

ADVANCES IN GEOGRAPHIC INFORMATION SCIENCE

Basudeb Bhatta

Analysis of Urban Growth and Sprawl from Remote Sensing Data



Springer

Contents

1	Urban Growth and Sprawl	1
1.1	Introduction	1
1.2	Urban Geography	1
1.3	Urban Development, Urban Growth, and Urbanisation	2
1.4	Urban Area	3
1.5	Urban Ecosystem	6
1.6	Urban Sprawl	7
1.6.1	Defining Urban Sprawl	8
1.7	Physical Patterns and Forms of Urban Growth and Sprawl	10
1.7.1	Urban Growth Patterns as Sprawl	12
1.8	Temporal Process of Urban Growth and Sprawl	14
2	Causes and Consequences of Urban Growth and Sprawl	17
2.1	Introduction	17
2.2	Causes of Urban Growth and Sprawl	17
2.2.1	Population Growth	18
2.2.2	Independence of Decision	20
2.2.3	Economic Growth	21
2.2.4	Industrialisation	21
2.2.5	Speculation	21
2.2.6	Expectations of Land Appreciation	21
2.2.7	Land Hunger Attitude	22
2.2.8	Legal Disputes	22
2.2.9	Physical Geography	22
2.2.10	Development and Property Tax	23
2.2.11	Living and Property Cost	23
2.2.12	Lack of Affordable Housing	23
2.2.13	Demand of More Living Space	24
2.2.14	Public Regulation	24
2.2.15	Transportation	24
2.2.16	Road Width	24
2.2.17	Single-Family Home	25

2.2.18	Nucleus Family	26
2.2.19	Credit and Capital Market	26
2.2.20	Government Developmental Policies	26
2.2.21	Lack of Proper Planning Policies	26
2.2.22	Failure to Enforce Planning Policies	26
2.2.23	Country-Living Desire	27
2.2.24	Housing Investment	27
2.2.25	Large Lot Size	27
2.3	Consequences of Urban Growth and Sprawl	28
2.3.1	Inflated Infrastructure and Public Service Costs	29
2.3.2	Energy Inefficiency	30
2.3.3	Disparity in Wealth	30
2.3.4	Impacts on Wildlife and Ecosystem	30
2.3.5	Loss of Farmland	31
2.3.6	Increase in Temperature	31
2.3.7	Poor Air Quality	33
2.3.8	Impacts on Water Quality and Quantity	34
2.3.9	Impacts on Public and Social Health	34
2.3.10	Other Impacts	36
3	Towards Sustainable Development and Smart Growth	37
3.1	Introduction	37
3.2	Sustainable Development	37
3.3	Smart Growth	39
3.3.1	Compact Neighbourhoods	42
3.3.2	Transit-Oriented Development	42
3.3.3	Pedestrian- and Bicycle-Friendly Design	43
3.3.4	Others Elements	43
3.4	Restricting Urban Growth and Sprawl	44
4	Remote Sensing, GIS, and Urban Analysis	49
4.1	Introduction	49
4.2	Remote Sensing	49
4.3	Urban Remote Sensing	50
4.4	Consideration of Resolutions in Urban Applications	52
4.4.1	Spatial Resolution	53
4.4.2	Spectral and Radiometric Resolutions	54
4.4.3	Temporal Resolution	55
4.5	Geographic Information System	56
4.5.1	GIS in Urban Analysis	57
4.6	Urban Analysis	58
4.6.1	Analysis of Urban Growth	59
4.6.2	Analysis of Urban Growth Using Remote Sensing Data	61

5 Mapping and Monitoring Urban Growth	65
5.1 Introduction	65
5.2 Image Overlay	65
5.3 Image Subtraction	68
5.4 Image Index (Ratioing)	70
5.5 Spectral-Temporal Classification	72
5.6 Image Regression	73
5.7 Principal Components Analysis Transformation	74
5.8 Change Vector Analysis	75
5.9 Artificial Neural Network	76
5.10 Decision Tree	77
5.11 Intensity-Hue-Saturation Transformation	78
5.12 Econometric Panel	79
5.13 Image Classification and Post-classification Comparison	79
5.14 Challenges and Constraints	82
6 Measurement and Analysis of Urban Growth	85
6.1 Introduction	85
6.2 Transition Matrices	86
6.2.1 Transition Matrix in Urban Growth Analysis	86
6.3 Spatial Metrics	87
6.3.1 Remote Sensing, Spatial Metrics, and Urban Modelling	88
6.3.2 Spatial Metrics in Urban Growth Analysis	89
6.4 Spatial Statistics	92
6.4.1 Types of Spatial Statistics	92
6.4.2 Spatial Statistics in Urban Growth Analysis	96
6.5 Quantification and Characterisation of Sprawl	97
7 Modelling and Simulation of Urban Growth	107
7.1 Introduction	107
7.2 Urban Model and Modelling	107
7.2.1 Classification of Urban Models	109
7.3 Theoretical Models	109
7.4 Aggregate-Level Urban Dynamics Models	110
7.5 Complexity Science-Based Models	110
7.5.1 Cell-Based Dynamics Models	111
7.5.2 Agent-Based Models	113
7.5.3 Artificial Neural Network (ANN)-Based Models	114
7.5.4 Fractal Geometry-Based Models	116
7.6 Rule-Based Land-Use and Transport Models	116
7.7 Modelling of Urban Growth	118
7.7.1 Modelling of Urban Growth from Remote Sensing Data	118
8 Limitations of Urban Growth Analysis	123
8.1 Introduction	123

8.2	Data and Scale Dependency	123
8.2.1	Spatial Scale	124
8.2.2	Pattern Quantification Scale	125
8.2.3	Pattern Summarisation Scale	126
8.3	Data Generation Methods	126
8.4	Classification Accuracy	126
8.5	Selection of Metrics	127
8.6	Definition of the Spatial Domain	128
8.7	Spatial Characterisation	130
8.8	Spatial Dependency (Autocorrelation)	131
8.9	Spatial and Temporal Sampling	132
8.10	Modifiable Areal Unit Problem	132
References		135
Index		169