

Contents

1	General Introduction	1
1.1	Introduction	1
1.2	Problem Statement	3
1.2.1	Rapid Urban Expansion of Tehran	3
1.2.2	Limitations of Previous Approaches	4
1.3	Research Hypotheses	4
1.4	Research Questions	5
1.5	Research Objectives	5
1.6	Research Approach	6
1.7	Organisation of the Thesis	7
	References	8
2	Literature Review	9
2.1	Introduction	9
2.2	Land Use/Cover Change	9
2.3	Land Use/Cover Change Causes and Consequences	10
2.3.1	Loss of Biodiversity	10
2.3.2	Climate Change	11
2.3.3	Pollution	11
2.3.4	Other Impacts	11
2.4	Driving Forces of the Land Use/Cover Changes	11
2.5	Land Use/Cover Change Simulation	12
2.6	Land Use Change Trend	13
2.7	Predicting Future Land Use Patterns	14
2.8	Simulating Sprawl	14
2.9	Approaches to the LUCC Modelling	15
2.10	Agent-Based Modelling and Geosimulation Terminology	15
2.10.1	Agents and Agent-Based Models	16

2.11	Characteristics of the Geosimulation Model	18
2.11.1	Management of Spatial Entities	18
2.11.2	Management of Spatial Relationships	19
2.11.3	Management of Time	19
2.11.4	Direct Modelling	19
2.12	The Basic of Geosimulation Framework: Automata	20
2.13	Cellular Automata versus Multi-Agent Systems	20
2.14	Geographic Automata System	21
2.14.1	Definitions of Geographic Automata Systems	21
2.14.2	Geographic Automata Types	22
2.14.3	Geographic Automata States and State Transition Rules	22
2.14.4	Geographic Automata Spatial Migration Rules	23
2.14.5	Geographic Automata Neighbours and Neighbourhood Rules	23
2.14.6	Types of Simulation Systems for Agent-Based Modelling	24
2.15	Current Simulation Systems	24
2.15.1	ASCAPE	25
2.15.2	StarLogo	25
2.15.3	NetLogo	26
2.15.4	OBEUS	26
2.15.5	AgentSheets	26
2.15.6	AnyLogic	27
2.15.7	SWARM	27
2.15.8	MASON	27
2.15.9	NetLogo	27
2.15.10	Repast	28
2.15.11	Agent Analyst Extension	28
2.16	Selection of ABM Implementation Toolkit	29
2.17	Designing a Multi Agent System	29
2.18	Fuzzy Decision Theory in Geographical Entities	31
2.18.1	Fuzzy Geographical Entities	33
2.18.2	Processing Fuzzy Geographical Entities	34
2.19	The Analytical Hierarchy Process Weighting	35
2.20	Moran's Autocorrelation Coefficient Analysis	36
2.21	Accuracy Assessment and Uncertainty in Maps Comparison	37
2.21.1	Calibration and Validation	37
2.21.2	Techniques of Validation for Land Change Models	38
2.22	Summary	40
	References	40

3	Study Area Description	45
3.1	Introduction	45
3.2	Case Study Description	45
3.3	Geography	47
3.4	Transportation	48
3.5	Climate	49
3.6	Demography	50
3.7	Pollution	50
3.8	Tehran Spatial Structure	51
3.9	Land Consumption Per Person	51
3.9.1	Spatial Distribution of Population	53
3.9.2	Pattern of Daily Trips	54
3.10	Ancillary Information	55
3.11	Summary	56
	References	57
4	Data Preparation and Processing	59
4.1	Introduction	59
4.2	Data Acquisition and Data Collection	59
4.3	Data Processing	60
4.4	Temporal Land Use Map Extraction Through Remote Sensing	60
4.5	Temporal Mapping and Changes Visualisation	61
4.6	Evaluation of Change Trends	62
4.7	Measuring Change and Sprawl	65
4.8	Socio-Demographic Changes	65
4.9	Measuring Per Capita Construction	67
4.10	Estimation of Change Demand	67
4.11	Summary	68
	Reference	68
5	Implementation of Traditional Techniques	69
5.1	Introduction	69
5.2	Selected Techniques for Implementation	69
5.3	Cellular Automata Model Scenario	70
5.3.1	CA Transition Rules	71
5.3.2	Training Process and Calibration of the CA Model	72
5.4	The Markov Chain Model Scenario	75
5.4.1	Markovian Property Test	76
5.4.2	Execution of the Markov Chain Module	77

5.5	Cellular Automata Markov Scenario	78
5.5.1	Execution of the Cellular Automata Markov Model	79
5.5.2	Validation of the Cellular Automata Markov Model	82
5.6	The Logistic Regression Model Scenario	83
5.6.1	An Overview of the Logistic Regression Technique	84
5.6.2	Implementation of the Spatially Explicit Logistic Regression Model	86
5.6.3	Calibration of the Logistic Regression Model	89
5.6.4	Validation of the Logistic Regression Model	92
5.6.5	Land Change Prediction	93
5.7	Summary	93
	References	94
6	Designing and Implementing Multi Agent Geosimulation	95
6.1	Introduction	95
6.2	Abstract Model of the ABM	95
6.3	Agents Characteristics and Behaviour	96
6.4	Spatial Distribution of the Agents	97
6.5	Classification of Agents	97
6.5.1	Resident Agents	97
6.5.2	Developer Agents	101
6.5.3	Government Agents	104
6.5.4	The Agent Combination Process	107
6.6	Summary	108
	Reference	108
7	Analysis of Results	109
7.1	Introduction	109
7.2	Data Gathering and Management	109
7.3	Spatio-Temporal Change Mapping	110
7.4	Analysis of Socio-Demographic Changes	110
7.5	Findings Through the Traditional LUCC Modelling Approaches	111
7.5.1	Cellular Automata Scenario Results	111
7.5.2	Validation of the CA Approach	112
7.5.3	Outcomes of the Markov Chain Model	113
7.5.4	The Markov Chain Model Validation	114
7.5.5	Outcomes of Cellular Automata Markov	114
7.5.6	Validation of the Cellular Automata Markov Model	117

7.5.7	Outcomes of the Logistic Regression Model	117
7.5.8	Validation of Logistic Regression Model	118
7.6	Outcomes of Multi-Agent Simulation	119
7.6.1	Resident Agents	120
7.6.2	Developer Agents	121
7.6.3	Government Agents	122
7.6.4	Combination of the Agents and Their Interactions . . .	124
7.7	Validation of the Simulations	124
7.8	Comparison of the Employed Models	125
7.9	Discussion of the Outcomes	126
7.10	Summary	128
	References	130
8	Conclusions and Recommendations.	131
8.1	General Discussion.	131
8.1.1	Strengths and Weaknesses of Each Particular Model	132
8.1.2	Uncertainty Analysis.	133
8.1.3	Model Limitations	133
8.1.4	Data Limitations	134
8.2	ABM Method versus Alternatives	134
8.3	Conclusions.	134
8.4	Directions for Future Works	138
8.5	Limitations of the Present Study	138
8.6	Original Guidelines in the Contributions of the Thesis	138
8.7	Summary	139
	References	139



<http://www.springer.com/978-3-642-23704-1>

Dynamic land use/cover change modelling
Geosimulation and multiagent-based modelling

Jamal, J.A.

2012, XVI, 140 p., Hardcover

ISBN: 978-3-642-23704-1