

## Table of Contents

<b>Introduction</b> . . . . .	xiii
<b>Chapter 1. From Prevention to Risk Management: Use of GIS</b> . . . . .	1
Sophie SAUVAGNARGUES-LESAGE	
1.1. Introduction . . . . .	1
1.2. GIS and public security . . . . .	3
1.3. Examples of applications for public security . . . . .	8
1.3.1. SIGASC application . . . . .	8
1.3.2. Application . . . . .	12
1.3.3. SIG CODIS application . . . . .	15
1.4. Prospects for development . . . . .	18
1.5. Conclusion . . . . .	19
1.6. Bibliography . . . . .	19
<b>Chapter 2. Coupled Use of Spatial Analysis and Fuzzy Arithmetic: Assessing the Vulnerability of a Watershed to Phytosanitary Products</b> . . . . .	23
Bertrand DE BRUYN, Catherine FREISSINET and Michel VAUCLIN	
2.1. Introduction . . . . .	23
2.2. Construction of the index . . . . .	24
2.3. Implementation of fuzzy calculations . . . . .	26
2.4. Application to the watershed of Vannetin: vulnerability to atrazine . . . . .	28
2.4.1. The research site . . . . .	28
2.4.2. Parameters of the watershed . . . . .	28
2.4.2.1. Pluviometry . . . . .	28
2.4.2.2. Anthropogenic sub-index . . . . .	29
2.4.2.3. Pedology . . . . .	29
2.4.2.4. Summary of data common to the entire watershed . . . . .	29

2.4.3. Cell parameters . . . . .	29
2.4.3.1. Geographic characteristics of the area. . . . .	29
2.4.3.2. Vegetation cover . . . . .	30
2.4.4. Fuzzy parameters . . . . .	30
2.4.5. Representation of the indicator and of its related inaccuracy . . . . .	31
2.5. Conclusion . . . . .	33
2.6. Bibliography . . . . .	36
<b>Chapter 3. Agricultural Non-Point Source Pollution . . . . .</b>	<b>39</b>
Philippe BOLO and Christophe BRACHET	
3.1. Introduction. . . . .	39
3.2. Mapping non-point source pollution phenomenon . . . . .	40
3.2.1. Mapping principles . . . . .	40
3.2.2. Description of the research phenomenon . . . . .	41
3.2.3. Mapping steps . . . . .	41
3.3. Territorial database building rules . . . . .	42
3.3.1. Choosing software programs . . . . .	43
3.3.2. Design of the implemented GIS . . . . .	44
3.3.3. Organizing and creating geographic information layers . . . . .	46
3.3.3.1. Implementation of a conceptual data model . . . . .	46
3.3.3.2. Digitization of paper-based document. . . . .	46
3.3.3.3. Digital data import . . . . .	47
3.3.3.4. Controlling the geographic data integrity. . . . .	47
3.3.4. Organizing and creating attribute tables . . . . .	47
3.3.4.1. Implementing a conceptual data model . . . . .	47
3.3.4.2. Creating a data dictionary . . . . .	47
3.3.4.3. Thematic data processing or import . . . . .	48
3.3.4.4. Controlling the attribute data integrity . . . . .	48
3.4. The data sources used. . . . .	48
3.4.1. Identifying the available information . . . . .	48
3.4.2. Soil-related data. . . . .	49
3.4.2.1. Surface texture of the soils . . . . .	50
3.4.2.2. Soil hydromorphy. . . . .	51
3.4.2.3. Soil textural differentiation . . . . .	51
3.4.3. Topography-related data. . . . .	52
3.4.3.1. The slope. . . . .	53
3.4.3.2. Slope orientation . . . . .	53
3.4.4. Land use-related data. . . . .	54
3.4.5. Land planning-related data . . . . .	56
3.4.5.1. Hedges . . . . .	56
3.4.5.2. Ditches . . . . .	56
3.4.5.3. Agricultural land drainage. . . . .	57

