

## Table of Contents

<b>Preface</b> . . . . .	xiii
<b>Introduction</b> . . . . .	xv
<b>Chapter 1. Modeling Concepts Used in Spatial Analysis</b> . . . . .	1
François DURAND-DASTÈS	
1.1. Introduction. . . . .	1
1.2. Modeling universals. . . . .	2
1.2.1. Logical frames for modeling . . . . .	2
1.2.2. The language of models . . . . .	6
1.2.2.1. Material or physical model languages. . . . .	6
1.2.2.2. The language of images: iconic models. . . . .	7
1.2.2.3. Modeling in mathematical language. . . . .	9
1.3. A few specific features of spatial models . . . . .	11
1.4. Spatial models: a study grid . . . . .	16
1.4.1. Sequencing and explanation . . . . .	16
1.4.2. The group and the individual . . . . .	18
1.4.3. The random and the determined . . . . .	20
1.4.4. Movement and balance . . . . .	21
1.5. Conclusion . . . . .	25
1.6. Bibliography . . . . .	26
<b>Chapter 2. Geographical Scales and Multidimensional Statistical Methods</b> . . . . .	29
Hélène MATHIAN and Marie PIRON	
2.1. Introduction. . . . .	29
2.2. Scaling issues. . . . .	31

2.2.1. The consideration of different geographical levels: two possible approaches . . . . .	31
2.2.2. Formalization of relations between two levels . . . . .	33
2.2.2.1. Nested relations and partition graph . . . . .	33
2.2.2.2. Neighborhood relations and proximity graphs . . . . .	35
2.2.3. Processing of multilevel information . . . . .	37
2.2.3.1. Multilevel structure and attributes . . . . .	37
2.2.3.2. Multidimensional statistical methods . . . . .	39
2.3. Change of levels, change of structures . . . . .	40
2.3.1. Scale and variability . . . . .	41
2.3.2. Exploratory analysis of the scale system . . . . .	41
2.3.2.1. Analysis of aggregated levels or interclass analysis . . . . .	43
2.3.2.2. Transition analysis between two levels or intraclass analysis . . . . .	45
2.3.3. Application of outlying Ouagadougou space to the social and spatial organization . . . . .	46
2.4. Integration of the different levels . . . . .	51
2.4.1. The scale: a set of territorial and spatial references . . . . .	51
2.4.2. The analysis of local differences . . . . .	55
2.4.3. Other local analysis methods . . . . .	58
2.5. Multilevel models . . . . .	59
2.5.1. Contextual effects and regression models . . . . .	60
2.5.2. Multilevel modeling . . . . .	65
2.6. Conclusion . . . . .	68
2.7. Bibliography . . . . .	69
<b>Chapter 3. Location of Public Services: From Theory to Application . . . . .</b>	<b>73</b>
Dominique PEETERS and Isabelle THOMAS	
3.1. Introduction . . . . .	73
3.2. The modeling approach . . . . .	75
3.2.1. A typology of public services: an attempt . . . . .	76
3.2.2. Estimating demand . . . . .	77
3.2.3. Analyzing supply . . . . .	78
3.2.4. Adjusting supply to demand . . . . .	79
3.2.5. Evaluating the solutions . . . . .	82
3.2.6. Methodological perspectives . . . . .	83
3.3. A prototype location model: the $k$ -median . . . . .	84
3.4. An example: recycling centers . . . . .	86
3.4.1. The problem: the optimal location of recycling centers . . . . .	86
3.4.2. Results of the model . . . . .	88
3.5. Conclusion . . . . .	91
3.6. Bibliography . . . . .	92

