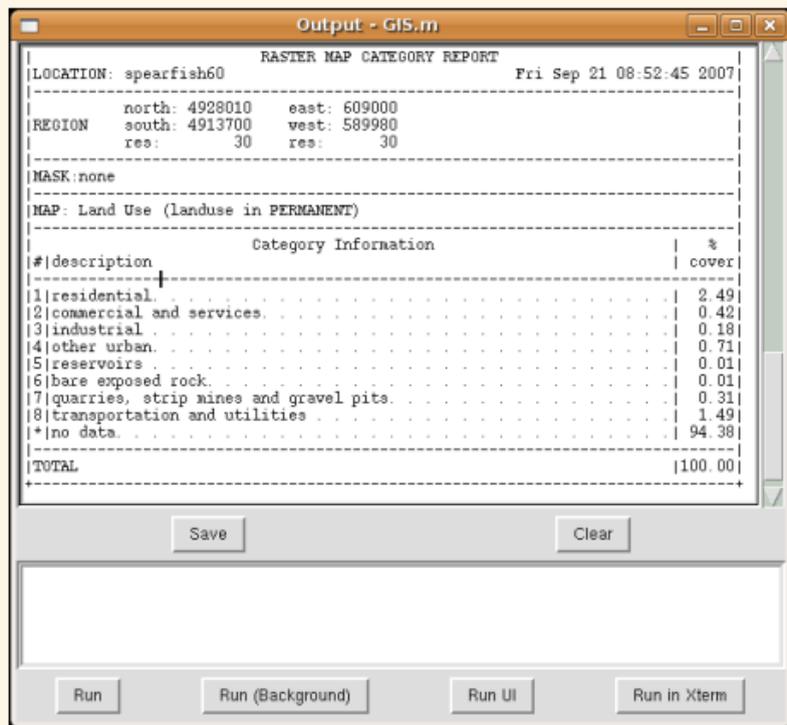


Figure 16: Output of Report

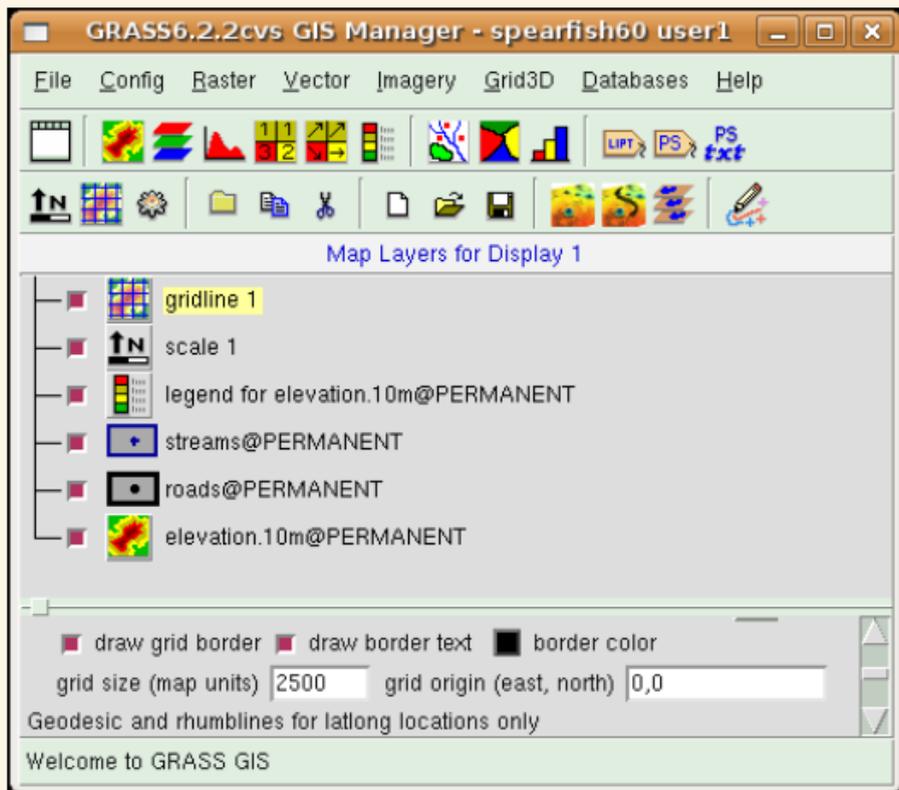


Figure 17: Composing Map

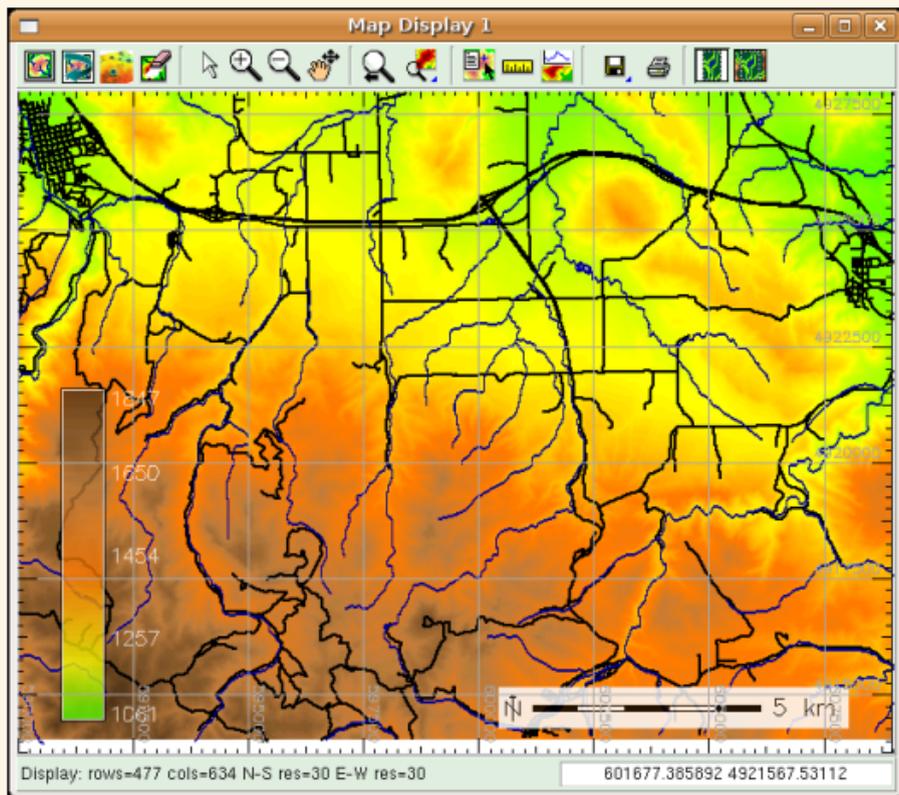
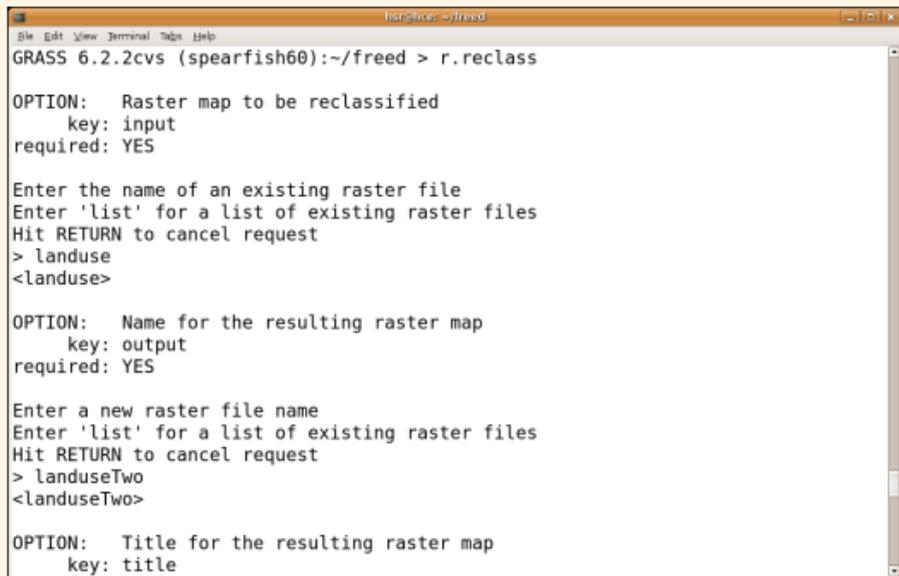


Figure 18: composed Map Display



```
GRASS 6.2.2cvs (spearfish60):~/freed > r.reclass

OPTION:  Raster map to be reclassified
         key: input
         required: YES

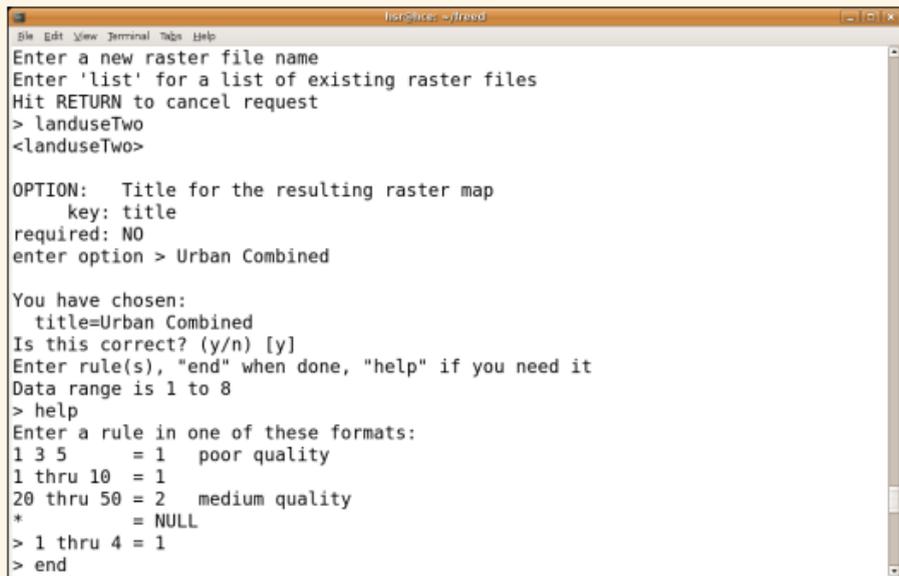
Enter the name of an existing raster file
Enter 'list' for a list of existing raster files
Hit RETURN to cancel request
> landuse
<landuse>

OPTION:  Name for the resulting raster map
         key: output
         required: YES

Enter a new raster file name
Enter 'list' for a list of existing raster files
Hit RETURN to cancel request
> landuseTwo
<landuseTwo>

OPTION:  Title for the resulting raster map
         key: title
```