3.5. Pollution risk zoning . . . . .	58
3.5.1. Treatments to be performed . . . . .	58
3.5.1.1. Zoning of the potential for pollution . . . . .	58
3.5.1.2. Vulnerability zoning . . . . .	59
3.5.1.3. Risk zoning . . . . .	59
3.5.2. An example of risk zoning . . . . .	60
3.5.2.1. General presentation of the research area . . . . .	60
3.5.2.2. Knowing the risks . . . . .	60
3.5.2.3. Transfer diagnosis . . . . .	64
3.5.2.4. Risk management . . . . .	65
3.6. Risk zoning applications . . . . .	66
3.6.1. Risk knowledge applications . . . . .	67
3.6.2. Spatial planning applications . . . . .	67
3.6.3. Applications related to monitoring water quality . . . . .	68
3.7. Conclusion . . . . .	69
3.8. Bibliography . . . . .	70
<b>Chapter 4. Cartographic Index and History of Road Sites that Face Natural Hazards in the Province of Turin . . . . .</b>	<b>71</b>
Paola ALLEGRA, Laura TURCONI and Domenico TROPEANO	
4.1. Introduction . . . . .	71
4.2. Principal risks . . . . .	73
4.3. Research area . . . . .	74
4.3.1. Geological insight . . . . .	74
4.3.2. Morphology of the research areas . . . . .	75
4.4. Working method . . . . .	76
4.5. Computer-based synthetic analysis and transcription of historical data and information collected on the research area . . . . .	78
4.6. First results . . . . .	80
4.7. Structure of computer thematic mapping . . . . .	82
4.8. Application and use of the method . . . . .	84
4.9. Bibliography . . . . .	85
<b>Chapter 5. Forest and Mountain Natural Risks: From Hazard Representation to Risk Zoning – The Example of Avalanches . . . . .</b>	<b>87</b>
Frédéric BERGER and Jérôme LIÉVOIS	
5.1. Introduction . . . . .	87
5.1.1. General information on forests . . . . .	87
5.1.2. The protective role of mountain forests . . . . .	88
5.2. Identification of protective forest zones . . . . .	90
5.2.1. General principle . . . . .	90
5.2.2. Methodology . . . . .	90

5.2.3. Building up a synthesis map of natural hazards . . . . .	91
5.2.3.1. General information on the process of mapping avalanches. . .	92
5.2.3.2. General principles to build a synthesis map of natural hazards upon existing cartographic documents . . . . .	94
5.2.3.3. A method to characterize potential avalanche terrain. . . . .	95
5.2.4. Building up the forest map . . . . .	102
5.2.5. Building up the natural forest-hazard synthesis map . . . . .	102
5.2.6. Building up the map of socio-economic issues and vulnerability. .	103
5.2.7. Building up the priority areas for forestry action map . . . . .	104
5.3. Perspectives . . . . .	105
5.4. The creation of green zones in risk prevention plans . . . . .	106
5.4.1. Natural hazard prevention plans . . . . .	106
5.4.1.1. Objectives . . . . .	106
5.4.1.2. Tools . . . . .	107
5.4.1.3. A necessity. . . . .	107
5.4.2. Transfer from researchers to users . . . . .	107
5.4.3. The method used . . . . .	108
5.4.4. Consequences of these works. . . . .	111
5.4.5. Reflections and perspectives . . . . .	111
5.5. Conclusion: general recommendations. . . . .	112
5.6. Bibliography . . . . .	112
<b>Chapter 6. GIS and Modeling in Forest Fire Prevention . . . . .</b>	<b>115</b>
Marielle JAPPIOT, Raphaële BLANCHI and Franck GUARNIERI	
6.1. Understanding forest fire risks . . . . .	115
6.1.1. Risk . . . . .	116
6.1.2. Description of the phenomenon . . . . .	116
6.1.3. Particularities of fire risk . . . . .	117
6.1.3.1. Forest fire hazard . . . . .	117
6.1.3.2. Human response to the phenomenon . . . . .	121
6.1.3.3. Specific issues. . . . .	121
6.1.4. A spatio-temporal variation of forest fire risk . . . . .	122
6.2. Forest fire management: risk mapping and the use of spatial analysis .	123
6.2.1. Requirements with respect to forest fire risk assessment. . . . .	123
6.2.1.1. Chronological evolution in the field of forest fire risk mapping	123
6.2.1.2. Town planning requirements . . . . .	124
6.2.1.3. Forest management requirements . . . . .	125
6.2.1.4. Other requirements . . . . .	126
6.2.2. Forest fire risk assessment and mapping: the use of geographic information systems . . . . .	126
6.2.2.1. Towards a risk analysis approach . . . . .	127

