

Contents

Foreword	13
About this Book	15
I Introduction to Geospatial Technology	17
1 Spatial Data Models	19
1.1 Introduction	19
1.2 Objective: Explore and Understand Geospatial Data Models	19
1.3 Task 1 - Working with the Browser panel	20
1.4 Task 2 - Become Familiar with Geospatial Data Models	22
1.5 Task 3 - Working with the Data Source Manager	25
1.6 Conclusion	30
1.7 Discussion Questions	31
2 Displaying Geospatial Data	33
2.1 Introduction	33
2.2 Objective: Create a Map that Meets the Customer's Requirements	33
2.3 Task 1 - Add Data, Organize Map Layers and Set Coordinate Reference System	34
2.4 Task 2 - Style Data Layers	39
2.5 Task 3 - Compose Map Deliverable	47
2.6 Conclusion	54
2.7 Discussion Questions	55
2.8 Challenge Assignment	55
3 Creating Geospatial Data	57
3.1 Introduction	57
3.2 Objective: Digitize Information from a Scanned Hard Copy Source	57
3.3 Task 1 - Create a New Shapefile	58
3.4 Task 2 - Georeferencing an Image	59
3.5 Task 3 - Digitizing From Georeferenced Data	66
3.6 Task 4 - Editing Existing Geospatial Data	70
3.7 Conclusion	71
3.8 Discussion Questions	72
3.9 Challenge Assignment	72
4 Understanding Remote Sensing and Analysis	73
4.1 Introduction	73
4.2 Objective: Learn the Basics of using QGIS for Image Analysis	73
4.3 Task 1 - Display and Inspection of Image Data	73
4.4 Task 2 - Performing an Unsupervised Classification	78
4.5 Conclusion	80
4.6 Challenge Assignment	80

5	Basic Geospatial Analysis Techniques	83
5.1	Introduction	83
5.2	Objective: Use Basic Spatial Analysis Techniques to Solve a Problem	83
5.3	Task 1 - Data Preparation	84
5.4	Task 1.1 - Obtain Shapefiles of NGS Monuments	84
5.5	Task 1.2 - Obtain the Municipal Boundaries	84
5.6	Task 1.3 - Obtain the Census Tract Boundaries	85
5.7	Task 1.4 - Obtain Road Data	85
5.8	Task 2 - Querying and Extracting Subsets of Data	85
5.9	Task 2.1 - Working with coordinate reference systems	85
5.10	Task 2.2 - Dissolving Tract Boundaries into a County boundary	88
5.11	Task 2.3 - Select Monuments	89
5.12	Task 3 - Buffering and Clipping Data	91
5.13	Task 4 - Preparing a Map	97
5.14	Conclusion	98
5.15	Discussion Questions	98
5.16	Challenge Assignment	98
II	Spatial Analysis	101
1	Explore Data Models, Structures, Attributes and GeoDatabases	103
1.1	Introduction	103
1.2	Objective: Use Basic Spatial Analysis Techniques to Solve a Problem	103
1.3	Task 1 - GIS Data – Vector	104
1.4	Task 2 - GIS Data - Raster	105
1.5	Task 3 - Introduction to Geodatabases (Spatialite)	106
1.6	Task 4 - Exploring Coordinate Systems	108
1.7	Task 5 - GIS Data Attributes and Attribute Tables	110
1.8	Conclusion	111
1.9	Discussion Questions	111
2	Introduction to Table Joins and Classification	113
2.1	Introduction	113
2.2	Objective: Explore and Understand Geospatial Data Models	113
2.3	Task 1 - Data Exploration and Attribute Joins	113
2.4	Task 2 - Data Classification	117
2.5	Conclusion	120
2.6	Discussion Questions	121
2.7	Challenge Assignment	121
3	Working with Attributes and Spatial Queries	123
3.1	Introduction	123
3.2	Objective: Understanding Attribute Queries and Spatial Queries	123
3.3	Task 1 - Selecting Records	123
3.4	Task 2 - Calculating Values	126
3.5	Task 3 - Using Variables in Field Calculations	129
3.6	Task 4 - Calculating Values Challenge	130
3.7	Task 5 - Getting Statistics	131
3.8	Task 5.1 - Creating Statistical Summaries	131
3.9	Task 5.2 - Generating Histograms	132
3.10	Task 6 - Conditional Formatting of Attribute Tables	133
3.11	Task 7 - Buffering and Spatial Queries	133
3.12	Conclusion	136
3.13	Discussion Questions	137

