

## Table of Contents

<b>Foreword</b> . . . . .	xi
<b>General Introduction</b> . . . . .	xix
<b>PART I. CARTOGRAPHY: AN EVOLVING SCIENTIFIC DISCIPLINE</b> . . . . .	1
<b>Part I. Introduction</b> . . . . .	3
<b>Chapter 1. A Brief History of Thematic Cartography</b> . . . . .	5
1.1. From cartography to thematic cartography . . . . .	5
1.1.1. The Middle Ages in the West: symbolic maps. . . . .	6
1.1.2. From the Renaissance to the 19 <sup>th</sup> century: resurgence of cartography due to discoveries and innovations. . . . .	6
1.1.3. The 20 <sup>th</sup> century: widespread acceleration. . . . .	8
1.2. Thematic cartography from its birth until the 1950s. . . . .	9
1.2.1. Towards an abstract code and adapted procedures . . . . .	10
1.2.2. The 20 <sup>th</sup> century: the birth of a scientific discipline. . . . .	11
1.3. Main trends from 1950 until after 2000 . . . . .	12
1.3.1. Remarkable facts . . . . .	12
1.3.2. From 1950 to 1975: paradigms and the technological revolution . . . . .	14
1.3.3. From 1975 to 1995: a diversified evolution . . . . .	17
1.3.4. A new paradigm for the 21 <sup>st</sup> century: geovisualization (1995-2009) . . . . .	20
1.3.5. The specific views of W. Bunge and W. Tobler. . . . .	22
1.4. Conclusion . . . . .	23

<b>Chapter 2. Cartography: A Discipline of Transformations</b> . . . . .	25
2.1. The discipline and its output. . . . .	25
2.1.1. From a map. . . . .	25
2.1.2. . . . to cartography . . . . .	33
2.2. Categories of maps and cartography . . . . .	40
2.2.1. Maps galore . . . . .	40
2.2.2. From cartography to cartographies. . . . .	45
2.3. Functions of maps and of cartography . . . . .	51
2.3.1. Four essential functions of maps . . . . .	51
2.3.2. A map as a logical series of transformations . . . . .	53
2.4. Conclusion . . . . .	62
<b>Chapter 3. The Map – a Construction Based on Scientific Reasoning.</b> . . . .	63
3.1. Terms to be defined . . . . .	63
3.1.1. Approach. . . . .	63
3.1.2. “Scientific” . . . . .	64
3.1.3. “Experimental” . . . . .	64
3.1.4. Experimental scientific approach . . . . .	65
3.2. From scientific approach to cartographic reasoning . . . . .	65
3.2.1. Heuristic thematic and cartographic phase . . . . .	66
3.2.2. The verification phase – exclusively disciplinary logic . . . . .	72
3.3. The demonstration phase dominated by cartographic logic. . . . .	73
3.3.1. From real world to a cartographic object . . . . .	73
3.3.2. At the core of the process: mapmaking (T3 and T4) . . . . .	76
3.3.3. A completely revolutionized step: the display transformation (T5) . . . . .	78
3.4. Conclusion . . . . .	81
<b>Part I. Conclusion</b> . . . . .	83
<b>PART II. DATA CONSTRUCTION: A TRANSFORMATION DEFINING THE QUALITY OF THE MAP.</b> . . . . .	85
<b>Part II. Introduction</b> . . . . .	87
<b>Chapter 4. Localized Data: the Specialty of Cartography</b> . . . . .	91
4.1. Characteristics of spatial data . . . . .	93
4.1.1. Characteristics related to the topic treated . . . . .	93
4.1.2. Scale constraints and its implications . . . . .	97
4.1.3. The choice of a projection system . . . . .	99
4.1.4. Data characteristics in numerical form . . . . .	104