6.2.2.2. Implementing traditional spatial analysis tools to assess forest fire risks . . . . .	132
6.2.2.3. Coupling to models. . . . .	135
6.3. Using GIS to map forest fire risks . . . . .	137
6.3.1. Forest fire risk assessment and mapping in the Massif des Maures (Department of Var): raster GIS . . . . .	138
6.3.1.1. Analytical approach: the example of fire propagation hazard . . . . .	138
6.3.1.2. Towards a global approach: characterization of interfaces with the use of remote sensing . . . . .	141
6.3.2. WILFRIED – fire fighting support (coupling GIS and model) . . . . .	143
6.3.2.1. Model systems and knowledge-based systems for the processing of knowledge . . . . .	143
6.3.2.2. WILFRIED, a PSE dedicated to forest fire prevention . . . . .	144
6.3.2.3. Partial conclusion . . . . .	147
6.4. Conclusion . . . . .	147
6.5. Bibliography . . . . .	148
<b>Chapter 7. Spatial Decision Support and Multi-Agent Systems: Application to Forest Fire Prevention and Control . . . . .</b>	<b>151</b>
Franck GUARNIERI, Alain JABER and Jean-Luc WYBO	
7.1. Introduction. . . . .	151
7.2. Natural risk prevention support and the need for cooperation between the software programs . . . . .	152
7.2.1. The cooperation issue between the information systems. . . . .	152
7.2.2. The various approaches aiming at facilitating this type of cooperation. . . . .	153
7.3. Towards an intelligent software agent model to satisfy the cooperation between the decision-support systems dedicated to natural risk prevention . . . . .	154
7.3.1. The multi-agent paradigm. . . . .	154
7.3.2. Intelligent software agents . . . . .	155
7.3.3. A proposed intelligent software agent model . . . . .	157
7.4. Experiment in the field of forest fire prevention and control. . . . .	158
7.4.1. Context of the experiment . . . . .	158
7.4.2. The experiment scenario. . . . .	160
7.4.3. First part of the scenario. . . . .	160
7.4.4. Second part of the scenario . . . . .	161
7.4.5. An example of problem solving . . . . .	165
7.4.6. Conclusion of the scenario . . . . .	166
7.5. Conclusions and perspectives . . . . .	166
7.6. Bibliography . . . . .	167

<b>Chapter 8. Flood Monitoring Systems</b> . . . . .	169
Jean-Jacques VIDAL and Noël WATRIN	
8.1. Introduction. . . . .	169
8.2. Flood monitoring and warning . . . . .	170
8.3. Situation diversity . . . . .	171
8.3.1. Spatial information for a better understanding of the phenomenon. . . . .	173
8.3.2. Spatial information for flood impact assessment . . . . .	174
8.4. Technical answers . . . . .	175
8.4.1. Hydrological observing networks . . . . .	175
8.4.2. Data processing . . . . .	176
8.4.3. The integration of acquired knowledge in the natural hazard prevention policy . . . . .	178
8.5. Conclusion . . . . .	178
8.6. Bibliography . . . . .	179
<b>Chapter 9. Geography Applied to Mapping Flood-Sensitive Areas: A Methodological Approach</b> . . . . .	181
Christophe PRUNET and Jean-Jacques VIDAL	
9.1. Introduction. . . . .	181
9.2. A geographic analysis of flooding . . . . .	182
9.2.1. Intensity . . . . .	182
9.2.2. Frequency . . . . .	182
9.2.3. Extension. . . . .	185
9.2.3.1. Extension of the flood-sensitive alluvial plain . . . . .	185
9.2.3.2. An accurate analysis of the fluvial landform development . . . . .	185
9.2.3.3. Locating water projects . . . . .	186
9.2.3.4. How does society use space? . . . . .	186
9.2.3.5. Extension of liable-to-flooding riverside areas lacking hydrological monitoring . . . . .	187
9.3. A concrete example . . . . .	188
9.4. Bibliography . . . . .	190
<b>Chapter 10. Information Systems and Diked Areas: Examples at the National, Regional and Local Levels</b> . . . . .	193
Pierre MAUREL, Rémy TOURMENT and William HALBECQ	
10.1. Context. . . . .	193
10.2. Analysis of the current situation for the management of diked areas . . . . .	195
10.3. Spatial dimension and integrated management of diked areas . . . . .	197
10.4. Examples of information systems dedicated to diked areas. . . . .	198
10.4.1. An information system at the national level for dike inventory . . . . .	199