3.14	Challenge Assignment	137
4	Vector Data Analysis - Overlay Techniques	139
4.1	Introduction	139
4.2	Objective Understanding Basic Vector Analysis Using Overlays	139
4.3	Task 1 - Clip	139
4.4	Task 2 - Intersection	141
4.5	Task 3 - Union	144
4.6	Task 4 - Intersection # 2	147
4.7	Conclusion	149
4.8	Discussion Questions	149
4.9	Challenge Assignment	149
5	Vector Data Analysis - Creating a Site Selection Model	151
5.1	Introduction	151
5.2	Objective: Understanding Site Selection Analysis Using the Graphical Modeler	151
5.3	Task 1 - Exploring the Data	151
5.4	Task 2 - Creating the Model - Part 1	153
5.5	Task 3 - Creating the Model - Part 2	158
5.6	Task 4 - Creating the Model - Part 3	164
5.7	Conclusion	167
5.8	Discussion Questions	168
5.9	Challenge Assignment	168
6	Vector Data Analysis - Network Analysis	169
6.1	Introduction	169
6.2	Objective: Learn the Basics of Network Analysis	169
6.3	Task 1 - Basic Network Analysis	169
6.4	Task 2 - Allocating Service Areas	172
6.5	Conclusion	175
6.6	Discussion Questions	175
6.7	Challenge Assignment	176
7	Raster Data Analysis - Working with Topographic Data	177
7.1	Introduction	177
7.2	Objective: Learn the Basics of Terrain Analysis	177
7.3	Task 1 - Terrain Analysis	177
7.4	Task 1.1 - Creating a Color Hillshade Image	177
7.5	Task 1.2 - Calculating Slope and Aspect	182
7.6	Task 2 - Reclassification	183
7.7	Task 3 - Using the Raster Calculator	185
7.8	Conclusion	187
7.9	Discussion Questions	187
7.10	Challenge Assignment	188
8	Raster Data Analysis - Density Surfaces	189
8.1	Introduction	189
8.2	Objective: Learn Density Analysis Methods	189
8.3	Task 1 - Rendering Points as Heatmaps	189
8.4	Task 2 - Creating Point Density Rasters	190
8.5	Task 3 - Raster to Vector Conversion	192
8.6	Task 4 - Vector to Raster Conversion	198
8.7	Conclusion	199
8.8	Discussion Questions	200
8.9	Challenge Assignment - A	200