Figure 19: Reclassing 1/2

A screenshot of a terminal window titled "hsr@psice: ~/freed". The terminal shows a sequence of commands and prompts for reclassifying a raster file. The user enters "landuseTwo" as the raster file name. An option "title" is set to "Urban Combined". The user is asked to enter a rule, and they enter "1 thru 4 = 1". The terminal output shows the resulting rule list.

```
hsr@psice: ~/freed
File Edit View Terminal Tabs Help
Enter a new raster file name
Enter 'list' for a list of existing raster files
Hit RETURN to cancel request
> landuseTwo
<landuseTwo>

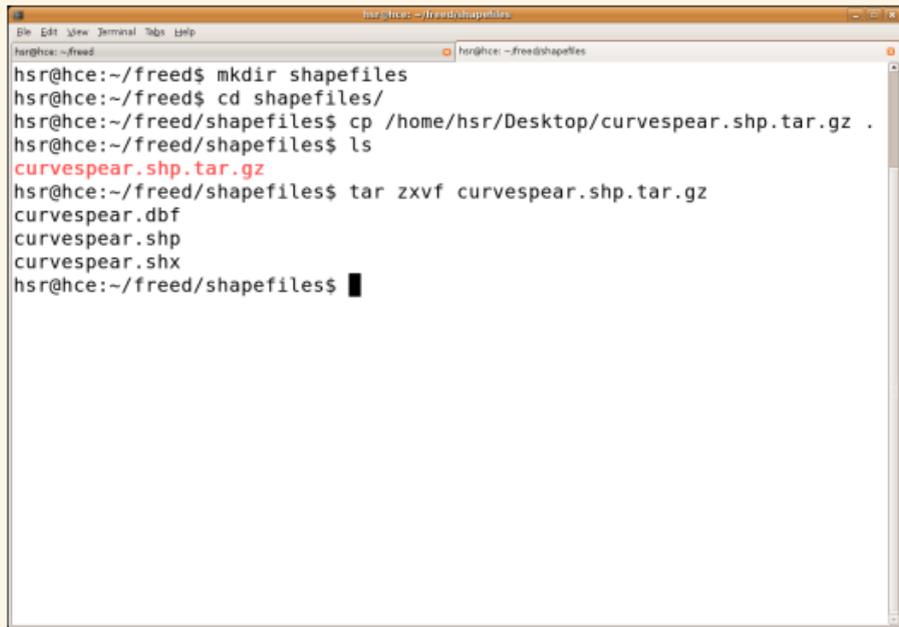
OPTION: Title for the resulting raster map
key: title
required: NO
enter option > Urban Combined

You have chosen:
title=Urban Combined
Is this correct? (y/n) [y]
Enter rule(s), "end" when done, "help" if you need it
Data range is 1 to 8
> help
Enter a rule in one of these formats:
1 3 5 = 1 poor quality
1 thru 10 = 1
20 thru 50 = 2 medium quality
* = NULL
> 1 thru 4 = 1
> end
```

Figure 20: Reclassing 2/2


```
GRASS 6.2.2cvs (spearfish60):~/freed > r.report map=landuseTwo unit=p
r.stats: 100%
+-----+
+-----+
|          RASTER MAP CATEGORY REPORT          |
|LOCATION: spearfish60                          Sat Sep 22 12:26:37 2007|
+-----+
| REGION      north: 4928010   east: 609000   |
|              south: 4913700  west: 589980  |
|              res:      30    res:      30    |
+-----+
|MASK:none                                     |
+-----+
|MAP: Urban Combined (landuseTwo in user1)    |
+-----+
|          Category Information          | % |
| #|description                          | cover |
+-----+
| 1| . . . . .                          | 3.80 |
| *|no data. . . . .                    | 96.20|
+-----+
|TOTAL                                     |100.00|
+-----+
GRASS 6.2.2cvs (spearfish60):~/freed > █
```

Figure 22: Reclassed Report

A terminal window titled "hsr@hce: ~/freed/shapefiles" showing a series of commands and their outputs. The user creates a directory, navigates to it, copies a file from the desktop, lists the contents, and then extracts a tar archive. The extracted files are listed as curvespear.dbf, curvespear.shp, and curvespear.shx.

```
hsr@hce:~/freed$ mkdir shapefiles
hsr@hce:~/freed$ cd shapefiles/
hsr@hce:~/freed/shapefiles$ cp /home/hsr/Desktop/curvespear.shp.tar.gz .
hsr@hce:~/freed/shapefiles$ ls
curvespear.shp.tar.gz
hsr@hce:~/freed/shapefiles$ tar zxvf curvespear.shp.tar.gz
curvespear.dbf
curvespear.shp
curvespear.shx
hsr@hce:~/freed/shapefiles$
```

Figure 23: Downloading Shapefile



Figure 24: Importing Shapefile 1/3

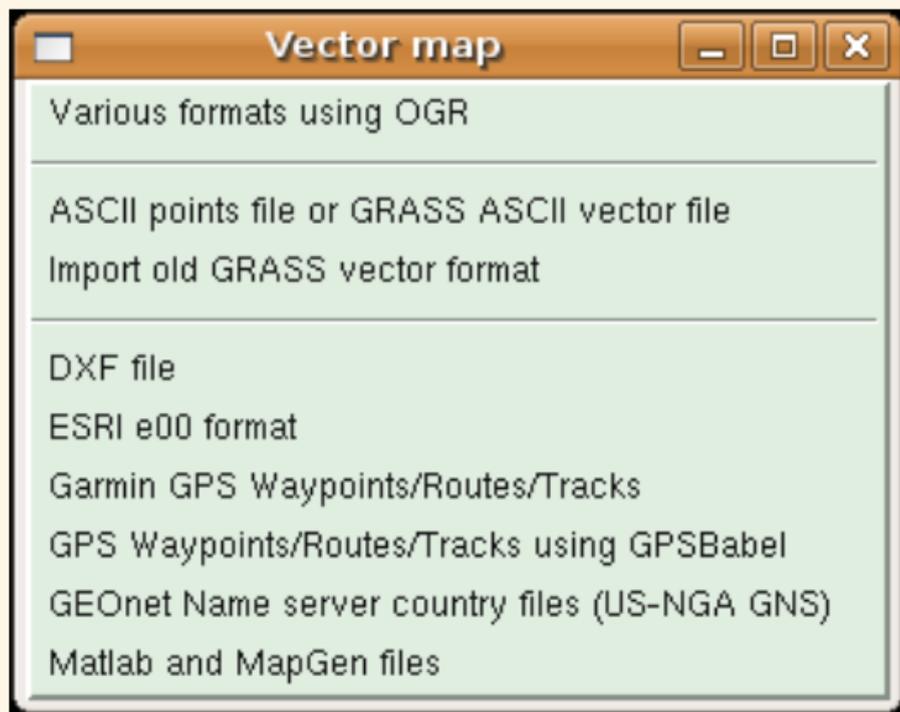


Figure 25: Importing Shapefile 2/3

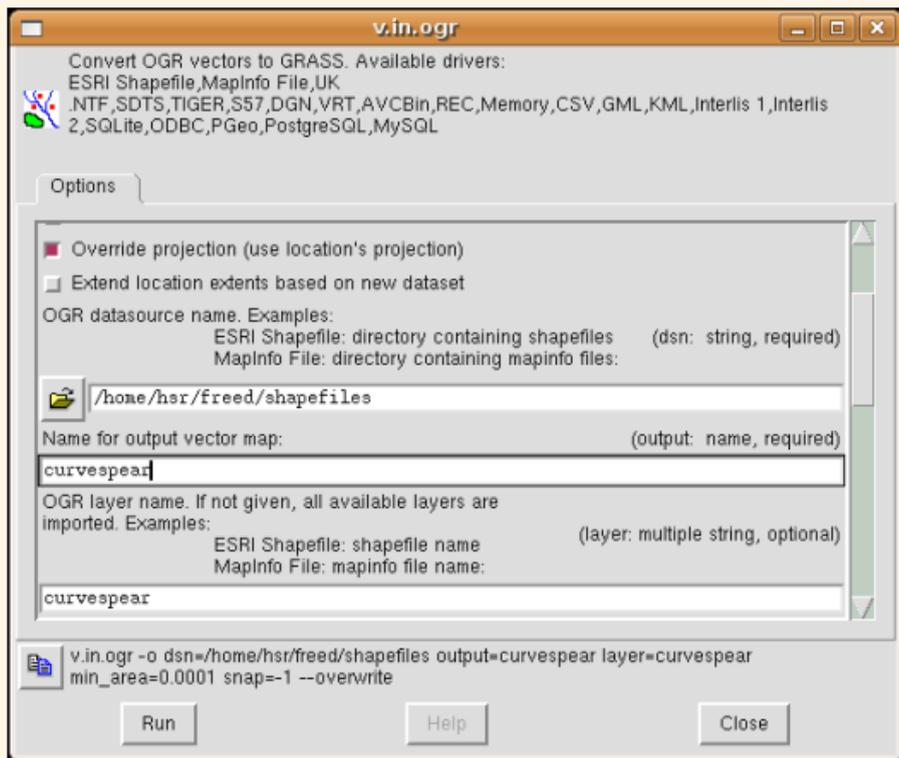
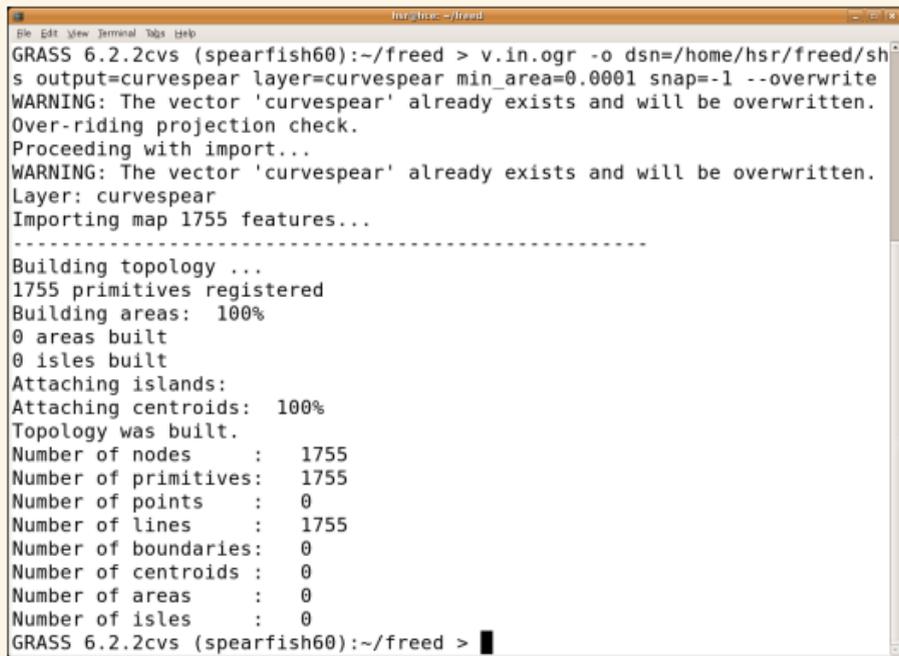