4.2. The acquisition of localized data: a domain in revival. . . . .	110
4.2.1. Indirect data collection. . . . .	111
4.2.2. Direct data collection. . . . .	122
4.3. From the cartographic generalization to the change of spatial base. . . . .	129
4.3.1. A crucial transformation: generalization . . . . .	129
4.3.2. Modifications in the spatial base . . . . .	139
4.4. Conclusion . . . . .	144
<b>Chapter 5. Attributes: the Specificity of Thematic Cartography . . . . .</b>	<b>147</b>
5.1. The need to harmonize vocabulary . . . . .	147
5.1.1. From raw data to information. . . . .	147
5.1.2. Around the attributes. . . . .	149
5.2. Highly heterogenous sources . . . . .	149
5.2.1. From the existence of a source to its availability . . . . .	150
5.2.2. Data that need to be created. . . . .	151
5.3. Raw data, information and measurements. . . . .	153
5.3.1. From geographical entities to measurement . . . . .	153
5.3.2. Attributes: dimension and significance . . . . .	162
5.3.3. Attributes and characteristics . . . . .	167
5.4. Conclusion . . . . .	169
<b>Chapter 6. Locations and Attributes: Quality Criteria . . . . .</b>	<b>171</b>
6.1. Data quality: digital and visual criteria. . . . .	172
6.1.1. Characteristics of quality criteria. . . . .	173
6.1.2. Errors in digital cartography . . . . .	179
6.2. A condition of quality: metadata and their standards . . . . .	185
6.2.1. Metadata . . . . .	185
6.2.2. Objectives of standards . . . . .	185
6.2.3. The ISO 19115 standard. . . . .	186
6.3. Spatial Data Infrastructure and Digital Earth concept . . . . .	190
6.3.1. The definition of Spatial Data Infrastructures (SDI) . . . . .	190
6.3.2. Components of Spatial Data Infrastructures (SDI) . . . . .	191
6.3.3. Hierarchy of SDIs . . . . .	193
6.3.4. A regional initiative – the European SDI and the INSPIRE project . . . . .	194
6.4. Conclusions. . . . .	196
<b>Part II. Conclusion . . . . .</b>	<b>199</b>

<b>PART III. NECESSARY TRANSFORMATIONS IN THEMATIC CARTOGRAPHY . . .</b>	<b>201</b>
<b>Part III. Introduction . . . . .</b>	<b>203</b>
<b>Chapter 7. A Permanent Phase: The Semiotic Transformation . . . . .</b>	<b>205</b>
7.1. Communication and sign system . . . . .	205
7.1.1. Cartographic communication . . . . .	206
7.1.2. From a system of signs to the “language” of cartography . . . . .	211
7.2. Signs in cartography and their syntax . . . . .	219
7.2.1. A specialty of cartography: spatial dimensions . . . . .	219
7.2.2. Visual variables – minimum graphical units . . . . .	222
7.2.3. Non-visual semiotic variables . . . . .	241
7.2.4. Formation rules for signifying units . . . . .	243
7.3. From recipient to transmitter: perception, reading and rules of construction . . . . .	251
7.3.1. Recipient and his/her physiological and psychological characteristics . . . . .	251
7.3.2. From recipient to emitter: reading and using a map. . . . .	258
7.3.3. Rules of cartographic construction for the transmitter . . . . .	263
7.3.4. The map and the problems of its validation . . . . .	273
7.4. Conclusion . . . . .	278
<b>Chapter 8. Cartographic Transformations: the Representation Modes . . . . .</b>	<b>279</b>
8.1. Point-based representation modes. . . . .	284
8.1.1. Point-based representations with nominal data . . . . .	285
8.1.2. Point-based representations with binary data (distribution maps) . . . . .	287
8.1.3. Point-based representations with ordinal data . . . . .	289
8.1.4. Point-based representations with quantitative data . . . . .	290
8.2. Linear representation modes. . . . .	301
8.2.1. Variation criteria for linear representations. . . . .	301
8.2.2. Linear representations associated with linear meaning . . . . .	304
8.2.3. Linear representations with areal meaning . . . . .	309
8.2.4. Linear representations with volumetric meaning . . . . .	315
8.3. Areal representation modes . . . . .	324
8.3.1. Discrete areal representations. . . . .	325
8.3.2. Continuous areal representations. . . . .	347
8.3.3. Areal maps and multiple membership. . . . .	366
8.4. Conclusion . . . . .	367
<b>Chapter 9. Cartographic Design . . . . .</b>	<b>371</b>
9.1. Map elements: a guided inventory . . . . .	372
9.1.1. A ubiquitous component: lettering. . . . .	372

9.1.2. Mapping area: a component related to the objective of the map . . .	378
9.1.3. Components which depend on the recipient: title and legend . . . .	381
9.1.4. Ubiquitous information associated with the container . . . . .	382
9.1.5. Additional informative text . . . . .	384
9.2. A fundamental component: the legend . . . . .	384
9.2.1. Basic elements . . . . .	385
9.2.2. General legends . . . . .	386
9.2.3. Presentations to be adapted . . . . .	389
9.3. General layout and thematic meaning . . . . .	394
9.3.1. Organizing factors . . . . .	394
9.3.2. Governing principles . . . . .	395
9.3.3. Crucial qualities . . . . .	396
9.4. Conclusion . . . . .	396
<b>Part III. Conclusion . . . . .</b>	<b>397</b>
<b>General Conclusion . . . . .</b>	<b>399</b>
<b>Bibliography . . . . .</b>	<b>403</b>
<b>Software Used. . . . .</b>	<b>451</b>
<b>List of Authors . . . . .</b>	<b>453</b>
<b>Index . . . . .</b>	<b>455</b>
<b>Summary of Other Volumes in the Series . . . . .</b>	<b>465</b>