10.4.2. An information system at the regional level to analyze dike failure risks in the Mid-Loire region . . . . .	200
10.4.3. An information system at local level for the integrated management of diked areas . . . . .	203
10.4.3.1. Functional analysis of the diked system . . . . .	203
10.4.3.2. Conceptual modeling and prototyping . . . . .	204
10.4.3.3. Examples of results . . . . .	209
10.5. Recent progress and perspectives . . . . .	212
10.6. Bibliography . . . . .	213
<b>Chapter 11. Geomatics and Urban Risk Management: Expected Advances . . . . .</b>	<b>215</b>
Jean-Pierre ASTÉ	
11.1. Towns, risks and geomatics . . . . .	215
11.1.1. An overview . . . . .	215
11.1.2. City: a much sought after security area . . . . .	216
11.1.3. Risk: a poorly understood notion . . . . .	217
11.1.4. Geomatics as a data structuring and management tool . . . . .	217
11.2. Prevention stakeholders: their responsibilities, their current resources and expectations . . . . .	218
11.2.1. Ordinary state or emergency state . . . . .	218
11.2.2. Government and institutional stakeholders . . . . .	218
11.2.3. Municipal stakeholders and the populations they represent . . . . .	219
11.2.4. Operational and technical stakeholders . . . . .	220
11.2.5. Insurance agents . . . . .	220
11.2.6. Scientific stakeholders . . . . .	221
11.2.7. Compelled to live with an identified risk . . . . .	222
11.3. Today's methods and tools: strengths and weaknesses . . . . .	223
11.3.1. Urban reference systems and the expected connection with the digitizing of cadastral maps . . . . .	223
11.3.2. Managing experience . . . . .	224
11.3.3. Knowledge and modeling of phenomena . . . . .	226
11.3.4. Monitoring phenomena . . . . .	227
11.3.5. Reducing vulnerability . . . . .	227
11.3.6. Risk assessment . . . . .	228
11.3.7. Macro and microeconomic approach . . . . .	229
11.3.8. The means of exchange of experiences, skills and knowledge . . . . .	230
11.3.9. Consultation, public information, training and culture . . . . .	230
11.4. New potentialities using geomatic methods and tools . . . . .	232
11.4.1. Geomatics . . . . .	232
11.4.2. Acquiring and structuring spatial and temporal data . . . . .	233
11.4.2.1. Data for territories . . . . .	233

11.4.2.2. Data of phenomena . . . . .	233
11.4.2.3. Data related to exposed elements . . . . .	234
11.4.3. Modeling phenomena and behaviors . . . . .	235
11.4.3.1. Modeling phenomena . . . . .	235
11.4.3.2. Vulnerability assessment . . . . .	236
11.4.3.3. Understanding social and economic behavior . . . . .	236
11.4.4. Task analysis and support to complete and control them . . . . .	237
11.4.5. Managing experience and knowledge . . . . .	238
11.4.6. Quantified and hierarchical appreciation of the risks involved . . . . .	239
11.5. Some ongoing initiatives since the beginning of 2001 . . . . .	240
11.5.1. Examples from Lyon: the information system of the service of Balmes and the GERICO project . . . . .	240
11.5.2. An Alpine concern: avalanche risk management . . . . .	242
11.5.3. Risk management and natural or man-made subterranean caverns, mines and quarries . . . . .	243
11.5.4. The RADIUS project of the international decade for natural disaster reduction (Décennie internationale pour la prevention des catastrophes naturelles (DIPCN)) . . . . .	243
11.5.5. Bogotá and its risk and crisis information system (SIRE) . . . . .	244
11.5.6. The CŒUR project in preparation between the Rhône-Alpine and Mediterranean cities . . . . .	244
11.5.7. The Base-In project of recording Grenoble's historical floods . . . . .	245
11.6. Assessment and outlook: fundamental elements of future systems . . . . .	245
11.6.1. Territory . . . . .	246
11.6.2. Phenomena . . . . .	246
11.6.3. Stakeholders . . . . .	247
11.7. Bibliography . . . . .	247
<b>List of Authors</b> . . . . .	<b>249</b>
<b>Index</b> . . . . .	<b>251</b>