8.10 Challenge Assignment - B	200
III Data Acquisition and Management	203
1 Exploring Geospatial Data Models and File Formats	205
1.1 Introduction	205
1.2 Objective: Explore and Understand Geospatial Data Models and File Formats	205
1.3 Task 1 - GIS Data Models	205
1.4 Task 2 - GIS Data File Formats	206
1.5 Conclusion	208
1.6 Discussion Questions	208
1.7 Challenge Assignment	208
2 Setting Up a Project Database	211
2.1 Introduction	211
2.2 Objective: Learn How to Normalize Data and Import it into a PostGIS Database	211
2.3 Task 1 - Investigate and Normalize Project Data	211
2.4 Task 2 - Create a New PostGIS Database	215
2.5 Task 3 - Populate the New PostGIS Database	217
2.6 Conclusion	222
2.7 Discussion Questions	222
3 Vector Data Quality	225
3.1 Introduction	225
3.2 Objective: Learn To Verify the Quality of Vector Data with Topology Rules	225
3.3 Task 1 - Topology Rules - Part 1	225
3.4 Task 2 - Topology Rules - Part 2	228
3.5 Task 3 - Fixing Topology Errors	228
3.6 Conclusion	232
3.7 Discussion Questions	232
3.8 Challenge Assignment	233
4 Spatial Data Quality	235
4.1 Introduction	235
4.2 Objective: Learn to Assess Data Quality, Work with Metadata and Aggregate Data	235
4.3 Task 1 - Exploring Data Accuracy by Mapping Delimited Text Coordinates	235
4.4 Task 2 - Metadata	237
4.5 Task 3 - Data Aggregation - Dissolving Features	239
4.6 Conclusion	241
4.7 Discussion Questions	241
4.8 Challenge Assignment	241
5 Raster Data Structure	243
5.1 Introduction	243
5.2 Objective: Work with the Raster Data Model	243
5.3 Task 1 - Merging and Clipping Raster Data	243
5.4 Task 2 - Raster Pyramids	247
5.5 Conclusion	248
5.6 Discussion Questions	248
5.7 Challenge Assignment	248
6 Geocoding Address Data	251
6.1 Introduction	251
6.2 Objective: Learn to Map Address Data via Geocoding	251
6.3 Task 1 - Geocoding	251

6.4	Task 2 - Building a Map	256
6.5	Conclusion	256
6.6	Discussion Questions	256
6.7	Challenge Assignment	256

IV Cartographic Design 259

1	Map Composition	261
1.1	Introduction	261
1.2	Objective: Learn about inverted polygon shapeburst fills and map composition	261
1.3	Task 1 - Inverted Polygon Shapeburst Fills	261
1.4	Task 2 - Composing a Map and Configuring Map Elements	264
1.5	Task 2.1 - Setting Up the Map Title	266
1.6	Task 2.2 - Setting Up the Legend	267
1.7	Task 2.3 - Descriptive Text	268
1.8	Task 2.4 - Using Variables for Adding Your Name as Author	268
1.9	Task 2.5 - Adding a North Arrow	270
1.10	Task 2.6 - Inserting a Scale Bar	271
1.11	Task 2.7 - Creating a Coordinate Grid (graticule)	272
1.12	Task 2.8 - Finishing and Exporting the Map	273
1.13	Task 3 - Creating Inset Maps	274
1.14	Conclusion	276
2	Creating an Atlas	279
2.1	Introduction	279
2.2	Objective: Create a Map Atlas	279
2.3	Task 1 - Setting Up an Atlas	279
2.4	Task 2 - Creating Dynamic Map Elements	281
2.5	Task 3 - Highlighting the Coverage Feature	282
2.6	Task 4 - Previewing and Exporting the Atlas	283
2.7	Conclusion	285
3	Exploring Coordinate Systems and Map Projections	287
3.1	Introduction	287
3.2	Objective: Explore and Understand Map Projections and Coordinate Systems	287
3.3	Task 1 - Setting Map Projections and Coordinate Systems in QGIS	288
3.4	Task 2 - Exploring World Map Projections	292
3.5	Task 3 - Exploring National Map Projections & Defining a Custom CRS	293
3.6	Task 4 - Exploring State Map Projections & Layer Reprojection	300
3.7	Task 5 - Exploring the Universal Transverse Mercator (UTM) Coordinate System	303
3.8	Conclusion	304
3.9	Discussion Questions	305
3.10	Challenge Assignment	305
4	Working with Labels	307
4.1	Introduction	307
4.2	Objective: Learn techniques for labeling features including placement and rendering	307
4.3	Task 1 - Automatic Label Placement	307
4.4	Task 2 - Labeling Expressions	310
4.5	Task 3 - Manually Placing Labels	311
4.6	Task 4 - Working with Labels in a Print Layout	313
4.7	Conclusion	314
4.8	Discussion Questions	314

