



Table of Contents

1	A Survey of GIS for Disaster Management	1
1.1	Introduction	1
1.2	GIS and Geographical Context	2
1.3	GIS and Situation Awareness	4
1.3.1	GIS provides backing in 2 stages of Situation Awareness:	5
1.4	The Continued Need for GIS in Disaster Management	8
1.5	Scope, Scale, & Intensity of Disasters	11
1.6	The Need for Improved Coordination, Sharing, & Interoperability	13
1.7	Problems of GIS Awareness in Disaster Management	15
1.8	The Opportunity: Increased Awareness & Advocacy of GIS and Mapping	16
1.9	Crisis Mapping and Mappers	19
1.9.1	Crisis Mappers	21

1.10	Spatial Thinking & Disaster Management	22
1.11	Summary	22
1.12	References	23
2	Fundamentals of Geographic Information and Maps	26
2.1	Introduction	26
2.2	Data vs. Information	28
2.3	Scale	29
2.4	Three Ways of Representing Map Scale	30
2.4.1	Statement of Scale	31
2.4.2	Representative Fraction (R. F.)	31
2.4.3	Graphical or Bar Scale	31
2.5	Large VS Small-Scale Maps	32
2.6	Why Scale Matters: Details and Accuracy	33
2.7	Maps Projection	34
2.7.1	Types of Map Projection	34
2.8	Coordinate Systems	35
2.9	Universal Transverse Mercator Coordinate System	37
2.10	State Plane Coordinate (SPC) System	38
2.11	Datums	40
2.12	Reference Ellipsoids	42
2.13	Control Points	43
2.14	The Importance of Datums	44
2.15	Coordinate Systems: The Whole Picture	45
2.16	Basic Principles of Cartography	46
2.16.1	The Principles	49
2.17	Mapping Principles	49
2.17.1	Geodesics	49
2.17.2	Topography	50
2.17.3	Cartography	51
2.18	Data Measurement	51
2.19	Visual Variables	53
2.20	Figure and Ground Relationships	54
2.21	Map Types: Reference and Thematic	55
2.21.1	General Reference Maps	55
2.21.2	Thematic (Special Purpose) Maps	56
2.22	Reference Maps	57
2.22.1	Types of a Reference Map	57

2.23	Thematic Maps	57
2.24	GIS in Nutshell	59
2.25	Designing Usable Maps in a GIS Context	59
2.25.1	Map Proposal	60
2.25.2	Map Drafting	60
2.25.3	Map Compilation	61
2.26	Common Examples of Poorly Made Maps Created with a GIS	61
2.27	Resources	63
2.27.1	ArcGIS Online	63
2.27.2	Atlas of Historical County Boundaries	63
2.27.3	DIVA-GIS	63
2.27.4	Earth Explorer	63
2.27.5	GIS Cloud	63
2.27.6	GIS Internet Resources	64
2.27.7	GIS Services, University of Oregon	64
2.28	Geodesy (including datums and reference ellipsoids)	64
2.29	History of Cartography	65
2.30	Basics of Statistical Data Classification for Maps	66
2.31	Designing Good Maps in a GIS Context	66
2.32	Map color	67
2.33	References	69
3	Everything about Geographic Information Systems	70
3.1	Introduction	70
3.2	What Is GIS?	71
3.3	Organizing the World Geographically: Map Layers	73
3.4	What Can You Do (and Not Do) with GIS Software?	76
3.5	Data and Spatial Asset Management	77
3.6	Analysis	78
3.7	GIS Programming	80
3.7.1	Overview of GIS Code	81
3.7.2	Program Type	81
3.7.3	Languages Used	81
3.8	Modelling	82
3.9	Cartography, Visualization, and Map Production	84
3.9.1	Cartography	84
3.9.2	Visualization	86
3.9.3	Map Production	87

3.10	Geocoding	88
3.11	Limitations of GIS	90
3.12	Understanding GIS Data Models	92
3.12.1	Vector Data Representation	92
3.12.2	Raster Data Model	93
3.12.3	The TIN Model (Triangulated Irregular Network)	94
3.12.4	Digital Elevation Model (DEM)	95
3.13	Vector Models	97
3.14	Raster	98
3.15	GIS Metadata	99
3.16	Specific GIS Technology	101
3.17	GIS Technology Platforms and Disaster Management	102
3.18	ArcGIS	104
3.19	Google Maps and Other Google Geospatial Technology	105
3.20	QGIS	106
3.21	Other Commercial, Free, and Open-Source or Openly Available GIS Technologies	107
3.21.1	Open Geospatial Consortium (OGC) Standards	108
3.22	OpenStreetMap	108
3.23	Other GIS Technologies	108
3.24	Free and Open-Source Datasets Relevant to Disaster Management	109
3.25	How to Choose the Right GIS Technology for Disaster Management	110
3.26	Getting Started with GIS Technology and GIS Technology Configuration Ideas	111
3.27	References	112