Figure 26: Importing Shapefile 3/3



```
hsr@hsr:~/freed
File Edit View Terminal Tabs Help
GRASS 6.2.2cvs (spearfish60):~/freed > v.in.ogr -o dsn=/home/hsr/freed/sh
s output=curvespear layer=curvespear min_area=0.0001 snap=-1 --overwrite
WARNING: The vector 'curvespear' already exists and will be overwritten.
Over-riding projection check.
Proceeding with import...
WARNING: The vector 'curvespear' already exists and will be overwritten.
Layer: curvespear
Importing map 1755 features...
-----
Building topology ...
1755 primitives registered
Building areas: 100%
0 areas built
0 isles built
Attaching islands:
Attaching centroids: 100%
Topology was built.
Number of nodes      : 1755
Number of primitives: 1755
Number of points     : 0
Number of lines      : 1755
Number of boundaries: 0
Number of centroids  : 0
Number of areas      : 0
Number of isles      : 0
GRASS 6.2.2cvs (spearfish60):~/freed > █
```

Figure 27: Shapefile import: Command in Terminal



Figure 28: Display of COntours

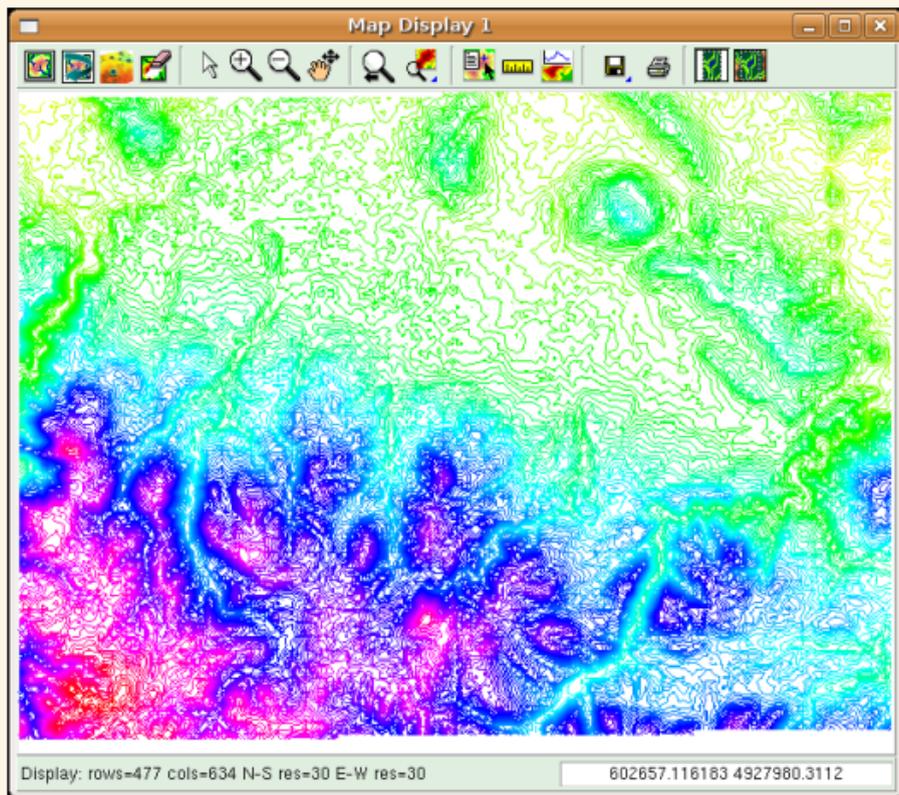


Figure 29: Contours in Raster

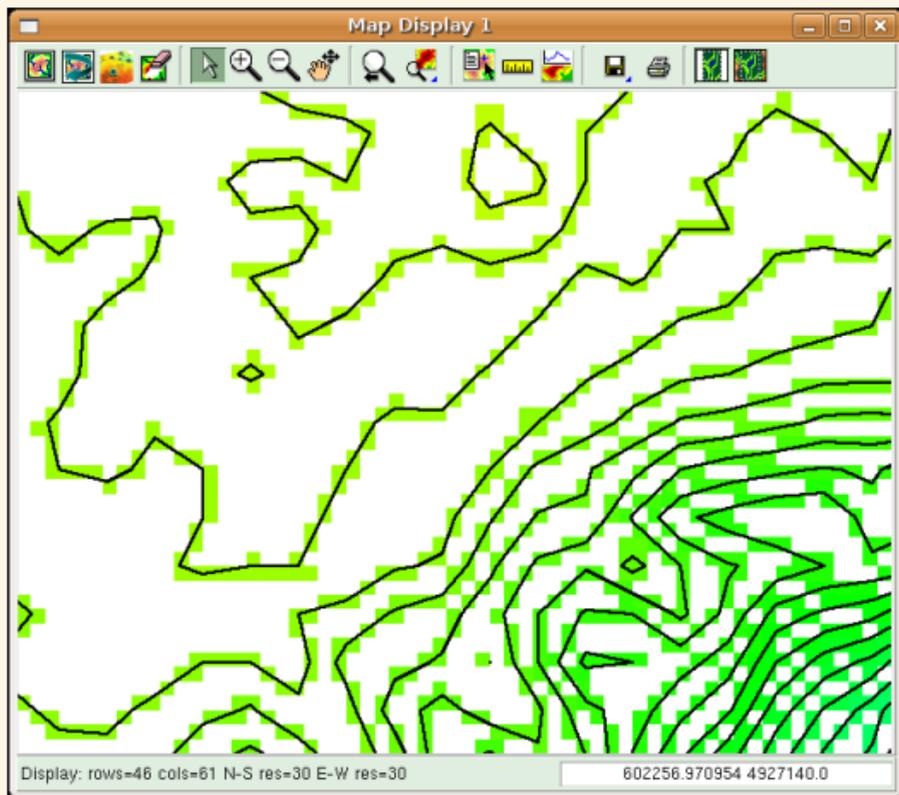


Figure 30: Contour Comparison: Vector and Raster

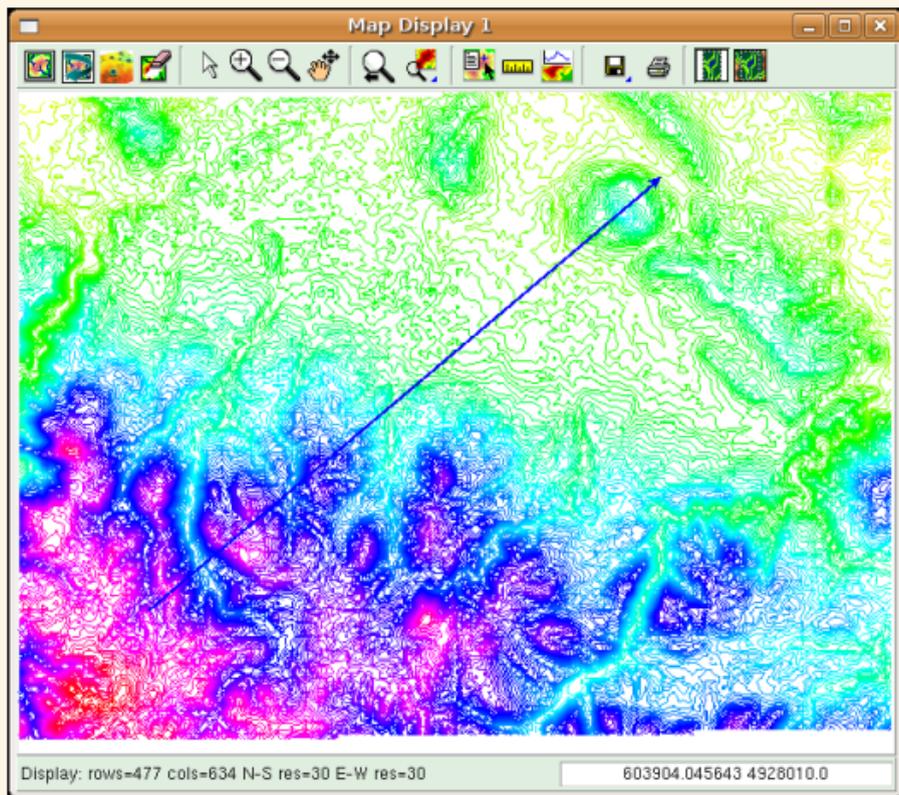


Figure 31: Profile Transect

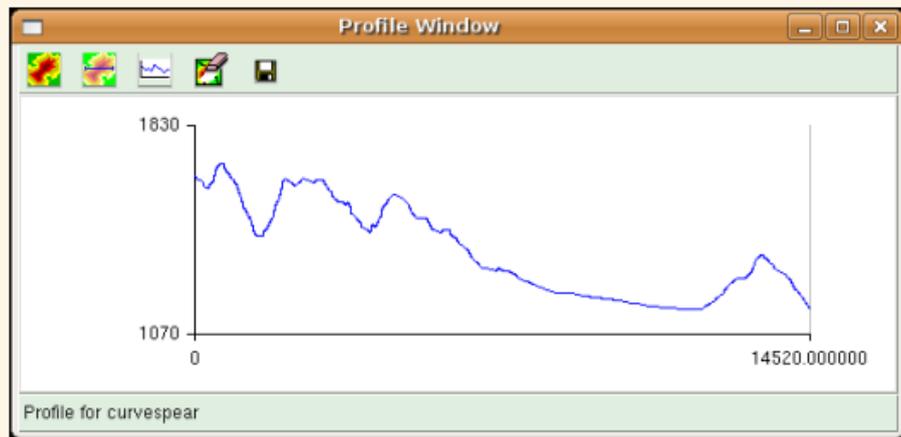


Figure 32: Profile Display

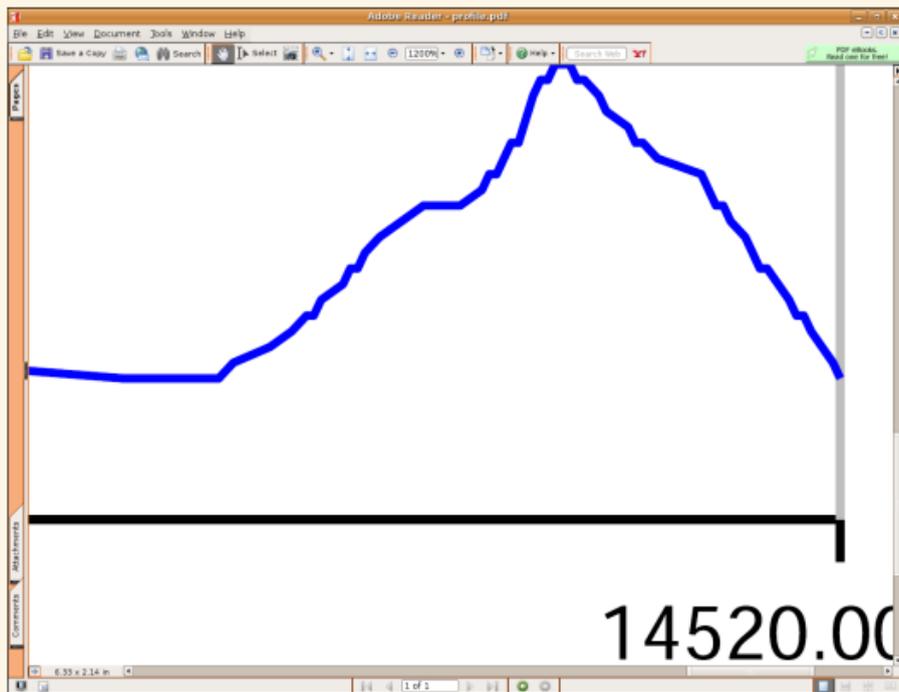


Figure 33: Profile: From PDF file

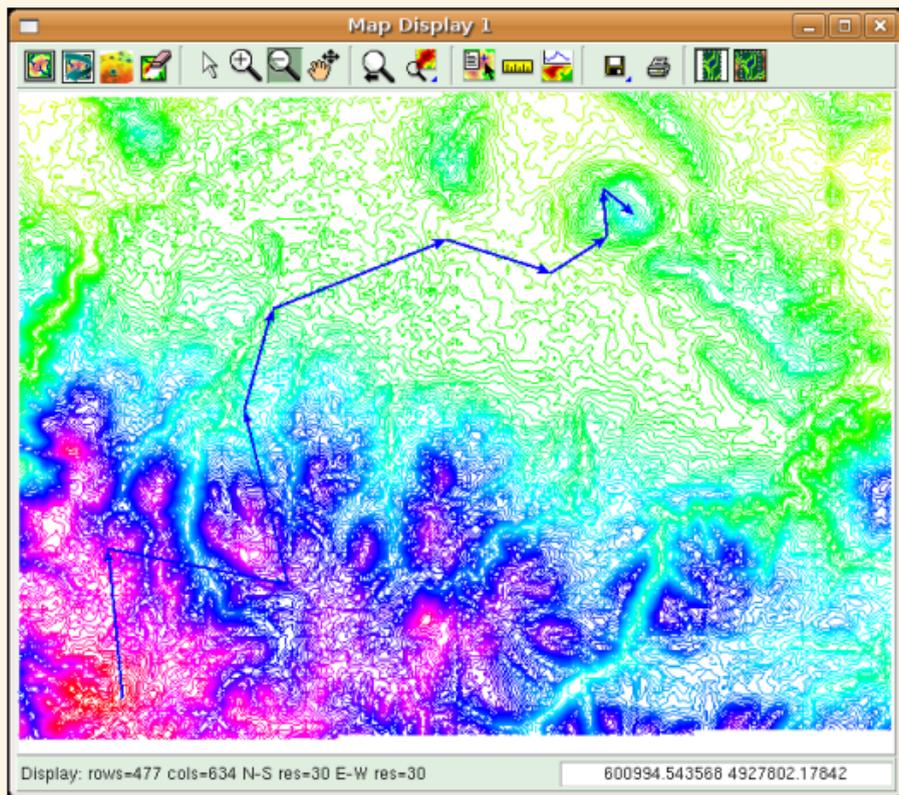