5	Creating a Colorful U.S. State Map with Expression-based Symbols	317
5.1	Introduction	317
5.2	Objective: Design and construct a colorful map of the USA.	318
5.3	Task 1 - Implementing Topological Coloring	318
5.4	Task 2 - Implementing Shapeburst Fills	319
5.5	Task 3 - Creating a Random Dot Boundary Using a Marker Line and a Data Defined Override	321
5.6	Task 4 - Finishing Touches	322
5.7	Challenge Assignment	323
5.8	Conclusion	323
V	Advanced Data Visualization	325
1	Using Live Layer Effects	327
1.1	Introduction	327
1.2	Objective: Learn About Special Effects Available via Live Layer Effects	327
1.3	Task 1 - Exploring Live Layer Effects	327
1.4	Task 2 - Lifting Features Off of a Busy Background	330
1.5	Task 3 - Neon Cartography	330
1.6	Task 4 - Bathymetry	332
1.7	Conclusion	332
2	Creating Effects with Blending Modes	335
2.1	Introduction	335
2.2	Objective: Learn Use Cases for Blending Modes	335
2.3	Task 1 - Opacity Versus Blending Modes	335
2.4	Task 2 - Feature Blending Mode	337
2.5	Task 3 - Dodge Blending Mode	338
2.6	Conclusion	339
2.7	Discussion Questions	340
3	The Power of Geometry Generators	341
3.1	Introduction	341
3.2	Objective: Learn About Working with Geometry Generators	341
3.3	Task 1 - Rendering Polygons as Centroids	342
3.4	Task 2 - Creating Interior Buffers	344
3.5	Task 3 - Creating Label Callouts	345
3.6	Conclusion	349
3.7	Discussion Questions	349
4	Mapping Photopoints	351
4.1	Introduction	351
4.2	Objective: Learn Tools for Mapping and Visualizing Photopoints	351
4.3	Task 1 - Importing Geotagged Photos	351
4.4	Task 2 - Using Widgets and Identify Features	353
4.5	Task 3 - Creating Wedge Buffers and Using a Raster Image Marker	354
4.6	Task 4 - Geometry Generator Challenge	357
4.7	Conclusion	358
5	Rendering Points	359
5.1	Introduction	359
5.2	Objective: Learn techniques for rendering points	359
5.3	Task 1 - Using the Point Cluster Renderer	359
5.4	Task 2 - Using the Point Displacement Renderer	361
5.5	Task 3 - Generating Heatmaps	363

5.6	Conclusion	364
6	Animating Temporal Data with Time Manager	365
6.1	Introduction	365
6.2	Objective: Learn How to Animate Temporal Data with the Time Manager Plugin	365
6.3	Task 1 - Setting up the Data	365
6.4	Task 2 - Animating Tropical Cyclones	366
6.5	Conclusion	369
6.6	Challenge Assignment	369
7	Working with 3D Views	371
7.1	Introduction	371
7.2	Objective: Learn About Working with Native QGIS 3D Views	371
7.3	Task 1 - Working with the 2.5D Renderer	371
7.4	Task 2 - Setting Up a 3D View	372
7.5	Task 3 - Adding a 3D View to a Print Layout	374
7.6	Task 4 - Creating an Animation	376
7.7	Task 5 - Working with 3D Vector Data	377
7.8	Conclusion	379
7.9	Challenge Assignment	380
8	Working with Mesh Data	381
8.1	Introduction	381
8.2	Objective: Learn How to Work With Mesh Data in QGIS	382
8.3	Task 1 - Loading Mesh Data	382
8.4	Task 2 - Symbolizing Mesh Data	382
8.5	Task 3 - Using Crayfish to Plot Mesh Data	384
8.6	Task 4 - Animating Mesh Data	386
8.7	Conclusion	388
8.8	Challenge Assignment	389
	Conclusion	391
	Appendix	393
	A. Keyboard Shortcuts	393
	B. Popular Plugins	395
	C. Getting Involved	399
	Index	401