4 Disaster Management and Geographic Information System 114

4.1	Introduction	114
4.1.1	Predating Management of Disaster	115
4.1.2	Management Through Disasters	115
4.1.3	Management After Disaster	115
4.2	Geographic Information System	116
4.2.1	How does it Work?	117
4.3	Disaster Management Cycle terms: Emergency, Disaster, Crisis, and Catastrophe	117

4.4	Disaster Management Cycle	119
4.4.1	Mitigation	120
4.4.2	Preparedness	120
4.4.3	Response	121
4.4.4	Recovery	122
4.5	Role of GIS within Disaster Management	
	Policy and Practice	122
4.5.1	Essential Goals of GIS Database Formation	123
4.5.2	The GIS Database Covers the following information that is helpful in Disaster Management.	123
4.6	How GIS deals with various risks?	124
4.7	Policy in the United States: The National Incident Management System (NIMS)	124
4.7.1	National Incident Management System	124
4.7.2	NIMS and National Response Framework	126
4.7.3	NIMS Assistance with Domestic Incident Management	126
4.7.4	The part of Chosen and Designated Leaders at the time of an Emergency	126
4.7.5	Preparedness NIMS	127
4.8	The Incident Command System (ICS)	127
4.8.1	The Basic Idea of Incident Command System	128
4.9	United States Department of Homeland Security (DHS) Geospatial Concept of Operations (GeoCONOPS)	129
4.9.1	Public Authorities	131
4.9.2	People	131
4.9.3	Infrastructure	131
4.9.4	Public Support	131
4.9.5	Info Support Service Area	131
4.10	United States National Spatial Data Infrastructure	132
4.10.1	Big Data	132
4.10.2	Framework	133
4.10.3	At the time of Disaster	133
4.10.4	Partnerships	134
4.10.5	Measures	134
4.10.6	Local Government: Cities, Towns, and Counties	134
4.11	FEMA	138

4.12	GIS and Other US Federal Agencies	139
4.12.1	Another U.S. Federal Agencies	139
4.13	Private Sector	140
4.13.1	In India Private Sector Improvement	140
4.13.2	Private-Sector Perspective: Interview with Alan Leidner	141
4.14	International Disaster Management Community and GIS	142
4.15	Non-governmental Organizations	143
4.16	MapAction	143
4.17	Humanitarian OpenStreetMap Team (HOT)	145
4.18	Crisis Mappers	146
4.18.1	Methods	147
4.19	GISCorps	148
4.19.1	Vision and Purposes	149
4.19.2	GISCorps Remains Volunteerism	150
4.19.3	GISCorps is Recovery of Disaster	150
4.19.4	GISCorps is Building of Community	150
4.19.5	GISCorps is Sustainability	150
4.20	International Disaster Management Support Mechanisms	151
4.21	International Charter on Space and Major Disasters	152
4.21.1	Purpose	153
4.21.2	Requirement	153
4.21.3	Types of Disasters Recommended	153
4.21.4	Mechanism	154
4.22	Global Disaster Alert and Coordination System (GDACS)	155
4.23	World Bank GFDRR	156
4.24	United Nations	158
4.25	UN-SPIDER	159
4.25.1	Activities of UN-SPIDER	160
4.26	References	162

5 GIS in Disaster Planning and Preparedness 165

5.1	Introduction	165
5.1.1	GIS and Disaster Management Planning	167
5.1.2	GIS and Disaster Management Preparedness	168
5.2	Technology and Dataset Planning and Preparation	169