Figure 34: Multi-segment Profile



Figure 35: Display of Multi-segment Profile

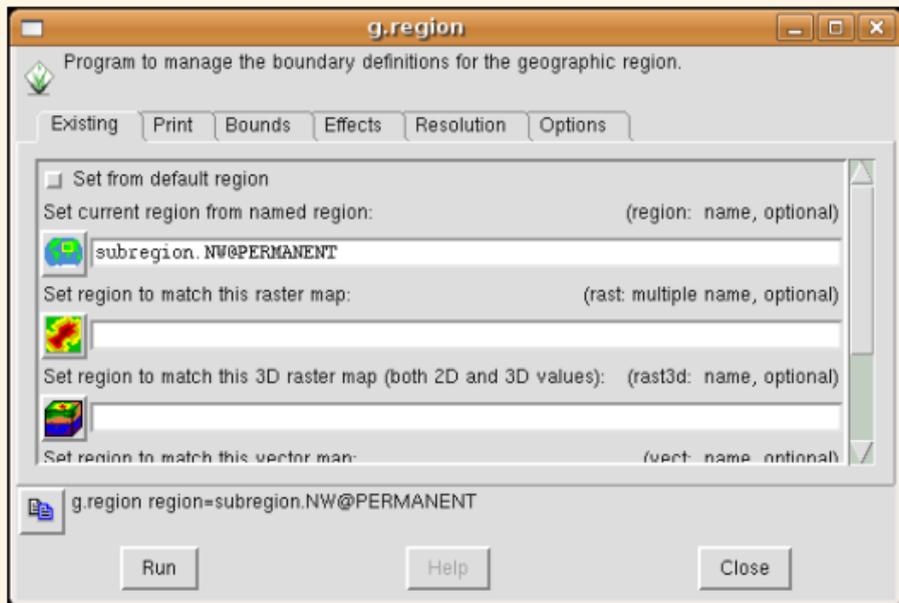


Figure 36: Resetting Region

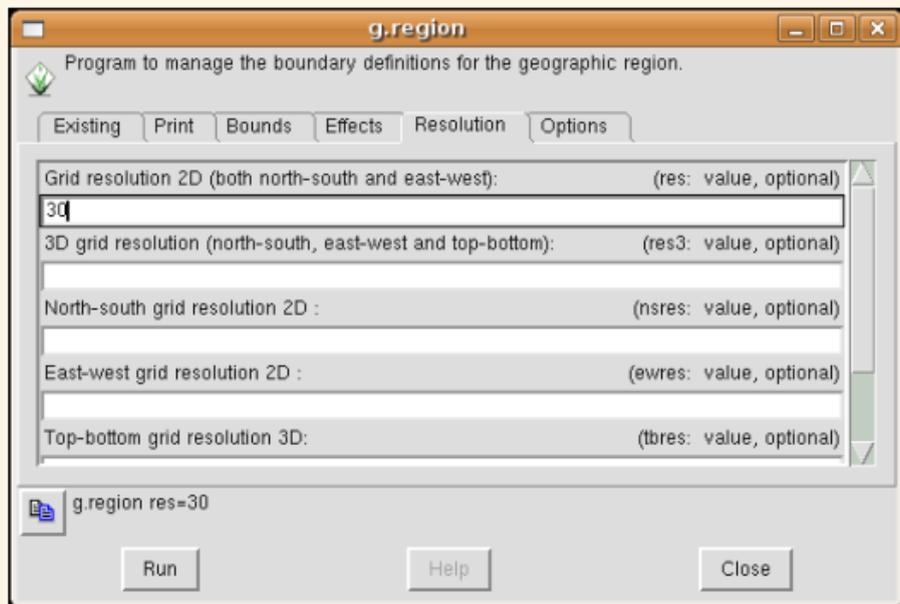


Figure 37: Resetting Resolution

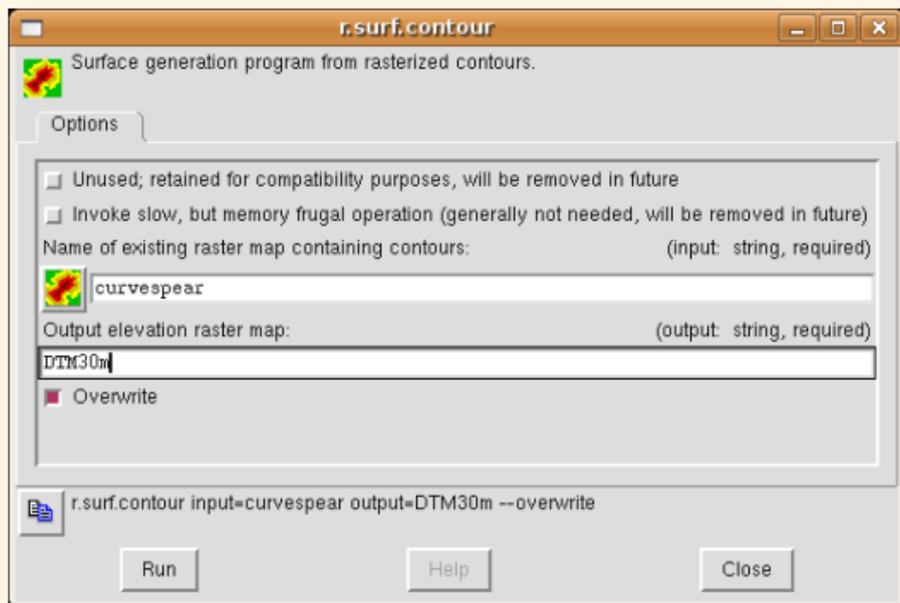


Figure 38: DTM.png

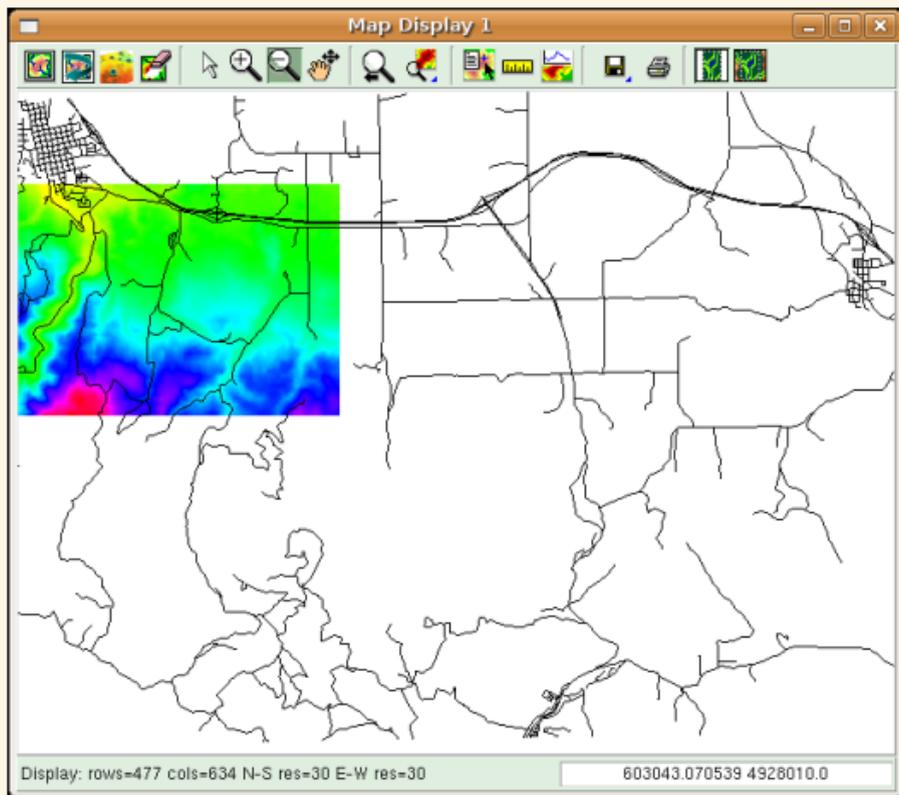


Figure 39: Display of DTM

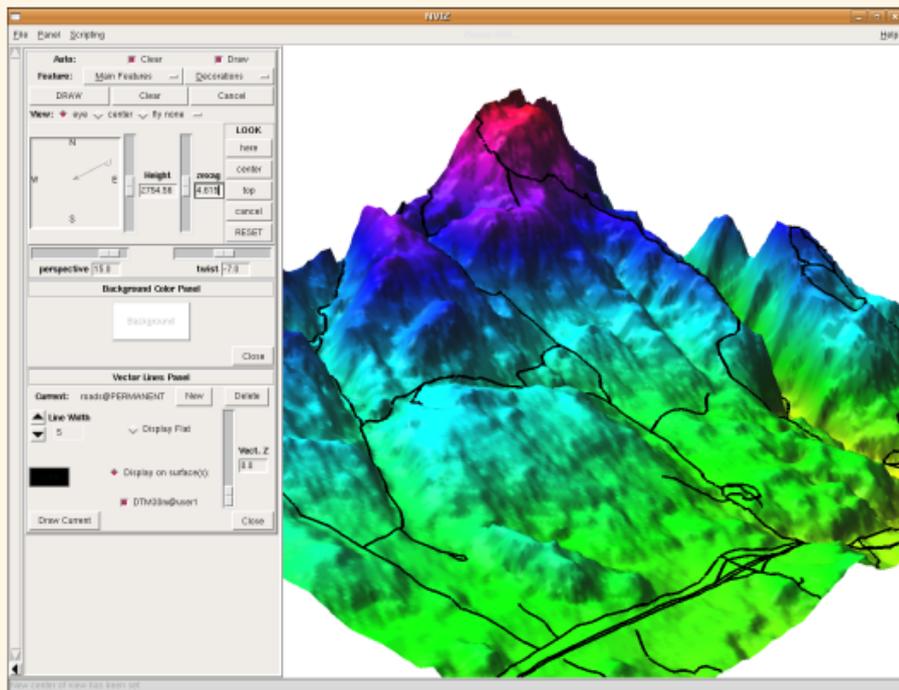


Figure 40: NVIZ

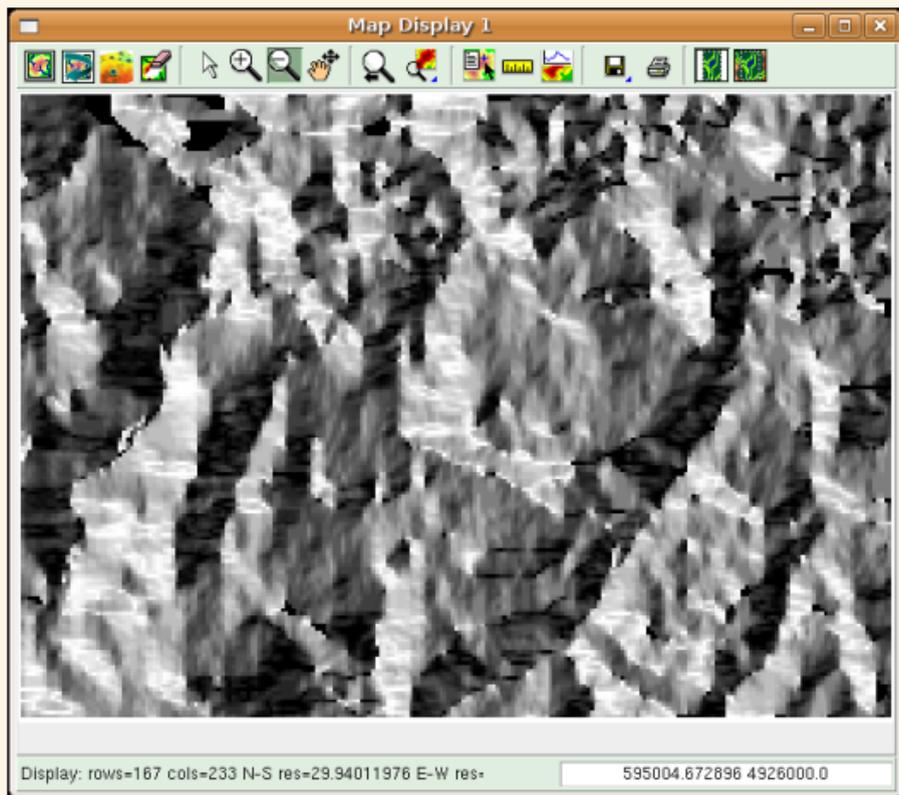


Figure 41: Display of Aspect Map

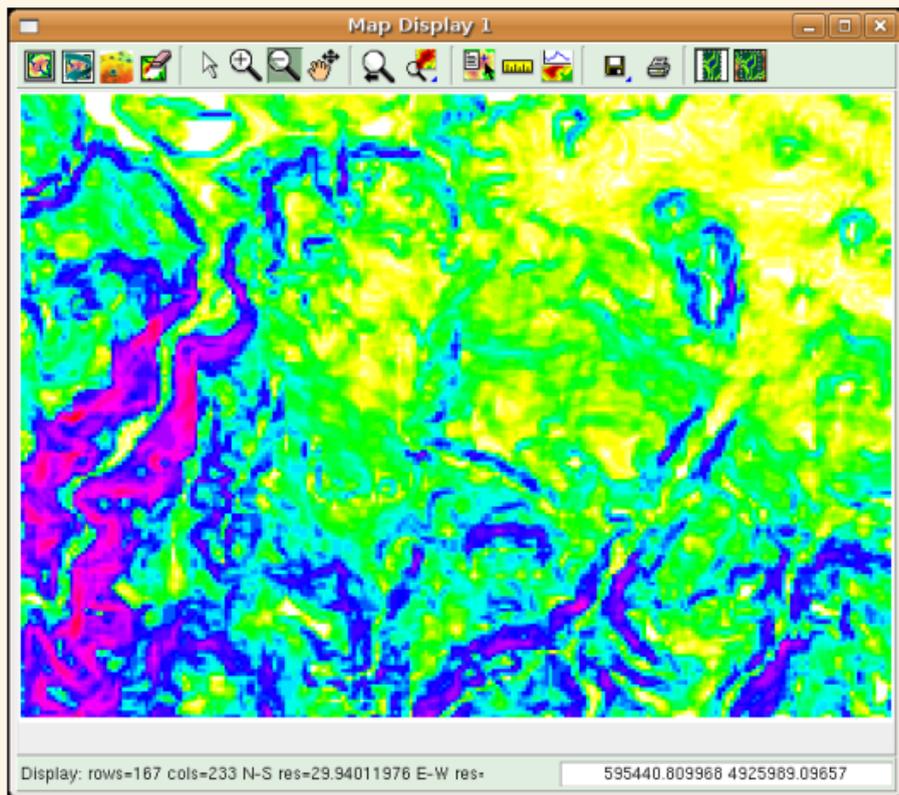


Figure 42: Display of Slope Map

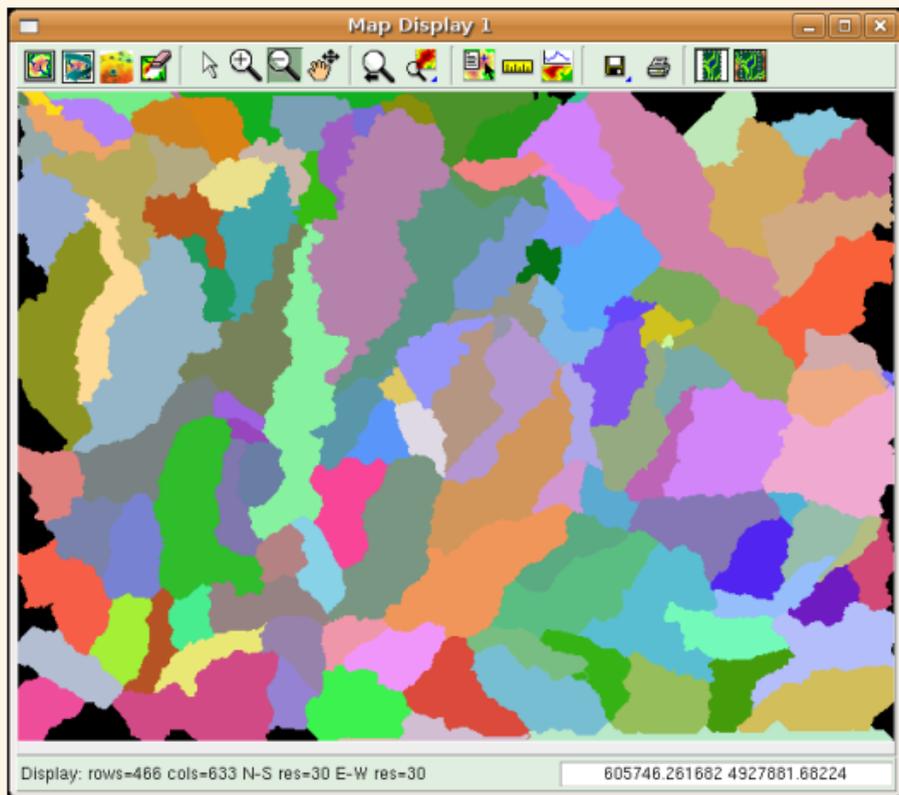


Figure 43: Basin

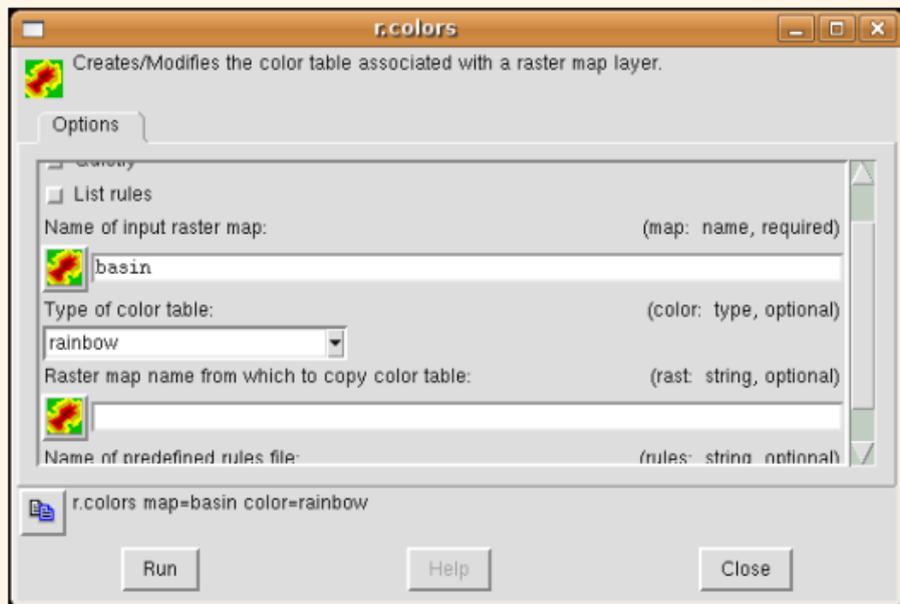


Figure 44: Colour Change

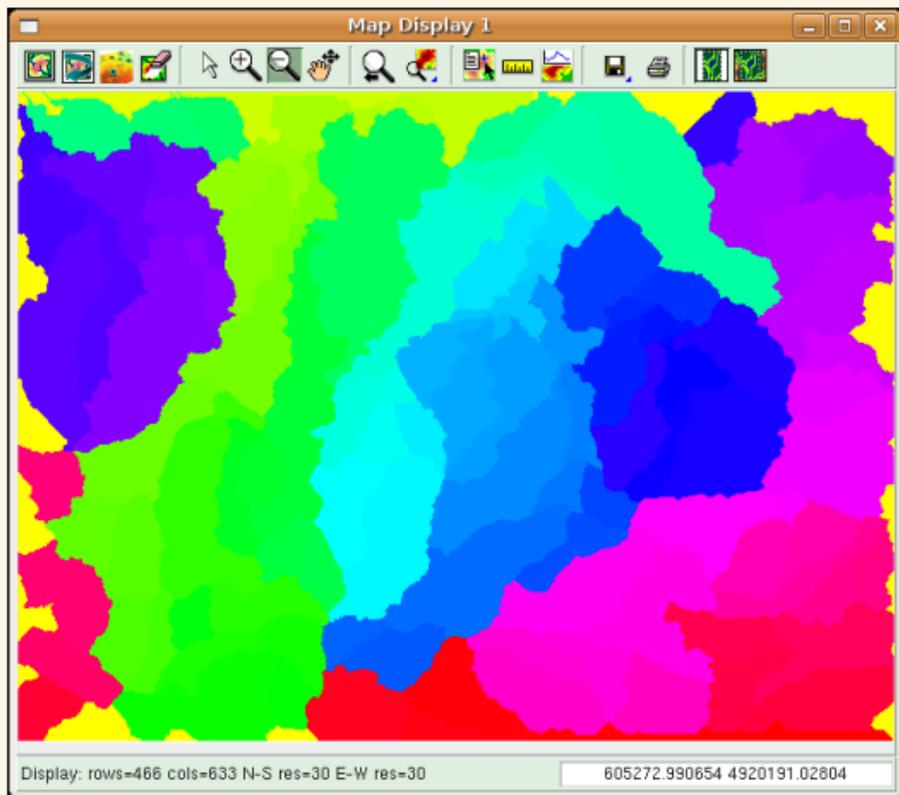


Figure 45: Basin with Rainbow Colours

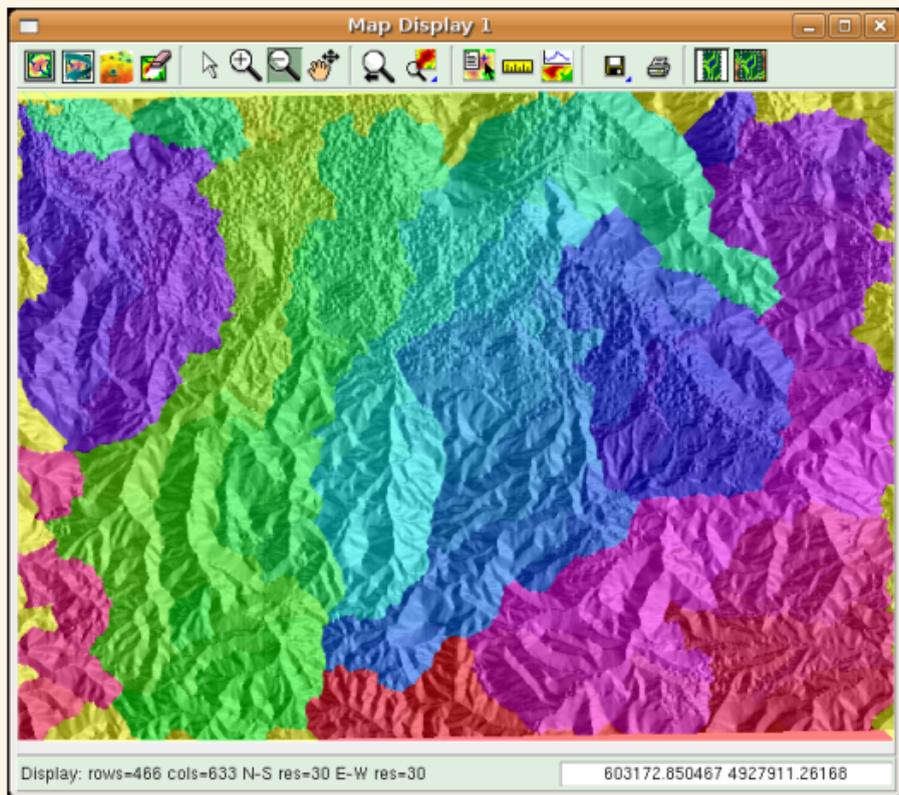


Figure 46: Basin and Aspect Maps

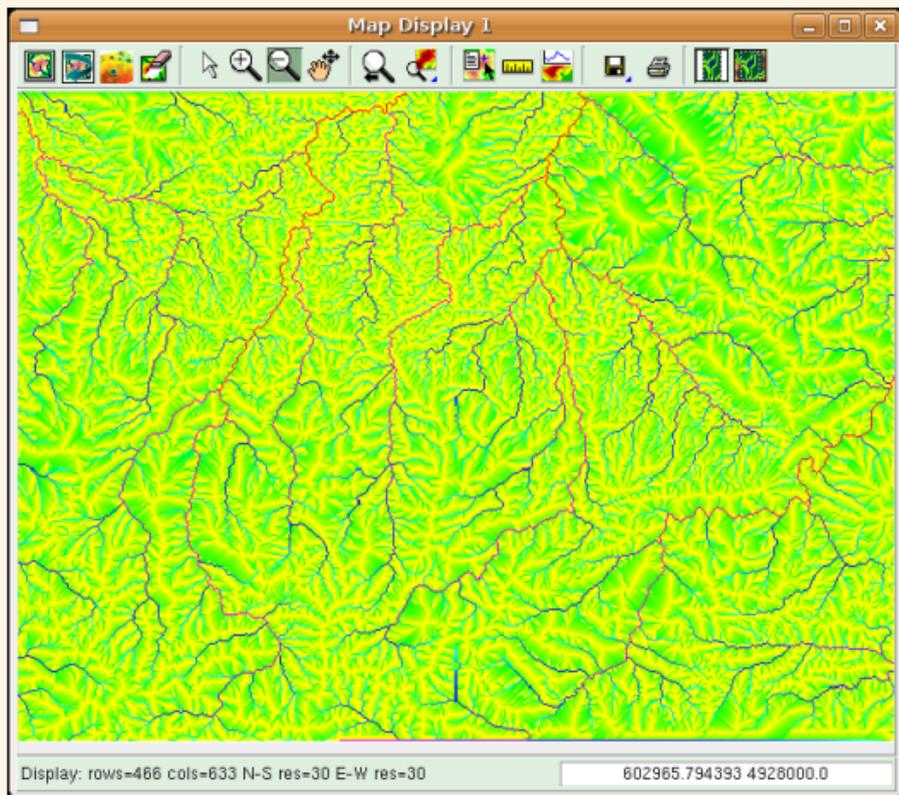


Figure 47: Log Accumulation

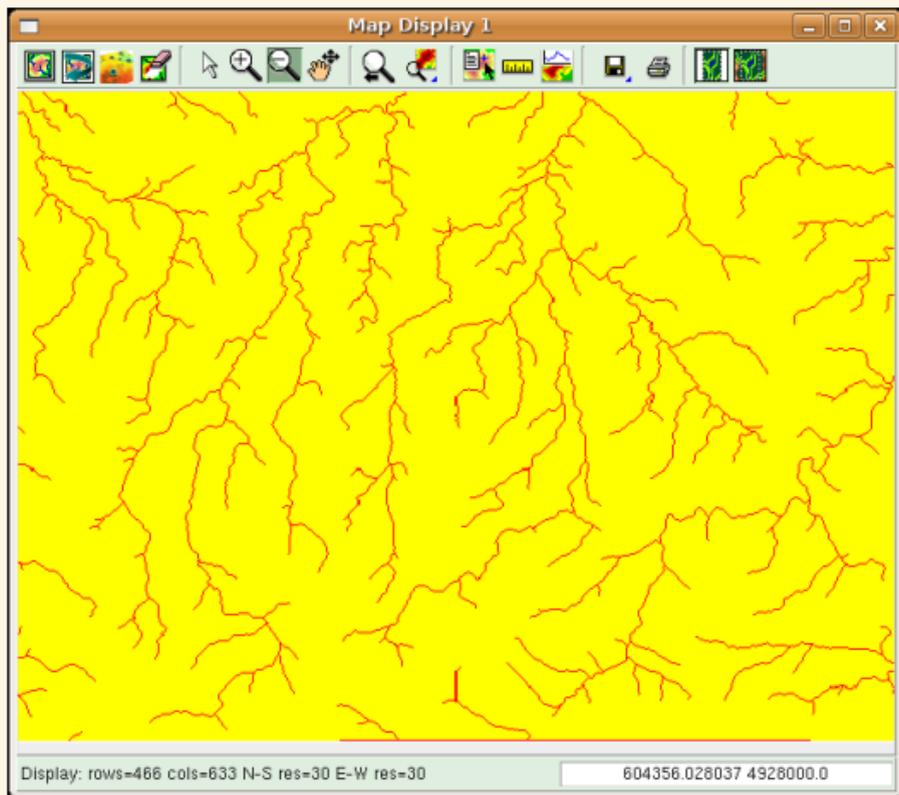


Figure 48: Raster Rivers

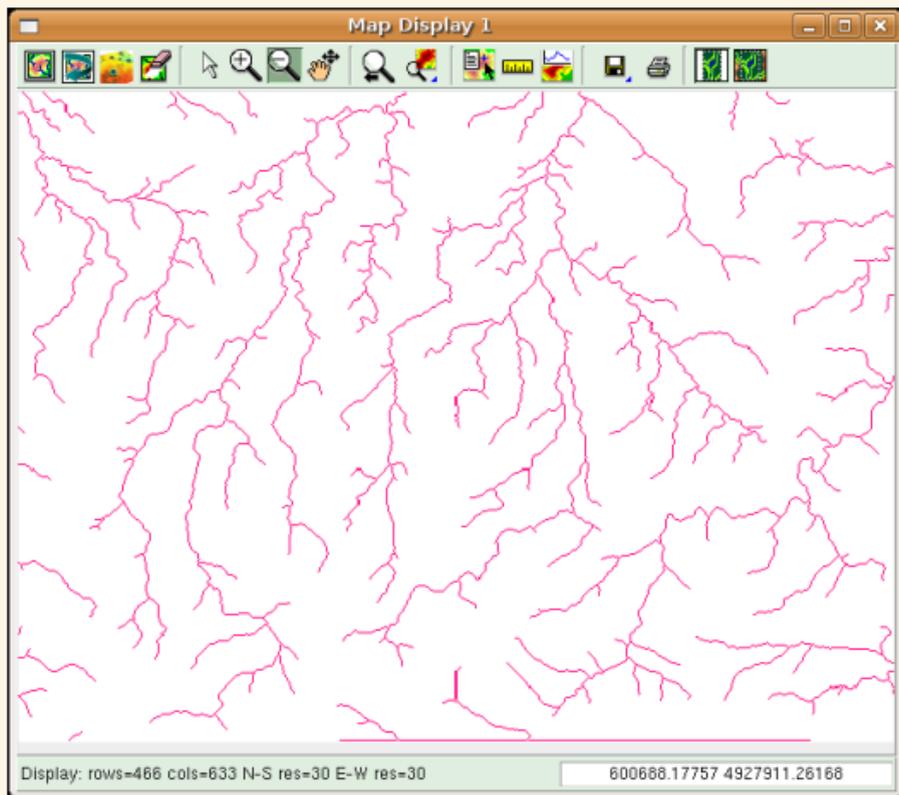


Figure 49: Thinned Rivers

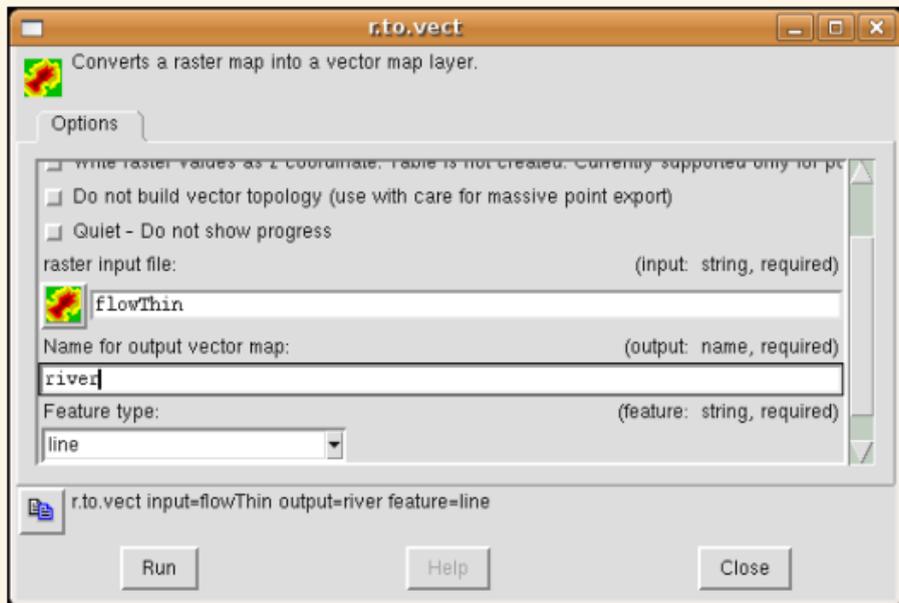


Figure 50: Rivers: Raster to Vector

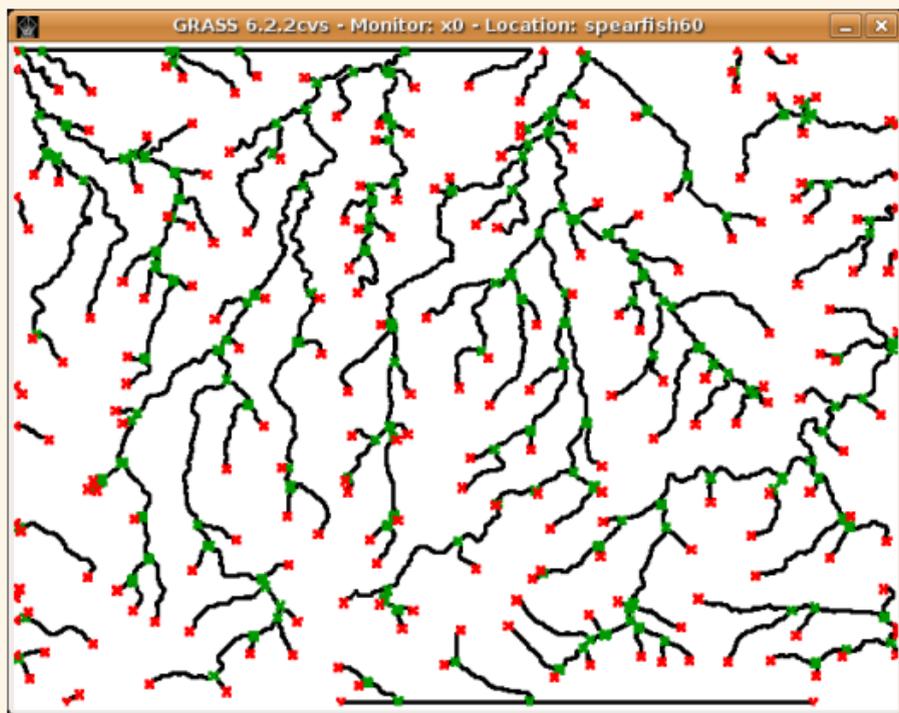


Figure 52: Errors

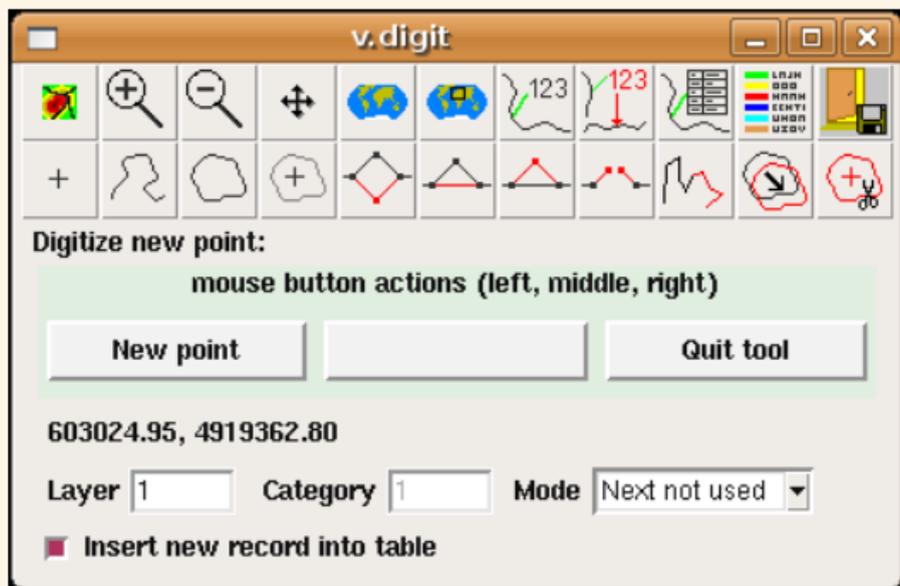


Figure 53: Editing Wrong Rivers

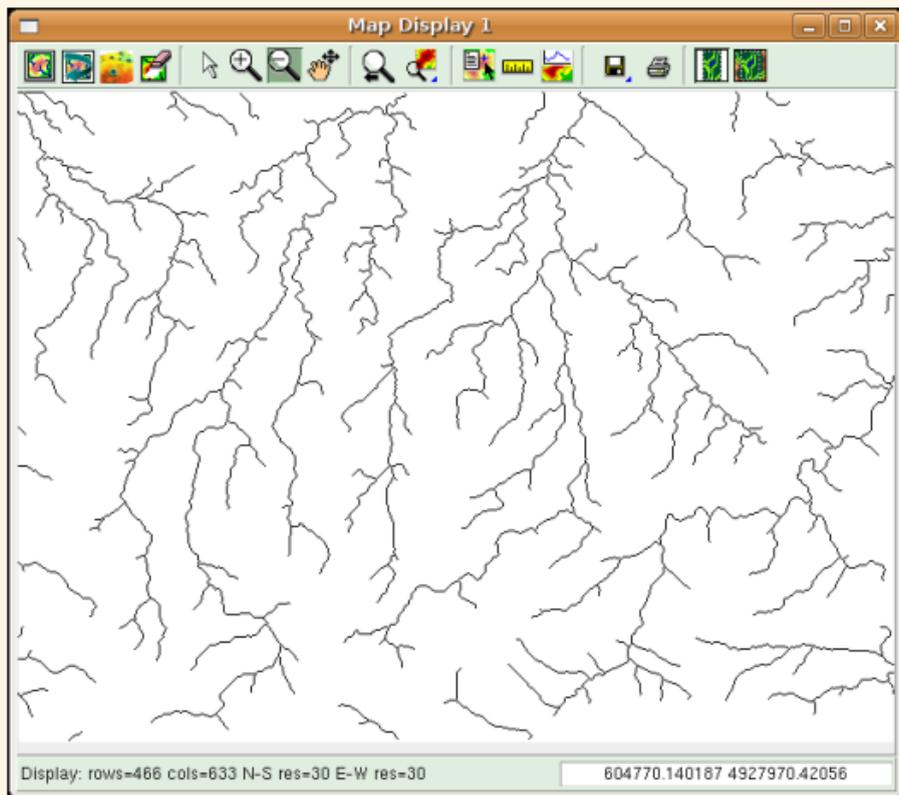


Figure 54: Rivers Corrected

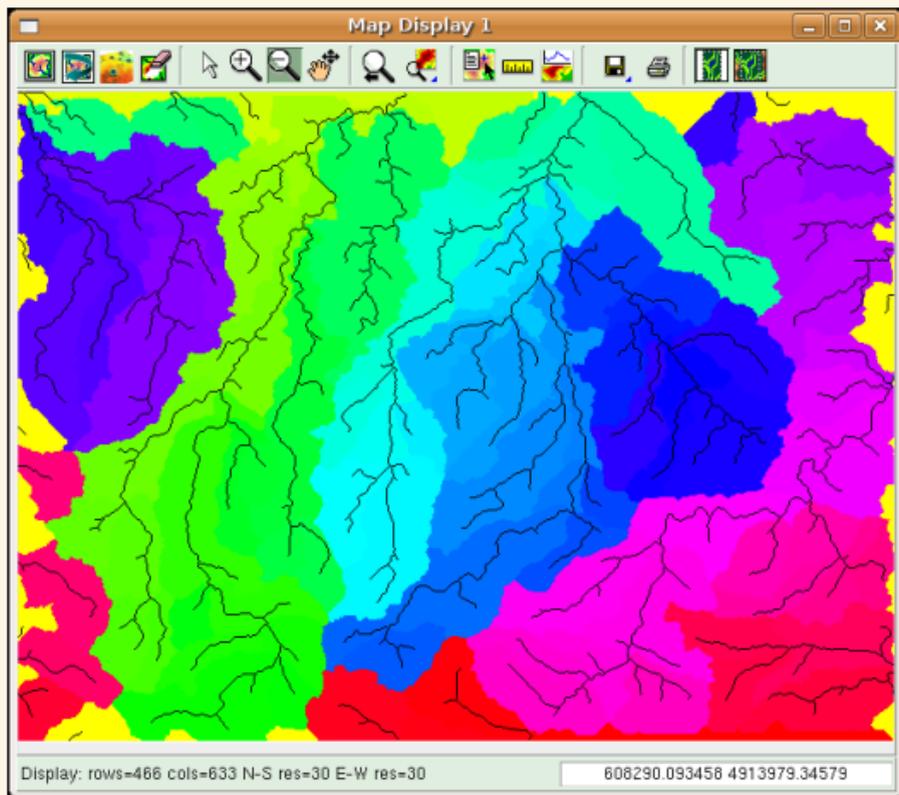


