
Contents

1	Open Source software and GIS	1
1.1	Open Source concept	1
1.2	GRASS as an Open Source GIS	3
1.3	The North Carolina sample data set	5
1.4	How to read this book	5
2	GIS concepts	7
2.1	General GIS principles	7
2.1.1	Geospatial data models	7
2.1.2	Organization of GIS data and system functionality	11
2.2	Map projections and coordinate systems	13
2.2.1	Map projection principles	13
2.2.2	Common coordinate systems and datums	16
3	Getting started with GRASS	21
3.1	First steps	21
3.1.1	Download and install GRASS	21
3.1.2	Database and command structure	23
3.1.3	Graphical User Interfaces for GRASS 6: QGIS and gis.m	26
3.1.4	Starting GRASS with the North Carolina data set	27
3.1.5	GRASS data display and 3D visualization	30
3.1.6	Project data management	34
3.2	Starting GRASS with a new project	37
3.2.1	Defining the coordinate system for a new project	40
3.2.2	Non-georeferenced xy coordinate system	44
3.3	Coordinate system transformations	44
3.3.1	Coordinate lists	45
3.3.2	Projection of raster and vector maps	47
3.3.3	Reprojecting with GDAL/OGR tools	48

4	GRASS data models and data exchange	53
4.1	Raster data	54
4.1.1	GRASS 2D and 3D raster data models	54
4.1.2	Managing regions, raster map resolution and boundaries	56
4.1.3	Import of georeferenced raster data	58
4.1.4	Import and geocoding of a scanned historical map	66
4.1.5	Raster data export	69
4.2	Vector data	70
4.2.1	GRASS vector data model	70
4.2.2	Import of vector data	73
4.2.3	Coordinate transformation for xy CAD drawings	78
4.2.4	Export of vector data	80
5	Working with raster data	83
5.1	Viewing and managing raster maps	83
5.1.1	Displaying raster data and assigning a color table	83
5.1.2	Managing metadata of raster maps	86
5.1.3	Raster map queries and profiles	88
5.1.4	Raster map statistics	90
5.1.5	Zooming and generating subsets from raster maps	91
5.1.6	Generating simple raster maps	92
5.1.7	Reclassification and rescaling of raster maps	94
5.1.8	Recoding of raster map types and value replacements	97
5.1.9	Assigning category labels	99
5.1.10	Masking and handling of no-data values	103
5.2	Raster map algebra	105
5.2.1	Integer and floating point data	107
5.2.2	Basic calculations	108
5.2.3	Working with “if” conditions	109
5.2.4	Handling of NULL values in <code>r.mapcalc</code>	110
5.2.5	Creating a MASK with <code>r.mapcalc</code>	111
5.2.6	Special graph operators	112
5.2.7	Neighborhood operations with relative coordinates	113
5.3	Raster data transformation and interpolation	115
5.3.1	Automated vectorization of discrete raster data	115
5.3.2	Generating isolines representing continuous fields	118
5.3.3	Resampling and interpolation of raster data	119
5.3.4	Overlaying and merging raster maps	124
5.4	Spatial analysis with raster data	126
5.4.1	Neighborhood analysis and cross-category statistics	126
5.4.2	Buffering of raster features	133
5.4.3	Cost surfaces	135
5.4.4	Terrain and watershed analysis	140
5.4.5	Landscape structure analysis	153