5.2.1	Technology for Disaster Planning	169
5.2.2	Dataset Planning and Preparation	174
5.3	Essential Disaster Management Map Layers	179
5.3.1	Cadastral Data	180
5.3.2	Geodetic Control	181
5.3.3	Geographical Area Boundaries	182
5.3.4	Hydrography	182
5.3.5	Transportation	183
5.4	Other Sources of Ideas for Essential Disaster Management Map Layers	183
5.4.1	Hazard Map Layer	184
5.4.2	Historical landslide Layer	185
5.5	Department of Homeland Security Geospatial Data Model	185
5.5.1	GIS Disaster Event Models	186
5.6	Technology Planning and Preparation	188
5.7	Organizational Perspectives	191
5.8	GIS is used to support Planning & Preparation Activities	193
5.9	Spatial Perspectives on Broader Planning as well as Preparation Activities	194
5.10	Common GIS Tasks for Disaster Planning and Preparation Activities	195
5.10.1	Emergency Planning	196
5.10.2	Warning Systems	197
5.10.3	Public Information	197
5.11	Evacuation Route Planning	198
5.11.1	Planning an Evacuation Route with InaSAFE	199
5.11.2	CASPER	205
5.12	Evacuation Zone Planning	207
5.12.1	Mastic/Shirley Peninsula Evacuation Study	209
5.13	Scenario Modeling to Answer What-If Questions	210
5.14	Public Outreach and Citizen Participation	212
5.15	GIS and Disaster Management Planning: A United Nations Perspective	213
5.16	References	217
6	Geographic Information System and Disaster Response	219
6.1	Introduction	219

6.2	Disaster Response Policy in the United States	220
6.2.1	The Core Responsibilities	221
6.2.2	Phases in the Development of the System	223
6.3	Geographical Aspects of Situation Awareness	224
6.3.1	Factors Influencing the Situation of Awareness	224
6.4	Maps and Emergency Operation Centers	226
6.5	GIS and Disaster Warnings	227
6.6	Spatial Data Deluge	227
6.7	Hot Spot Mapping	228
6.8	Density Mapping	229
6.9	Real-Time GIS	230
6.10	Disaster Response GIS Products	231
6.11	Online Disaster Response Geographic Data Streams	232
6.12	GIS and Damage Assessment	233
6.13	Field Data Collection and Mobile GIS	233
6.14	Public and Disaster Response Mapping: Crisis Mapping and Citizen Reporting	234
6.15	Summary	234
6.16	Reference	236

7 Geographic Information Systems and Disaster Recovery 238

7.1	Introduction	238
7.2	Geographical Aspects of Disaster Recovery	240
7.3	Using GIS to Support Disaster Recovery Tasks	243
7.3.1	Situation Understanding	243
7.3.2	First Response	245
7.3.3	Healthcare	246
7.3.4	Infrastructure and Housing	247
7.3.5	GIS in Aceh Province Today	247
7.4	Geo collaboration	248
7.5	Restoring Critical Infrastructure	250
7.6	Debris Cleanup	252
7.7	Recovery Planning	253
7.7.1	Disaster Recovery Plan	254
7.7.2	Recovery Plan Benefits	255
7.7.3	Use of GIS in Disaster Recovery Planning	256
7.8	Transition from Recovery to Mitigation	258

7.9	References	260
8	Geographic Information Systems and Disaster Mitigation	262
8.1	Mitigation - An Introduction	262
8.2	Vulnerability	265
	8.2.1 How to Prepare for it?	268
	8.2.2 Tools used to Assess Them	270
8.3	Resilience	271
8.4	Disaster Mitigation Policy & International Perspectives on GIS	274
	8.4.1 The United States National Mitigation Framework	274
	8.4.2 International Perspectives on Disaster Mitigation: UNDRR	276
8.5	GIS Techniques for Disaster Mitigation	277
8.6	Spatial Indexing and Modeling of Risk and Vulnerability	278
8.7	Social Variables	278
8.8	Physical Variables	280
8.9	Using GIS to Develop Spatial Indexes of Vulnerability and Risk	281
8.10	Summary	282
8.11	References	284
9	Special Topics	287
9.1	Introduction	287
9.2	Special Topics	290
	9.2.1 Software	290
	9.2.2 Hardware	290
	9.2.3 Data	291
	9.2.4 Users	291
	9.2.5 Methods	292
9.3	Visual Analytics	292
9.4	Big Data and Disaster Management	293
9.5	Serious Games for GIS and Disaster Management	295
9.6	Geographic Information Science and Disaster Management	297

9.7	The Future of GIS for Disaster Management	299
9.8	Research Agenda	301
9.9	Developing a GIS for Disaster Management Career	302
9.9.1	GIS is an Interdisciplinary Tool	303
9.10	GIS for Disaster Management Career Summary Points	304
9.11	Staying Current in the GIS for Disaster Management Field	306
9.12	Organization	307
9.13	Conferences	310
9.14	Journals and Magazines	312
9.15	Training and Education	314
9.15.1	Step 1: Obtain Postsecondary Training in GIS Technology	315
9.15.2	Step 2: Seek Employment	315
9.15.3	Step 3: Obtain a Professional Credential	315
9.15.4	Step 4: Pursue Continuing Education	316
9.16	Volunteer Opportunities	316
9.17	References	317
10 Abbreviations		318
Index		325