Figure 55: Rivers and Basins

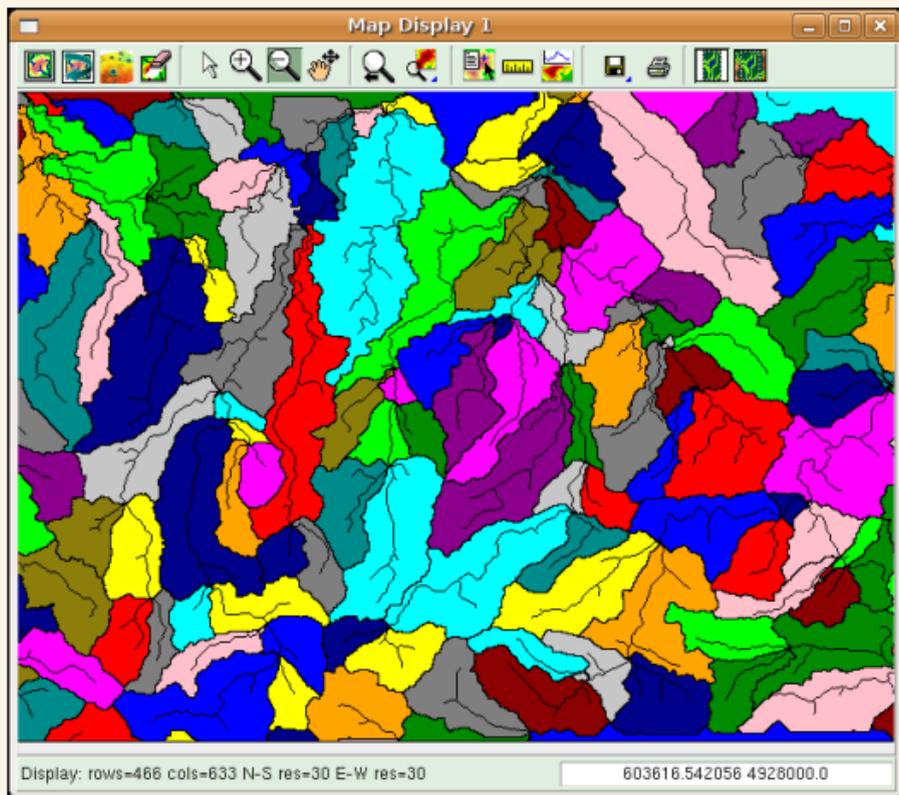


Figure 56: Rivers Basins: Vectorised

5. Creating Own Data

In this section, procedure to create DTM (Digital Terrain Model) will be explained. This is used to represent earth's surface, i.e. its hills and valleys.

5.1. Data preparation

The data pertaining to Earth Surface may be represented, for isolated plot in x, y , and z otherwise it is expressed Easting / Longitude, Northing / Latitude, and Altitude.

This information may be in CSV format, which may be exported from spreadsheet (OpenOffice's Calc). It is assumed that this data is there in file named `farmHouse.txt`.

5.2. New Location

- Open the TERMINAL window
- In TERMINAL window, type “grass62” and the press ENTER.
- In GRASS’s pop up window, click on PROJECTION VALUES.
- In PROJECTION VALUES, enter the name for the location, this will be the folder, where whole work done in GRASS will be saved. Press ESC key and then ENTER key

- A new window will open to verify the location (say Manali) of file. It will ask “Would you like to create location (Manali) ? (y/n) [y]”

Press ENTER to accept default value, which is “Yes”

- To create a new LOCATION, you will need the following information:
 1. The coordinate system for the database:
 - x,y (for imagery and other unreferenced data)
 - Latitude-Longitude
 - UTM
 - Other Projection

