

CONTENTS

Preface	xiii
Biography	xv
1 A Survey of GIS for Disaster Management	1
Chapter Objectives	1
Introduction	1
GIS and Geographical Context	2
GIS and Situation Awareness	5
The Problem: Continued Need for GIS in Disaster Management	9
Scale, Scope, and Intensity of Disasters	9
Case Study: Burkina Faso—Disasters in the Developing World	10
The Need for Improved Coordination, Sharing, and Interoperability	14
Problems of GIS Awareness in Disaster Management	16
The Opportunity: Increased Awareness and Advocacy of GIS and Mapping	17
Crisis Mapping	18
Interview with Dr. Jennifer Ziemke, Cofounder and Codirector of the International Network of Crisis Mappers	20
Spatial Thinking and Disaster Management	23
Chapter Summary	24
Discussion Questions	25
References	25
2 Fundamentals of Geographic Information and Maps	29
Chapter Objectives	29
Introduction	29
Data vs. Information	30
Scale	30
Three Ways of Representing Map Scale	31
Large- vs. Small-Scale Maps	32
Why Scale Matters: Detail and Accuracy	33
Map Projections	35
Coordinate Systems	39
Universal Transverse Mercator Coordinate System	39
State Plane Coordinate (SPC) System	43
Datums	43
Reference Ellipsoids	43
Control Points	45
The Importance of Datums	46
Coordinate Systems: The Whole Picture	47

CONTENTS

Basic Principles of Cartography	47
Mapping Principles	48
Data Measurement	48
Visual Variables	50
Figure and Ground Relationships	51
Map Types: Reference and Thematic	52
Reference Maps	52
Thematic Maps	55
Summary	58
Designing Usable Maps in a GIS Context	59
Common Examples of Poorly Made Maps Created with a GIS	61
Interview with Dr. Anthony C. Robinson	64
Chapter Summary	69
Discussion Questions	70
Resources	70
Principles of Mapping	70
Geodesy (including Datums and Reference Ellipsoids)	70
History of Cartography	70
Basics of Statistical Data Classification for Maps	70
Designing Good Maps in a GIS Context	70
Map Color	71
References	71
3 Geographic Information Systems	73
Chapter Objectives	73
Introduction	73
What Is GIS?	74
Organizing the World Geographically: Map Layers	77
What Can You Do (and Not Do) with GIS Software?	78
Data and Spatial Asset Management	78
Analysis	83
GIS Programming	83
Modeling	84
Cartography, Visualization, and Map Production	87
Geocoding	88
Limitations of GIS	88
Understanding GIS Data Models	89
Vector Models	89
Raster	92
GIS Metadata	95
Specific GIS Technology	96
GIS Technology Platforms and Disaster Management	97
ArcGIS	97
Google Maps and Other Google Geospatial Technology	100

QGIS	101
Other Commercial, Free, and Open-Source or Openly Available GIS Technologies	102
OpenStreetMap	102
Other GIS Technologies	102
Free and Open-Source Datasets Relevant to Disaster Management	103
How to Choose the Right GIS Technology for Disaster Management	105
Getting Started with GIS Technology and GIS Technology Configuration Ideas	105
Chapter Summary	107
Discussion Questions	108
Resources Notes	109
References	110
4 Disaster Management and Geographic Information Systems	111
Chapter Objectives	111
Introduction	111
Disaster Management Cycle	112
Terms: Emergency, Disaster, Crisis, and Catastrophe	112
Disaster Management Cycle	113
Role of GIS within Disaster Management Policy and Practice	114
Policy in the United States: The National Incident Management System (NIMS)	115
Incident Command System (ICS)	116
United States Department of Homeland Security (DHS) Geospatial Concept of Operations (GeoCONOPS)	118
United States National Spatial Data Infrastructure	118
Local Government: Cities, Towns, and Counties	120
County GIS: Interview with Scott McCarty	120
State	123
National	124
FEMA	124
GIS and Other US Federal Agencies	124
Non-US Federal-Level Disaster Management: Interview with Dr. Michael Judex	126
Private Sector	129
Private-Sector Perspective: Interview with Alan Leidner	129
International Disaster Management Community and GIS	132
Nongovernmental Organizations	132
MapAction	132
Humanitarian OpenStreetMap Team (HOT)	133
Crisis Mappers	133
GISCorps	134
International Disaster Management Support Mechanisms	134
International Charter on Space and Major Disasters	134
Global Disaster Alert and Coordination System (GDACS)	135
World Bank GFDRR	135