<b>Chapter 4. Time-geography: Individuals in Time and Space</b> . . . . .	97
Sonia CHARDONNEL	
4.1. Introduction: why integrate “time” when we analyze space? . . . . .	97
4.1.1. The study of spatio-temporal processes . . . . .	97
4.1.2. For a time-integrated geography . . . . .	98
4.2. The foundations of time-geography . . . . .	99
4.2.1. The premises. . . . .	99
4.2.2. A certain vision of the world . . . . .	100
4.3. The conceptual framework of time-geography . . . . .	102
4.3.1. The creation of a “notation system” . . . . .	102
4.3.2. Tools to decrypt daily life . . . . .	103
4.3.2.1. Trajectory, station, project: basic concepts . . . . .	103
4.3.2.2. Different types of constraints . . . . .	105
4.3.2.3. A transversal analysis of the “three worlds” . . . . .	109
4.4. Time-geography in practice . . . . .	110
4.4.1. Simulation of individual activity programs: public transport possibilities in the city of Karlstad – an application by Bo Lenntorp . . . . .	111
4.4.1.1. General features of the simulation model. . . . .	111
4.4.1.2. The application of Karlstad . . . . .	111
4.4.1.3. New implementations and operational methods in time-geographic research . . . . .	115
4.4.1.4. Partial conclusion. . . . .	118
4.4.2. Daily lives of women: adaptation strategies in time and space – the Tora Friberg method. . . . .	118
4.4.2.1. From Højrup’s life forms to Friberg’s three women life forms. . . . .	119
4.4.2.2. Relation with time-geography . . . . .	120
4.5. Conclusion . . . . .	121
4.6. Bibliography . . . . .	122
<b>Chapter 5. The Process of Spatial Diffusion and Modeling Change</b> . . . . .	127
Thérèse SAINT-JULIEN	
5.1. Introduction. . . . .	127
5.2. The manifestations of diffusion in space. . . . .	128
5.2.1. Elements and levels of approach of a spatial diffusion process . . . . .	129
5.2.2. Distances and propagation channels . . . . .	131
5.2.3. Spatial diffusion in time . . . . .	136
5.3. Simulating a spatial diffusion process: Hägerstrand’s pioneer approach . . . . .	137
5.3.1. A probabilistic model . . . . .	138
5.3.2. The rules of the basic model . . . . .	139
5.3.2.1. Diffusion in a homogenous space . . . . .	139

5.3.2.2. Diffusion in a heterogeneous space . . . . .	139
5.3.3. Simulation procedure . . . . .	141
5.4. Analysis models, interpretative models . . . . .	143
5.4.1. References . . . . .	143
5.4.2. Models of form . . . . .	145
5.4.3. Explanatory models . . . . .	149
5.5. Conclusion . . . . .	153
5.6. Bibliography . . . . .	153
<b>Chapter 6. Spatial Microsimulation Models . . . . .</b>	<b>159</b>
Einar HOLM and Lena SANDERS	
6.1. Introduction. . . . .	159
6.2. Choosing the aggregation level for modeling. . . . .	160
6.2.1. “Micro-objects” and spatial analysis. . . . .	161
6.2.1.1. Arguments for choosing a modeling level . . . . .	161
6.2.1.2. Individuals as the favored micro-objects in spatial microsimulation . . . . .	164
6.2.2. Theoretical point of view: interactions and emergence phenomena . . . . .	169
6.2.3. Thematic point of view: the driving role of the inter-individual diversity . . . . .	170
6.2.4. Technical point of view: management of information tables . . . . .	171
6.3. The elements of a dynamic microsimulation model . . . . .	172
6.3.1. The different sources of microdata: comprehensive information, samplings, artificial worlds . . . . .	172
6.3.2. Statistical procedures or agent type autonomy: the different ways to formalize individual change . . . . .	176
6.4. National forecasts and simulation of individual biographies with the SVERIGE model . . . . .	178
6.4.1. Classical aggregate outputs . . . . .	179
6.4.2. The biography of Kristina . . . . .	181
6.5. A simulation of population spatial dynamics with MICDYN . . . . .	185
6.5.1. Operation of the MICDYN model . . . . .	185
6.5.2. Determining workplaces and places of residence of migrants. . . . .	187
6.5.3. Simulating the population evolutions 1990-2040 . . . . .	188
6.5.4. Perspectives . . . . .	191
6.6. Conclusion . . . . .	192
6.7. Bibliography . . . . .	193