2. The zone for the UTM database and all the necessary parameters for projections other than Latitude-Longitude, x,y, and UTM
3. The coordinates of the area to become the default region and the grid resolution of this region
4. A short, one-line description or title for the location

Do you have all this information? (y/n) [y]

Press ENTER, if you have all the information.

- Then it will ask, to specify the co-ordinate system for location (Manali)?

Please specify the coordinate system for location
<Manali>

A x,y

B Latitude-Longitude

C UTM

D Other Projection

RETURN to cancel

Enter 'A' as we are using x-y co-ordinate system,
and then press ENTER

- x,y coordinate system? (y/n) [y]

PRESS ENTER

- Please enter a one line description for location <Manali>

then give a one line description something like “Area around Guest House at Manali” and press ENTER

- ok? (y/n) [y]

PRESS ENTER

- Press <ESC><ENTER>

- It will display

projection: 0 (x,y)

zone: 0

north: 1

south: 0

east: 1

west: 0

e-w res: 1

n-s res: 1

total rows: 1

total cols: 1

total cells: 1 Do you accept this region? (y/n) [y]

Press ENTER

- Now it will open Terminal Window, GIS Manager, Display window, and Output window.

5.3. Importing point data

- From menu bar of GRASS window, click FILE – > IMPORT – > VECTOR MAP
- Click on ‘ASCII POINTS FILE or GRASS ASCII VECTOR FILE’, and then on ‘vector 3D’; browse the CSV File already saved with the name of ‘farmHouse.