5.5	Landscape process modeling	155
5.5.1	Hydrologic and groundwater modeling	155
5.5.2	Erosion and deposition modeling	158
5.5.3	Final note on raster-based modeling and analysis	166
5.6	Working with voxel data	166
6	Working with vector data.....	169
6.1	Map viewing and metadata management	169
6.1.1	Displaying vector maps	169
6.1.2	Vector map metadata maintenance	172
6.2	Vector map attribute management and SQL support	173
6.2.1	SQL support in GRASS 6	174
6.2.2	Sample SQL queries and attribute modifications.....	181
6.2.3	Map reclassification.....	185
6.2.4	Vector map with multiple attribute tables: layers	186
6.3	Digitizing vector data	187
6.3.1	General principles for digitizing topological data.....	187
6.3.2	Interactive digitizing in GRASS	189
6.4	Vector map queries and statistics	192
6.4.1	Map queries	192
6.4.2	Raster map statistics based on vector objects	194
6.4.3	Point vector map statistics	196
6.5	Geometry operations.....	196
6.5.1	Topological operations	197
6.5.2	Buffering	203
6.5.3	Feature extraction and boundary dissolving.....	204
6.5.4	Patching vector maps	205
6.5.5	Intersecting and clipping vector maps	206
6.5.6	Transforming vector geometry and creating 3D vectors ..	209
6.5.7	Convex hull and triangulation from points	211
6.5.8	Find multiple points in same location	212
6.5.9	Length of common polygon boundaries	214
6.6	Vector network analysis	216
6.6.1	Network analysis	216
6.6.2	Linear reference system (LRS)	221
6.7	Vector data transformations to raster	227
6.8	Spatial interpolation and approximation	230
6.8.1	Selecting an interpolation method	230
6.8.2	Interpolation and approximation with RST	235
6.8.3	Tuning the RST parameters: tension and smoothing ...	237
6.8.4	Estimating RST accuracy	241
6.8.5	Segmented processing	244
6.8.6	Topographic analysis with RST	247
6.9	Working with lidar point cloud data	249

6.10	Volume based interpolation	257
6.10.1	Adding third variable: precipitation with elevation	258
6.10.2	Volume and volume-temporal interpolation	261
6.10.3	Geostatistics and splines	262
7	Graphical output and visualization	263
7.1	Two-dimensional display and animation	263
7.1.1	Advanced map display in the GRASS monitor	263
7.1.2	Creating a 2D shaded elevation map	266
7.1.3	Using display tools for analysis	267
7.1.4	Monitor output to PNG or PostScript files	269
7.2	Creating hardcopy maps with ps.map	271
7.3	Visualization in 3D space with NVIZ	273
7.3.1	Viewing surfaces, raster and vector maps	273
7.3.2	Querying data and analyzing multiple surfaces	279
7.3.3	Creating animations in 3D space	280
7.3.4	Visualizing volumes	283
7.4	Coupling with an external OpenGL viewer Paraview	284
8	Image processing	287
8.1	Remote sensing basics	287
8.1.1	Spectrum and remote sensing	287
8.1.2	Import of image channels	291
8.1.3	Managing channels and colors	292
8.1.4	The feature space and image groups	295
8.2	Data preprocessing	297
8.2.1	Radiometric preprocessing	297
8.2.2	Deriving a surface temperature map from thermal channel	300
8.3	Radiometric transformations and image enhancements	303
8.3.1	Image ratios	303
8.3.2	Principal Component Transformation	305
8.4	Geometric feature analysis with matrix filters	307
8.5	Image fusion	310
8.5.1	Introduction to RGB and IHS color model	310
8.5.2	Image fusion with the IHS transformation	311
8.5.3	Image fusion with Brovey transform	313
8.6	Thematic classification of satellite data	314
8.6.1	Unsupervised radiometric classification	316
8.6.2	Supervised radiometric classification	319
8.6.3	Supervised SMAP classification	322
8.7	Multitemporal analysis	323
8.8	Segmentation and pattern recognition	326

9	Notes on GRASS programming	331
9.1	GRASS programming environment	331
9.1.1	GRASS source code	332
9.1.2	Methods of GRASS programming	333
9.1.3	Level of integration	334
9.2	Script programming	335
9.3	Automated usage of GRASS	338
9.3.1	Local mode: GRASS as GIS data processor	338
9.3.2	Web based: PyWPS – Python Web Processing Service	340
9.4	Notes on programming GRASS modules in C	341
10	Using GRASS with other Open Source tools	347
10.1	Geostatistics with GRASS and gstat	348
10.2	Spatial data analysis with GRASS and R	353
10.2.1	Reading GRASS data into R	355
10.2.2	Kriging in R	358
10.2.3	Using R in batch mode	363
10.3	GPS data handling	364
10.4	WebGIS applications with UMN/MapServer and OpenLayers	365
A	Appendix	367
A.1	Selected equations used in GRASS modules	367
A.2	Landscape process modeling	381
A.3	Definition of SQLite-ODBC connection	383
	References	385
	Index	393



<http://www.springer.com/978-0-387-35767-6>

Open Source GIS

A GRASS GIS Approach

Neteler, M.; Mitasova, H.

2008, XX, 406 p., Hardcover

ISBN: 978-0-387-35767-6