<b>Chapter 7. Multi-agent Simulations of Spatial Dynamics</b> . . . . .	197
Jean-Pierre TREUIL, Christian MULLON, Edith PERRIER and Marie PIRON	
7.1. Introduction. . . . .	197
7.2. The multi-agent approach . . . . .	199
7.2.1. Multi-agent systems . . . . .	200
7.2.2. Multi-agent simulation of natural and social phenomena . . . . .	204
7.3. Modeling of spatial dynamics . . . . .	206
7.3.1. Computer models and simulation of spatial dynamics . . . . .	207
7.3.1.1. An example: modeling of the ecosystem of the interior delta of the river Niger. . . . .	207
7.3.1.2. The concepts of a computer model of spatial dynamics . . . . .	210
7.3.2. Mathematical models of spatial dynamics . . . . .	212
7.3.2.1. Eulerian and Lagrangian approaches . . . . .	212
7.3.2.2. An example on water runoff modeling . . . . .	216
7.3.3. Computer and mathematical models of spatial dynamics toward convergence . . . . .	219
7.3.3.1. A common duality: Eulerian point of view and Lagrangian point of view . . . . .	219
7.3.3.2. Source and necessity of the comparison: simulation and its limits . . . . .	220
7.4. The multi-agent approach in spatial dynamics modeling: a point of view. . . . .	222
7.4.1. The methodology . . . . .	222
7.4.2. Hierarchy of choices and the place of agents: an example. . . . .	223
7.5. Conclusion . . . . .	224
7.6. Bibliography . . . . .	225
 <b>Chapter 8. From Image to Model: Remote Sensing and Urban Modeling</b> . . . . .	 231
Françoise DUREAU and Christiane WEBER	
8.1. Introduction. . . . .	231
8.1.1. A modeling of urban reality. . . . .	232
8.1.2. Objectives of the chapter . . . . .	233
8.2. The satellite image in the demographic information production. . . . .	237
8.2.1. The different phases of information production from satellite imagery . . . . .	238
8.2.2. Area sampling method on satellite image: general principles . . . . .	239
8.2.3. Application in Bogota in 1993 . . . . .	240
8.3. The use of imagery in urban modeling. . . . .	242
8.3.1. The potential model and satellite data. . . . .	242
8.3.2. Application of the model to satellite imagery . . . . .	244
8.3.3. Application in Bogota . . . . .	247

8.4. Spatial information and dynamic modeling . . . . .	253
8.4.1. Towards a dynamic multilevel model . . . . .	255
8.4.2. Application in Bogota: a preliminary simulation . . . . .	255
8.5. Conclusion . . . . .	257
8.6. Bibliography . . . . .	258
<b>Chapter 9. Mathematical Formalization for Spatial Interactions . . . . .</b>	<b>261</b>
Alain FRANCOIS	
9.1. Introduction. . . . .	261
9.2. Formalizations . . . . .	264
9.3. Notion of perfect aggregation of variables . . . . .	267
9.4. Mean field . . . . .	269
9.5. Example of the Ising model . . . . .	271
9.6. Use of mean field notion in ecology . . . . .	273
9.7. Reaction-diffusion models . . . . .	275
9.8. Conclusion . . . . .	277
9.9. Bibliography . . . . .	278
<b>Chapter 10. Fractals and Geography . . . . .</b>	<b>281</b>
Pierre FRANKHAUSER and Denise PUMAIN	
10.1. Introduction . . . . .	281
10.2. Fractality and structuring of the geographical space . . . . .	282
10.2.1. Density: a traditional but unsuitable measure. . . . .	282
10.2.2. The fractals: references adapted to the space of human societies. . . . .	284
10.3. Fractal models of spatial structures . . . . .	286
10.3.1. Surface models . . . . .	286
10.3.2. Line models . . . . .	288
10.3.3. Multifractal models . . . . .	290
10.3.4. Stochastic models . . . . .	290
10.4. Measuring fractality . . . . .	290
10.4.1. Notion of fractal dimension . . . . .	291
10.4.2. Global analysis methods . . . . .	292
10.4.2.1. The grid analysis . . . . .	292
10.4.2.2. The correlation analysis . . . . .	293
10.4.3. Local methods of analysis . . . . .	293
10.4.3.1. Radial analysis. . . . .	293
10.4.3.2. The curve of scaling behavior. . . . .	294
10.5. The morphology of contours . . . . .	295
10.6. The morphology of land occupation . . . . .	296
10.6.1. Form of occupied surfaces. . . . .	296
10.6.2. Intensity of land occupation . . . . .	300

10.7. The morphology of hierarchies: population and systems . . . . .	302
10.7.1. Urban hierarchies . . . . .	302
10.7.2. Measuring the morphology of networks. . . . .	302
10.8. Towards dynamic models. . . . .	304
10.9. Conclusion . . . . .	306
10.10. Bibliography. . . . .	308
<b>List of Authors</b> . . . . .	<b>313</b>
<b>Index</b> . . . . .	<b>317</b>