Name the output name for the file , say farmHouse
change the field separator to (,)

Change the z - co-ordinate from (0) to (3), as if (0) is used , then z-axis is not taken into consideration , so we make it (3) to make z-axis into consideration.

Number of column used as a category for point modes should be remain empty. The default 0 should be deleted.

Click on OVERWRITE then click RUN

Now check the output window, if there is any error.

OUTPUT —>>

```
v.in.ascii z input = /home/ce19/z.csv output = Z3  
format = point fs=,skip=0 x=1 y=2 z=3 overwrite
```

5.4. Build topography

- VECTOR —> DEVELOP MAP —> CREATE / REBUILD TOPOGRAPHY

- Now in new popup window, browse the input for the vector map which is (farmHouse) created in previous step.
- Click on OVERWRITE and then press RUN
OUTPUT —> v.build map = farmHouse option = build overwrite

5.5. Changing region

- From Menu bar, Click on CONFIG —> REGION —> CHANGE REGION SETTINGS
- Browse the “farmHouse SET REGION TO MATCH THE VECTOR MAP

- Click RUN

5.6. Creating surface

- From Menu bar click RASTER – > INTERPOLATE SURFACE – > REGULARIZED SPLINE TENSION INTERPOLATION FROM VECTOR POINTS ON CONTOURS
- From pop up window, browse the “farmHouse” file for “NAME OF VECTOR FILE WITH INPUT DATA”
- Change the “FIELD VALUE” from (1) to (0) as the z-axis is to be taken in the data.

- Name the “OUTPUT SURFACE RASTER FILE (ELEVATION): as DTM