CONTENTS

United Nations	136
Office for the Coordination of Humanitarian Affairs: ReliefWeb	136
UN-SPIDER	136
UN-SPIDER Perspectives: Interview with Antje Hecheltjen	137
GIS, Disaster Management, and the United Nations: Interview with Dr. Jörg Szarzynski	139
Chapter Summary	144
Discussion Questions and Activities	145
Resources Notes	146
References	147
5 Geographic Information Systems and Disaster Planning and Preparedness	151
Chapter Objectives	151
Introduction	151
Technology and Dataset Planning and Preparation	153
Essential Disaster Management Map Layers	153
Additional Sources of Ideas for Essential Disaster Management Map Layers	153
Department of Homeland Security Geospatial Data Model	161
Technology Planning and Preparation	161
Organizational Perspectives	161
Using GIS to Support Planning and Preparation Activities	163
Spatial Perspectives on Broader Planning and Preparation Activities	163
Common GIS Tasks for Disaster Planning and Preparation Activities	164
Evacuation Route Planning	164
Evacuation Zone Planning	166
Scenario Modeling to Answer What-If Questions	170
Public Outreach and Citizen Participation	171
GIS and Disaster Management Planning: A United Nations Perspective	175
Interview with Lóránt Czárán	175
Summary	182
Discussion Questions and Activities	183
Resources Notes	184
References	184
6 Geographic Information Systems and Disaster Response	187
Chapter Objectives	187
Introduction	187
Disaster Response Policy in the United States	189
Geographical Aspects of Situation Awareness	192
Maps and Emergency Operation Centers	193
GIS and Disaster Warnings	194
Spatial Data Deluge	194
Thematic Maps	195
Spatial Statistics	195

Hot Spot Mapping	195
Density Mapping	199
Real-Time GIS	200
Disaster Response GIS Products	201
Online Disaster Response Geographic Data Streams	203
GIS and Damage Assessment	203
Field Data Collection and Mobile GIS	204
Public and Disaster Response Mapping—Crisis Mapping and Citizen Reporting	208
Chapter Summary	208
Discussion Questions and Activities	210
Resources Notes	211
References	211
7 Geographic Information Systems and Disaster Recovery	213
Chapter Objectives	213
Introduction	213
Geographical Aspects of Disaster Recovery	214
Using GIS to Support Disaster Recovery Tasks	215
Geocollaboration	215
Restoring Critical Infrastructure	218
Debris Cleanup	220
Recovery Planning	221
Transition from Recovery to Mitigation	223
Interview with David Alexander: US Federal Government Geospatial Technology Leader and Expert	225
Chapter Summary	230
Discussion Questions and Activities	230
Resources Notes	231
References	231
8 Geographic Information Systems and Disaster Mitigation	233
Chapter Objectives	233
Introduction	233
Vulnerability	234
Resilience	235
Disaster Mitigation Policy and International Perspectives on GIS	236
The United States National Mitigation Framework	236
International Perspectives on Disaster Mitigation: UNISDR	237
GIS Techniques for Disaster Mitigation	237
Spatial Indexing and Modeling of Risk and Vulnerability	238
Social Variables	238
Physical Variables	239
Using GIS to Develop Spatial Indexes of Vulnerability and Risk	240

Chapter Summary	244
Discussion Questions and Activities	247
Resources Notes	248
References	249
9 Special Topics: The Future of GIS for Disaster Management, Developing a GIS for Disaster Management Career, and Keeping Up with Current Trends	251
Chapter Objectives	251
Introduction	251
Special Topics	252
Visual Analytics	252
Big Data and Disaster Management	253
Serious Games for GIS and Disaster Management	254
Geographic Information Science and Disaster Management	256
The Future of GIS for Disaster Management	256
Interviews	256
Jen Zimeke, PhD, Crisis Mappers (Chapter 1, Specialty: Crisis Mapping)	256
Anthony Robinson, PhD, Penn State (Chapter 2, Specialty: Cartography)	260
Alan Leidner, Booz Allen Hamilton (Chapter 4, Specialty: Private-Sector GIS)	261
Antje Hecheltjen, UN-SPIDER (Chapter 4, Specialty: Remote Sensing)	265
Michael Judex, PhD, German Federal Office of Civil Protection and Disaster Assistance (Chapter 4, Specialty: Federal Government GIS (Germany))	265
Scott McCarty, Monroe County GIS (Chapter 4, Specialty: County Government GIS (United States))	266
Lóránt Czárán, United Nations Cartographic Section and Office for Outer Space Affairs (Chapter 5, Specialty: Remote Sensing International GIS Organization, United Nation)	267
David Alexander, US Federal Government (Chapter 7, Specialty: Federal Government GIS (United States))	269
Research Agenda	270
Developing a GIS for Disaster Management Career	272
Interviews	272
Alan Leidner (Chapter 4)	272
Antje Hecheltjen (Chapter 4)	273
Michael Judex, PhD (Chapter 4)	274
Scott McCarty (Chapter 4)	275
Jörg Szarzynski, PhD (Chapter 4)	275
Lóránt Czárán (Chapter 5)	276
David Alexander (Chapter 7)	278
GIS for Disaster Management Career Summary Points	278
Staying Current in the GIS for Disaster Management Field	279
Organizations	279
Conferences	279
Journals and Magazines	279

Training and Education	280
Volunteer Opportunities	280
Chapter Summary	280
Discussion Questions and Activities	281
Resources Notes	282
References	282
Index	285