- Click OVERWRITE, then click RUN

5.7. Generating contours

- From Menu bar, click on RASTER – > GENERATE VECTOR CONTOUR LINES
- In pop up window, browse the DTM file for the “NAME THE INPUT RASTE”
- Give contour1 name in “NAME THE OUTPUT VECTOR MAP”

- Give the INCREMENTS BETWEEN CONTOUR LEVEL, according to the data given. A value of 100 is used in this case.
- Check Overwrite, then click RUN
- Repeat above mentioned procedure, with contour2 name for “NAME THE OUTPUT VECTOR MAP”, increment of 20.

5.8. Displaying contours

- From Menu bar, click on CONFIG – > X-MONITOR DISPLAY – > CONFIGURE MONITOR DISPLAY
- Enter x0 in “NAME OF GRAPHIC MONITOR TO START”

- Enter x0 in “NAME OF GRAPHIC MONITOR TO SELECT”
- Type d.rast in TERMINAL WINDOW
- In pop up window, browse the DTM file for “RASTER MAP TO BE DISPLAYED”
- Click RUN
- Repeat above mention procedure, with Contour1 in the “NAME OF VECTOR MAP”, and select “shape” and “zcoor” in the DISPLAY.
- Again repeat it, with Contour2 in the “NAME OF VECTOR MAP”, and select “shape” in the DISPLAY.

6. Possibilities

- Neighborhood Analysis
- Solar Radiance and Shadows
- Terrain Analysis: (Visibility or Line of Sight)
- Hydraulic Modelling: Sediment Erosion / Transport / Depositioning
- Landscape Structure Modelling
- Wildfire Modelling
- Network Analysis: Shortest Route / Traveling Salesman Analysis

Thank you



My E-mail ID for contact is hardeep.rai@gmail.com